



Analysis of Machine Learning Models for Pairs Trading

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Received: 29 May 2024

Revised: 16 Jul 2024

Accepted: 25 July 2024

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ABSTRACT

This paper delves into pairs trading, a rule-based investment strategy known as statistical arbitrage, which exploits temporary price inefficiencies between two statistically similar assets. It aims to profit from deviations in the spread between a long position in an undervalued asset and a short position in an overvalued counterpart. Various techniques, including correlation, spread, cointegration, and Bollinger Bands, are employed to identify suitable pairs. Data sourced from the NSE encompasses 12 IT sector stocks and 12 Auto sector stocks, from which three pairs are selected based on correlation, beta values, and cointegration analysis. Cointegration regression serves as the spread, and trading strategies are devised using standard deviation bands, subsequently tested via back testing. Machine learning methodologies are then applied to forecast these strategies. The study aims to scrutinize the pair selection process and evaluate the accuracy of the implemented machine learning techniques. Employing Logistic Regression, Gradient Boosting Regression, Ridge Regression, and Random Forest models, our analysis reveals that Gradient Boosting surpasses other models in predictive performance.

Key words: Machine Learning, Pairs Trading, Cointegration, Logistic Regression, Gradient Boosting Regression, Ridge Regression, Random forest Regression

INTRODUCTION

Introduction to systematic investment strategy: The Evolution of pairs trading

Pairs trading, a sophisticated investment technique, has evolved from a niche Wall Street secret to a mainstream strategic approach embraced by savvy investors worldwide. This symmetric performance investment strategy transcends traditional market directions, offering a balanced act in the financial theater. Pairs trading emerged as a response to the limitations of traditional trading strategies, which often relied on predicting the direction of the market or the performance of individual securities. (Rao, 2013) Before the advent of pairs trading,



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investors typically focused on fundamental analysis to make buy or sell decisions based on a company's financial health and market conditions. However, this approach carried significant directional risk, as it depended on the ability to forecast market movements accurately. The need for a more stable and market-neutral strategy became apparent, especially during periods of high volatility or when the market lacked a clear trend. Pairs trading, also known as statistical arbitrage, offered a solution by focusing on the relative performance of two correlated securities rather than their individual price movements (Anmol Agarwal, 2022)

Brief History

Pairs trading concept was developed by Nunzio Tartaglia and his team at Morgan Stanley in the late 1980s, later adopted by prominent hedge funds. It involves taking opposite positions (long and short) in two highly correlated assets profiting from temporary price discrepancies. It reduces arbitrage opportunities due to market evolution and technology advancements led to a decline in the early 2000s. A renewed interest emerged around a decade later, fueled by sophisticated methodologies and advanced research. Today, pairs trading is experiencing a revival as a versatile and resilient strategy with diverse applications.

REVIEW OF LITERATURE

(Titman, 1995) explores two ideas: overreaction (buying stocks that fell too much) and delayed reaction to broad factors (like interest rates). The study finds overreaction is the key driver, suggesting the market is not perfectly efficient as it overreacts to company-specific news. This challenges the prevailing view that contrarians profit from delayed reactions.

(Vapnik, 1999) The book emphasizes the importance of statistical learning theory, particularly Vapnik's work, for designing effective algorithms in financial applications like pairs trading and statistical arbitrage. The key is to develop models that can learn well from limited data and generalize to unseen data, a challenge addressed by VC theory which provides guarantees for real-world performance. (Nath, 2003) This research explores using pairs trading, a strategy that profits from price differences between similar assets, for U.S. government debt in the secondary market. It acknowledges the differences between government debt and stocks (equities) in this context. The strategy incorporates automatic risk controls and evaluates profitability considering transaction costs and other factors. It provides valuable insights for applying pairs trading to this specific asset class. (Vidyamurthy, 2004) two key pairs trading approaches for stocks: statistical arbitrage and risk arbitrage. Statistical arbitrage seeks to profit from temporary price discrepancies between similar stocks, while risk arbitrage focuses on exploiting price gaps between a target company and an acquirer before a merger is finalized. (Evan G Gatev, 2006) This research examines pairs trading, a strategy that identifies similar stocks and capitalizes on temporary price discrepancies between them. The study tests a distance-based method for pairing stocks and finds it profitable, generating excess returns even after transaction costs. Notably, these profits seem independent of overall market performance but are sensitive to factors like company size and style. The study raises the possibility that pairs trading profits go beyond price corrections and might even contribute to market stability.

(Datta Chaudhuri, 2015) This research proposes a three-indicator approach for short-term stock trading profits. It focuses on practical application and uses momentum (identifying trends), Bollinger Bands (volatility and reversal points), and MACD (momentum changes) to make trading decisions. This trader-centric approach aims for reasonable returns while managing risk (JEL codes G11 & G17). (Johannes Stubinger, 2018) The paper develops a pairs trading framework based on a mean-reverting Jump-Diffusion Model. It applies this framework to minute-by-minute data of S&P 500 oil companies spanning from 1998 to 2015. The strategy enables both intraday and overnight trading. Mean-Reverting-Jump-Diffusion Model is a 3 step calibration procedure to determine the spreads of all possible pair combinations during a formation period.

(Horta, 2020) This study investigates using unsupervised machine learning to find profitable pairs for pairs trading, along with forecasting models to reduce periods of losses. The research shows that these methods outperform traditional techniques and have the potential to significantly improve pairs trading strategies, especially for hedge





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funds and investment banks. (Chun-Hao Chen, 2022) This research introduces AGBCPT, an advanced approach to pairs trading that builds upon a previous method (GBCPT). AGBCPT tackles limitations of the prior method by considering additional factors impacting profitability. It utilizes a genetic algorithm to optimize six key parameters affecting returns. The algorithm iteratively refines these parameters to find a combination that maximizes profit and minimizes risk. The study demonstrates AGBCPT's effectiveness through positive results on a set of stocks. (Y. -F. Chen, 2023) The paper proposes using proximal policy optimization (PPO) a deep reinforcement learning algorithm to optimize trading and stop loss boundaries. This is aimed at maximizing profit in pairs trading. A demonstration buffer is utilized to pre-train the model, enhancing the training efficacy. The method outperforms traditional strategies in terms of investment return and risk. It has been tested in both the Tiwan and United States Stock Markets, showing promising results.

Objectives

The primary objective of this research is to enhance the pairs trading strategy within the Auto Sector of the National Stock Exchange (NSE) by employing machine learning algorithms. The study aims to (i) Predict the future distance curve between cointegrated stock pairs using machine learning techniques. (ii) Determine optimal entry and exit points for long and short positions based on the predicted distance curve. (iii) Improve the decision-making process in pairs trading by reducing reliance on traditional static thresholds for mean reversion. (iv) Check for the accuracy levels of the machine learning models for the best fit.

METHODOLOGY

Introduction to Research Design

The paper selects 12 stocks from Auto sector from NSE. The beta values of the stocks were calculated. The stationarity of individual stock price data. Pairwise correlations were calculated and visualized using heatmaps and identified potential cointegrated pairs. A cointegration test was conducted to find statistically significant cointegration pairs. Defined the spread as the cointegration regression. Designed the entry and exit points for the trading strategy and used ML to find the accuracy of the strategies.

Calculate spread using regression

$$\text{spread} = y - (\text{beta} * x + \text{alpha})$$

where x and y are the stocks data.

The spread is visualized and potential spike highlights in the context of pairs trading. The spread represents the separation between the price movements of the two stocks. The calculated spread is plotted over time.

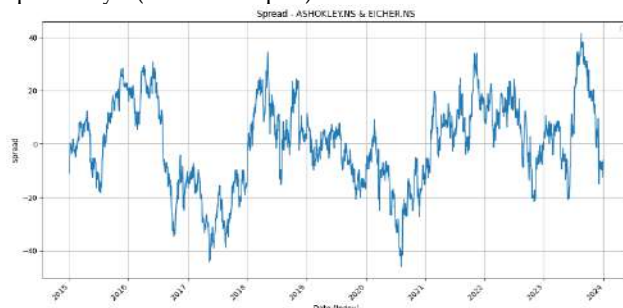
The cointegration of ASHOKLEY.NS AND EICHERMOT.NS IS
0.012028661205637779

Cointegration Regression:

$$y = 0.0477x + -9.9392$$

Spread was calculated based on the equation

$$\text{spread} = y - (\text{beta} * x + \text{alpha})$$





Separation Line: The separation line represents the average spread between the two normalized series (Refer Fig 2).

Standard Deviation Bands: Standard deviation bands represent the expected range around the separation line. They are typically constructed by adding and subtracting one standard deviation of the spread from the average spread. These bands capture the normal fluctuations in the difference series (Refer Fig 3).

Feature Engineering for Trading Strategies

Exploring z scores

Z-scores measure how far the spread is from its average. When the z-score is below a certain threshold (lower_threshold), it suggests a buying opportunity (buy_signal). Conversely, a high z-score (above upper_threshold) indicates a potential sell (sell_signal). Based on these signals, "trading_actions" are generated, recommending "Buy", "Sell", or "Hold" for each day (Refer Fig 4).

Simple trading strategy was implemented based on the spread trading.

- Cash : Initial cash balance was set to 0.
- Position: Initial position size was assumed to be 0 which means no position was held. Looping over trading actions: Here the loop is iterated over each trading day, where I is the index of the current day, and $action$ is the trading signal (either *Buy* or *Sell*) for that day.
- Buy and Sell Logic: If the trading signal is *Buy* and there is no existing position ($Position = 0$), it buys one unit of the *spread* (assuming *spread* is a list/array containing spread values) and deducts the purchase cost from the cash balance (cash)
- If the trading signal is *Sell* and there is an existing long position ($Position = 1$), it sells the entire position and adds the sale proceeds to the cash balance.
- Calculating total Returns: After iterating through all trading days, the total returns are calculated as the final cash balance minus the initial cash balance. Since the strategy is assumed to start with no positions, the final cash balance represents the total returns.
- Finally total returns was calculated.

Modelling

The following models were chosen for pairs trading strategies as they provide insights into market dynamics , forecasting price movements and generating trading signals based on historical data and input features. Their flexibility, adaptability and ability to handle different types of data make them valuable tools for analysts and traders in pairs trading strategies.(Siddha Raj Bhatta, 2020).

Logistic Regression:

Logistic regression is a statistical method used for binary classification tasks. It models the probability of a binary outcome based on one or more predictor variables. In pairs trading, logistic regression can be used to classify whether to take a long or short position based on input features such as spread values, moving averages or other technical indicators.

Gradient Boosting Regressor

Gradient Boosting is an ensemble learning technique that builds a predictive model in the form of an ensemble of weak learners(usually decision trees). It trains new models to correct the errors of the previous models. Gradient boosting can capture complex relationships between input features and target variables in pairs trading. It can handle non-linear relationships and interactions between features effectively.

Ridge Regressor

Ridge Regression is a regularization technique used to mitigate multicollinearity (correlation between predictors) in regression models. It adds a penalty term to the ordinary least squares objective function to shrink the coefficients





towards zero. Ridge Regression can be useful in pairs trading to handle multicollinearity between input features, especially when dealing with multiple correlated variables such as spread values, beta coefficients, and moving averages.

Random Forest regressor

Random Forest Regressor is another ensemble learning technique that constructs multiple decision trees during training and outputs the mean prediction of the individual trees for regression tasks. It captures complex non-linear relationships and interactions between input features in pairs trading.

RESULTS AND DISCUSSION

Data Acquisition and Preprocessing

For this research paper, 12 stocks chosen from Auto sector are ASHOKLEY.NS, BAJAJ-AUTO.NS, BHARATFORG.NS, BOSCHLTD.NS, EICHERMOT.NS, HEROMOTOCO.NS, M&M.NS, MARUTI.NS, MOTHERSON.NS, MRF.NS, TATAMOTORS.NS, TVS.NS.

The data includes each stock's daily opening price, high, low, closing price, adjusted close, and volume from 01-01-2015 to 01-01-2024. From that only Close Price was chosen and a data frame for all the stocks was created. It has (2221,12) observations for Auto Stocks. The cointegration for the stocks was calculated within the sector the Auto Sector. It was found that only a few pairs have the needed cointegration values less than 0.05. The selected stocks for pairs trading with cointegration less than 0.05 are Refer Table 1.

The spread, cointegration regression was calculated for each of the pairs (Refer Table 2).

Stationarity tests were conducted to check whether the "spread" is stationary. Then Z-scores, a statistical measure that indicates how many standard deviations a data point is from the mean of a data set was found. These are used to assess the relative position of individual data points within a distribution. The trading strategies was then applied to find the total returns of the strategy with initial cash value equal to zero. In all the three cases we got the positive values. Then Machine learning models Logistic Regression, Gradient Boosting Regressor, Ridge Regressor, Random Forest Regression were applied to analyse the pairs trading forecasting (Refer Table 3 and Table 4).

Comparing the four models for predicting pairs trading: Logistic Regression, Gradient Boosting Regression, Ridge Regression, and Random Forest Regression, it is summarized as :

- **Gradient Boosting Regression** emerged as the winner with the lowest error metrics (MSE, RMSE, MAE) and the highest R-squared (0.86), indicating the best fit to the data.
- **Logistic Regression** and **Random Forest Regression** performed similarly, achieving reasonable accuracy but with a slight edge to Logistic Regression in terms of R-squared (0.83).
- **Ridge Regression** lagged behind in all metrics, suggesting a weaker fit (R-squared of 0.69) compared to the other models (Refer Table 5).

For ASHOKLEY.NS-EICHERMMOT.NS

The Sharpe ratio of 1.5694 indicates that the risk-adjusted return of the portfolio is favourable. The Treynor Ratio 432.6864 suggests that the excess return per unit of systematic risk (beta) is relatively high. The Jensen's Ratio of 106,2809 indicates that the portfolio has outperformed its expected return based on the CAPM(Capital Asset Pricing Model).

This code essentially simulates a trading strategy that buys and sells based on predefined signals (trade_actions) and tracks the resulting cash balance to calculate the total returns. However, it is important to keep in mind that this is a





simplistic representation and may not capture all aspects of real-world trading, such as transaction costs, slippage, or market impact.

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Table 1. The selected stocks for pairs trading with cointegration less than 0.05 are

ASHOKLEY.NS-EICHERMOT.NS	0.012028661205637779
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Table 2. The spread, cointegration regression was calculated for each of the pairs.

ASHOKLEY.NS-EICHERMOT.NS	Cointegration Regression: $y = 0.0477x + -9.9392$
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Table 3. The accuracy results of Logistic Regression for ASHOKLEY.NS- EICHERMOT.NS are

Model Accuracy	0.9594594594594594
Sharpe Ratio	0.010654122134095657
Mean Squared Error	0.04054054054054054
Root Mean Squared Error	0.2013468165642073
Mean Absolute Error	0.04054054054054054
R-Squared	0.8334583645911477





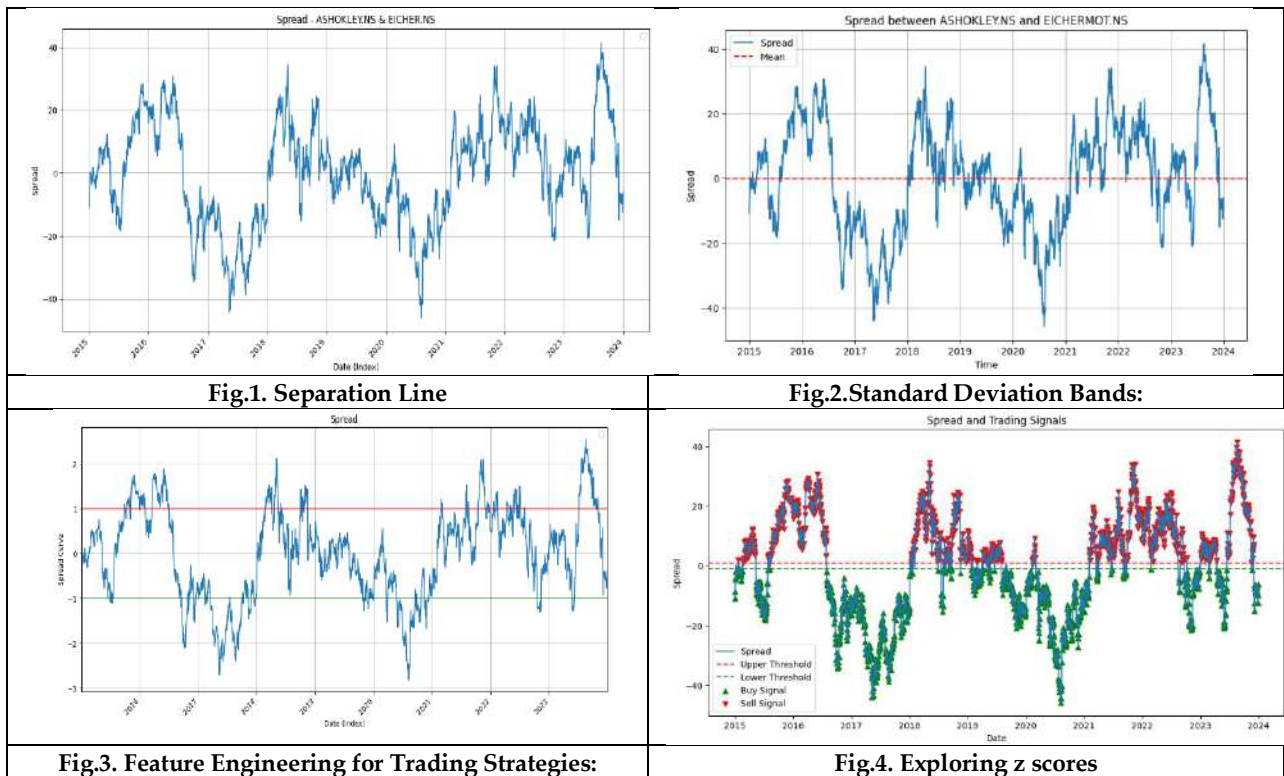
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Table 4. Comparing the four models for predicting pairs trading:

Accuracy measures	LR	GBR	RR	RFR
Mean Squared Error	0.040540541	0.03344045	292.6835321	0.040540541
Root Mean Squared Error	0.201346817	0.182867301	17.10799614	0.201346817
Mean Absolute Error	0.040540541	0.047088402	0.233685161	0.040540541
R-Squared	0.833458365	0.862625729	0.686633693	0.833458365

Table 5. ASHOKLEY.NS-EICHERMMOT.NS

	ASHOKLEY.NS-EICHERMMOT.NS
Sharpe Ratio	1.5694274648784516
Treynor Ratio	432.6863
Jensen's Ratio	106.2809





RESEARCH ARTICLE

Normative Deconstruction: Shashi Deshpande's Heroines as Catalysts of Psychological Emancipation in 'the Binding Vine'

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

In '*The Binding Vine*' Shashi Deshpande portrays the women's life in India through the female characters like Vanna, Mira, Sakuntai and Kalpana. All of them though being wronged by the patriarchal society and its conventional moralities never lose hope. All of them in their own way struggle hard for their existence and to prove their self-prestige. Shashi Deshpande aims to criticize the society through different female characters. She is not against the society but against the unacceptable viewpoints of society. They always accept a ray of hope even amidst chaotic and pathetic situations of their lives. They struggle hard for survival and sanity in the psycho- emotional world of the Indian women. This paper portrays the women who have great inner strength and resilience, and parade with elegance and grace out of turmoil.

Keywords: Moralities, Inner strength, Resilience, Patriarchy, Emotional, Psychological, Emancipation, Catalysts.

INTRODUCTION

Normative deconstruction" in Shashi Deshpande's work, particularly in her novel "The Binding Vine," involves a critical examination of how her female protagonists challenge traditional gender roles and expectations, leading to their psychological liberation. Deshpande's portrayal of women grappling with oppressive familial structures, societal pressures regarding marriage and motherhood, and the suppression of their identities sheds light on the complexities of women's lives in a patriarchal society. The term "heroines" refers to these female protagonists who serve as agents of change, questioning norms and asserting their autonomy. Analyzing Deshpande's depiction of these characters involves exploring how their actions contribute to their psychological emancipation, as they



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negotiate relationships, pursue personal goals, and assert their right to self-determination. Deshpande's exploration of these themes illuminates the ongoing struggle for women's liberation within patriarchal systems.

Each and every living being on this earth is struggling for existence. They struggle to affirm their existence through various methods. The exploration of moral and psycho dilemmas and repercussions of the women characters of Shashi Deshpande provide them success only after the hard struggle for existence. They never accept secondary position as their fate. The crisis of value adaptation and attachment with the family and society pulls them down. Shashi Deshpande seems to grapple with the identity crisis of the Indian women. She always deals with the middle class Indian woman who struggles to emerge out of the cocoon of self-pity, to spread her wings of self-confidence. For many centuries the Indian women have been the silent sufferers. Playing multi-tasking roles – as a wives, mothers, sisters and daughter, they have never been able to claim their own individuality.

The heroines of Shashi Deshpande strive to obtain autonomy through which they try to realize their immense potentialities for action and self-actualization. They learn to live in the patriarchal society with self-identity and self-realisation. In the conventional Indian society, a woman is essentially acknowledged as a shadow of male identity with little scope for the assertion of her choices. Traditional images of women essentially affirm the subjugated status of women, but Shashi Deshpande categorically tries to establish that woman is endowed with inherent potential to recognize her feminine and to assert her inward powers as individual. Her protagonists obviously venture to discover their self-identity Elaine Shawvalter calls it, "the female phase" which is a phase of self-discovery, a turning inward, freed from the dependence of opposition and a search for identity" (Shawvalter – *A literature of their own*). She explores and reveals the long smothered wait of the fragmented psyche of her female protagonists imprisoned within the shades of domesticity, drifting between tradition and modernity. In spite of her concern with the traditional position of women, she portrays them as living individuals, struggling and endeavoring to make spaces of their own in the existing social order. Shashi Deshpande depicts the anxiety of the educated independent middle class Indian women who search for a balance between their familial bonds and their self-identities in a predominantly patriarchal society.

In Indian society the tradition recommended by legends and religious canons are the foundation of man and woman relationship. The epic figures like Sita and Draupadi are glorified as the idealized beings endowed with exceptional power of endurance to sustain their identity beyond the deals of society. In Indian social life, a woman is conditioned to survive with the support of male desires only. Shashi Deshpande tries to establish that in the scheme of things, women are not weak and insensitive. A woman can recognize her energy to resist the forces which are hostile to her respect and freedom. Shashi Deshpande is one of those sensitive thinkers who perceive the various dimensions of human experiences. She tries to establish serious conclusions about the plight of individuals against the unbearable conventions of the society. The novel 'The Binding Vine' was published in 1993 which is basically concerned with the obsession of a young mother Urmil who is the chief narrator in the novel. She appears as an agonized mother craving for the loss of her own daughter. Urmil is a lecturer in a college by profession. The untimely death of her daughter, Anu comes as a serious shock to the maternal sensibility of Urmil. A sense of guilt grips her conscience after Anu's death. The idea of personal happiness without Anu becomes a betrayal for her. Beneath the anguish of lost motherhood of Urmil, Shashi Deshpande reflects on the issue of undesirable and torturous sexual relationship, the apathy of society, the horrors of rape and the hollowness of the institution of marriage. Urmil articulates the voice of other women characters who lead invisible existence in the shadows of shame and silence. Shashi Deshpande controls the narrative seeking a balance of past and present revealing the predicament of the women representing three generations and three destitute classes. Urmil is herself a victim of personal loss but she analyses her loss in the background of the life condition of two women of her own family, Mira her own mother-in-law and Kalpana an unfortunate teenage girl who becomes the victim of rape. Present is represented by Urmil but the past echoes in the silence of Mira and future is focused in the suffering of Kalpana. There is an extension of Shashi Deshpande's vision, asserting that woman is expected to register her voice of protest to shatter the bondages of patriarchal conversions. Shashi Deshpande admits that maternal instincts are invariably integrated in feminine sensibility and to impose them as societal obligation is undesirable and irrational. Urmil is endowed with excessive love for her lost daughter but she is not ready to bear the sight of humiliation of human in the name of feminine virtues. Urmil believes that women





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have rights over their body and that cannot be violated even in marriage. Urmi tries to find out common grounds of justification in the suffering of Mira, her mother-in-law and Kalpana the rape victim. In order to reveal her vision at a common point Shashi Deshpande brings two generations together. Mira who suffers out of bridal veil tries to affirm her existence through her poems. The imaginative perception revealed in the poetry of Mira becomes the reality of the life of Kalpana. In most of her poems, Mira exhibits her strong aversion against the sexual relationship with her husband. When physical violence occurs in the life of a young girl, it is treated as a shame but when the same thing is forced upon her in the name of marriage; it is acknowledged as the fulfillment of life. Mira's poem clearly exhibits her hatred towards conjugal life. In one of her poems she says:

"Talk, he says to me, why don't you say something why don't you speak to me? What shall I talk about, I ask him stupidly. "What did you do today? Where did you go? What have you been thinking about all evening and so he goes on dragging my day, my whole self out of me. But I have my defenses; I give him the facts nothing more, never my feelings. And so it begins 'please' he says, 'please I love you.' And over and over again until he has done, 'I love you.' Love! How I hate the word. If this is love it is a terrible thing. What is there in me? Why does it have to be me? Why can't they leave me alone? (p-66- 67).

For Shashi Deshpande, the forced sexual relationships without the emotional involvement are nothing but 'rape' though it is within or beyond marital relationship. The sexual violence against women is a method of taming woman into passivity. Urmi shares the anguish of both Mira and Kalpana.

Each and every female character in *The Binding Vine* is endowed with a never ending fighting quality irrespective of their generation and status. All of them struggle and fight for their existence and none accepts their life as it is. The protagonist Urmi struggles to overcome her sadness of her daughter's death through all means. Her motherhood sensibility doesn't allow her to lead a normal life after her daughter Anu's death. She suffers the turmoil out of grief and inability but never gives up. Even when her brother tries to console her after her hysteric behavior she asks him to give her some time to recover from sadness. She never thinks of surrendering her to the clutches of grief. The novel opens with the confident words of Urmi which exhibits her determined mind when she says,

'That's why they want Kishore to be here – to pick up the bits and pieces. And put them together again? All the kings' horses and all the kings' men could not put Humpty – Dumpty together again. What's broken can't be mended. But I am not broken; I am not going to break.....were connected to our physical selves by the fragile thread snaps that it's all over. That hasn't happened to me, not as yet. I want to live. And I won't break down; I am in full control of myself.' (19-20)

People around her expected her to cry, 'become hysterical and behave like those who beat at their breasts and tear their hair in their grief (96). Of course, Urmi is depressed and an emptiness is engulfing her but she knows how to control her emotions. She is in anguish, which leads to an attack of asthma, leaving her breathless. Her struggling for breath is enough for everyone to decide that she is unbearable. But Urmi is tough. She is a new woman who is emotionally and intellectually balanced. Shashi Deshpande's women are realistic and aware of the inevitability of life and death. Women who are provoked to the extent of becoming hysterical are thought to be weak. Her women are strong. Women in the middle class milieu are tough as they experience both joys and sorrows simultaneously. They also know that nothing is too prolonged as life changes quickly. Urmi's fighting quality with which she tries to compromise is revealed through her words:

"No I must reject these memories, I have to conquest them. This is one battle I have to win if am to go on living. And yet my victory will carry with it the taint of betrayal. To forget is to betray. But to go on living like this is to wrong the living Karthick above all, Karthick who watches me so anxiously, so fearfully. I cannot wrong him. I must let Anu go." (21).





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The story follows the moods, activities and memories of Urmi. All along her life she has to cope with herself. Grown up entirely under the care of grandparents, Urmi has developed a free and independent nature and thinking ability of her own. Both the grandparents have doted on her and obliged her always. Her marriage with Kishore is her own decision and it is a love marriage. Her grandmother Bajajji has died when she was only fifteen years old. She boldly managed everything along with grandfather adopting his emotional and psychological strengths. She was shocked when grandfather committed suicide. Very early in life Urmi has learnt to manage the family. Later after marriage, the responsibility of the family fell on her because her husband, a naval officer is away from home most of the time.

Urmi loves Kishore very much. His job in the navy is an obstacle for her. She wants him to stay with her always like Vanna's husband. Urmi always got what she desired. She did not bargain for anything less. She is overconfident that Kishore loves her very much. She is taken aback at his behavior on the first day of their marriage. For him marriage is a forced binding whereas for Urmi it is a binding of love. She wants to tell him, 'Don't leave me and go. Each time you leave me, the parting is like death' (84). But sensing his detachment she is afraid to speak out. Silence distances them. A fear engulfed her. The same fear she experienced on the day of grandfather's death. She heard a noise "A kind of irregular, rhythmic heavy sound from the passage" (85). She turned cold with fear. Though fear syndrome is present in Urmi she also has the ability to overcome the fear, as she is a rational thinker. Similarly she accepts the death of Anu as inevitability but takes her own time to overcome it. She realizes that however painful the experience may be, one can never give up. As Urmi says, "We struggle to find something with which we can anchor ourselves to this strange world we find ourselves in. Only when we love do we find this anchor." (86)

The novel 'The Binding Vine,' is a bold attempt of the novelist to portray the agony of a wife who is the victim of marital rape. Urmila is completely a different version from the earlier female protagonists. The early protagonists like Saritha, Jaya and Indu fight for themselves while Urmi tries to help other women and fight for them. As an upper middle-class career woman she is highly sensitive to the suffering of other women. Urmila does not want to leave that person who has wronged Kalpana. In spite of the bitter fact the victim's mother wishes for the death of her daughter in order to avoid social scandal, Urmila decides to fight for her. In her attempt to find solace out of grief Urmi is drawn into the lives of three women of different character. But all have the similar never ending fighting attitude who all never accepts their life as it is and struggle for their existence.

The first woman is Urmila's dead mother-in-law Mira who exists only in the notebooks that she has found from a dusty storage trounce. Urmi tries to identify her own life in the life of Mira who lived and died in silence but made a desperate burial of her suppressed consciousness in her unexplored letters and diaries. Mira had died in Urmi's husband, Kishore's birth. Urmi was highly shocked and excited to read the poems of Mira who exhibited her rebellious nature through her poems. Urmi gets lots of papers and unpublished poems. Mira's dairies were written in English, but poems were written in Kannada. Mira's creative writings were in Kanada but her diary was written in English. Mira's personal diary bears the 'mark strictly private and confidential.' It was a personal communication within herself, an account of her daily routine of life. This obviously evinces that each woman has her own private world and tries to find an outlet of it in the world which is adverse and hostile to her imagination. Urmi is reluctant to read her dead mother –in-laws diaries. Urmi herself is a victim of personal loss. She tries to analyse her loss in the background of the life condition of her own mother-in-law. In the novel 'The Binding Vine' there is an extension of her vision asserting that woman is expected to register her voice of protest to shatter the bondage of patriarchal conventions.

Mira's poems and diaries reveal the distress of a vibrant young, educated woman who is trapped in an unhappy marriage. She is gifted with excellent writing skills through which she tries to express her protest against the tradition of marriage and the evil clutches of the patriarchal society. Being the silent sufferer of her conjugal life and the restrictions, it has imposed upon her, Mira's life is a tale of grief full of submission and unhappiness. She desired to be free from the rules of tradition or the clutches of unban marriage. Though a submissive wife to her husband she never accepted her slavery. Her poems expressed her struggles for existence. The education which she got offers a





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means of escape from the oppression and loneliness. Writing was a means of finding freedom for Mira. She was highly shocked and stunned when she was named Nirmala after her marriage (101).

'A glittering ring gliding on the rice
Carefully traced a name 'Nirmala'
Who is this? None but I,
My name here, bestowed upon me.
Nirmala, they call, I stand statue still
Do you build the new without racing the old?
A tablet of rice, a pencil of gold
Can they make me Nirmala? I am Mira.' (p. 54)

Writing is a means of finding freedom for Mira. According to Mira writing is not only a self-expression but also freeing the captive imagination. Mira has written poems about her own life. Her suppressed anger and agonies are expressed through her poems. In *'The Binding Vine'* Shashi Deshpande portrays the women's life in India through the female characters like Vanna, Mira, Sakuntai and Kalpana. All of them though being wronged by the patriarchal society and its conventional moralities never lose hope. All of them in their own way struggle hard for their existence and to prove their self-prestige.

Not only the protagonist but each and every minor character reveals their struggles for their existence. They always accept a ray of hope even amidst chaotic and pathetic situations of their lives. They struggle hard for survival and sanity in the psycho- emotional world of the Indian women. The theme of survival may not be applicable to everyone. Sulu commits suicide. This is an extreme step taken by Sulu when life loses its importance. Mira would have struggled to survive if she did not die in her delivery. Akka, Urmi, Vanna and Sakuntai relent to the situation because they want to survive. They are born warriors who embrace their inner strength gracefully and face their challenges head-on. They never allow challenges thrown at them to hold them back and have an irresistible confidence to conquer anything that comes in their way.

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Stability of Expired Dosage Forms – A Comprehensive Review

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Received: 02 Nov 2023

Revised: 03 Apr 2024

Accepted: 15 June 2024

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ABSTRACT

In recent years drug stability problem is catching attention. The stability of pharmaceutical products play important role in quality of drugs and in economic point of view especially after exceeding the expiry dates. The shelf-life obtained determines the expiry date, which is typically between 1 and 5 years and commonly set in a conservative manner. In the past years, the FDA has launched several programs for shelf-life extension in order to defer replacement costs and to prevent drug shortages due to supply disruption. However, there are not many studies reported on the stability of dosage forms past their expiration dates. The aim of the review was to bring together the available literature for a stability of expired dosage forms. It seems to be reasonable for a large portion of dosage forms to extend the expiry dates far beyond the five years.

Keywords: Drug Stability, Expiry date, Shelf life, Long-term stability





INTRODUCTION

The stability studies must be in accordance with the International Conference on Harmonization (ICH) guidelines on testing of new drug substances and products Q1A(R2) [1]. Pharmaceutical manufacturers have to provide stability data of the active drug substance (API) and the finished pharmaceutical product (FPP) when they ask regulatory authorities for market authorization. The content of the API has to be within the specification of 95–105% during the time available on the market. Based on the results of real-time and accelerated stability tests, a shelf-life is assigned to the FPP, typically set in a range of 1-5 years [2]. Drugs stored under labelled conditions retain stability and potency throughout their shelf life. If they were subjected to stress in other words not stored under required storage conditions may lose their potency even within their shelf life period. Liquid orals (antibiotics, analgesics etc.), Insulin and Nitroglycerin tablets are not stable past their expiry date.

Solid dosage forms, such as tablets and capsules, are most stable past their expiration date. Drugs that exist in solution or as a reconstituted suspension may not have the required potency if used when outdated. The best evidence of acceptable potency of the medications beyond their expiration date is provided by the Shelf Life Extension Program (SLEP) undertaken by the FDA for the Department of Defense. The aim of the SLEP program was to reduce medication costs for the military. SLEP has found that 88% of 122 different drugs stored under ideal conditions should have their expiration dates extended more than 1 year, with an average extension of 66 months, and a maximum extension of 278 months.

Certain medications have a narrow therapeutic index and little decreases in the pharmacological activity can result in serious consequences for patients. Monoclonal antibodies should be included in this group. These drugs should not be used beyond the expiry date. SLEP (Shelf life extension Programme) installed by FDA sponsored by US DOD (Department of Defence), about 122 drugs different medication products, nearly 90% met the requirements for an extension and all lots tested by SLEP when approaching their expiration dates met the criteria for initial shelf life extension. Whereas the shelf life of most medications in the United States is 1 to 5 years, the average additional extension length by SLEP was 5.5 years, and some lots were extended by more than 20 years Markus Zilker et.al [3]. analyzed the ampoules of 40 years age and they were found to retain their stability. There is no evidence of adverse effects of taking expired dosage forms except Tetracycline is known to be harmful when it expired, causes fanconi syndrome [4], and this is a rare form of kidney damage. The occurrence of chemical, physical, and microbiological instabilities is affected by environmental factors during storage of various dosage forms i.e. solids, liquids and injectables e.g. heat, relative humidity, light, and oxygen. Figure-1 shows the hydrolysis of Lidocaine degradation of epinephrine and epimerization of Doxycycline [5].

Physical stability is crucial for the quality of FPPs. Suitable attributes like the dissolution rate, the hardness, and the friability are very important for solid dosage forms where the appearance, the pH, and the presence of any precipitation must be considered in liquid dosage forms. The efficacy and safety of sustained release tablets and capsules or depot dosage forms could be affected in a highly negative manner because of too much or too little of API release per unit time. In addition, the chemical instability is characterized by the decay of the active pharmaceutical ingredient (API), typical degradation reactions occurring during long-term storage are hydrolysis, oxidation, photolysis, polymerization, and isomerization [6-7]. A very common pathway of API degradation is hydrolysis of esters, amides, and carbamates, which are prone to hydrolysis resulting in compounds containing a carboxylic acid group [6-7] where as any photon affects the chemical bonds of a molecule, likely happening in Dipyrindamole, Nifedipine, and Aztreonam solutions [8-9]. Racemization and epimerization are typical degradation reactions being usually observed when finished pharmaceutical products (FPP) are manufactured with isomerically pure compounds. Our present review emphasizes on the work done on stability of expired dosage forms and their analytical approaches to find out the purity and stability of expired dosage forms in their unopened form. In addition, the FDA updated the expiry dates of auto-injectors used as nerve agent antidotes in emergency situations [10].



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Certain lots of Atropen (atropine), CANA (diazepam), DuoDote containing atropine and pralidoxime chloride, morphine sulfate, and pralidoxime chloride injectors all manufactured by Meridian Medical Technologies were declared to be eligible for use by up to six years beyond their original expiry dates. In a further issue, the FDA alerted health care professionals of new extended shelf-lives for various injection solutions manufactured by Baxter Healthcare Corporation, e.g. saline, sterile water, potassium chloride etc [11].

Short expiry dates of drugs are costly challenge for hospitals, nursing homes and agencies which stockpile large quantities of medicines in US Department of Defense (US-DOD) and German armed forces. India's Pharmaceutical industry is losing around 500 crores annually on account of destruction of expired drugs. The healthcare systems around the world would highly benefit if expired drugs are extended beyond expiry date. The attributes tested for a drug product [12] varied depending on the dosage form. For solid oral drug products, the attributes were potency (assay), impurities, water content, dissolution, and physical appearance. For reconstituted dry powders, the attributes were potency, pH, water content, and physical appearance. For injectable solutions, the attributes were potency, impurities, pH, preservatives, and physical appearance (color, particulates). For creams and ointments, the attributes were potency, pH, and physical appearance. For auto injectors, the attributes were potency (assay), degradants, pH, preservatives, injection mechanics, and physical appearance. In recent years the FDA issued guidance for federal agencies [13-14], state and local governments on testing to extend shelf-life of emergent medicines like antivirals, doxycycline, nerve agent antidotes, and potassium iodide.

REVIEW ON SHELF-LIFE EXTENSION PERIOD OF PHARMACEUTICAL DOSAGE FORMS

DISCUSSION

Roger Bate *et.al* [15], reported a weak linear association ($R^2 = 0.33$) was between the age of samples and their state of degradation relative to brand-identical samples on Raman spectrometry. Sixty- eight samples were retested in February 2009 using Raman spectrometry, between eight and 65 months post-expiry. 66 of 68 (97%) samples passed Raman spectrometry retesting. The data indicate that FDC-ALU is chemically and physically stable well beyond its stated shelf-life in uncontrolled, tropical conditions. Method: Seventy samples of expired FDC-ALU were collected from private pharmacies and malaria researchers in seven African countries. The samples were subjected to thin-layer chromatography (TLC), disintegration testing, and near infrared Raman spectrometry for ascertainment of active ingredients, tablet integrity, and chemical degradation of the tablet formulation including both active ingredients and excipients.

Raman G. Kutty *et.al* [16], reported novel, method to measure concentrations of albuterol and montelukast using HPLC. A novel method to collect and measure concentrations of albuterol in pre-packaged oral inhaler devices. Both montelukast and albuterol retain their potency for many years beyond their listed "expiry" dates. These data may serve to guide pharmacists, physicians, and patients in the decision-making process of using "expired" medications at home, in free clinics, in national defense, and in international humanitarian efforts.

Method: Two HPLC methods were developed, validated, and applied to achieve this goal. Quantitative analysis of each drug was performed using two different reversed phase C18 columns with a linear gradient of acetonitrile in 0.1% aqueous formic acid at a flow rate of 1 mL/min for both methods. Detection wavelength for montelukast and albuterol was 280 and 277 nm, respectively.

G.Vidyasagar *et.al* [17], Frovatriptan is a selective 5-HT_{1B/1D} – receptor agonist that has chemical structure susceptible to degradation and therefore in this work forced studies of drugs were carried out by a validated stability indicating liquid chromatographic method. The results of performed study might suggest that storage of analyzed batches of tablets over time period exceeding the expiry date given by the manufacturer did not influence their contents.



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Method: Drug was subjected to all stress conditions such as hydrolysis (acidic and alkaline), oxidation, photolysis, thermal degradation and humidity study. Content determination was performed using RP-HPLC method; the percent of dissolved substance from tablets was also performed. All stressed samples were successfully analyzed on C18 column using mobile phase acetonitrile: methanol: 0.1% orthophosphoric acid 45:15:40 (v/v/v) mobile phase (pH 5.6). A flow rate was maintained at 1 mL/min and detection was made at 245 nm. The proposed method was validated with regard to linearity, sensitivity and accuracy and precision.

Emma Browne *et.al* [18], assessed the stability of five emergent expired drugs (atropine, nifedipine, flucloxacillin, naproxen, and bendroflumethiazide) returned from Antarctic bases. Drugs were opportunistically obtained and tested using stability-indicating assays and all tested drugs were stable. The results suggest that the studied drugs may be stable beyond expiry, even when not maintained in strictly temperature-controlled conditions

Method: Stability-indicating reverse-phase HPLC analysis was used for each agent. Each drug was compared to a within-date batch of the drug; where a within-date version of the drug with the same formulation could not be obtained, an equivalent drug formulation and a pure drug sample were used. Calibration plot was linear over the range of 5 to 40 micrograms per mL ($y = 80,178x - 6187$; $R^2 = 0.999$; $n = 8$). Precision at 5, 20, and 40 micrograms per mL was 1.6, 1.4, and 1.2%, respectively ($n = 5$). Samples were diluted 1:10 in water for HPLC analysis ($n = 3$).

Magdalena Jasinska *et.al* [19], determine tablet content of expired tablets and tablets with expiry date has not been exceeded. The analyzed tablets contained metoprolol tartrate (50 mg) and propranolol hydrochloride (10 mg), respectively. Content determination was performed using HPLC method with UV detection. The results of performed study might suggest that storage of analyzed batches of tablets over time period exceeding the expiry date given by the manufacturer did not influence their contents.

Method: The column used for chromatographic separations was Supelcosil TM LC-18-S (250 mm × 2.1 mm, 5 μm). Mobile phase was pumped in gradient mode at a flow rate of 0.3 mL/min at 25°C. The analytical wavelength was set at 275 nm for metoprolol and 290 nm for propranolol, respectively, indicated by the UV spectra. Samples of 125 μL were automatically injected. In addition, Whatman No. 45 filter paper and single use syringe Minisart filters, pore size 0.2 μm (Supelco, USA) were used. Buffers, the following solutions were used: buffer A - the 0.1 M ammonium acetic solution (pH adjusted to 4.0 with acetic acid), buffer B - the mixture of buffer A and acetonitrile (ratio 50/50). The concentration of buffer B was risen up to 100% in 20 min.

Zilker *et.al*, [20], determine the content of nine expired ampoules manufactured in the last century and identifying the impurity profile by means of HPLC-UV and HPLC-MS respectively. The ampoules are part of the “PEAK-collection” of long expired finished pharmaceutical products at IBMP, Nürnberg-Heroldsberg, and consists among others of epinephrine (Suprarenin and Adrenalin in Oil), etilefrine (Effortil®), synephrine (Sympatol®), caffeine and procaine (Impletol), caffeine and sodium salicylate (Caffeinum Salicylicum), dipyridamole (Persantin®), furosemide (Lasix®), and metamizole (Novalgin). The results were compared to current reference ampoules. Five out of nine ampoules were still within the specified content limits.

Method: For chromatographic investigations, methods of the European Pharmacopoeia for related substances were used; for determining the content, they were validated for linearity, precision, and accuracy.

Sushil Sharma *et.al*, [21] the drugs selected for study were analgesics. The parameters investigated were chemical potency, physical stability, and analgesic efficacy. The active ingredient in all the drugs were within the accepted range as per IP during the study period indicating that they retained their potency up to a period of two years post expiry.

Methods: Chemical potency: The study drugs were subjected to analytical assays to estimate the active ingredient in the pharmaceutical preparations. The estimation of chemical potency was performed as per IP by using the High-





Performance Liquid Chromatography (HPLC) method. Ten samples of each study drug were tested, initially during the shelf life, then once immediately after the expiry, followed by every six months beyond the expiry date. The chemical potency was considered acceptable if the test results were within the acceptable ranges (lower and upper) as per Indian Pharmacopoeia

Physical stability: Disintegration time and dissolution time are well accepted and validated tests to estimate the changes in physical parameters, which are crucial for the absorption and bioavailability of an oral pharmaceutical formulation. Six tablets of each formulation were tested as per IP. The tablets were considered to have passed the test if they disintegrate within 30 min. The dissolution time was tested using the Digital tablet dissolution rate test apparatus, as per USP/IP standards. The tablets were kept in the inner fine mesh basket, which was rotated at a defined RPM, and the time taken for the entire tablet to pass through the inner basket and disappear into the beaker was taken as the surrogate marker for 100% dissolution of that tablet.

Analgesic efficacy: was analyzed in two animal models, viz tail-flick method and acetic acid-induced writhing method. Six albino mice of either sex were used to estimate analgesic efficacy for each drug initially before expiry and subsequently every six months, till two years after the expiry date.

K Kudlacek *et.al* [22] reported that Two injection solutions of quinine 79, 77 resp. years were analyzed using RP-HPLC. The conditions of separation were optimized. The quinine content is decreased about 13% for 79-year-old sample and about 8% for 77-year-old sample, respectively. Quinotoxine has been found as the decomposition product. The compounds were identified by MS, and the ESI fragmentation mechanisms of compounds found were proposed.

Method: Isocratic elution by the mixture of 0.02 M acetate buffer (pH = 4.00) and acetonitrile (80:20, v/v) was adopted for analysis. The mobile phase flow rate was 1.0 cm³ /min. The separation was performed on a Zorbax Eclipse C18 column (150 x 4.5 mm i.d., particle size 3.5 μm; Agilent); the column oven temperature was maintained at 30°C. A 5 μl sample was injected. The compounds were detected using DAD (at 254 nm) and mass spectrometer. Ionization of the analytes was performed in the positive ion mode at capillary voltage 4.5 kV. The pressure of the nebulizing gas (nitrogen) was set to 0.30 bar. Nitrogen (3.5 dm³ /min) was used as drying gas at 200°C. Quinine and quinotoxine were quantified using calibration curves of the standards in the concentration range of 20–100 mg/dm³. Pentamethylene tetrazole quantified using calibration curves of the standards in the concentration range of 50–200 mg/dm³.

K Nesmerak *et.al* [23] reported that, Pharmaceutical preparations of heroin and cocaine more than seventy years old were analyzed using RP-HPLC. Heroin was found to be quantitatively decomposed to morphine, the small amount of codeine (<4%) was probably present in the sample from beginning. No decomposition product of morphine was found; this agrees with the long-term study of the stability of morphine injection solution which were found not to decompose for 7, 11, or 37 years.

Method: A HP 1100 series liquid chromatograph (Hewlett/Packard, Germany) with an internal diode-array detector was used, followed by a Bruker Esquire 3000 mass spectrometer (Bruker, Germany) with ion-trap and APPI ionization. The separation was performed on a Supelco RP C18 column (150 x 4.6 mm i.d., particle size 5 μm); the column oven temperature was maintained at 25°C. A 10 μl sample was injected. The compounds were detected using mass spectrometer. Ionization of the analytes was performed in the positive ion mode under atmospheric pressure at capillary voltage 1.5 kV, and at a source temperature of 400°C. The pressure of the nebulizing gas (nitrogen) was set to 30 psi. Nitrogen (5.0 L/min) was used as drying gas at 250°C. Lee Cantrell *et.al*²⁴, findings were, 12 of the 14 drug compounds tested were present in concentrations at least 90% of the labeled amounts, the generally recognized minimum acceptable potency. Three of these compounds were present at greater than 110% of the labeled content. Two compounds (aspirin and amphetamine) were present in amounts of less than 90% of labeled content.



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One compound (phenacetin) was present at greater than 90% of labeled amounts from 1 medication tested, but less than 90% in another medication that contained that drug

Method: Tablets or capsule contents were dissolved and sonicated in methanol, reconstituted in analysis buffer (10% methanol) and analyzed with Liquid Chromatograph (Agilent Technologies) Time-of-Flight Mass Spectrometer (Agilent) using electrospray ionization in negative and positive polarities. Chromatography was run with gradient elution using Eclipse Plus C18 column (Agilent). Data analysis was performed using Mass Hunter Qualitative and Quantitative Analysis (Agilent). Quantification was performed by isotope dilution method with a 6-point calibration curve.

R German *et.al* [25], conducted a study to investigate the quality of reference substances which were produced long before the introduction of advanced analysis and purification techniques. The quality and antimicrobial activity of WHO and EP oxytetracycline, doxycycline, colistin and spiramycin reference standards were assessed. The oldest substance was stored for 54 years in a freezer. Assay and purity tests were conducted according to Ph. Eur. 6.0. Additionally, the results of the study show that several of the tested substances remained stable for over 40 years and one for over 50 years of storage. Investigation of antibacterial activity, purity and the potential usefulness for microbiological or chemical analysis (HPLC) of the official reference substances stored for over 40 years in a freezer.

Method: All chromatographic conditions had been set precisely in accordance to the corresponding Ph. Eur. monographs. Following are the monograph numbers and the columns used. Oxytetracycline: monograph 01/2008:0198, column: divinyl benzene copolymer 250 mm × 4.6 mm, particle size 8 μm (Polymer Laboratories, Church Stretton, UK). Doxycycline: monograph 01/2008:0272, column: divinyl benzene copolymer 250 mm × 4.6 mm, particle size 8 μm (Polymer Laboratories, Church Stretton, UK). Colistin monograph 01/2008:0320, column: C18 BDS Hypersil 250 mm × 4.6 mm, particle size 5 μm (Thermo scientific, Waltham, MA, USA). Spiramycin monograph 01/2008:0293, column: Symmetry Shield RP18 250 mm × 4.6 mm, particle size 5 μm (Waters Corporation, Milford, MA, USA).

C Scholtissek *et.al* [26], Amantadine and Rimantadine hydrochloride were tested for stability after storage at different temperatures and under different conditions for extended periods of time. Both compounds were quite stable after storage for at least 25 years at ambient temperature; they both retained full antiviral activity after long-term storage or after boiling and holding at 65–85°C for several days. Thus, amantadine and Rimantadine could be synthesized in large quantities and stored for at least one generation without loss of activity in preparation for the next influenza pandemic in humans.

Method: one, newly purchased amantadine hydrochloride (Sigma); two, Amantadine stored at room temperature (20°C) at SJCRH for at least 25 years; three, Amantadine stored at 4°C in Giessen for at least 20 years; four, Amantadine hydrochloride (Giessen) made up to 1 mg/ml in PBS, heated at 100°C for 60 min and held at 65°C for 5 days; five, newly purchased Rimantadine hydrochloride (Forest Pharmaceuticals); six, Rimantadine stored at room temperature (20°C) at SJCRH for at least 25 years; and seven, Rimantadine heated at 100°C for 120 min and held at 80°C for 4 days. A/Singapore/1/57 (H2N2) was diluted to produce approximately 8.0 (log₁₀) plaques in MDCK cells and treated with amantadine and Rimantadine hydrochloride in the overlay at the above concentrations.

Zilker *et.al* [27], reported the long term stability of 50 drug classes representing common drug classes of pharmaceutical use, some of the drugs with more stability and with less degradants were mentioned in the Table 1.

Method: The methods utilized were in accordance with the Ph. Eur. 9.3 and the United States Pharmacopoeia 40 - NF 35 (USP) as far as monographs were available. 1, 21 Titrations and HPLC–UV were used for assay. Liquid chromatographic methods were applied for the assessment of related substances. Thin layer chromatography (TLC) methods were carried out whenever it was required in the Ph. Eur. for detecting of potential degradation products.



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Water content was determined by means of Karl-Fischer titration. Column:Agilent Zorbax Eclipse Plus C18 (250x4.6 mm; 5 µm) Mobile phase: A: CAN(Acetonitrile), MeOH (39:61 V/V); B: 11 g of SHS(Sodium heptane sulfonate) dissolved in 1000 mL of water, 5.0 mL of TEA(Tri ethyl amine), pH 2.7 (H3PO4), Gradient, 1.0 mL/min, 270 nm, 25°C, 10 µL.

Table-1 shows the list of drugs past their expiry dates retaining stability and the instrumental methods used to establish their stability and potency by various authors. Expiry drug based corrosion inhibitors were reported by several authors²⁸⁻³⁴ with their alloy and media in shown in Table-2.

CONCLUSION

In this review report, we provide a comprehensive background to determine the post-expiration strength of expired dosage forms. In doing so, the financial burden of disposal (Incineration) may be reduced and the use of these medications beyond expiration at home and free clinics during shortage could be justified. Temperature, humidity and light exposure are critical parameters in long term stability of FPPs. The stability of FPP varies with batch to batch or brand to brand or generic to brand. Another idea is that If some of the expired dosage forms do not meet the stability standards then the researcher will seek for API extraction from the dosage forms by various techniques, if it was also not possible they were tested for corrosion inhibition property for metals. Some of the expired drugs (aspirin, paracetamol) used as disinfectants by doing simple treatment to the dosage forms. The expired drugs from the above mentioned literature had the age ranging from 8-80 years. It is not reasonable that to extend the shelf life of that much age because in due course of time the Stability of drug products may lost due to various reasons by maximum extent if may or may not store under proper conditions. So, to extend their shelf life one need to analyze in a systematic time interval (1mo,2 mo,6 mo,1 yr and 2 yrs) with suited attributes by following the Pharmacopieal standards (IP,USP,BP) immediately after its expiry.

To the best of my knowledge, by following this periodical testing, we can establish the stability data and can extend the shelf life from months to years based on stability and purity of expired drug products. From the above literature, Physical stability can be assessed through visual observation for any color changes or any visual reaction for Solid dosage forms, dissolution and disintegration studies. In case of liquid dosage forms, any particles in injectables or any color changes in solutions etc. Chemical stability is determined in the form of potency (assay), PH and degradants assessed through HPLC method mentioned in the standard Pharmacopoeias (IP, USP, BP) for analyzing the expired drugs, because HPLC is the most reliable and economical method to establish the stability of expired drugs. As SLEP sponsored by USDOD performed by FDA, it is suggested that Indian government may also perform SLEP, where the national stockpiles are needed, it is very useful during epidemics and National emergencies. Medicines do not expire: patients expire

ACKNOWLEDGMENTS

The authors wish to thank the Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur for their constant support to complete this work.

DISCLOSE OF INTEREST

The authors have not disclosed any conflicts of interest.

FUNDING

According to authors, the review described in this paper did not receive any financial support.



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Table-1: List of various drugs retained their potency, stability past their expiry reported by various authors

S. No.	Category	Name of Expired Drugs	Instruments Used for testing stability	Author Name	May be Extended
1	Anti-Malarial agents	Artemether- Lume fantrine	TLC, Disintegration testing, Raman Spectroscopy	Roger Bate et.al	Yes
2	Anti-asthmatic agents	Albuterol- Montelukast	RP-HPLC	Raman G. Kutty et.al	Yes
3	5HT-Agonist	Frovatriptan		G.Vidyasagar et.al	Yes
4	Anti- cholinergic Anti- hypertensive Anti-bacterial NSAID Diuretic	atropine Nifedipine, Flucloxacillin, Naproxen Bendroflumethi azide	Titration	Brwne et.al	Yes





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5	Anti-hypertensive	Metoprolol tartrate, Propranolol HCl	HPLC	M. Jasinska et al.	Yes
6	CNS stimulant NSAID Anti-platelet agent Diuretic Hyperthyroidism	Caffeine, Sodium salicylate, Dipyridamole, Furosemide, Methimazole	HPLC	Markus Zilker et.al	Yes
7	NSAID	Tab. Ibuprofen, Diclofenac, Tab Piroxicam Inj Diclofenac, Inj Piroxicam	Disintegration, Dissolution, HPLC and Analgesic activity	Sushil Sharma et.al	Yes
8	Anti-Malarial agent	Quinine	HPLC/MS	K Kudlacek et al	Yes
9	Opioid Analgesic	Heroin, Cocaine		Nesmerak Et al	Yes
10	NSAID	Aspirin Phenacetin	HPLC/MS	Lee Cantrell et al	
11	CNS stimulant	Amphetamine			
12	Antibiotics	Doxycycline Oxytetracycline Colistin A Colistin B Spiramycin	HPLC Anti-bacterial activity	R German et al	Yes
13	Anti-viral Agents	Amantidine Rimantidine	Anti-viral Activity (Ex-vivo)	C Scholtissek et al	Yes
14	Anti-hypertensive agents	Pindolol Timolol	Assay, TLC, HPLC-UV, Karl-Fischer titration	Zilker et.al	Yes
15	β-Sympathomimetic	Etilefrine			
16	Anti-Cholinergics	Hyosine			
17	NSAID	Mefenamic acid			
18	Anti-Psychotic	Chlorprothiene			
19	Anti-Arrhythmic	Propafenone			

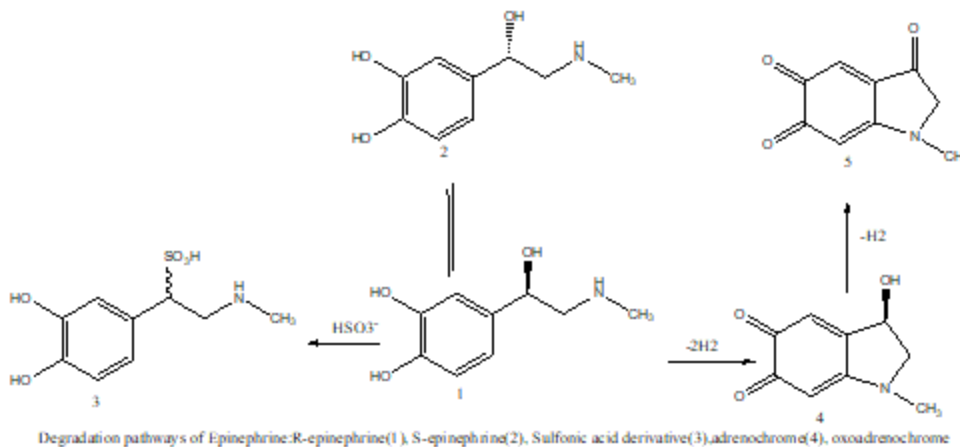
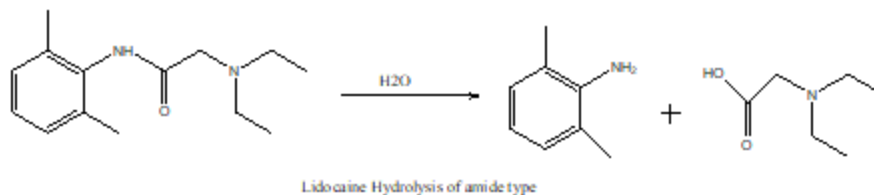
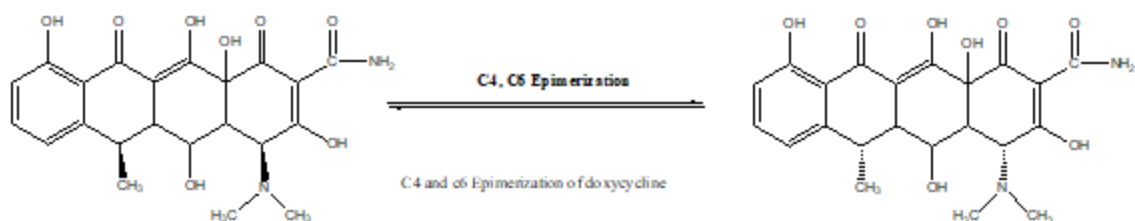
Table-2: List of some of the Expired dosage forms reported as Corrosion Inhibitors

S. No.	Expiry drug as Corrosion Inhibitor	Metal/alloy	Media	Author
1	Ranitidine	Mild steel	1.0 M HCl	Abdel Hameed, R.S. et.al [28]
2	Carbamazepine	Carbon Steel	0.1 M H ₂ SO ₄	Vaszilcsin, N et.al [29]
3	Paracetamol		0.25 M acetic acid, 0.25 M sodium acetate	





4	1-Phenytoin Sodium		1.0 M HCl	Al-Shafey, H.I et.al [30]
5	Ambroxol	Mild Steel	1.0 M HCl, 1.0 M H ₂ SO ₄	Geethamani, P et.al [31]
6	Amlodipine besylate	Low Carbon Steel	1.0M HCl	Fouda, A.S et.al [32]
7	Nifedipine	Mild Steel	1.0M HCl	Gupta, N.K et.al [33]
8	Lorazepam		3.0 M HCl	Raghavendra, N et.al [34]



Degradation pathways of Epinephrine: R-epinephrine(1), S-epinephrine(2), Sulfonic acid derivative(3), adrenochrome(4), oxoadrenochrome

Figure-1: Degradation, Epimerization reactions of Lidocaine, Epinephrine and doxycycline





A New Weighted Generalized Aradhana Distribution with Properties and its Applications

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 29 Jun 2024

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ABSTRACT

In the present paper, a new class of generalized Aradhana distribution termed weighted generalized Aradhana distribution has been introduced. Its different statistical characteristics have been thoroughly studied and explored. Furthermore, the model parameters of executed distribution have been developed through the technique of maximum likelihood estimation. Finally, a new distribution has been illustrated with a real lifetime data set to determine its superiority in comparison with its classical distribution.

Keywords: Generalized Aradhana distribution, Weighted distribution, Order statistics, Reliability analysis, Maximum likelihood estimation.

INTRODUCTION

The theory of weighted distribution provides an integrative approach for model specification and data representation problems. The idea of weighted distribution was suggested by Fisher (1934) in association with his studies on how the method of ascertainment can affect the form of distribution of recorded observation. Later, Rao (1965) developed this concept in a unified manner to deal with modelling statistical data where the routine practice of using classical distributions was found to be inappropriate. The weighted distributions play a dominant role in statistics because they create new flexible distributions that are applied for modelling different real data occurring from various engineering and medical sciences. The weighted distributions provide a collective approach for the correction of biases that exist in unequally weighted sample data. The weighted distribution reached a milestone for efficient modelling of statistical data and prediction. The weighted distributions have been employed largely in various research areas related to reliability, ecology, biomedicine, Meta-analysis, econometrics, survival analysis, renewal





process and several other areas for the development of proper statistical models. The weighted distribution reduces to length length-biased distribution when the weight function considers only the length of units of interest. The concept of length-biased distribution was introduced by Cox (1962) in the context of renewal theory. Length-biased sampling situations may occur in clinical trials, population studies and reliability theory where a proper sampling frame is absent. The weighted distributions were formulated in such a situation to record the observation according to some weight function. A valuable and remarkable contribution has been made by various authors to develop some important weighted probability models along with their statistical features and applications in various fields. Hassan et al. (2019) presented a weighted quasi-exponential distribution with properties and applications. Sen, Chandra and Maiti (2017) presented the weighted Xgamma distribution and obtained its properties and applications. Asgharzadeh et al. (2016) discussed on new weighted Lindley distribution with application. Elan Govan, Mohanasundari and Kumar (2019) studied weighted quasi-Sujatha distribution with properties and applications to bladder cancer data in survival analysis. Sarma and Das (2021) presented a weighted inverse Nakagami distribution. Ganaie et al. (2023) proposed weighted power Garima distribution with applications in blood cancer and relief times. Ahmad and Ahmad (2019) discussed on the weighted analogue of inverse gamma distribution with statistical properties, estimation and simulation study. Ajami and Jahanshahi (2017) presented parameter estimation in weighted Rayleigh distribution. Reyad et al. (2017) obtained the length-biased weighted freshet distribution with properties and estimation. Bashir and Khan (2023) proposed the characterization of weighted power function distribution with reliability functions and moments. The generalized Aradhana distribution is a recently introduced two-parametric continuous lifetime distribution proposed by Welday and Shanker (2018) which includes one parameter exponential and Aradhana distribution are particular cases of it. Its various statistical properties including shapes of probability density function for varying values of parameters, stochastic ordering, coefficient of variation, coefficient of skewness, coefficient of kurtosis, index of dispersion, mean residual life function, hazard function, mean deviations, stress-strength reliability, Bonferroni and Lorenz curves have been discussed. Furthermore, its parameters have also been estimated based on maximum likelihood estimation.

Weighted Generalized Aradhana (WGA) Distribution

The probability density function of the generalized Aradhana distribution is given by

$$f(x; \theta, \alpha) = \frac{\theta^3}{\theta^2 + 2\alpha\theta + 2\alpha^2} (1 + \alpha x)^2 e^{-\theta x}; \quad x > 0, \theta > 0, \alpha \geq 0 \quad (1)$$

and the cumulative distribution function of generalized Aradhana distribution is given by

$$F(x; \theta, \alpha) = 1 - \left(1 + \frac{\alpha\theta x(2\theta + \alpha\theta x + 2\alpha)}{\theta^2 + 2\theta\alpha + 2\alpha^2} \right) e^{-\theta x}; \quad x > 0, \theta > 0, \alpha \geq 0 \quad (2)$$

Let X be the random variable that represents a non-negative condition that has a probability density function $f(x)$

.Let $w(x)$ be its non-negative weight function, then the probability density function of the weighted random variable

X_w is given by

$$f_w(x) = \frac{w(x)f(x)}{E(w(x))}, \quad x > 0.$$

Where $w(x)$ be the non - negative weight function and $E(w(x)) = \int w(x)f(x)dx < \infty$.

For various forms of weight function $w(x)$ when $w(x) = x^c$, the resulting distribution is termed a weighted distribution. In this paper, we have to obtain the weighted version of the generalized Aradhana distribution termed weighted generalized Aradhana distribution. So, the weight function considered at $w(x) = x^c$, the resulting distribution is called weighted distribution with probability density function given by

$$f_w(x) = \frac{x^c f(x)}{E(x^c)} \quad (3)$$





$$E(x^c) = \int_0^{\infty} x^c f(x; \theta, \alpha) dx$$

$$E(x^c) = \frac{\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)}{\theta^c (\theta^2 + 2\alpha\theta + 2\alpha^2)} \tag{4}$$

Now substituting equations(1) and (4) in equation (3), we will get the required probability density function of weighted generalized Aradhana distribution as

$$f_w(x) = \frac{x^c \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} (1 + \alpha x)^2 e^{-\theta x} \tag{5}$$

and the cumulative distribution function of weighted generalized Aradhana distribution can be obtained as

$$F_w(x) = \int_0^x f_w(x) dx$$

$$F_w(x) = \int_0^x \frac{x^c \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} (1 + \alpha x)^2 e^{-\theta x} dx$$

$$F_w(x) = \frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \int_0^x x^c \theta^{c+3} (1 + \alpha x)^2 e^{-\theta x} dx$$

$$F_w(x) = \frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \int_0^x x^c \theta^{c+3} (1 + \alpha^2 x^2 + 2\alpha x) e^{-\theta x} dx$$

$$F_w(x) = \frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \left(\theta^{c+3} \int_0^x x^c e^{-\theta x} dx + \alpha^2 \theta^{c+3} \int_0^x x^{c+2} e^{-\theta x} dx + 2\alpha\theta^{c+3} \int_0^x x^{c+1} e^{-\theta x} dx \right)$$

(6)

Put $\theta x = t \Rightarrow \theta dx = dt \Rightarrow dx = \frac{dt}{\theta}$ Also $x = \frac{t}{\theta}$

When $x \rightarrow x, t \rightarrow \theta x$ and when $x \rightarrow 0, t \rightarrow 0$

After the simplification of equation (6), we will obtain the cumulative distribution function of the weighted generalized Aradhana distribution as

$$F_w(x) = \frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \left(\theta^2 \gamma(c+1, \theta x) + \alpha^2 \gamma(c+3, \theta x) + 2\alpha\theta \gamma(c+2, \theta x) \right) \tag{7}$$





Reliability Analysis

In this section, we will discuss the reliability function, hazard rate function, reverse hazard rate function and Mills ratio of the weighted generalized Aradhana distribution.

Reliability function

The reliability function is also known as the survival function and the reliability function of the weighted generalized Aradhana distribution can be obtained as

$$R(x) = 1 - F_w(x)$$

$$R(x) = 1 - \frac{1}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)\right)} \left(\theta^2\gamma(c+1, \theta x) + \alpha^2\gamma(c+3, \theta x) + 2\alpha\theta\gamma(c+2, \theta x)\right)$$

Hazard function

The hazard function is also known as the failure rate or hazard rate and is given by

$$h(x) = \frac{f_w(x)}{R(x)}$$

$$h(x) = \frac{x^c \theta^{c+3} (1 + \alpha x)^2 e^{-\theta x}}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)) - (\theta^2\gamma(c+1, \theta x) + \alpha^2\gamma(c+3, \theta x) + 2\alpha\theta\gamma(c+2, \theta x))}$$

Reverse hazard function

The reverse hazard rate function is given by

$$h_r(x) = \frac{f_w(x)}{F_w(x)}$$

$$h_r(x) = \frac{x^c \theta^{c+3} (1 + \alpha x)^2 e^{-\theta x}}{(\theta^2\gamma(c+1, \theta x) + \alpha^2\gamma(c+3, \theta x) + 2\alpha\theta\gamma(c+2, \theta x))}$$

Mills Ratio

$$M.R = \frac{1}{h_r(x)} = \frac{(\theta^2\gamma(c+1, \theta x) + \alpha^2\gamma(c+3, \theta x) + 2\alpha\theta\gamma(c+2, \theta x))}{x^c \theta^{c+3} (1 + \alpha x)^2 e^{-\theta x}}$$

Order Statistics

Order statistics play a significant role in statistical sciences and have a wide range of applications in the field of reliability and life testing. Consider $X_{(1)}, X_{(2)}, \dots, X_{(n)}$ be the order statistics of a random sample X_1, X_2, \dots, X_n drawn from a continuous distribution with probability density function $f_X(x)$ and cumulative distribution function $F_X(x)$, then probability density function of r^{th} order statistics $X_{(r)}$ is given by

$$f_{X_{(r)}}(x) = \frac{n!}{(r-1)!(n-r)!} f_X(x) (F_X(x))^{r-1} (1 - F_X(x))^{n-r} \tag{8}$$

Now substituting equations(5) and (7) in equation (8), we will get the required probability density function of the order statistics of weighted generalized Aradhana distribution as





$$\begin{aligned}
 f_{x(r)}(x) &= \frac{n!}{(r-1)!(n-r)!} \left(\frac{x^c \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} (1+\alpha x)^2 e^{-\alpha x} \right) \\
 &\times \left(\frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} \left(\theta^2 \gamma(c+1, \theta x) + \alpha^2 \gamma(c+3, \theta x) + 2\alpha \theta \gamma(c+2, \theta x) \right) \right)^{r-1} \\
 &\times \left(1 - \frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} \left(\theta^2 \gamma(c+1, \theta x) + \alpha^2 \gamma(c+3, \theta x) + 2\alpha \theta \gamma(c+2, \theta x) \right) \right)^{n-r}
 \end{aligned}$$

Therefore, the probability density function of higher order statistic $X_{(n)}$ of weighted generalized Aradhana distribution can be determined as

$$\begin{aligned}
 f_{x(n)}(x) &= \frac{n x^c \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} (1+\alpha x)^2 e^{-\alpha x} \\
 &\times \left(\frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} \left(\theta^2 \gamma(c+1, \theta x) + \alpha^2 \gamma(c+3, \theta x) + 2\alpha \theta \gamma(c+2, \theta x) \right) \right)^{n-1}
 \end{aligned}$$

and probability density function of first order statistic $X_{(1)}$ of weighted generalized Aradhana distribution can be determined as

$$\begin{aligned}
 f_{x(1)}(x) &= \frac{n x^c \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} (1+\alpha x)^2 e^{-\alpha x} \\
 &\times \left(1 - \frac{1}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha \theta \Gamma(c+2) \right)} \left(\theta^2 \gamma(c+1, \theta x) + \alpha^2 \gamma(c+3, \theta x) + 2\alpha \theta \gamma(c+2, \theta x) \right) \right)^{n-1}
 \end{aligned}$$





Likelihood Ratio Test

Consider X_1, X_2, \dots, X_n be the random sample of size n drawn from generalized Aradhana or weighted generalized Aradhana distribution. To examine its significance, we consider the hypothesis for testing

$$H_0 : f(x) = f(x; \theta, \alpha) \quad \text{against} \quad H_1 : f(x) = f_w(x; \theta, \alpha, c)$$

To determine, whether the random sample of size n comes from the generalized Aradhana distribution or weighted generalized Aradhana distribution, the given below test statistic is used.

$$\Delta = \frac{L_1}{L_0} = \prod_{i=1}^n \frac{f_w(x; \theta, \alpha, c)}{f(x; \theta, \alpha)}$$

$$\Delta = \frac{L_1}{L_0} = \prod_{i=1}^n \left(\frac{x_i^c \theta^c (\theta^2 + 2\alpha\theta + 2\alpha^2)}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \right)$$

$$\Delta = \frac{L_1}{L_0} = \left(\frac{\theta^c (\theta^2 + 2\alpha\theta + 2\alpha^2)}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \right)^n \prod_{i=1}^n x_i^c$$

We should refuse to retain the null hypothesis, if

$$\Delta = \left(\frac{\theta^c (\theta^2 + 2\alpha\theta + 2\alpha^2)}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)} \right)^n \prod_{i=1}^n x_i^c > k$$

Equivalently, we should also refuse to retain the null hypothesis where

$$\Delta^* = \prod_{i=1}^n x_i^c > k \left(\frac{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)}{\theta^c (\theta^2 + 2\alpha\theta + 2\alpha^2)} \right)^n$$

$$\Delta^* = \prod_{i=1}^n x_i^c > k^*, \text{ Where } k^* = k \left(\frac{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2) \right)}{\theta^c (\theta^2 + 2\alpha\theta + 2\alpha^2)} \right)^n$$

Whether the $2 \log \Delta$ is distributed as a chi-square distribution with one degree of freedom if the sample is large of size n and also chi-square distribution is employed for obtaining the p -value. Thus we should refute to retain the null hypothesis if the probability value is given by

$$p(\Delta^* > \beta^*), \text{ Where } \beta^* = \prod_{i=1}^n x_i^c \text{ is smaller than a specified level of significance and } \prod_{i=1}^n x_i^c \text{ is the observed value of the statistic } \Delta^* .$$

Structural Properties





In this section, we will discuss the different statistical properties of weighted generalized Aradhana distribution including moments, harmonic mean, moment generating function and characteristics function.

Moments

Let X be the random variable following weighted generalized Aradhana distribution with parameters θ, α and c , then the r^{th} order moment $E(X^r)$ of the proposed distribution can be obtained as

$$E(X^r) = \mu_r = \int_0^\infty x^r f_w(x) dx$$

$$E(X^r) = \int_0^\infty x^r \frac{x^c \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)} (1+\alpha x)^2 e^{-\theta x} dx$$

$$E(X^r) = \int_0^\infty \frac{x^{c+r} \theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)} (1+\alpha x)^2 e^{-\theta x} dx$$

$$E(X^r) = \frac{\theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)} \int_0^\infty x^{c+r} (1+\alpha x)^2 e^{-\theta x} dx$$

$$E(X^r) = \frac{\theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)} \int_0^\infty x^{c+r} \left(1 + \alpha^2 x^2 + 2\alpha x\right) e^{-\theta x} dx$$

$$E(X^r) = \frac{\theta^{c+3}}{\left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)} \left(\int_0^\infty x^{(c+r+1)-1} e^{-\theta x} dx + \alpha^2 \int_0^\infty x^{(c+r+3)-1} e^{-\theta x} dx + 2\alpha \int_0^\infty x^{(c+r+2)-1} e^{-\theta x} dx \right) \tag{9}$$

After the simplification of equation (9), we obtain

$$E(X^r) = \mu_r = \frac{\theta^2 \Gamma(c+r+1) + \alpha^2 \Gamma(c+r+3) + 2\alpha\theta \Gamma(c+r+2)}{\theta^r \left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)} \tag{10}$$

Now substituting $r = 1, 2, 3$ and 4 in equation (10), we will get the first four moments of weighted generalized Aradhana distribution as

$$E(X) = \mu_1 = \frac{\theta^2 \Gamma(c+2) + \alpha^2 \Gamma(c+4) + 2\alpha\theta \Gamma(c+3)}{\theta \left(\theta^2 \Gamma(c+1) + \alpha^2 \Gamma(c+3) + 2\alpha\theta \Gamma(c+2)\right)}$$





$$E(X^2) = \mu_2' = \frac{\theta^2\Gamma(c+3) + \alpha^2\Gamma(c+5) + 2\alpha\theta\Gamma(c+4)}{\theta^2 \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)}$$

$$E(X^3) = \mu_3' = \frac{\theta^2\Gamma(c+4) + \alpha^2\Gamma(c+6) + 2\alpha\theta\Gamma(c+5)}{\theta^3 \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)}$$

$$E(X^4) = \mu_4' = \frac{\theta^2\Gamma(c+5) + \alpha^2\Gamma(c+7) + 2\alpha\theta\Gamma(c+6)}{\theta^4 \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)}$$

$$\text{Variance} = \frac{\theta^2\Gamma(c+3) + \alpha^2\Gamma(c+5) + 2\alpha\theta\Gamma(c+4)}{\theta^2 \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} - \left(\frac{\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3)}{\theta \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} \right)^2$$

$$S.D(\sigma) = \sqrt{\left(\frac{\theta^2\Gamma(c+3) + \alpha^2\Gamma(c+5) + 2\alpha\theta\Gamma(c+4)}{\theta^2 \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} - \left(\frac{\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3)}{\theta \left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} \right)^2 \right)}$$

Harmonic mean

The harmonic mean for the proposed weighted generalized Aradhana distribution can be obtained as

$$H.M = E\left(\frac{1}{x}\right) = \int_0^\infty \frac{1}{x} f_w(x) dx$$

$$H.M = \int_0^\infty \frac{1}{x} \frac{x^c \theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} (1 + \alpha x)^2 e^{-\theta x} dx$$

$$H.M = \int_0^\infty \frac{x^{c-1} \theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} (1 + \alpha^2 x^2 + 2\alpha x) e^{-\theta x} dx$$

$$H.M = \frac{\theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} \int_0^\infty x^{c-1} (1 + \alpha^2 x^2 + 2\alpha x) e^{-\theta x} dx$$

$$H.M = \frac{\theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2) \right)} \left(\int_0^\infty x^{(c+1)-2} e^{-\theta x} dx + \alpha^2 \int_0^\infty x^{(c+2)-1} e^{-\theta x} dx + 2\alpha \int_0^\infty x^{(c+1)-1} e^{-\theta x} dx \right)$$

After simplification, we obtain





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$$H.M = \frac{\theta(\theta\Gamma(c+1) + \alpha^2\Gamma(c+2) + 2\alpha\theta\Gamma(c+1))}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))}$$

Moment generating function and characteristic function

Let X be the random variable following weighted generalized Aradhana distribution with parameters θ, α and c , then the moment generating function of the proposed distribution can be obtained as

$$M_X(t) = E(e^{tx}) = \int_0^\infty e^{tx} f_w(x) dx$$

Using Taylor’s series, we obtain

$$\begin{aligned} &= \int_0^\infty \left(1 + tx + \frac{(tx)^2}{2!} + \dots \right) f_w(x) dx \\ &= \int_0^\infty \sum_{j=0}^\infty \frac{t^j}{j!} x^j f_w(x) dx \\ &= \sum_{j=0}^\infty \frac{t^j}{j!} \mu_j \\ &= \sum_{j=0}^\infty \frac{t^j}{j!} \left(\frac{\theta^2\Gamma(c+j+1) + \alpha^2\Gamma(c+j+3) + 2\alpha\theta\Gamma(c+j+2)}{\theta^j(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \right) \\ M_X(t) &= \frac{1}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \sum_{j=0}^\infty \frac{t^j}{j!} \left(\theta^2\Gamma(c+j+1) + \alpha^2\Gamma(c+j+3) + 2\alpha\theta\Gamma(c+j+2) \right) \end{aligned}$$

Similarly, the characteristic function of weighted generalized Aradhana distribution can be obtained as

$$\varphi_x(t) = M_X(it)$$

$$M_X(it) = \frac{1}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \sum_{j=0}^\infty \frac{it^j}{j!\theta^j} \left(\theta^2\Gamma(c+j+1) + \alpha^2\Gamma(c+j+3) + 2\alpha\theta\Gamma(c+j+2) \right)$$

Bonferroni and Lorenz Curves

The Bonferroni and Lorenz curves also termed as classical curves are mostly being applied to study the distribution of inequality in income or poverty. The Bonferroni and Lorenz curves can be defined as

$$B(p) = \frac{1}{p\mu_1} \int_0^q x f_w(x) dx$$

and $L(p) = pB(p) = \frac{1}{\mu_1} \int_0^q x f_w(x) dx$





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Where $\mu_1' = \frac{\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3)}{\theta(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))}$ and $q = F^{-1}(p)$

$$B(p) = \frac{\theta(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))}{p(\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3))} \int_0^q \frac{x^c \theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)\right)} (1 + \alpha x)^2 e^{-\theta x} dx$$

$$B(p) = \frac{\theta(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))}{p(\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3))} \int_0^q \frac{x^{c+1} \theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)\right)} (1 + \alpha^2 x^2 + 2\alpha x) e^{-\theta x} dx$$

$$B(p) = \frac{\theta^{c+4}}{p(\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3))} \int_0^q x^{c+1} (1 + \alpha^2 x^2 + 2\alpha x) e^{-\theta x} dx$$

$$B(p) = \frac{\theta^{c+4}}{p(\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3))} \left(\int_0^q x^{(c+2)-1} e^{-\theta x} dx + \alpha^2 \int_0^q x^{(c+4)-1} e^{-\theta x} dx + 2\alpha \int_0^q x^{(c+3)-1} e^{-\theta x} dx \right)$$

After simplification, we obtain

$$B(p) = \frac{\theta^{c+4}}{p(\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3))} \left(\gamma(c+2, \theta q) + \alpha^2 \gamma(c+4, \theta q) + 2\alpha \gamma(c+3, \theta q) \right)$$

$$L(p) = \frac{\theta^{c+4}}{(\theta^2\Gamma(c+2) + \alpha^2\Gamma(c+4) + 2\alpha\theta\Gamma(c+3))} \left(\gamma(c+2, \theta q) + \alpha^2 \gamma(c+4, \theta q) + 2\alpha \gamma(c+3, \theta q) \right)$$

Maximum Likelihood Estimation and Fisher’s Information Matrix

In this section, we will discuss the technique of maximum likelihood estimation to estimate the parameters of weighted generalized Aradhana distribution. Consider X_1, X_2, \dots, X_n be the random sample of size n from the weighted generalised Aradhana distribution, then the likelihood function can be defined as

$$L(x) = \prod_{i=1}^n f_w(x)$$

$$L(x) = \prod_{i=1}^n \left(\frac{x_i^c \theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)\right)} (1 + \alpha x_i)^2 e^{-\theta x_i} \right)$$

$$L(x) = \prod_{i=1}^n \left(\frac{x_i^c \theta^{c+3}}{\left(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)\right)} (1 + \alpha^2 x_i^2 + 2\alpha x_i) e^{-\theta x_i} \right)$$





$$L(x) = \frac{\theta^{n(c+3)}}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))^n} \prod_{i=1}^n \left(x_i^c (1 + \alpha^2 x_i^2 + 2\alpha x_i) e^{-\theta x_i} \right)$$

The log-likelihood function is given by

$$\begin{aligned} \log L = n(c+3) \log \theta - n \log(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)) + c \sum_{i=1}^n \log x_i \\ + \sum_{i=1}^n \log(1 + \alpha^2 x_i^2 + 2\alpha x_i) - \theta \sum_{i=1}^n x_i \end{aligned} \tag{11}$$

Now differentiating log likelihood equation (11) concerning parameters θ , α and c . we must satisfy the following

normal equations

$$\begin{aligned} \frac{\partial \log L}{\partial \theta} = \frac{n(c+3)}{\theta} - n \left(\frac{2\theta\Gamma(c+1) + 2\alpha\Gamma(c+2)}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \right) - \sum_{i=1}^n x_i = 0 \\ \frac{\partial \log L}{\partial \alpha} = -n \left(\frac{2\alpha\Gamma(c+3) + 2\theta\Gamma(c+2)}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \right) + \sum_{i=1}^n \left(\frac{2\alpha x_i^2 + 2x_i}{(1 + \alpha^2 x_i^2 + 2\alpha x_i)} \right) = 0 \end{aligned}$$

$$\frac{\partial \log L}{\partial c} = n \log \theta - n\psi(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2)) + \sum_{i=1}^n \log x_i = 0$$

Where $\psi(\cdot)$ is the digamma function.

Because of the complicated form of the above likelihood equations algebraically, it is very difficult to solve the system of nonlinear equations. Therefore, we use numerical techniques like the Newton-Raphson method for estimating the parameters of the proposed distribution.

To use the asymptotic normality results for determining the confidence interval. We have that if

$\hat{\lambda} = (\hat{\theta}, \hat{\alpha}, \hat{c})$ denotes the MLE of $\lambda = (\theta, \alpha, c)$. we can determine the results as

$$\sqrt{n}(\hat{\lambda} - \lambda) \rightarrow N_3(0, I^{-1}(\lambda))$$

Where $I^{-1}(\lambda)$ is Fisher's information matrix. i.e

$$I(\lambda) = -\frac{1}{n} \begin{pmatrix} E\left(\frac{\partial^2 \log L}{\partial \theta^2}\right) & E\left(\frac{\partial^2 \log L}{\partial \theta \partial \alpha}\right) & E\left(\frac{\partial^2 \log L}{\partial \theta \partial c}\right) \\ E\left(\frac{\partial^2 \log L}{\partial \alpha \partial \theta}\right) & E\left(\frac{\partial^2 \log L}{\partial \alpha^2}\right) & E\left(\frac{\partial^2 \log L}{\partial \alpha \partial c}\right) \\ E\left(\frac{\partial^2 \log L}{\partial c \partial \theta}\right) & E\left(\frac{\partial^2 \log L}{\partial c \partial \alpha}\right) & E\left(\frac{\partial^2 \log L}{\partial c^2}\right) \end{pmatrix}$$





Here, we can define

$$E\left(\frac{\partial^2 \log L}{\partial \theta^2}\right) = -\frac{n(c+3)}{\theta^2} - n \left(\frac{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))(2\Gamma(c+1))}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))^2} \right)$$

$$E\left(\frac{\partial^2 \log L}{\partial \alpha^2}\right) = -n \left(\frac{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))(2\Gamma(c+3))}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))^2} \right) + \sum_{i=1}^n \left(\frac{(1 + \alpha^2 x_i^2 + 2\alpha x_i)(2x_i^2)}{(1 + \alpha^2 x_i^2 + 2\alpha x_i)^2} - \frac{(2\alpha x_i^2 + 2x_i)(2\alpha x_i^2 + 2x_i)}{(1 + \alpha^2 x_i^2 + 2\alpha x_i)^2} \right)$$

$$E\left(\frac{\partial^2 \log L}{\partial c^2}\right) = -n\psi'(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))$$

$$E\left(\frac{\partial^2 \log L}{\partial \theta \partial \alpha}\right) = -n \left(\frac{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))(2\Gamma(c+2))}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))^2} \right)$$

$$E\left(\frac{\partial^2 \log L}{\partial \theta \partial c}\right) = \frac{n}{\theta} - n\psi \left(\frac{(2\theta\Gamma(c+1) + 2\alpha\Gamma(c+2))}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \right)$$

$$E\left(\frac{\partial^2 \log L}{\partial \alpha \partial c}\right) = -n\psi \left(\frac{(2\alpha\Gamma(c+3) + 2\theta\Gamma(c+2))}{(\theta^2\Gamma(c+1) + \alpha^2\Gamma(c+3) + 2\alpha\theta\Gamma(c+2))} \right)$$





Where $\psi(\cdot)'$ is the first order derivative of digamma function.

Since λ being unknown, we estimate $I^{-1}(\lambda)$ by $I^{-1}(\hat{\lambda})$ and this can be used to obtain asymptotic confidence intervals for θ , α and c .

Application

In this section, we have used a real lifetime data set in weighted generalized Aradhana distribution to determine its goodness of fit and then fit has been compared to over-generalized Aradhana, quasi-Aradhana, Aradhana and Lindley distributions. The following real lifetime data set is given below as The following real data set given below in Table 1 represents the strength data of glass of the aircraft window reported by Fuller et al. (1994) and the data set is given below as To determine the model comparison criterion values along with the estimation of unknown parameters, the technique of R software is employed. To compare the performance of weighted generalized Aradhana distribution over-generalized Aradhana, quasi-Aradhana, Aradhana and Lindley distributions, we use the criterion values AIC (Akaike Information Criterion), BIC (Bayesian Information Criterion), $AICC$ (Akaike Information Criterion Corrected) and $-2\log L$. The distribution is better which shows lesser criterion values of AIC , BIC , $AICC$ and $-2\log L$. For determining the criteria such as AIC , BIC , $AICC$ and $-2\log L$ following formulas are used.

$$AIC = 2k - 2 \log L, \quad BIC = k \log n - 2 \log L, \quad \text{and} \quad AICC = AIC + \frac{2k(k+1)}{n-k-1} \quad \text{Where}$$

n is the sample size, k is the number of parameters in the statistical model and $-2\log L$ is the maximized value of the log-likelihood function under the considered model. From Table 2 given above, it has been realized and observed from the result that the weighted generalized Aradhana distribution has lesser AIC , BIC , $AICC$ and $-2\log L$ values as compared to the generalised Aradhana, quasi-Aradhana, Aradhana and Lindley distributions. Hence, it can be concluded that the weighted generalised Aradhana distribution provides a better fit over-generalised Aradhana, quasi-Aradhana, Aradhana and Lindley distributions.

CONCLUSION

The present article deals with a novel distribution known as the weighted generalized Aradhana distribution which has been developed and studied by using the weighted technique for its baseline distribution. Its different statistical properties include the shape of the behaviour of pdf and cdf, moments, harmonic mean, reliability function, hazard rate function, reverse hazard function, moment generating function, characteristic function, Bonferroni and Lorenz curves and order statistics have been thoroughly explored and presented. Furthermore, the parameters of the developed distribution have been estimated based on the maximum likelihood estimation. Finally, a new distribution has been examined and analysed with a real lifetime data set to demonstrate its usefulness and hence it is revealed from the result that the proposed weighted generalized Aradhana distribution provides a quite satisfactory result over generalized Aradhana, quasi-Aradhana, Aradhana and Lindley distributions.

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Table 1: Data regarding the strength of the glass of the aircraft window reported by Fuller et al. (1994)

18.83	20.80	21.657	23.03	23.23	24.05	24.321	25.50	25.52	25.80
26.69	26.77	26.78	27.05	27.67	29.90	31.11	33.20	33.73	33.76
33.89	34.76	35.75	35.91	36.98	37.08	37.09	39.58	44.045	45.29
45.381									

Table 2: Shows Comparison and Performance of Fitted Distributions

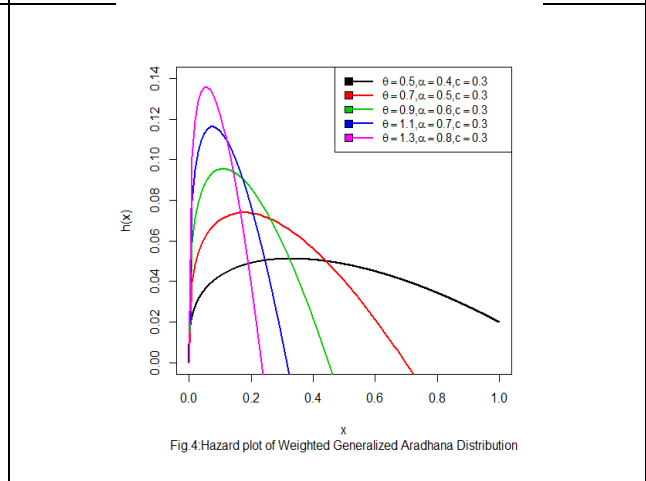
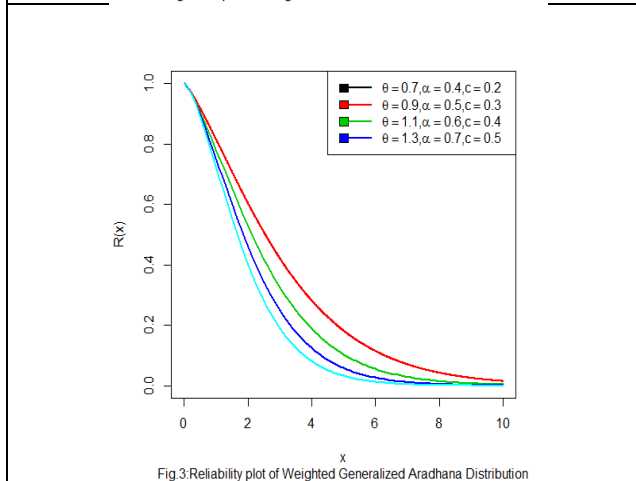
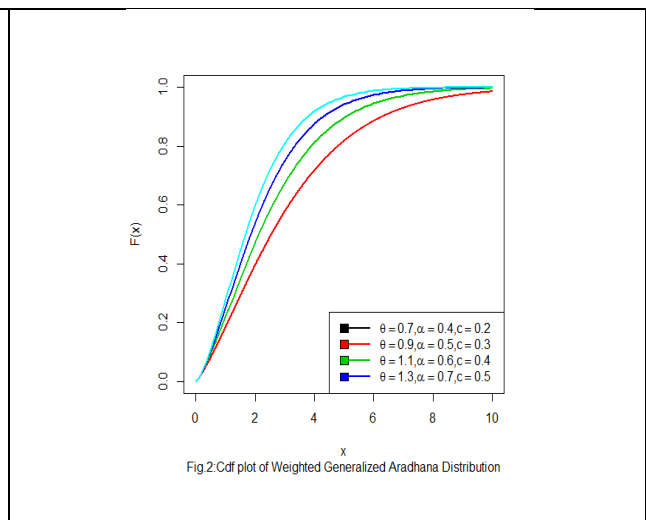
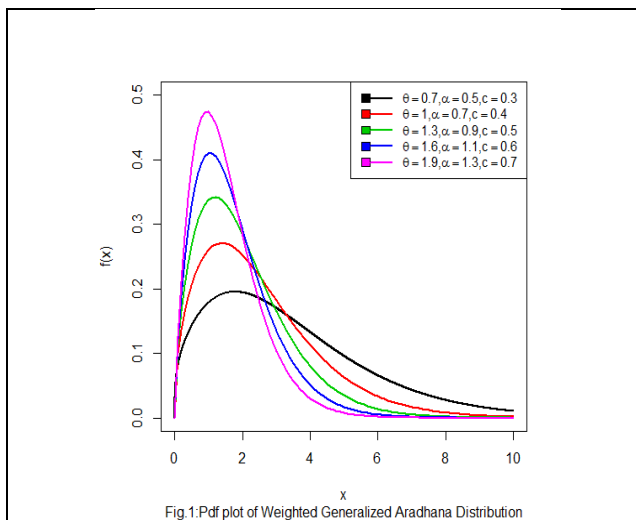
Distributions	MALE	S.E	-2logL	AIC	BIC	AICC
Weighted Generalized Aradhana	$\hat{\alpha} = 8.5188747$ $\hat{\theta} = 0.6147400$ $\hat{c} = 15.9490099$	$\hat{\alpha} = 376.509798$ $\hat{\theta} = 0.1572428$ $\hat{c} = 4.8218477$	208.2317	214.2317	218.5337	215.1205





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Generalised Aradhana	$\hat{\alpha} = 5.687360$ $\hat{\theta} = 9.736449$	$\hat{\alpha} = 1.186406$ $\hat{\theta} = 1.009583$	240.4691	244.4691	247.337	244.8976
Quasi Aradhana	$\hat{\alpha} = 0.00100000$ $\hat{\theta} = 0.09734626$	$\hat{\alpha} = 0.58419899$ $\hat{\theta} = 0.01671826$	240.4843	244.4843	247.3523	244.9128
Aradhana	$\hat{\theta} = 0.094321315$	$\hat{\theta} = 0.00978075$	242.2289	244.2289	245.6629	244.3668
Lindley	$\hat{\theta} = 0.062990212$	$\hat{\theta} = 0.00800477$	253.9884	255.9884	257.4224	256.1263





Comparative Study and Analysis of Deep Fake Detection using Machine Learning

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

In the rapidly evolving landscape of deepfake technology, which poses substantial threats to privacy and security, this research conducts a comparative analysis between two advanced detection methods: The ViT image classifier employing convolutional neural networks and the Meso4 method to analyse images at mesoscopic level. Motivated by the pervasive impact of deepfakes on individuals, particularly celebrities and politicians, the study aims to discern the effectiveness of these methods in distinguishing authentic from manipulated images. The methodological approach prioritizes practical implementation, utilizing the DFDC (Deep Fake Detection Challenge by Kaggle) dataset for ViT and a combination of self-made and Face2Face dataset for Meso4 model. The DFDC dataset is a massive 260 GB dataset comprising over 1 million images, both real and fake, while the combined dataset for MESO consists of approximately 400 videos made by the author and over a thousand videos from the Face2Face dataset, encompassing real and fake instances. The ViT model exhibits exceptional proficiency, achieving a 99.9% accuracy within its dataset and an 85% accuracy for subtly deceptive images. Conversely, the Meso4 model faces challenges, resulting in a 60% accuracy and displaying biases, particularly towards female subjects due to its heavy trainings on adult content. In conclusion, the ViT image processor emerges as a superior and user-friendly method, despite its substantial data footprint, showcasing superior efficacy, especially in real-world scenarios. The findings emphasize the importance of advancing robust and unbiased deepfake detection methods, acknowledging considerations such as model size in the context of application requirements.





Keywords: Deepfake Detection, Machine Learning, Convolutional Neural Networks (CNN), Meso4, Vision Transformer (ViT), Image Processing.

INTRODUCTION

Deepfakes impact people's lives by eroding trust in digital content, leading to potential misinformation and manipulation. They pose threats to privacy through the creation of fabricated explicit content, causing emotional distress. In the realm of cybersecurity, deepfakes can contribute to identity theft and phishing attacks. The prevalence of deepfakes underscores the need for robust detection tools and increased awareness to mitigate their societal implications [2]. Deep fakes, crafted with advanced artificial intelligence, pose a significant threat by manipulating information and eroding trust in digital content. Deepfakes detection is vital for countering the spread of misinformation [5], which can disrupt democratic processes and public discourse, ensuring the authenticity of digital content. This research paper serves as a crucial safeguard close against privacy violations through the creation of nonconsensual explicit content, as it compares the two models which helps us to understand and gain in depth knowledge about the genuine and effective usage of the methods which help us deal with the cons of AI, a growing concern in the deep fake era [1]. In the realm of cybersecurity, the research paper plays a pivotal role in preventing identity theft, phishing attacks, and other malicious activities [5]. It upholds ethical standards in content creation and aids forensic analysis, verifying the credibility of digital evidence in legal proceedings. In the intricate landscape of image analysis, this paper undertook a thorough exploration, employing two distinct pretrained models. The initial model, utilizing heatmaps, meticulously scrutinized distortions within images [6], albeit encountering challenges in accuracy. Simultaneously, the ViT image classifier exhibited exceptional precision, albeit at the expense of computational time and database compatibility. Undeterred, the research endeavoured to merge the strengths of both models, envisioning a hybrid approach that harmonizes accuracy and efficiency, setting the stage for a groundbreaking solution in deepfake detection. Hence, as a catalyst for research and development, deepfake detection project stays ahead of evolving deep fake technology, raising public awareness to empower individuals in recognizing associated risks [7]. It also supports journalism by enabling the verification of user-generated content. Ultimately, projects like these contribute to responsible AI use, reinforcing the ethical foundation of artificial intelligence in a world increasingly dependent on digital media.

METHODOLOGY

In the realm of artificial intelligence and deep learning, the DFDC (Deepfake Detection Challenge) and Face2Face datasets serve as cornerstone resources for advancing research in the field of deepfake detection. The DFDC dataset, characterized by its expansive scale, places a prominent emphasis on nuanced alterations in both facial and vocal features within manipulated videos. This extensive repository provides a diverse array of scenarios, encompassing variations in lighting conditions and backgrounds, thereby offering a comprehensive testbed for the development of sophisticated deepfake detection algorithms. Conversely, the Face2Face dataset, though comparatively smaller in scale, specializes in the meticulous representation of realistic facial expression transfer. It concentrates on controlled settings, allowing for an in-depth exploration of the intricacies associated with facial manipulation. DFDC presents challenges in the identification of subtle manipulations, requiring algorithms to navigate varying video quality and manipulation techniques. On the other hand, Face2Face demands algorithms proficient in discerning realistic facial reenactments from authentic expressions, albeit within a potentially more constrained range of scenarios. Both datasets synergize effectively when utilized in conjunction with dedicated models for deepfake detection. DFDC proves particularly beneficial in scenarios where the precise identification of manipulated audio-visual content is paramount. Simultaneously, Face2Face contributes to studies that specifically delve into the nuances of facial expression transfer and manipulation.



**Devang Mulye et al.,****Meso4 model**

The Meso4 deepfake detection network (as in fig 1.) employs a cascading series of convolutional layers, each followed by batch normalization for enhanced training stability and accuracy. Feature extraction progresses through these layers, culminating in fully connected layers and dropout for robust classification. Max pooling reduces dimensionality, while the final sigmoid activation outputs a probability score for the input image being a deepfake. This concise architecture leverages key elements for effective deepfake detection.

Contribution 1

The Meso4 model incorporates an innovative enhancement through the integration of a threshold value derived from a heatmap, offering an enriched approach to image analysis and data visualization. The model's workflow begins with the loading of an image, followed by the conversion of the image into a NumPy array presented in matrix form for heatmap Generation (as in fig 5. and fig 6.). The heatmap plays a pivotal role in determining a threshold value, subsequently utilized to calculate the confidence level [9]. This threshold value is integral to the decision-making process employed by the Meso4 model. After initializing the model and loading pretrained weights, the image undergoes preprocessing for subsequent predictions. By leveraging the threshold value and confidence level, the model classifies the image as either genuine or manipulated (as in fig 5. And fig 6.). The heatmap is instrumental in accentuating regions within the input image that are deemed critical or carry distinctive information. The fusion of the heatmap with the model contributes to the discernment of discriminative regions. It facilitates the identification of crucial areas in the image, thereby improving the model's resistance to adversarial attacks [10]. This adaptive feature learning ensures that the model dynamically adjusts its attention based on the heatmap information, reducing the likelihood of false positives or negatives. In essence, the fusion of the heatmap with the Meso4 model not only enhances the interpretability of the model but also provides adaptive insights into relevant regions, making it more robust, accurate, and resilient in the realm of deepfake detection.

ViT model

The ViT model architecture (as in fig 2.) leverages the powerful attention mechanism of Transformer encoders for image classification. The input image is first decomposed into non overlapping patches, which are then linearly embedded into a lower dimensional space. To retain spatial information, positional encodings are incorporated. The resulting sequence of patch representations is then fed to a stacked Transformer encoder. Each encoder layer employs multi- head self-attention, allowing the model to learn complex relationships and dependencies between patches, extracting global features beyond local patch information. Finally, the encoded representation is projected onto class log it's for image classification. This approach demonstrates the effectiveness of Transformer-based encoders in capturing long-range dependencies in image data, leading to promising performance in image classification tasks.

Contribution 2

The data processing pipeline for this machine learning workflow initiates with loading the dataset using the PIL library [11], emphasizing the significance of efficient dataset handling for robust model training and evaluation. Subsequently, labels and IDs are mapped, with zero representing fake and one representing real, establishing a clear ground truth for supervised learning. The dataset is then judiciously split into training and testing sets to gauge the model's generalization capabilities beyond the training data. The code proceeds to load the model and create a processor for the Vision Transformer (ViT) pretrained model [12], crucial steps in integrating the pre-trained model into the workflow for feature extraction and classification. The input image size is aligned with the ViT model's expectations to optimize information flow during training and evaluation. Image Transformations are applied to enhance model robustness, allowing it to learn from variations in the dataset and improve generalization. A collate function is defined to efficiently prepare batched data for model training. Pre-trained weights for the ViT model are then loaded, leveraging knowledge from prior training to facilitate faster convergence. The model undergoes training and evaluation on the validation set, providing insights into its learning progress and predictive accuracy on unseen data. To showcase the model's practical application, an image is uploaded into the pipeline, demonstrating real-time predictions. The results, displayed as scores and labels, offer a concise and interpretable summary of the model's



**Devang Mulye et al.,**

predictions, ensuring easy interpretation and informed decision-making based on the provided outputs (as in fig 7. and fig 8.).

RESULTS AND DISCUSSIONS

Details of the dataset

This paper includes a comparative analysis of the Meso4 [3] and ViT image classifiers [4], it considers a meticulous approach to dataset selection [8], tailoring each to meet the specific requirements of the respective models. The dataset for the Meso4 model comprises 2,043 images, meticulously categorized into 960 fake images (as in fig 3(a)) with varying difficulty levels (easy, medium, or hard) and 1,081 real images (as in fig 4(a)). This comprehensive dataset was utilized for training, testing, and validation purposes, forming the foundation for our model evaluation. Conversely, the dataset for the ViT model was more extensive, encompassing a total of 190,305 images. For testing, we utilized 5,492 fake and 5,413 real images, while the training set comprised 70,000 images each for fake and real scenarios. Additionally, the validation set included 19,600 fake images (as in fig 3(b)) and 19,800 real images (as in fig 4(b)). This diverse and sizable dataset facilitated robust training, allowing ViT to demonstrate its capabilities across various image classification tasks. Based on the outputs obtained from these datasets, we meticulously computed and compared the performance metrics, summarizing the findings in the provided comparison table. This methodical approach ensures a comprehensive evaluation of the models, considering their specific training data and testing conditions. The Meso4 model's accuracy (as in fig 9(a)) starts at 0.65 at the first epoch and increases to 0.99 by the tenth epoch, indicating that the model is learning and improving its predictions with each epoch. The line graph shows a positive trend, which is a good sign in the context of model training. The model seems to be performing well as it's achieving high accuracy on the training data over time. As training progresses, the accuracy curve plateaus (as in fig 9(b)), indicating the model is no longer significantly improving. This could be due to:

- Saturation: The model has learned all it can from the data.
- Overfitting: The model is memorizing the training data too well and might not generalize well to unseen data.

CONCLUSION

This research work represents a thorough investigation into the realm of deepfake detection, leveraging the distinct strengths of Meso4 and ViT models while drawing insights from the DFDC and Face2Face datasets. Meso4's compact architecture, enriched by an innovative heatmap-driven enhancement, emerges as a pragmatic solution, demonstrating efficiency, interpretability, and resource economy. Its adaptability to real-time applications positions it as an asset for scenarios prioritizing quick responses. On the other hand, ViT, with its larger size and advanced transformer encoders, excels in accuracy and generalization, making it a versatile choice for diverse image classification tasks. The longer training times and slower inference speeds are counterbalanced by strong transfer learning capabilities and the accessibility of pretrained models. This research marks a significant milestone in the ongoing battle against the escalating threat of manipulated media. The developed detection system, comprising both Meso4 and ViT models, stands as a robust defense against deceptive information and identity theft in the digital age. Its distinguishing features include adaptability and scalability, effectively countering new and emerging threats in real-time data streams or large content batches. The seamless integration with social media platforms is a key highlight, enabling automatic identification and removal of deepfake content and thereby enhancing the credibility of online information. A pivotal aspect of our work is the emphasis on ethical use, regulatory compliance, and responsible content practices. By prioritizing these principles, the project not only addresses the immediate challenges posed by deepfake technology but also underscores the importance of responsible technological advancements. The significance of ongoing research and community engagement is highlighted in navigating the evolving deepfake landscape. Deepfake detection systems developed in this research can be applied in environmental monitoring by ensuring the authenticity of multimedia content related to environmental issues. By integrating the Meso4 and ViT models into surveillance systems, it can help identify and filter out manipulated





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media, enhancing the credibility of environmental data shared online. The adaptability, scalability, and real-time capabilities of the system make it suitable for monitoring large data streams or batches of content, contributing to responsible content practices in the context of environmental information dissemination. Ethical use, regulatory compliance, and collaboration with the community are emphasized, emphasizing the importance of responsible technological advancements in addressing challenges in the evolving environmental landscape. As we continue to refine and adapt our detection system, collaboration and shared knowledge will play a crucial role in staying ahead of the evolving techniques employed by those who seek to manipulate media for malicious purposes.

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13. Meso4 model Working Architecture source link
14. <https://viso.ai/deep-learning/vision-transformer-ViT/>

Table 1. Comparative study of findings from both the models

Metric	Meso4	ViT
Model Size	Compact	Large
Complexity	Moderate	Easy
Training Time	Fast	Medium – Slow
Inference speed	Faster	Slower
Accuracy	60% (Fluctuates as per dataset size)	>90% (reduces to >45 on unknown datasets)
Robustness	Task-specific	Generalizes well
Resource Requirements	Less	Higher
Transfer Learning	Good	Strong
Availability	Pre-trained models available	Pre-trained models available



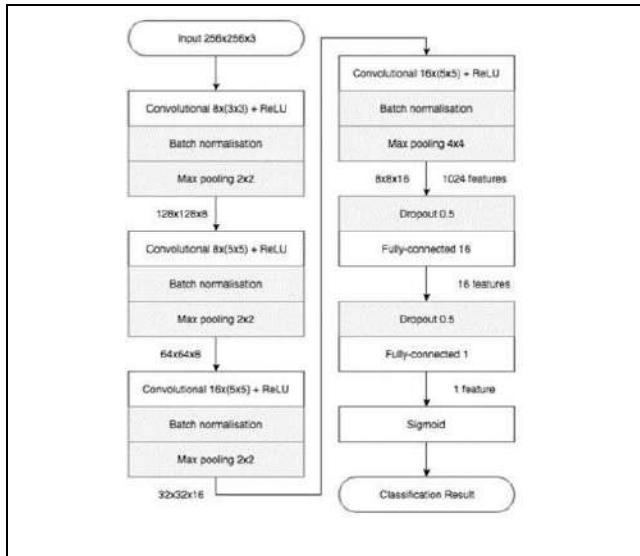


Figure 1. Working architecture of the Meso4 model. [13]

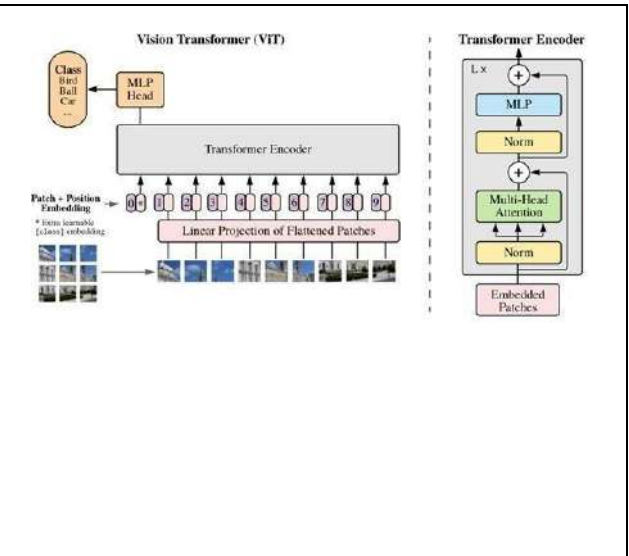


Figure 2. Architecture of the ViT Image Classifier model. [14]

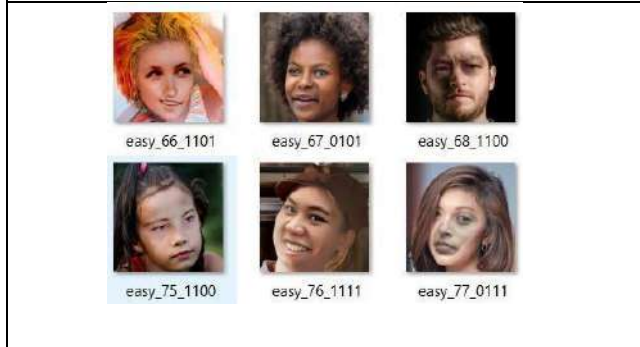


Figure 3. Samples of fake images used for (a) Meso4



Figure 3. (b) ViT



Figure 4. Samples of real images used for (a) Meso4



Figure 4. (b) ViT





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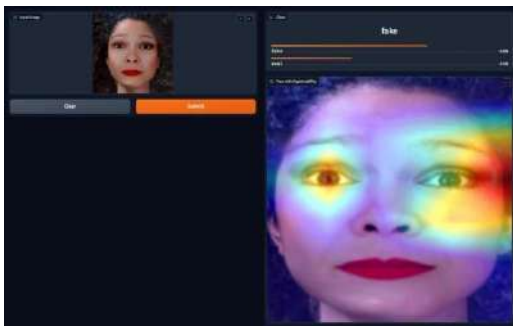


Figure 5. Mseo4 Output as a fake image

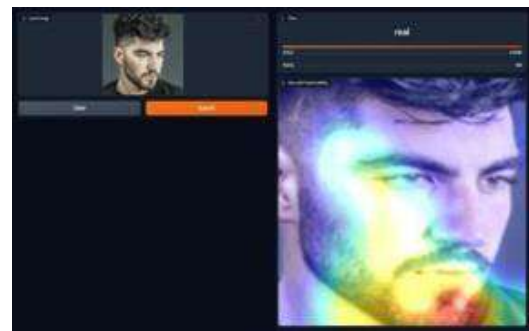


Figure 6. Meso4 Output as a real image

```
from PIL import Image
# Load an image from a file
image_path = "E:/Image Deepfake/Image Dataset/Validation/Real/real_128.jpg"
image = Image.open(image_path)
# Display the image
image
# Apply the 'pile' function to process the 'image' variable.
pile(image)
[{"score": 0.9970718122532278, "label": "Real"}, {"score": 0.863803219554270964, "label": "Fake"}]
```

Figure 7. ViT Output as a real image

```
from PIL import Image
# Load an image from a file
image_path = "E:/Image Deepfake/Image Dataset/Validation/Real/real_128.jpg"
image = Image.open(image_path)
# Display the image
image
# Apply the 'pile' function to process the 'image' variable.
pile(image)
[{"score": 0.995508123737488, "label": "Fake"}, {"score": 0.8994494150812778427, "label": "Real"}]
```

Figure 8. ViT Output as a fake image

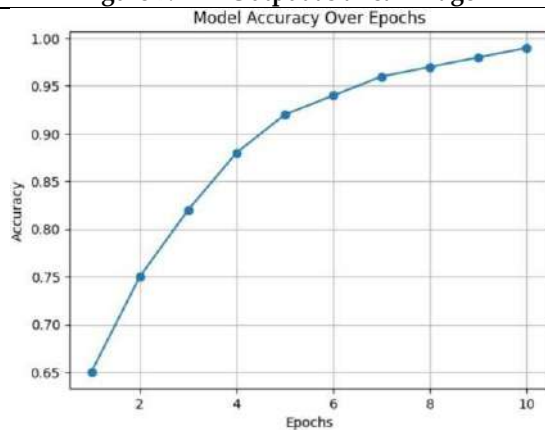


Figure 9. a) Accuracy versus Epochs of Meso4 model

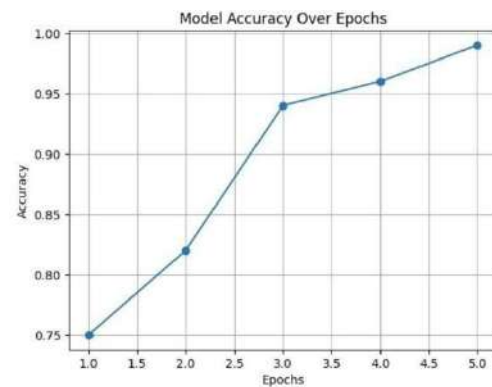


Figure 9. b) ViT models





Harnessing Blockchain Technology: A Comprehensive Review of Application Domains, Industry Transformations, and Future Prospects

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

This article examines the versatile and revolutionary uses of blockchain technology in several sectors. Through an analysis of practical applications in financial services, supply chain management, healthcare, and the public sector, we emphasize the substantial influence and potential of blockchain technology to transform conventional systems. Furthermore, this study examines upcoming patterns and potential uses, offering a forward-thinking viewpoint on how blockchain technology is positioned to continue to revolutionize and introduce advancements in several industries. The analysis also encompasses regulatory and legal factors to comprehend the difficulties and possibilities in navigating the dynamic terrain of blockchain technology.

Keywords: Blockchain, Web3.0, Genesis Block, Distributed ledger (DLT), Bitcoin (BTC), Ether (ETH), Peer – to – Peer Network, Mining, Immutability, Smart Contract, Consensus, Transaction, Transaction Pool (Mem Pool), Wallet, Trust less, DApps, Double Spending, IoT (Internet of Things), IoV (Internet of Vehicle), RFID, Blockchain Applications, Industry Impact, Financial Services, Supply Chain Management, Healthcare, Government Sector, Emerging Trends, Regulatory Considerations





INTRODUCTION

Blockchain technology has quickly grown from its use in cryptocurrencies to a potent innovation tool across many industries. Decentralization, transparency, and immutability can revolutionize more than digital currency. This paper enthusiastically and thoroughly explores how blockchain technology is transforming numerous sectors with secure and effective solutions. Decentralized finance (DeFi) platforms that offer financial services without middlemen are revolutionizing the financial services industry by cutting costs and boosting accessibility. Blockchain supports cross-border transactions and secures financial records, so cryptocurrency and smart contracts are just the beginning of its impact on finance. Blockchain technology is also changing supply chain management. Blockchain helps prevent fraud, improve inventory management, and verify product authenticity by ensuring transparency and traceability. Blockchain supply chain case studies show significant efficiency and reliability gains. Healthcare uses blockchain technology to secure patient data, streamline clinical studies, and track drugs. These apps improve data security and patient outcomes by improving data exchange and management. Blockchain is benefiting the public sector through digital identity verification, voting systems, and public record-keeping. Blockchain is making governance more responsible and efficient by decreasing bureaucratic inefficiencies and increasing transparency. Future blockchain trends and applications promise even bigger advances. Blockchain can be used with IoT and AI to increase its influence in numerous fields. This paper also covers blockchain's legislative and legal landscape, highlighting the need for a supporting framework to overcome its problems and capitalize on its benefits. Blockchain technology will continue to revolutionize sectors, enabling efficiency, security, and transparency. Blockchain's current and future applications and possibilities are covered in this paper, demonstrating its impact on several industries.

APPLICATION AREAS OF BLOCKCHAIN

Blockchain can be used for all those systems in which reversible transactions are not allowed.

Land Revenue (RoR)

A great deal of paperwork is required for land revenue transactions, including evidence of ownership and financial standing, as well as the transfer of deeds and titles. In order to verify and transfer ownership of land, blockchain technology could be used to record revenue transfers. Transactions can be processed faster, less paperwork can be generated, and costs can be reduced or eliminated altogether if counterfeiting is not an issue.

Monetary transactions

The original idea that inspired blockchain technology is still a good use case today. Blockchain-based monetary transfers have the potential to be both cheaper and more expedient than the current system. Particularly true for the time-consuming and money-consuming process of international trade. Whereas traditional bank transfers in the US can take days, blockchain transactions can be completed in minutes.

Lending

Creditors can process collateralized loans using blockchain smart contracts. Smart contracts on the blockchain can be programmed to trigger payments for services, margin calls, loan repayment, and collateral releases, among other events. As a result, lenders can provide more competitive interest rates and streamline the loan application process.

Insurance

Insurance companies and their customers alike can gain from the increased openness made possible by smart contracts on a blockchain. If claims were maintained on a blockchain, customers wouldn't bother filing duplicates for the same incidence. Claims might potentially be settled more quickly with the help of smart contracts.



**Maitri Hingu and Kamlendu Pandey****Protect personal data**

The storage of sensitive information, such as a person's Social Security number, date of birth, and other identifying characteristics, on a public ledger (such as a blockchain) is one potential enhancement that might be made to the current state of data security. There is a possibility that blockchain technology might be utilized to enhance and broaden access to important identifying information in a variety of industries, including aviation, healthcare, finance, and education, among others.

Voting

We are one step closer to using blockchain technology in elections if we can store personally identifying information on the ledger. By utilizing blockchain technology, we can guarantee that no one casts a vote more than once, that only eligible citizens are able to cast ballots, and that votes are not subject to manipulation. In addition, it can make voting as easy as tapping a few keys on a smartphone, which could increase voter turnout. Concurrently, the cost of conducting an election would be cut drastically.

Government privileges

A blockchain-based digital identity system can improve the administration of welfare, Social Security, and health care programs. There is hope that blockchain technology can cut down on operational and fraud expenses. At the same time, digital distribution based on the blockchain allows recipients to acquire their money faster.

Securely transmit medical information

When patient information is stored on a distributed ledger, medical professionals will always have access to the most up-to-date and correct version of a patient's medical history. It is feasible that this will ensure that patients who see several doctors receive the highest possible level of treatment. Additionally, it can assist in the rapid acquisition of medical records, which, in certain circumstances, can shorten the amount of time required for treatment. If insurance information is stored in the database, medical professionals will be able to simply determine whether or not the care they provide to their patients will be paid by insurance. MedRec is portrayed in [1] as an endeavor into this field to demonstrate innovative electronic medical record (EMR) solutions that utilize blockchain technology. It is not shown as a universal solution for the management of medical records. The authors demonstrate a novel approach to the management of medical records by providing auditability, interoperability, and accessibility through the utilization of a comprehensive log [1]. Keeping track of the links between patients and providers that relate a medical record to viewing privileges is something that they do [1]. It is the care provider who is responsible for generating the data queries and the metadata associated with them, which is then updated whenever new items are added [1]. They assume that a large number of nodes, primarily care providers, are successfully managing databases that include patient information that is stored on servers that are connected to the network [1]. For the purpose of effectively monitoring data behavior and removing access to data that has violated rules or permissions, the architecture employs smart contracts and access control mechanisms [2]. In modern civilizations, cultures, and organized groupings, the dissemination of medical data has been regarded as a significant step forward in the discovery of novel treatments and medicines for the purpose of curing disorders [2]. One of the services that they offer is a blockchain-based data exchange system that is safe for untrusted parties to use for electronic medical records [2]. The use of the proposed approach will allow cloud service providers to achieve safe data provenance and auditing, as stated in the citation [2].

Artist royalties

The use of blockchain technology to monitor the movement of digital media files online might help guarantee that artists get their due. Aiming squarely at the problem of content duplication, blockchain technology offers a promising solution that might be used to combat piracy. Applying a blockchain to document streaming service sessions and a smart contract to distribute royalties could lead to more openness and guarantee that artists get their rightful pay.



**Non-fungible tokens (NFTs)**

Using non-fungible tokens (NFTs) is commonly linked to the purchase of digital artwork rights. Due to the blockchain's limitation on duplicate data, placing an NFT on the blockchain ensures that digital art pieces exist in a single, unalterable version. It might give the impression of buying tangible artwork without the responsibility of storing it. Although NFTs have many potential applications, at their core they are simply a means of transferring ownership of any digitally recorded item. It might be the privilege of airing a video or even a ticket to a live performance. The term "NFT" could be used to anything that is even marginally unusual.

Logistics and supply chain tracking

There is a possibility that there are a number of benefits associated with monitoring products as they move through a logistics or supply chain system. To begin, the availability of information on a public ledger that can be trusted makes the process of information sharing between organizations more efficient. It is also hard to change the information that is saved on the blockchain, which allows for an improvement in both the security and integrity of the data that is stored there. In light of the fact that the information that is provided is more likely to be reliable and up to date, participants in the supply chain and logistics may be able to collaborate more freely as a consequence. Due to the fact that counterfeiters are unable to prove possession of products on this system, they propose a revolutionary blockchain-based product ownership management system for the post-supply chain [3]. This system would render the efforts of counterfeiters to clone authentic tags futile. One of the most significant challenges that exists in both domestic and international trade is the counterfeiting of genuine products, particularly those that are well-known brands [3]. This allows all players, including those in the supply chain and the end users of the goods that are being tracked, to transfer and verify ownership of the items in question [3]. This protocol is fully functioning and allows all parties to transfer and verify ownership of the objects of interest. In order to facilitate the after-market supply chain, they propose a new product ownership management system (POMS) that is based on blockchain technology. Specifically, they propose a novel method for identifying the owners of products, hence removing the requirement for the use of phony tag cloners [3]. One of the most important advantages of the proposed POMS is that it has the capability to prevent customers from purchasing counterfeit items [3]. With the implementation of Blockchain technology in the supply chain, there is a promising development that has the potential to benefit all of the numerous stakeholders involved in the process [4] for example.

Increasing the inflow efficiency of planning decision optimization should be possible with the use of blockchain technology [4]. There is a possibility that the online food retailer will provide funding for a trial project that will put the solution into action [4]. The creation of data models that enable the flow of electronic information from beginning to finish is an essential requirement [4]. Blockchain technology has emerged as a leading technological layer capable of supporting financial applications [4]. There are a number of critical issues that need to be addressed, and one of the most crucial ones is the obligation to incorporate all of the different actors. The purpose of this study was to investigate a case study of a supply chain associated with a big industrial firm that utilized blockchain technology to describe the system architecture and intelligent contract operation mechanism [5]. Chain is a complex structure that has rapidly emerged in the 21st century as a result of the significant advancements in network and information technologies as well as their widespread application [5]. As a result of the development and broad adoption of network and information technologies, the traditional linear single chain notion of the supply chain has been rendered obsolete [5]. As a result of reading this essay, readers will gain an understanding of whether or not it is feasible and feasible to implement blockchain technology in the supply chain endogenous risk management of large manufacturing companies. Once they have constructed a network system that is comparable, all of the business topics that are involved in the supply chain will be able to publish their own supply and demand data [5]. From the point of view of management, this will increase the creditworthiness of each business subject as well as the operational efficiency of the firm [5].



**Maitri Hingu and Kamlendu Pandey****Secure Internet of Things networks**

While the IoT improves our quality of life, it also opens the door for cyber criminals to steal our personal information or take over our most important machines. Blockchain technology improves safety since it uses a distributed network to store information rather than a central server to do it. Also, data manipulation is prevented by blockchain's immutability.

Data storage

Integrating blockchain into a database system can improve its robustness and trustworthiness. In contrast to a centralized data storage provider, which may only have a few points of redundancy, it may be more difficult to hack into a decentralized network and wipe out all of the data. This also means that data is more readily available, as it will no longer be dependent on the actions of a single entity. Blockchain data storage has the potential to be cheaper in several use cases.

Gaming

There are a lot of ways in which the gaming business may use blockchain technology. One major advantage of running a casino on the blockchain is the improved transparency it provides to players. The immutability of the blockchain records every transaction, so players may check the casino's validity and game fairness. To add insult to injury, blockchain eliminates the requirement for participants to reveal personally identifiable information (such as a bank account)—a feature that may deter some prospective users. This technology is able to circumvent regulatory constraints because gamblers have the option to remain anonymous and the government cannot shut down the decentralized network. Blockchain is utilized for access management and data storage, for the purpose of managing transactions, which is a network consisting of several stakeholders such as hospitals, doctors, pharmacies, pathology labs, imaging centers, medical research centers, and insurance companies [6]. Blockchain is utilized for access management and data storage. Biomedical research and smart healthcare have long been top priorities that should be supported in any way feasible [6]. The core of the suggested architecture is the generative data ingestion from biosensors and smart wearables [6]. The cutting-edge blockchain architecture adheres to the primary audit approach used by stakeholders like insurance companies, hospitals, and doctors [6]. The author proposed a three-level architecture on different phases, including a Web Platform that patients can use to upload their health records and keep an Access Management Suite up to date [6]. The Web Platform's data will be fetched through REST API services, and Cloud Middleware will be utilized to call on Smart Contracts to carry out the required registration of newer blocks and to support consensus of the Nodes across the Blockchain network that is held in the third level [6].

They concluded that there is a high probability that Blockchain Technology will usher in a new era of digital services characterized by increased service efficiency, customer happiness, trust, security, privacy, cost savings, etc. [7]. New and potentially revolutionary, Blockchain Technology may soon alter the face of the ICT industry altogether [7]. The majority vote is required to authorize a transaction [7]. E-tender refers to a completely online tendering procedure [7]. Role assignment, network node authenticity, consensus mechanisms, and system consistency are all the purview of the ordered nodes [7]. A blockchain-based ID as a Service has been presented in this article, which is a novel type of ID as a Service for identification and authentication management [8]. They've seen a variety of blockchain financial uses, as well as a number of multinational companies using blockchain technology for a variety of purposes. They have introduced a new type of ID as a service for managing identification and authentication [8]. There is space for improvement in the planned BIDaaS. The suggested BIDaaS serves as an identity and authentication management infrastructure for a mobile telecommunications company's mobile user. When a user seeks access to a partner's service using their virtual ID, the partner receives the user's virtual ID and public key information from the BIDaaS blockchain [8]. They offer a user-centric approach to altering the content delivery ecosystem, which they believe is necessary [9]. Marc Prensky coined the phrase "Digital Natives" in 2001 to describe what he saw as a shift in the educational landscape. This generation is transforming the television industry by using over-the-top (OTT) services as their primary means of accessing a ubiquitous, on-demand, and user-centric entertainment experience [9]. They offered new approaches for blockchain-oriented software engineering based on the findings of the investigation,



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focusing on collaboration among large teams, testing activities, and specialized tools for the production of smart contracts [10]. The burgeoning concepts of blockchain and smart contracts have received a lot of attention in recent years. The goal of this article is to expose current issues and future directions in blockchain-oriented software engineering [10]. It looks into the demand for new specialized software engineering approaches in the blockchain industry. They describe blockchain-oriented software (BOS) as any program that interacts with a blockchain implementation. Because of the blockchain's distributed structure, certain measures are needed to assess its complexity, communication capability, resource consumption, and overall performance [10]. Blockchain is a novel platform that does away with the need for a single, centralized authority. It has a wide range of functionalities that are important to healthcare DApps, such as health data exchange and data access control [11]. Smart contracts are pieces of code constructed on top of a blockchain that can be executed if certain criteria are met. The storage of encrypted sensitive data should be limited in decentralized apps [11]. For businesses all across the world, fraud prevention is an important and continuous priority. According to the Association of Certified Fraud Examiners' 2016 Report to the Nations on Occupational Fraud and Abuse, the overall loss caused by fraud events in 2016 exceeded \$6.3 billion [12]. The main strategies for concealing frauds were modifying or deleting information in accounting systems, manipulating electronic documents, and generating fake electronic files. A more secure accounting information system is required to reduce fraud risk [12]. A smart grid system is equipped with a sovereign blockchain-based system that guarantees transparency, provenance, and immutability [13].

In the current day, it is believed that the utilization of electricity is the fundamental building block that makes it possible to discover or develop new technologies. To create a tamper-proof mechanism for safeguarding customer data stored and transferred onto the smart grid system, they suggest a sovereign blockchain-based solution paired with smart contracts [13]. They intend to put the system into practice and get workable outcomes [13]. They demonstrate the codes required to ensure the privacy of communications between customers and the relevant utility firms [13]. The smart contracts on the smart meter are activated and turn off the electricity when a consumer's power runs out [13]. This research differs from earlier works in that it offered a blockchain-based safe crowdsensing incentive system in which miners can remove the security and privacy concerns brought on by a central authority by analyzing verified data characteristics [14]. With the rise of smartphones with strong sensors built in, crowdsensing has emerged as a key paradigm for effectively collecting data by utilizing the widespread smartphone user base [14]. The privacy of the nodes could be obtained by the miner by confirming the transaction when a cryptocurrency like Bitcoin or Monero is used to encourage a node to accomplish a sensing task in a crowdsensing application. They suggest a blockchain-based safe crowdsensing incentive system where the security and privacy concerns brought on by a centralized authority can be resolved by the miners' verified data quality evaluation [14]. They investigate the prospect of integrating Blockchain technology to safeguard cloud-hosted healthcare data [15]. The gradual migration of data and services to the cloud is one particular trend seen in the healthcare industry. The accountable healthcare practitioner stores medical and clinical information about a specific patient in Electronic Medical Records (EMRs).

The requirement for real-time healthcare data sharing across various providers grows more obvious in medical tourist spots like Singapore [15]. Paper-based data is difficult to get into systems, expensive to store, and readily available when needed [15]. In order to facilitate the move from duplicated computing on the blockchain to distributed parallel computing architecture, this article presents a vision and suggests mechanisms for doing so. It does this by converting smart contracts to include data driven features from the ground up [16]. This article suggests a brand-new distributed parallel computing architecture on the blockchain for big data analysis, particularly for precision medicine [16]. Different hospitals, patients, and health service providers own and keep their own sets of data, which are kept in different places [16]. In [17], they present a vision and suggests methods for converting the blockchain's replicated processing into a distributed parallel computing architecture using smart contracts that are built on native data. For the study of huge data, particularly for precision medicine, this paper suggests a new blockchain distributed parallel computing architecture. Each hospital, patient, and provider of healthcare has their own collection of data, which is kept in a distinct place [17]. They provide a parallel healthcare system architecture built on artificial systems, computational experiments, and a parallel execution strategy [18]. The idea for SMART healthcare was inspired by IBM's 2009 smart earth project [18]. It describes the combined use of big data, cloud



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computing, Internet of Things, and artificial intelligence to provide an interactive platform for exchanging medical information [18]. The hospital's clinical system allows for the parallel execution of real and artificial doctors while developing a diagnostic and treatment plan [18]. The artificial physician incorporates the clinical expertise, professional expertise, reasoning styles, and actual gout cases with knowledge graph [18]. The PHSs replicate and depict real-world healthcare scenarios using artificial system modelling [18]. The first higher education institution to deposit academic credentials on the Bitcoin blockchain is Nicosia University [19]. Applying blockchain technology will increase confidence among stakeholders, including higher education institutions and students [19]. The higher education institution manages online transactions for the students' certifications and payment of fees [19]. Deep learning and quantum-resistant blockchain are combined in the architecture known as BinDaaS [20]. To guarantee the confidentiality and authentication of patient EHR records, a lattice-based signature technique is employed [20]. The proposed framework would comprise previous electronic health records (EHR) of patients who will be trained using node degree and diameter comparisons [20]. Patient health records are now stored electronically rather than manually as they once were [20]. The Lattice cryptosystem is used to create security evaluations, which are then computed and communicated cost-based [20]. The Internet of Things includes a wireless sensor network, which is crucial [21]. This paper's proposed authentication method identifies the authenticated party by using the direct management node of the ordinary node [21]. The investigation of security and performance reveals that the plan is both efficient and secure [21]. Every common node in the network has a distinct OID identity [21]. It is able to identify any regular node in the entire network using (SID, CID, and OID) in accordance with it. WSN subnet and cluster network, which correspond to the special cluster head node CID and base station SID [21].

By funding the most publications listed in Web of Science, the findings showed that the National Natural Science undation of China had made wise investments in blockchain research [22]. Since the creation of the digital currency Bitcoin in 2008, Blockchain technology has become a focus of attention for a wide spectrum of researchers and practitioners [22]. 616 of the 995 Blockchain papers that Web of Science has indexed from 2013 to 2018 have not yet received any citations [22]. Based on the typical annual number of citations, IEEE Access has published the two publications with the highest citation counts. China is the only Asian nation that actively produces highly regarded publications in this area [22]. Based on the overall number of articles, Lecture Notes in Computer Science and IEEE Access have emerged as the most popular venues [22]. Coins must be purchased from the controller in order to change its value in the blockchain record, which any consumer can do [23]. The blockchain's primary function is to ensure the safety of energy records, keep track of all trades, streamline operations, and reduce the likelihood of errors [23]. Because it integrates blockchain-based distributed architecture into the SG system, the proposed SETS ensure the confidentiality and security of all P2P network communications. Many modern systems rely heavily on energy, including those used for transportation, communication, and the administration of intelligent devices [23]. By storing their energy trading transactions in the blockchain, consumers have a new marketplace for their generated and sold energy [23]. Secure Energy Transaction System (SETS) protects both consumer and utility information against unauthorized access and disclosure [23] A thorough examination of the technical details revealed that the majority of the suggested solutions relied on the Ethereum platform's private blockchain [24].

Medical research has been steered toward blockchain-based architectures due to the necessity of highly protected interoperability and confidential and accurate medical data [24]. The use of blockchain technology, with its built-in cryptographic validation and timestamp mechanism, can improve clinical trial processes by laying the groundwork for more trustworthy and auditable clinical research [24]. Future directions may include either lessening the amount of data created or expanding the amount of storage space [24]. The potential of bringing blockchain to the healthcare sector has been boosted by the fact that existing healthcare systems have security, privacy, and interoperability problems [24]. Since blockchain may be used to resolve data management and identity management difficulties, it has great potential for use in the electronic health record [24]. By modifying the standard decentralized authentication approach, they propose a Blockchain-based technique for protecting intellectual property via homomorphic encryption [25]. The ephemeral nature of digital products, for example, presents numerous obstacles to the preservation of digital IP cores [25]. They present an alternative decentralized authentication approach to



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implement a Blockchain-based IP copyright protection mechanism that makes use of homomorphic encryption [25]. With more and more IP fundamentals moving to the digital realm, it is crucial to have safeguards in place to ensure their security [25]. When tested against a double-spending assault, the proposed approach performed better [25]. The distributed ledgers can be realized with blockchain technology, a new technology that has received a lot of study recently [26]. Many methods have been developed in recent years to address the scalability of blockchain, and these methods are described in Section III [26]. They explain the scalability issues with blockchain performance [26]. To increase Bitcoin's transaction throughput and decrease its confirmation time, SPECTRE, a Proof-of-Work (PoW) system, employs a structure known as a direct acyclic graph (DAG) [26]. Zilliqa increases throughput by splitting up transactions across multiple shards, but data for the entire network must still be stored on every node [26]. Experimental results show that the Optimal Least Square Support Vector Machine model may generate high-quality predicted outcomes for Blockchain money products [27]. As the world economy has expanded significantly in recent years, some issues that formerly hindered expansion have been rendered irrelevant [27]. Measuring the SVM model's performance on the training set in terms of Mean Absolute Percentage Error reveals that it has a propensity to make inaccurate predictions [27]. The OLS-SVM model's efficacy was tested using the target's ETH return rate [27]. In this study, we introduce a new model for predicting future returns using the OLS-SVM classification technique [27]. The article lists the four most important prerequisites for using blockchain technology in smart cities [28].

The rapid increase in urban populations around the world has a devastating impact on the standard of living for ordinary people. One of the most crucial requirements of blockchain technology in smart city applications is the protection of people's privacy [28]. Significant study is needed to develop suitable low-cost mechanisms for the quick processing of transactions. The purpose of this research is to examine how blockchain technology, a relatively new innovation, might be used to ensure the safety of smart cities [28]. The research highlights four aspects of blockchain technology that make it an ideal fit for smart cities. Key interoperability difficulties will be discussed, as will the application of blockchain in various device kinds [28]. The authors of this research offer a streamlined, user-friendly, and hassle-free platform for facilitating land registration [29]. This paper proposes a streamlined, user-friendly, and hassle-free platform for facilitating land registration. Involvement of brokers or middlemen, delays, and so on are only a few of the issues that arise [29]. For the purposes of building a ledger that records dealings in the transfer of real estate ownership, Ethereum is ideal. The blockchain keeps track of all the transactions that occur as a result of the needs of vendors and purchasers [29]. The potential is enormous, and the platform has a lot of potential applications [29]. Using data that has hitherto been kept confidential by hospitals, the suggested methodology can aid in the detection of COVID-19 patients through lung screening [30]. The suggested architecture gathers inputs and trains a smart model collectively [30]. The weights are a synthesis of the many regional models, with the confidentiality of the hospitals' information preserved. As hospitals are willing to share patient information, the proposed methodology can aid in the detection of COVID-19 patients through lung screening [30]. The proposed CC-19 dataset includes 34,006 CT scan slices from 89 patients [30]. Numerous deep learning models were subjected to extensive testing [30].

BLOCKCHAIN IN E-GOVERNANCE APPLICATIONS

Blockchain is a worthwhile technology for assisting governments in tracking, monitoring, and auditing the food supply chain, as well as assisting producers in recording transactions in a legitimate manner [31]. Each transaction segment has a permanent record in blockchain, which is bundled into individual blocks and cannot be tampered with. Although there are still some drawbacks, promoting blockchain is a worthwhile technology for assisting governments in tracking, monitoring, and auditing the food supply chain. Many customers have become less dependent on food as the number of food-borne diseases continues to rise. The government can collect statistics on numerous types of food using the traceability system's integrated feature [31]. Instead of looking to trusted third parties for evidence, such as government registries, blockchain technology has the potential to transform their paradigm for trusting records [32]. In this way, a trustworthy personal identity system can be established. In many nations and fields, blockchain technology has received a lot of attention. When blockchain technology is used to create an individual credit system, all of these personal records may be kept in one place. This will lower expenses, increase client happiness, and broaden the application's scope [32]. To maintain a constant standard block time T_n



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over a growing network with a growing hash power Hr, the difficulty is increased [33]. Selfish mining, the 51% attack, DNS attacks, eclipse attacks, and consensus latency are all made possible by the decentralized nature of the network [33]. There are a lot of cool potential uses for blockchain technology right now [33]. Internet of Things, healthcare, electronic voting, e-government solutions, and the supply chain are just a few of the areas where they are being put to use. Using Blockchains may open up new attack vectors for these kinds of attacks, even if they would be very impossible in a traditional client-server architecture [33]. Sixteen studies on E-governance in different contexts are found after a comprehensive search and critical quality rating [34]. This research reviews the vast majority of published material on the subject of protecting national e-governance systems [34]. Existing e-government frameworks have not been able to properly address a number of security and privacy issues [34]. In the past, researchers have not made use of blockchain technology to strengthen the safety of the Saudi E-Government network. To ensure the safety of the system and its users, a new framework has been proposed to include blockchain technology into Saudi Arabia's E-Governance [34]. The addition of blockchain technology as a bridge between the two safe areas will result in improved security in terms of data security, privacy, and control of who has access to what [34]. This research study examined the impact of big data and data analytics research on collective wisdom in human decision-making and smart computers while providing e-government services [35]. Cities worry about resource efficiency as urban systems become increasingly complicated. E-government improves public service efficiency, freeing up resources for expanding and developing metropolitan regions. Their article addresses E-Government from a European Union level to national performances and EU urban areas [35].

BLOCKCHAIN IN IOT

Even if only a handful of them are expressly intended for the Internet of Things, they discovered various use cases for private and decentralized data management that are consistent with their research aim [36]. The authors claim that if an attacker has a computational power multiple of the computational power of honest nodes, he or she can create a branch of the blockchain that can outperform the existing one in terms of PoW difficulty [36]. Because gaining a substantial fraction of processing power is difficult, such danger is avoided in existing big and robust blockchains like the Bitcoin one [36]. The Internet of Things refers to a network of multiple physical items that are connected to the Internet [36]. The eventual objective of their study is to use blockchain and peer-to-peer technologies to create a private-by-design IoT in which data generated by devices is not entrusted to centralized businesses [36]. In the current study, a novel algorithm based on statistical likelihood maximization and polynomial matrix factorization was effectively implemented with PoW [37]. The Internet of Things is the current network computer technology trend (IoTs) [37]. Blockchain has been popular in the IoT ecosystem due to its distributed method, consensus mechanism, and transparent transactions [37]. These advantages made it a trustworthy method for mining and cryptocurrency [37]. To reach a consensus that is assured, they suggest using a statistical approach to solve the mathematical conundrum in PoW [37]. IoT must effectively deliver the anticipated outcome so that condition-constrained devices can take part in the consensus [37]. No significant application of the power blockchain has yet been made [38]. Network nodes that share security are dynamically added.

In order to achieve network consensus and authentication, a power node is dynamically added. The block cannot be stored in the blockchain due to storage and data volume restrictions. The secure data transaction architecture can be employed in a powerful blockchain-based network to thwart the entry of illicit activity. Applications for the proposed secure data transport method include industrial IoT in the power and energy sectors [38]. They look into the potential uses of blockchain technology for IoV (Internet of Vehicles) applications [39]. As Internet of Vehicles technology advances, a sizable number of IoV nodes must access this vast network [39]. They outline the potential blockchain participation of IoV nodes and suggest a multi blockchain network architecture. There is a tremendous quantity of traffic to manage [39]. For in-vehicle networks, a decentralized trust management system based on blockchain technology is suggested [39]. The functionality added by blockchain technology through the APIs provided by network nodes or by any specialized intermediaries would undoubtedly benefit the Internet of Things [40]. Data that is directly incorporated in transactions and transmitted in messages between various IoT devices is routed to block chain nodes by devices that take part in exchanges. To ensure safe data transmission between internet-connected devices, the authors of the paper attempt to introduce blockchain technology for the internet of



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things. This is the important question that drives us to create a safer architecture for their IoT-based cars to ensure their safety and security [40]. One of the most disruptive technologies of this century has been named as the Internet of Things (IoT) [41]. The consensus mechanism must reduce the rate at which new blocks are accessed in order to prevent forking and maintain a single version of the ledger among all users [41]. Users can add their blocks to the blockchain at any moment, provided they process the previous transactions, thanks to a DAG-based consensus mechanism [41]. They evaluate the performance of Direct Acyclic Graph-based consensus with two widely used consensus mechanisms in order to highlight its benefits and drawbacks for IoT [41]. For large-scale IoT, DAG-based consensus techniques are preferable to Proof of Work and Proof of Stake [41]. Due to the large number of data generated by IoT Things, performance and scalability are the primary issues when integrating blockchain with the Internet of Things platform [42]. The Internet of Things intends to create a smart environment by connecting Things to the internet and exchanging acquired data in a peer-to-peer model [42]. Due to the large volume of data generated by IoT Things, performance and scalability are the primary issues when integrating blockchain with IoT platforms [42]. Permissioned blockchain is preferable to public blockchain for IoT platforms [42]. Sergio et al. did a mapping study to assist academics in understanding the characteristics, processes, existing solutions, and obstacles of blockchain-based IoT development [42]. The Industrial Internet of Things is made up of a variety of smart objects that are dispersed throughout the entire industrial system to gather vast amounts of ambient data [43].

This data can be used to spot performance bottlenecks, resolve issues, and spot malicious activity, effectively enforcing control over the physical world [43]. Several industrial sectors, including manufacturing, logistics, transportation, healthcare, energy, and utilities, are being transformed by the Internet of Things [43]. The Industrial Internet of Things (IIoT) is made up of numerous smart objects that are dispersed throughout the entire industrial system to gather vast amounts of ambient data that can be used to locate performance bottlenecks, resolve issues, and identify malicious behavior enforcing effective control over the physical world [43]. Numerous issues, including distributed consensus methods and data analytics with privacy preservation in IIoT systems, must be addressed [43]. They researched different blockchain commercial implementations in Industry 4.0 and the Industrial Internet of Things to establish an abstract metric of acceptance in real-world applications [44]. They investigated different blockchain commercial implementations in Industry 4.0 and IIoT to establish an abstract metric of acceptance in real-world settings [44]. They provide a summary of all the industry-specific case studies examined in this study in Table 2, along with information about the blockchain technology used in each area [44]. The transparency, dependability, and efficiency of the whole supply chain business have significantly increased thanks to features of blockchain such data accessibility and immutability [44]. In earlier work, authors presented a blockchain-based bloom filter technique for fast data aggregation and privacy preservation in smart grids [44]. Due to its necessity in many industries, decentralized architecture has gained a lot of recognition in recent years [45]. In-depth descriptions of numerous blockchain application cases are provided in this paper, which may be helpful to readers and researchers [45]. The incorporation of blockchain technology with IoT has made it possible for developers to envision a variety of uses in many industries [45]. These include smart grids, the energy industry, and agriculture [45].

Their focus is on the business world; thus, they've addressed the issue of how to use blockchain technology in industrial IoT [46]. New opportunities for profit in both business and social IoT settings have led to an increase in study of the IoT's implications [46]. To host apps, store data, and transfer information securely, the blockchain employs cryptography as a distributed ledger technology (DLT) [46]. Several IIoT solutions built on the blockchain are now being developed in various manufacturing sectors [46]. Blockchaining both IIoT entities and business processes is of great importance to the sectors [46]. Successful use of blockchain in digital twins is hampered by issues with scalability, standardization and laws, data protection, and interoperability [47] [48]. The current state of affairs with digital twins in preparation for Industry 4.0 can be enhanced by utilizing blockchain technology [47]. The widespread implementation of blockchain technology in DTs is hampered by issues with scalability, standardization and laws, data protection, and interoperability [47]. DTs' levels, design phases, industrial use cases, important objectives, enabling technologies, and core applications are all included in the taxonomy they give [47]. When used to sectors such as industry, transportation, commerce, urban planning, healthcare delivery, and the Internet of



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Industrial Things, DTs have proven to be revolutionary (IIoT) [47]. They described a four-tier eco-friendly IoT-based agriculture framework [49]. Smart farms, smart homes, wearables, and smart cities are just a few examples of how the Internet of Things has been put to use [49]. Security and privacy solutions for IoT applications are discussed, along with how they will be modified for use in environmentally friendly IoT-based farming [49]. They discussed the big picture of a four-tier green IoT-based farm system. To centrally manage permissions, Novo developed a blockchain-based distributed access control system [49]. Li et al. researches can guarantee the integrity of named data networks [49]. In this special issue, they provide the most recent findings on the application of private blockchain technology to the Internet of Things in the manufacturing sector [50]. In this special issue, they provide the most recent findings from studies of private blockchains' applications in the industrial Internet of Things [50]. Because of its benefits and industrial qualities, private blockchain has been successfully implemented in industrial IoT [50]. Optimizing the scalability and decentralization, Cao et al. introduce a new algorithm based on Two Arch [50]. When it comes to Internet of Things (IoT) and Internet security, they gave a review of the literature on how Blockchain smart contracts are being used [48]. As a whole, the Internet of Things (IoT) has been the focus of several solutions since it has greater security flaws than the Internet as a whole [48]. Access control, authentication, integrity assurance, data protection, secure key management, and non-repudiation are some of the most popular security services driven by smart contracts [48]. The growth of the Blockchain Technology development and research field has been exponential [48]. They found and compiled 77 original studies that addressed the topic of using Blockchain smart contracts for Internet of Things security [48]. In the future, we need to address these issues and put the proposed smart contract based security solutions through their paces in a variety of hostile environments [48].

DISCUSSION

In the banking sector in particular, blockchain technology has enormous potential to address current problems. The financial industry is preparing to incorporate blockchain technology into their offerings. According to NITI Ayog, all Indian states should adopt this technology to digitize their land and health records. The government of Andhra Pradesh has already begun using it for the city of Amaravathi's land records. Indian officials hope that by developing a national blockchain framework, they will be able to influence the future of 44 different industries, including education, healthcare, agriculture, energy, e-governance, and more. Since blockchain technology has many advantages over older methods while having fewer negatives, it should be implemented in services like these. Money laundering can be uncovered and stopped, which is good for the economy and will hopefully encourage people to be more forthright. The retrieval of misplaced paperwork will be a breeze. One of the difficulties is that blockchain hasn't been widely used in different sectors because its data structure requires universal agreement. Together, a large group of people using a blockchain can improve its performance and make it more efficient. Users aren't the only people who need to be part of a network; in the case of a blockchain ecosystem, for example, providers are required as well. Without widespread adoption, the benefits and scalability of blockchains cannot be realized. Another issue that can arise with blockchain technology is that it is susceptible to sabotage in the event that a miner with nefarious intents also controls the majority of the available processing power. By reversing the transactions, he is able to spend his coin twice as much. This strategy is often referred to as the "51 percent attack." They've presented a unique blockchain-based product ownership management system for the post-supply chain that renders counterfeiters' efforts to clone legitimate tags obsolete because they can't show product ownership on this system [3]. Counterfeiting of branded goods, for example, is one of the most important and challenging issues to address in national and international marketplaces [3]. They propose a comprehensive protocol that allows all parties, including supply chain partners and customers, to transfer and prove ownership of RFID-tagged objects [3]. For the post-supply chain, they have presented a revolutionary blockchain-based product ownership management system (POMS) [3]. They offer a revolutionary product ownership management system that eliminates counterfeiters' efforts to clone genuine tags [3]. They looked at the scalability problem with blockchain systems, which is a growing challenge when using blockchain in actual corporate settings [51]. Blockchain, the technology that powers Bitcoin and other cryptocurrencies, has drawn a lot of interest [51]. Both academia and business are attempting to integrate the innovative technology into a variety of fields, including the Internet of Things and smart cities [51]. They looked at the difficulty of scaling



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blockchain systems [51]. Researches are being done to develop efficient enabling technologies that will enable scalable blockchain systems [51]. Some enabling technologies have been introduced to effectively convey transaction information and decrease the demand on network bandwidth resources [51]. The role of blockchain technology in achieving smart agriculture's security objectives has been the subject of a recent comprehensive review [52]. They give a thorough analysis of the alternatives that have been presented for smart sensing applications that are based on the Internet of Things. Computational and communication expenses, as well as their benefits, limitations, and security features, have been thoroughly examined [48]. Some paths forward for some open and difficult challenges have been identified as a result of this research [52]. An alternative blockchain-based PKI has been proposed, which treats thin clients as fully functional users [52]. Zhou et al. presented a method of authentication that would make use of a public key infrastructure (PKI) based on identity-based encryption (IBE) [52].

CONCLUSION

The blockchain technology has demonstrated itself as a groundbreaking power, catalyzing significant transformations in several sectors. The fundamental characteristics of decentralization, transparency, and immutability provide unparalleled options for improving the effectiveness, safety, and reliability of digital transactions and data management. This article has explored the diverse uses of blockchain technology, demonstrating its revolutionary influence on areas such as financial services, supply chain management, healthcare, and the public sector. Blockchain technology in the financial services sector is enabling broader access through decentralized finance (DeFi) platforms. These platforms decrease dependence on conventional middlemen and improve the security of transactions. Smart contracts enhance the efficiency and security of financial agreements, minimizing the risk of mistakes and fraudulent activities. The incorporation of blockchain technology in cross-border transactions and financial record-keeping represents a significant transition towards more streamlined and transparent financial systems. The field of supply chain management greatly benefits from the real-time transparency and traceability that blockchain technology offers. Blockchain guarantees the genuineness and incorruptibility of items in businesses like pharmaceuticals by documenting every transaction and movement of goods on an unchangeable database. Enhanced visibility results in increased productivity, decreased costs, and enhanced consumer trust. Blockchain technology is a valuable solution for addressing important issues concerning the management of patient data in the healthcare sector. Blockchain improves privacy and data security by guaranteeing that patient records are protected, unchangeable, and exclusively accessible to authorized individuals.

Furthermore, it enhances the synchronization of healthcare and simplifies the process of conducting medical experiments by allowing secure and transparent exchange of information among all involved parties. Blockchain applications offer substantial benefits to the public sector as well. Blockchain-based digital identity verification solutions provide the potential to improve security and efficiency in government services. Blockchain has the potential to transform voting systems by enhancing openness and trust in election procedures. It can also enhance the maintenance of public records by guaranteeing the reliability and availability of important documents. The future holds great potential for the integration of blockchain with new technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI), offering significant opportunities for innovation and automation. Nevertheless, effectively maneuvering through the intricate regulatory and legal environment continues to be a crucial obstacle. Establishing conducive regulatory frameworks will be crucial to promote innovation while assuring adherence to rules and safeguarding security. To summarize, blockchain technology is positioned to bring about substantial progress and generate fresh opportunities in several industries. Industries may attain higher levels of efficiency, security, and transparency by utilizing the transformative capabilities of technology, thereby creating a path towards a more innovative and decentralized future.





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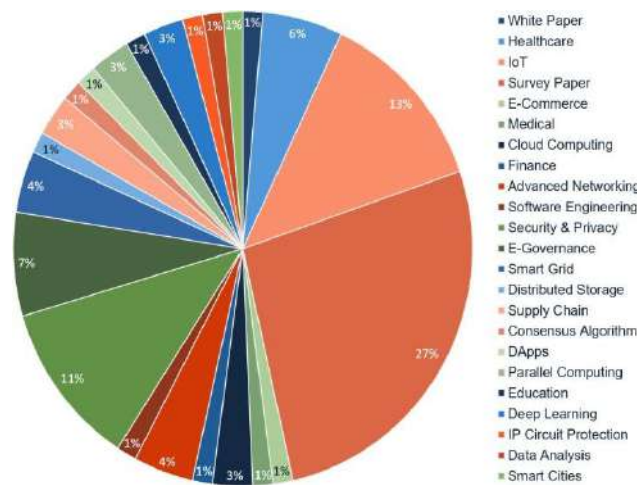


Fig. 1. Current Research in Blockchain around the world.





On Solving a Decision Making Model to Select a Hospital for Maternal Care using Bipolar Neutrosophic Soft Sets

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 01 Jul 2024

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ABSTRACT

This paper presents two different algorithmic approaches to solving the multi-criteria decision-making problem under a bipolar neutrosophic environment. Then, some new definitions of the bipolar neutrosophic soft sets are proposed, such as the comparison matrix, aggregate function, and score function. The comparison matrix is used to develop the first approach, and the second approach uses an aggregate function to rank the alternatives. Finally, the hospital selection problem has been explained with an appropriate numerical illustration.

Keywords: Bipolar neutrosophic soft set, Comparison matrix, Aggregate function, Score function, Hospital selection.

INTRODUCTION

Neutrosophic set theory was proposed by Florentin Smarandache[4] in 1998 and is a useful technique for handling information with ambiguous, indeterminate and inconsistent data. The neutrosophic set(NS) is extension of both fuzzy sets[1] and intuitionistic fuzzy sets [2]. Wang[6] developed the concept of single valued neutrosophic set(SVNS). Bipolar fuzzy sets (BFS) were developed by Zhang[7], and the membership values lie in [-1,1]. I.Deli[9] created the theory of the bipolar neutrosophic sets (BNS) and additionally proposed a MCDM technique based on BNWA and BNWG operators. The Bipolar neutrosophic set plays an important role in multi-criteria decision making problem(MCDM), and it has been applied to many real-world problems. Recently, A soft set and a bipolar fuzzy set

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were combined by M.Asalam and K.Ullah[8]and also propose a methodology to solve the MCDM problem.M.Ali[10] defined an aggregation bipolar neutrosophic soft operator and provided the algorithm based on bipolar neutrosophic soft sets(BNSS). M.N.Jafar [11] et al.introduced aggregation operators for bipolar neutrosophic soft sets(BNSS) and used them to solve MCDM problems. M.Lathamaheswari [12] et al. created bipolar neutrosophic frank aggregation operators and developed a MCDM approach to solve the bridge selection problem. Ashraf AI [13] et al. created a new method for decision-making using a complex bipolar-valued neutrosophic soft set. New distance and similarity measures for bipolar fuzzy sets were introduced by M.Riaz [14] and others, and they applied their method to supply chain management. SY.Musa [15] created a novel approach to parameter reduction based on bipolar hypersoft set. M.Jamil and others proposed the Einstein aggregation operators [16] and the hamacher geometric Aggregation operators [19] within the context of the bipolar neutrosophic set. S Pramanik [17] explored a vikor-based magdm in a bipolar neutrosophic environment. MK. Mahmood [18] et al. introduced the bipolar neutrosophic dombi aggregation operators and used their operators in MCDM problems. H Kamaci [20] created the dombi operators for bipolar trapezoidal neutrosophic sets. In this paper, we defined aggregate function, comparison matrix and modified score function for bipolar neutrosophic soft sets(BNSS). Then we develop two solution procedures for solving MCDM problems using bipolar neutrosophic information. This paper is organized as follows: Section 2 deals with basic definitions of bipolar neutrosophic soft sets(BNSS). The proposed methods are discussed in section 3. In section 4, a case study is presented. Section 5 includes the conclusion.

PRELIMINARIES

Proposed definitions of BNSS

Comparison matrix

This is a square matrix with an equal number of rows and columns.The rows are filled with objects u_1, u_2, \dots, u_n and the columns are filled with parameter e_1, e_2, \dots, e_m . The entries c_{ij} are defined by $c_{ij} = \tau + i - \beta$, For positive membership degree, the integer τ is computed as, how often is $\mathcal{T}^+_{u_i}(e_j)$ greater than or equal to $\mathcal{T}^+_{u_n}(e_j)$ for $u_i \neq u_n \forall u_n \in U$. The integer i is computed as, how often is $\mathcal{F}^+_{u_i}(e_j)$ greater than or equal to $\mathcal{F}^+_{u_n}(e_j)$ for $u_i \neq u_n \forall u_n \in U$. The integer β is computed as, how often is $\mathcal{T}^-_{u_i}(e_j)$ less than or equal to $\mathcal{T}^-_{u_n}(e_j)$ for $u_i \neq u_n \forall u_n \in U$. The integer i is computed as, how often is $\mathcal{F}^-_{u_i}(e_j)$ less than or equal to $\mathcal{F}^-_{u_n}(e_j)$ for $u_i \neq u_n \forall u_n \in U$. The integer β is computed as, how often is $\mathcal{F}^-_{u_i}(e_j)$ less than or equal to $\mathcal{F}^-_{u_n}(e_j)$ for $u_i \neq u_n \forall u_n \in U$.

Aggregate function

Let $\mathcal{B} = \{(e, \{\mathcal{T}^+(x), \mathcal{F}^+(x), \mathcal{T}^-(x), \mathcal{F}^-(x)\}: x \in X\}): e \in E\}$ be a bipolar neutrosophic soft set over X. Then, bipolar neutrosophic aggregate function $\mathbb{A}_{x_n}, n = 1, 2, \dots, k$ is defined as,

$$\mathbb{A}_{x_n} = \left\{ \begin{matrix} \max(\mathcal{T}_1^+, \mathcal{T}_2^+, \dots, \mathcal{T}_n^+), \text{avg}(\mathcal{T}_1^+, \mathcal{T}_2^+, \dots, \mathcal{T}_n^+), \min(\mathcal{F}_1^+, \mathcal{F}_2^+, \dots, \mathcal{F}_n^+) \\ \max(\mathcal{T}_1^-, \mathcal{T}_2^-, \dots, \mathcal{T}_n^-), \text{avg}(\mathcal{T}_1^-, \mathcal{T}_2^-, \dots, \mathcal{T}_n^-), \min(\mathcal{F}_1^-, \mathcal{F}_2^-, \dots, \mathcal{F}_n^-) \end{matrix} \right\}$$

Score function: The score of the element u_i is S_i , and is specified as, $S_i = \mathcal{T}_n^+ - \mathcal{F}_n^+ - \mathcal{T}_n^- - \mathcal{F}_n^-$.

METHODOLOGY

Proposed approaches for MCDM problem using BNSS

In this section, we develop two solving procedures based on comparison matrix and aggregate function. The proposed methods and their steps are given below, Let us consider this MCDM procedures adapted from M.Asalam [11] and I.Deli[12].

Solution Procedure-I

Step 1: Create the bipolar neutrosophic decision matrix given by the decision maker as follows,





$$\langle b_{ij} \rangle_{m \times n} = \begin{bmatrix} b_{11} & b_{12} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \dots & b_{mn} \end{bmatrix}$$

Where $b_{ij} = (J_{ij}^+, J_{ij}^+, F_{ij}^+, J_{ij}^-, J_{ij}^-, F_{ij}^-)$ with $J_{ij}^+, J_{ij}^+, F_{ij}^+, J_{ij}^-, J_{ij}^-, F_{ij}^- \in [0,1]$ such that $0 \leq J_{ij}^+ + J_{ij}^+ + F_{ij}^+ - J_{ij}^- - J_{ij}^- - F_{ij}^- \leq 6$ for $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

Step 2: Input the positive membership degree \mathbb{P}_{u_n} and negative membership degree \mathbb{N}_{u_n} of bipolar neutrosophic soft set \mathcal{B} . Construct a positive membership matrix $\langle P_{ij} \rangle_{m \times n}$ and a negative membership matrix $\langle N_{ij} \rangle_{m \times n}$ from the bipolar neutrosophic soft matrix $\langle b_{ij} \rangle_{m \times n}$.

$$\langle P_{ij} \rangle_{m \times n} = \begin{bmatrix} P_{11} & P_{12} & \dots & P_{1n} \\ P_{21} & P_{22} & \dots & P_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ P_{m1} & P_{m2} & \dots & P_{mn} \end{bmatrix} \text{ and } \langle N_{ij} \rangle_{m \times n} = \begin{bmatrix} N_{11} & N_{12} & \dots & N_{1n} \\ N_{21} & N_{22} & \dots & N_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ N_{m1} & N_{m2} & \dots & N_{mn} \end{bmatrix}$$

Where $P_{ij} = (J_{ij}^+, J_{ij}^+, F_{ij}^+)$ and $N_{ij} = (J_{ij}^-, J_{ij}^-, F_{ij}^-)$ with $J_{ij}^+, J_{ij}^+, F_{ij}^+, J_{ij}^-, J_{ij}^-, F_{ij}^- \in [0,1]$.

Step 3: Construct the comparison matrix $\langle C_{ij} \rangle_{m \times n}$ of positive membership degree (\mathbb{P}_{u_n}) and negative membership degree (\mathbb{N}_{u_n}).

$$\langle C_{ij} \rangle_{m \times n} = \begin{bmatrix} c_{11} & c_{12} & \dots & c_{1n} \\ c_{21} & c_{22} & \dots & c_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ c_{m1} & c_{m2} & \dots & c_{mn} \end{bmatrix}$$

Where $c_{ij} = t + i - f$, with the conditions for positive membership degree,

$t = n (J^+_{u_i}(e_j) \geq J^+_{u_n}(e_j))$, $i = n (J^+_{u_i}(e_j) \geq J^+_{u_n}(e_j))$ and $f = n (F^+_{u_i}(e_j) \geq F^+_{u_n}(e_j))$ for $u_i \neq u_n \forall u_n \in U$. The conditions for negative membership degree are $t = n (J^-_{u_i}(e_j) \leq J^-_{u_n}(e_j))$, $i = n (J^-_{u_i}(e_j) \leq J^-_{u_n}(e_j))$ and $f = n (F^-_{u_i}(e_j) \leq F^-_{u_n}(e_j))$ for $u_i \neq u_n \forall u_n \in U$.

$J_{ij}^+, J_{ij}^+, F_{ij}^+, J_{ij}^-, J_{ij}^-, F_{ij}^- \in [0,1]$ for $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

Step 4: Calculate the row sum (α) and column sum (β) of the positive membership degree (\mathbb{P}_{u_n}) and negative membership degree (\mathbb{N}_{u_n}).

Step 5: Compute the positive information score \mathbb{P}_s and negative information score \mathbb{N}_s .

Step 6: The final score \mathbb{S}_i is determined by deducting the positive information score \mathbb{P}_s from the negative information score \mathbb{N}_s . The maximum score is the preferable choice of decision maker.

3.2 Solution Procedure-II

Step 1: Create the bipolar neutrosophic soft matrix given by the decision maker,

$$\mathcal{B} = (b_{ij})_{m \times n} = (J_{ij}^+, J_{ij}^+, F_{ij}^+, J_{ij}^-, J_{ij}^-, F_{ij}^-)$$

Step 2: Compute the aggregate function of bipolar neutrosophic soft matrix $\langle b_{ij} \rangle_{m \times n}$, it is denoted by $A_{x_n}, n = 1, 2, \dots, k$.

Step 3: Compute the score values $\mathbb{S}_i, i = 1, 2, \dots, m$ of each object.

Step 4: Determine the maximum score value and rank the alternatives.

Case study

This section presents an application of the bipolar neutrosophic soft set for choosing a hospital for maternal care. The data were gathered using a linguistic variable set by the decision maker. The maternity hospital is one of the most crucial things to plan for during pregnancy. This study assesses the performance of hospitals in the district of Tiruvarur. Here, some selection criteria are given to select the maternity hospital.





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Quality of doctors and staff credentials

The doctors and medical staff are considered to be the most crucial factors. The obstetrician needs to be able to answer queries calmly and clearly, as well as have time and patience, a compassionate obstetrician can assure her of a safe and normal delivery.

Intensive care nursery

The maternity hospital needs to be well-equipped to address any last-minute emergency even though, in the majority of cases, the infants does not need to be placed in a neonatal intensive care unit (NICU). This can be handled by having a NICU and an adult intensive care unit (ICU).

Location

The maternity hospital should be as near as feasible to the mother's home. several times over the course of the pregnancy, the mother will need to attend a maternity hospital for check-up and tests.

24 hour availability

A 24-hour staff should be present in the maternity hospital. This is due to the possibility of an unforeseen visit to the clinic, even unusual hours may apply to this. Choose a maternity hospital where staff members may be contacted at any time, and be aware of the lead time before the doctor assumes control of the delivery.

Illustration

This section provides a numerical example for solving multi-criteria decision making problem. The decision maker wants to select the best hospital for maternal care. The linguistic variable set, $LV = \{EG, VG, G, M, B, VB, EB\}$ is used to evaluate the alternatives. Let us consider the universal set $U = \{\mathbb{H}_1, \mathbb{H}_2, \dots, \mathbb{H}_n\}$, it denotes the set of alternatives. Let $E = \{\mathbb{C}_1, \mathbb{C}_2, \mathbb{C}_3, \mathbb{C}_4\}$ be the set of parameters or criteria, where,

\mathbb{C}_1 – Quality of doctors and staff credentials, \mathbb{C}_2 – Intensive care nursery, \mathbb{C}_3 – location, \mathbb{C}_4 – 24-hour availability

Then consider $U = \{\mathbb{H}_1, \mathbb{H}_2, \mathbb{H}_3, \mathbb{H}_4\}$ be the set of hospitals, where,

\mathbb{H}_1 – Hospital A, \mathbb{H}_2 – Hospital B, \mathbb{H}_3 – Hospital C, \mathbb{H}_4 – Hospital D

Rank the alternatives based on the score value $\mathbb{H}_1 > \mathbb{H}_4 > \mathbb{H}_2 > \mathbb{H}_3$, clearly, the decision maker chose alternative \mathbb{H}_1 .

The decision matrix and linguistic terms are described in table 1, table 2 and table 3. The first method is described in table 4 to table 8.

Method-II

Compute aggregate function A_{x_n} of BNSS, for each $n = 1, 2, 3, 4$ as,

$$A_{x_n} = (\mu_1, \mu_2, \mu_3, \mu_4)$$

$$\mu_1 = \langle 0.9, 0.575, 0.2, -0.5, -0.5, -0.8 \rangle$$

$$\mu_2 = \langle 0.9, 0.575, 0.2, -0.5, -0.575, -0.8 \rangle$$

$$\mu_3 = \langle 0.9, 0.55, 0.2, -0.3, -0.6, -0.7 \rangle$$

$$\mu_4 = \langle 0.9, 0.575, 0.2, -0.5, -0.575, -0.8 \rangle$$

Compute the score value of S_i , for each $i = 1, 2, 3, 4$ as,

$$S(\mu_1) = 0.885$$

$$S(\mu_2) = 0.825$$

$$S(\mu_3) = 0.67$$

$$S(\mu_4) = 0.825$$

Rank all the alternatives of H, according to the score value as,

$\mathbb{H}_1 > \mathbb{H}_4 > \mathbb{H}_2 > \mathbb{H}_3$. Then, \mathbb{H}_1 is the most desirable alternative.

RESULTS AND DISCUSSIONS

The results of method-I and method-II clearly shows that, the alternative \mathbb{H}_1 is the optimal choice of decision maker, \mathbb{H}_1 represents Hospital-A. Then we get the conclusion that Hospital-A provides the best services for maternal





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care based on the opinion of the decision maker. Using this approaches to problem solving enables the decision maker to select the best course of action. The comparison analysis of proposed methods and existing approach are given below, Comparing the results of the suggested methodologies with those of the existing BNWA and BNWG operators, the aggregate values of the alternatives are some what distinctive and the optimal alternative is identical. Moreover, The proposed approaches have the precious characteristic of considering the criteria and can be more accuracy and effective in the application of MCDM problems. The findings achieved by both algorithms are represented graphically in the table below,

CONCLUSIONS

In this paper, we have created two strategies for multi-criteria decision making problem using a bipolar neutrosophic soft set. Here, the suggested approaches are used to create a decision making model for selecting a hospital for maternal care. In addition, a comparative study of the proposed techniques with existing methods is presented. The proposed approaches can be applied to other MCDM problems and many other extensions of the neutrosophic environment in the future.

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Table 1: Linguistic tremns and bipolar neutrosophic number

Extremely good	$\langle 0.8,0.7,0.3,-0.7,-0.6,-0.8 \rangle$
Very good	$\langle 0.7,0.5,0.2,-0.5,-0.8,-0.7 \rangle$
Good	$\langle 0.9,0.7,0.5,-0.6,-0.5,-0.3 \rangle$
Medium	$\langle 0.6,0.4,0.7,-0.8,-0.4,-0.6 \rangle$
Poor	$\langle 0.8,0.7,0.4,-0.7,-0.3,-0.8 \rangle$
Very Poor	$\langle 0.9,0.4,0.7,-0.2,-0.4,-0.6 \rangle$
Extremely Poor	$\langle 0.4,0.6,0.9,-0.3,-0.7,-0.2 \rangle$

Table 2: The evaluated linguistic values of decision maker

	C_1	C_2	C_3	C_4
H_1	VG	G	B	VG
H_2	EG	VG	M	G
H_3	G	M	VG	EB
H_4	M	G	EG	VG

Table 3: The bipolar neutrosophic values of decision maker

	C_1	C_2	C_3	C_4
H_1	$\langle 0.7,0.5,0.2,-0.5,-0.8,-0.7 \rangle$	$\langle 0.9,0.7,0.5,-0.6,-0.5,-0.3 \rangle$	$\langle 0.8,0.7,0.4,-0.7,-0.3,-0.8 \rangle$	$\langle 0.6,0.4,0.7,-0.8,-0.4,-0.6 \rangle$
H_2	$\langle 0.8,0.7,0.3,-0.7,-0.6,-0.8 \rangle$	$\langle 0.7,0.5,0.2,-0.5,-0.8,-0.7 \rangle$	$\langle 0.6,0.4,0.7,-0.8,-0.4,-0.6 \rangle$	$\langle 0.9,0.7,0.5,-0.6,-0.5,-0.3 \rangle$
H_3	$\langle 0.9,0.7,0.5,-0.6,-0.5,-0.3 \rangle$	$\langle 0.6,0.4,0.7,-0.8,-0.4,-0.6 \rangle$	$\langle 0.7,0.5,0.2,-0.5,-0.8,-0.7 \rangle$	$\langle 0.4,0.6,0.9,-0.3,-0.7,-0.2 \rangle$
H_4	$\langle 0.6,0.4,0.7,-0.8,-0.4,-0.6 \rangle$	$\langle 0.9,0.7,0.5,-0.6,-0.5,-0.3 \rangle$	$\langle 0.8,0.7,0.3,-0.7,-0.6,-0.8 \rangle$	$\langle 0.7,0.5,0.2,-0.5,-0.8,-0.7 \rangle$

Table 4: Positive information Function of BNSS

	C_1	C_2	C_3	C_4
H_1	(0.7,0.5,0.2)	(0.9,0.7,0.5)	(0.8,0.7,0.4)	(0.6,0.4,0.7)
H_2	(0.5,0.7,0.3)	(0.7,0.5,0.2)	(0.6,0.4,0.7)	(0.9,0.7,0.5)
H_3	(0.9,0.7,0.5)	(0.6,0.4,0.7)	(0.7,0.5,0.2)	(0.4,0.6,0.9)
H_4	(0.6,0.4,0.7)	(0.9,0.7,0.5)	(0.5,0.7,0.3)	(0.7,0.5,0.2)





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Table 5: Negative information Function of BNSS

	C_1	C_2	C_3	C_4
H_1	(-0.5, -0.8, -0.7)	(-0.6, -0.5, -0.3)	(-0.7, -0.3, -0.8)	(-0.8, -0.4, -0.6)
H_2	(-0.7, -0.6, -0.8)	(-0.5, -0.8, -0.7)	(-0.8, -0.4, -0.6)	(-0.6, -0.5, -0.3)
H_3	(-0.6, -0.5, -0.3)	(-0.8, -0.4, -0.6)	(-0.5, -0.8, -0.7)	(-0.3, -0.7, -0.2)
H_4	(-0.8, -0.4, -0.6)	(-0.6, -0.5, -0.3)	(-0.7, -0.6, -0.8)	(-0.5, -0.8, -0.7)

Table 6: Comparison matrix of Positive information Function

	C_1	C_2	C_3	C_4
H_1	2	4	4	-1
H_2	4	2	-3	5
H_3	4	-3	2	-1
H_4	-3	4	5	3

Table 7: Comparison matrix of Negative information Function

	C_1	C_2	C_3	C_4
H_1	1	3	-1	1
H_2	1	0	4	2
H_3	3	1	2	2
H_4	2	3	1	1

Table 8: Final Score table

Positive information score	Negative information score	Final score S_i
2	-3	5
1	0	1
-5	2	-7
3	1	2

Table 9: Comparison table of methods

Methods	Ranking	Optimal Choice
BNWA operator	$H_1 > H_4 > H_2 > H_3 H_1$	
BNWG operator	$H_1 > H_4 > H_2 > H_3 H_1$	
Solution Procedure-1	$H_1 > H_4 > H_2 > H_3 H_1$	
Solution Procedure-2	$H_1 > H_4 > H_2 > H_3 H_1$	





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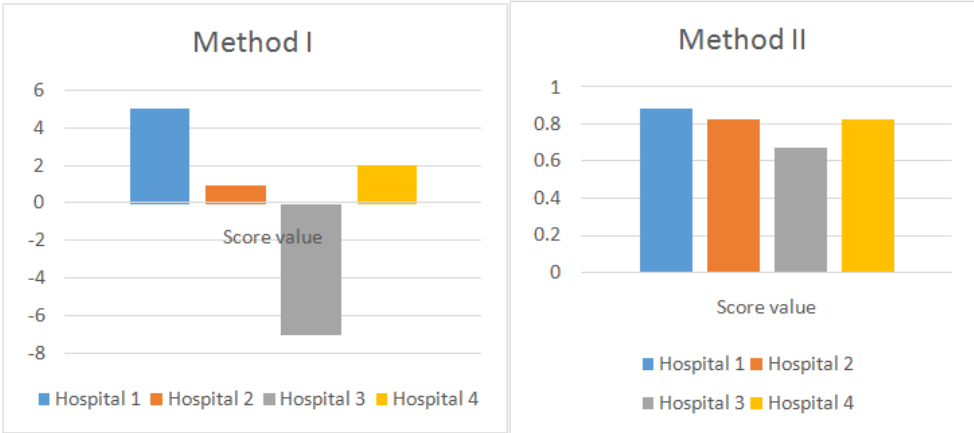


Figure 1: Alternative final score value with the proposed methods.





Opportunities Challenges and Self-Initiatives of Teacher Educators towards Continuing Professional Development in Jammu Kashmir : A Survey Study

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 12 Jul 2024

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ABSTRACT

Continuing Professional Development (CPD) is a long term, continuous and compound process where teachers irrespective of fields try to develop their personal and professional qualities. CPD is an important medium for teachers to increase the quality of their qualification at a gradual rate by making own initiatives to access the opportunities provided by external agencies too. Without self-efforts the opportunities remain isolated and the results of them may proven unfruitful. In short, both should go hand in hand. Teacher Educators of the B.Ed. Colleges are the architects of the prospect teachers for achieving their destiny by developing skills, knowledge, and attitude in terms of desirable behavior. In spite of all these the present research paper is a significant attempt to explore the self-initiatives and challenges of Teacher Educators' to access the opportunities made by external agencies in the form of CPD, and also commonly faced problems by teacher educators for taking part in CPD activities. The present research collected the required data from the sample of 154 teacher educators of the private B.Ed. Colleges affiliated by the University of Jammu. A self-constructed questionnaire has been employed for accomplishing the formulated objectives. The present study revealed that lack of time and financial assistance from the institutions affected the participation of Teacher Educators in Professional Development programs. The majority of the teacher educators(71%) opined that offline programs were much better than online events. Surprisingly the researchers observed that only 30-33 % of the participants were found to have an online membership of journals and libraries, and also only 29% of teacher educators were found to have enrolled for online courses. Beside these, more than 50% of the



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participants were putting their efforts for writing chapters in books (51%), research, articles for journals (58%) and preparing a portfolio for their self-improvement (56%).

Keywords: Initiatives, Opinion, Opportunities and Continuing Professional Development (CPD)

INTRODUCTION

A profession means any economic activity which demands requisite skills and timely polishing of that particular skills as per the need of the hour. It is a type of work that requires skilled education and training. Cruess and Johnston (2004) defined the term profession as an occupation whose core element is work based upon the mastery of a complex body of knowledge and skills. The Merriam –Webster Dictionary (2014) says a profession is a vocation requiring dedicated knowledge and often long and exhaustive academic preparation. Any type of work that needs special training or a particular skill (Cambridge Dictionary 2013). Professional Development is a kind of improvement, which helps a professional to acquire, develop, reinforce, and strengthen their skills and know the strategies and tactics to become more effective. It is a prime requisite of every profession to stand ready for meeting the ever-changing needs of the world. Professional development (PD) has been characterized as an inner cycle in which experts are involved in a formal or informal models embedded in the precarious assessment of expert practice (Smith, 2010). Professional development of Teacher educators' is an inevitable cycle and a crucial component for enhancing learning overall; therefore, teacher trainers should be dynamic mediators in their growth by keeping themselves up to date with novel information developing and improving knowledge on education and teacher instruction to enhance and boost their own teaching (Su and Wang, 2022).

Effective Professional Development (PD) is needed to help teachers learn and refine the instructional strategies required to teach these skills (Linda, Hammond, Maria, Hyler, Gardner and Espinoza 2017). Educators require knowledge regarding various methods of learning as employed by different individuals, such that they can efficiently goal education in the direction of learners' learning requirements (Su and Wang, 2022). In higher education teacher educators are those teachers who are properly involved in pre-service and in-service teacher education programs. They play their significant role in teaching and supervising the student-teachers, another way, it can be said that they are involved in the professional development of student-teachers (Bates, Swennen and Jones, 2011). In order to sensitize the student-teachers about professionalism and development, the teacher educators must go with Continuous Professional Development (CPD) to a great extent. The Government of India periodically made some reforms for bringing Continuous Professional Development as Panda (2017) highlighted some advance reforms in the current past which are introduced to transmute the quality of teaching learning. Among these the major three reforms are playing their great role for continuing professional development of the teachers. Pandit Madan Mohan Malaviya National Mission for Teachers and Teaching (PMMNMTT) (GoI, 2015), is the very first reform which directly laid emphasis on eminence augmentation in teaching-learning and research. The second reform was the starter of Choice Based Credit System (CBCS) (UGC, 2015). For the first time, a National Policy twisted a space for choice-based credit buildup in their own department courses and interdisciplinary as well as value-based credit courses. Study Web of Active Learning by Young and Aspiring Minds (SWAYAM) is the third reform synchronized by UGC, which introduces legal endowment for online/blended learning into higher education by which students can store up to 20% of total credit hours in subjects through massive open online courses (MOOCs).

Continuing Professional Development (CPD)

NCTE used the term CPD in place of INSTE in its NCFTE (National Curriculum Framework for Teacher Education 2009). Both CPD and INSTE (In-service Training Programmes) terms used interchangeably in the document. But the difference exists in both the terms as CPD comprises all activities and programmes of learning which a professional acquire formally and informally whereas INSET focuses to inculcate professional skills in a teacher as per the requirement of their profession (Singh and Gupta 2021). CPD is a steady training, which helps a person to grow

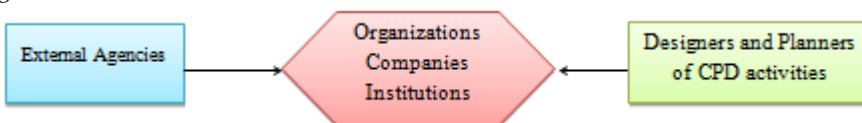




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gradually. The development of professionals varies from one profession to another, but the medium to access CPD remains same and mostly depends on the self-initiatives and accessible opportunities. Thorndike' laws of learning' are closely associated with the context of CPD. Law of readiness or law of action tendency is applicable here. A law which states that learning is dependent upon the learner's readiness to act or preparation of action. If people are not ready to learn something and also lack to access the opportunities, they cannot develop professionally in, turn it generates monotony and a passive mindset them. CPD indicates a deep relationship with the time a show long a person spent time in a particular profession can positively influence his/her CPD.NEP-2020 also recommended the 50 hours of Continuous Professional Development opportunities for each instructor will each year engage, motivated by his/her own wishes. Emma & Elaine (2019) found that, the great majority of teachers were taking participation in training activities, but they showed lower satisfaction because of critical weaknesses in the opportunities available and requisite professional development of the teachers. The key objectives of the CPD are to prepare teachers for competency based learning, which enables a teacher to discover, reflect and develop his/her own strategies and practices. Lisa Bartleton (2018) also emphasized that the reflective practice seems to be a beneficial CPD activity.

Europass Teacher Academy (2022) highlighted that CPD consists of a series of learning activities, which are planned for achieving the goals like: to strengthen the existing skills of a person, to develop the skills for achieving new level and to upgrade and update the skills and knowledge. The most effective and beneficial strategies of CPD involve collaboration, sharing of good practice and providing opportunities for reflection. So attending and holding seminars and conferences are the pathways to Professional Development of educator trainers and they are sometimes hired for bringing in new knowledge and activity (Hang and Wang, 2022). Today in the world of digitalization, the applications of ICT proved useful for professional development. New online CPD activities like E-conferences, workshops and webinars, which may not be mandated, but useful them by taking part in as per their convenience and interest. Massive Open Online Courses (MOOCs) also provide the platform for collaborative and cooperative teacher training, which helps to keep updated about new developments and searching for new quality content to improve learning outcomes. Although Bartleton (2018) acknowledged online CPD as a passive form of CPD. Even the Europass Teacher Academy (2022) also draws attention to some more ways by which CPD proves beneficial like – Best learning outcomes, effective methods of teaching, appropriate planning skills, effective classroom management, advance knowledge in their subjects, etc. All these training programs can be organized by external agencies.



These agencies felt the need of CPD activities for improving the performance in a particular profession and also assist the staff by encouraging them to take participation. But one thing should be kept in view that these agencies act only as an organizer of opportunities, but for accomplishing the intentions of CPD activities the professionals play a major role. Supremely, professionals should be responsible for their shortcomings, failings, or limitations when performing their tasks (Europass Teacher Academy 2022). Being an in-service teacher many times one has to undertake various means of Continuing Professional Development, but many times, due to multiple constraints the professionals overlook few opportunities to attend the CPD activities. All means of quality enhancement remains motionless, until and unless the self-initiatives work. One must take self-initiative only because of the desire and interest of a teacher to do the work which helps to bring professional development. The initiatives may be reading and writing of books, articles, publications, conducting research, attending workshops, seminars, webinars, conferences and online courses, etc. organized by the external agencies. One can also get Professional Development through official qualification, accreditation, or degree that benefits the educators to add some more qualification in their existing sets of skills. Work-based learning means the development takes place at their workplaces, like in the colleges, universities, and schools, etc. Now a day due to the advancement in technology all teachers or educators can get an opportunity to attend training programs organized by other countries too, here the teachers from different countries take advantage by learning series of strategies, skills, methods, etc. (Europass Teacher Academy 2022). It is understood from the



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reviews that, In India, professional development is not on main concern and not compulsory to attain these programs (Sabha, 2019). This is an area neglected by management, as the management does not allot time for teachers for attending CPD activities physically Gomba (2019). At the present time there are many online CPD programs available that can be attended at one's own convenience (Padwad & Dixit, 2011). But the self-initiatives of teachers are important to access all the online and offline CPD opportunities. Unless and until the professionals have determination to access the CPD activities, all will remain in vain. No doubt the means of CPD are increasing day by day both in online and offline mode, in spite of this the teacher educators show unwillingness to take part in CPD activities because of lack of incentives, rewarding system and other motivational factors. Tayagi (2021) identified the constraints like infrastructural challenges, institutional challenges, Psychological challenges, financial challenges and challenges related to time management hinders teacher educators attending CPD activities. Not only this the problem of lack of ICT skills emerged as a serious challenge in front of teacher educators as some teachers are technophobic and have little exposure to technology. They find difficult and get irritation as sometimes they lost their usernames, password etc. Such kind of teachers felt better to stay away from the current online CPD programmes due to their technophobic characteristics (Gomba 2019). CPD programmes are organised without considering the needs of the participants because the needs and activities organised by agencies mismatches due to this the teachers have lost their interest and avoid to attend CPD programmes (Gomba 2019, Yaqub, Cole, and Ofosua 2020) Teacher educators must endeavor to build a CPD portfolio either in e-format or paper-based, it would be helpful for them to reflect on their journey, which helps them to update, upgrade and integrate their knowledge with everyday practice (Yaqub, Cole and Of osua, 2020). From reviewed literature, the researchers arrived at the conclusion that there were lot of studies concentrated on how the school teachers develop professionally and what factors hinders them to become professional, but very few researches were conducted on the self-initiatives of teacher educators and their opportunities for Continuous Professional Development. So What self-initiatives are being taken by the teacher educators for Continuing Professional Development? Are they really interested to take some initiatives towards their CPD? What opinion and opportunities do they have for Continuing Professional Development? What kind of challenges do they encounter for accessing CPD programs?

Objectives of the study

1. To find out the self- initiative taken by teacher educators for Continuing Professional Development in the region of Jammu.
2. To ascertain the opportunities being granted by external agencies to teacher educators in their Continuing Professional Development.
3. To determine the challenges encountered by teacher educators to access CPD programs through their institutions.

METHODOLOGY OF THE STUDY

A descriptive survey design was followed to conduct the study with the Teacher Educators of Private B.Ed. Colleges, which affiliated to University of Jammu academic year (2022-24). The Jammu division consists of 10 districts; and 7 Universities out of which only 4 universities are running the bachelor of education program, i.e. University of Jammu, Cluster University, Baba Ghulamshah Badshah University and Central University of Jammu. The University of Jammu has 49 affiliated colleges which are offering bachelor of education program, out of which 48 colleges are private and only one college is government. Among these 48 private colleges, the 50% (24) colleges were selected conveniently for the sample of the study. All the colleges are distributed in nine out of ten districts except Ramban district. The following figure- shows the sampled colleges. In order to collect the requisite information for accomplishing formulated objectives, the investigator designed a self- constructed structured questionnaire which comprised 25 items. Three items have been constructed on three points Likert Type scale and remaining 22 items were constructed on restricted responses. After finalizing the tool for data collection, the investigators converted tool into online format (i.e., Google Forms) and link of google form had been sent to the target-group through email and WhatsApp. The questionnaires were sent to 178 teacher educators out of which 154 teacher educators responded over



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them (i.e. response rate 87%). The researcher participants were informed the need and objectives of the study telephonically and also clarified their doubts while responding the tool through google form. The participants were also assured that the data they provided would be kept confidential, and used only for the purpose of research. The following Table-1 shows the profile of the teacher educators who took participation in the study. Table 1 depicted the background information of the participants. Majority of the teacher educators were female working in teacher education institutions (84%) more than half of the participants were found with Arts stream (56%) and majority of the teacher educators belongs to urban locality so it can be assumed that, since they lived in urban area had got the scope of maximum access to opportunities of CPD than participants lived in rural area. Among all the participants only 27% of the teacher educators were found with an experience of 1-5 years and nearly half of the participants (52%) were found with the experience of 6-10 years, by looking on the above figures it can be examined that only 60% teachers had attended 1-5 workshops 28% had attended more than 6 workshops and rest of the 12% were not attended any kind of workshop. Table 2 shown that the majority of the participants (71%) opined that offline CPD programs were found to be better than online however 57% of the participants expressed as online events diluted the seriousness of the program so they avoided to attend online programmes on the other hand 50 % respondents found the CPD programs not so beneficial so they avoided to attend them. Table 3 reflected not a big difference in their agree and disagree responses, that only 58% of the participants were having the habit of writing research papers for publications in journals whereas nearly half of the participants (51%) were found with the habit of writing articles, ideas for newspapers and research chapters for edited books and 56% of the respondents were having the habit to prepare portfolio to assess their self- improvement. Figure 2 depicts that less than 50 % participants have enrolled for online courses for their Professional Development and only 30% participants had taken the membership of online journals whereas only 33% of the participants have a membership of online libraries. Less than half of the participants(49%) could develop e-content in any subject, but if we talk about the development of e-content in their own subject, than only 54% of the participants were agreed in this regard. The majority of the participants (78%) expressed as for their professional development they had taken part in online discussion forums too.

Figure 3 stated that the majority of the respondents (69%) agreed as their concerned institutions encouraged them to attend CPD programs, whereas 58% respondents declared as their institutions did not provide financial assistance for registration charges. 62% of the participants stated that after attending CPD activities their institutions didn't add any kind of increment in their salary this statement showed inconsistency with the view of Mizell (2010). Mizell stated that CPD helped teacher educators to get an increment in their salary. The majority of the participants revealed that their colleges allowed them to attend CPD programs (84%) but 71% of them stated that their colleges allowed them to attend CPD programs outside the state too. 65% of the participants viewed that their intuitions encouraged them to attend CPD programs, whereas the 69% of the participants agreed as their institution organized CPD programs for teacher educators. Figure 4 revealed that 56% of the respondents agreed as their institution did not provide some financial support to attending CPD programmes and the majority of the participants(68%) approved as they were not able to attend the CPD programmes which continued even after working hours Wilson & Corbett (2001) found the most important hindering factors included the following: Time constraints: Working part time made it hard for teachers to participate regularly or for extended periods of time. Although 75% of the respondents disagreed as their institution marks absent for duty leave instead of considering it as duty leave, but nearly half of the participants (53%) disagreed as their institution never gave worth to their CPD certificates. 60% participants declared that they did not get prior information regarding CPD events.

RESULTS AND DISCUSSION

The current study investigated the initiatives of teacher educators and opportunities to access the CPD programs. The result of the study shown consistent with the study conducted by Tyagi(2021)and Padwad & Dixit(2013). 46%-47% respondents opined that sometimes online programmes dilute the seriousness of the event and felt that offline programmes are better than online. But if we look over the self- initiatives of the teacher educators than will be able to find that only 51-58% of the respondents are interested and having the habit of writing research papers and



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published articles/ideas in newspapers/journals, writing chapters for edited books, prepare portfolio for self-improvement. On the other hand the initiatives made by teacher educators towards e-learning platforms have not quite good, as the results shown that less than 50% of the teacher educators were enrolled for online courses and taken the membership in online journals and libraries as well as able to develop e-content in any subject, But 64% of them are able to develop e-content in their own subject only. The findings of the study declared that the institution and management encouraged and support their teacher educators to take part in CPD activities as a majority of the respondents (69-84%) of the respondents agreed in this regard. But researchers have founding consistent with the findings of Gomba (2019), stated the management does not allot time to their teacher educators attending CPD activities. Even though the institutions, does not add any kind of increment in their salary on the basis of their Continuing Professional Development. On the other hand the current study found some challenges in front of teacher educators that hinder them not to attend the CPD programs like Lack of financial assistance from the institution and Long duration of programs make them unable to attend CPD programs, 56% -68% of the Teacher Educators have encountered with such kind of challenges. The study of Dilshad, Hussain, & Batool (2019) also support the findings of the current study as the lack of time and funding makes the participants uneasy to attend the CPD programs, However, nearly half of the participants (53%) felt that their institution never give worth to their valuing CPD certificates so they lacked their interest to take part in CPD programs, beside this the similar kinds of challenges were also found by Tyagi (2019). On the basis of the review of the related literature, objectives of the study, methodology results and limitation of the study, the researchers suggested that in the current study the researcher targeted the teacher educators only, one must include the Administrators and Principals of the Teacher Education Colleges.

CONCLUSION

It can be concluded that the outcomes of the present study can be significant for various stakeholders, including college management, committees, organizers of CPD programs, participants of CPD programs like teacher educators both pre-service and in-service teacher educators in a variety of ways. Teacher educators can analyze about their self -initiatives as in which type of CPD activities they lacked behind where they should move ahead for the quality enhancement. The agencies can get a view that which factors affects the participation of the participants in CPD programs and what kind of opinion does the Teacher Educators have regarding CPD programs. What type of motivation and awareness do the Teacher Educators required? For CPD the concerned institutions must prepare an advance annual plan by taking the viewpoints of Teacher Educators in consideration regarding Professional Development activities. The CPD programmes must be organised only after doing the need analysis of the teachers. But, if we think that CPD of a professional is possible only through the opportunities, we might be wrong here, one must contribute their positive efforts to achieve the goal of Continuing Professional Development. Both self-initiatives and CPD opportunities go hand in hand and the success of CPD cannot be possible without the efforts and platforms.

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Table 1 Profile of the participants

<i>Participant's Characteristics</i>	<i>N</i>	<i>%</i>
Gender		
Male	24	16





Female	130	84
Stream		
Arts	86	56
Commerce	36	23
Sciences	32	21
Locality		
Rural	60	39
Urban	94	61
Teaching Experience in Years		
0	6	4
1-5	41	27
6-10	80	52
11-15	15	10
16-20	10	6
21-Above	2	1
No. of Workshops attended		
0	18	12
1-5	93	60
6-10	26	17
11-15	5	3
16-20	7	5
21-Above	5	3
Total	154	100

Table 2 Opinion of Teacher Educators towards CPD programs

S. No.	Items	Agree	Neutral	Disagree
1.	Offline CPD programs are better than online	71%	12%	18%
2.	The CPD programs prove not useful so I avoid to attending	50%	6%	42%
3.	Online CPD programs dilutes the seriousness of the event	57%	13%	30%

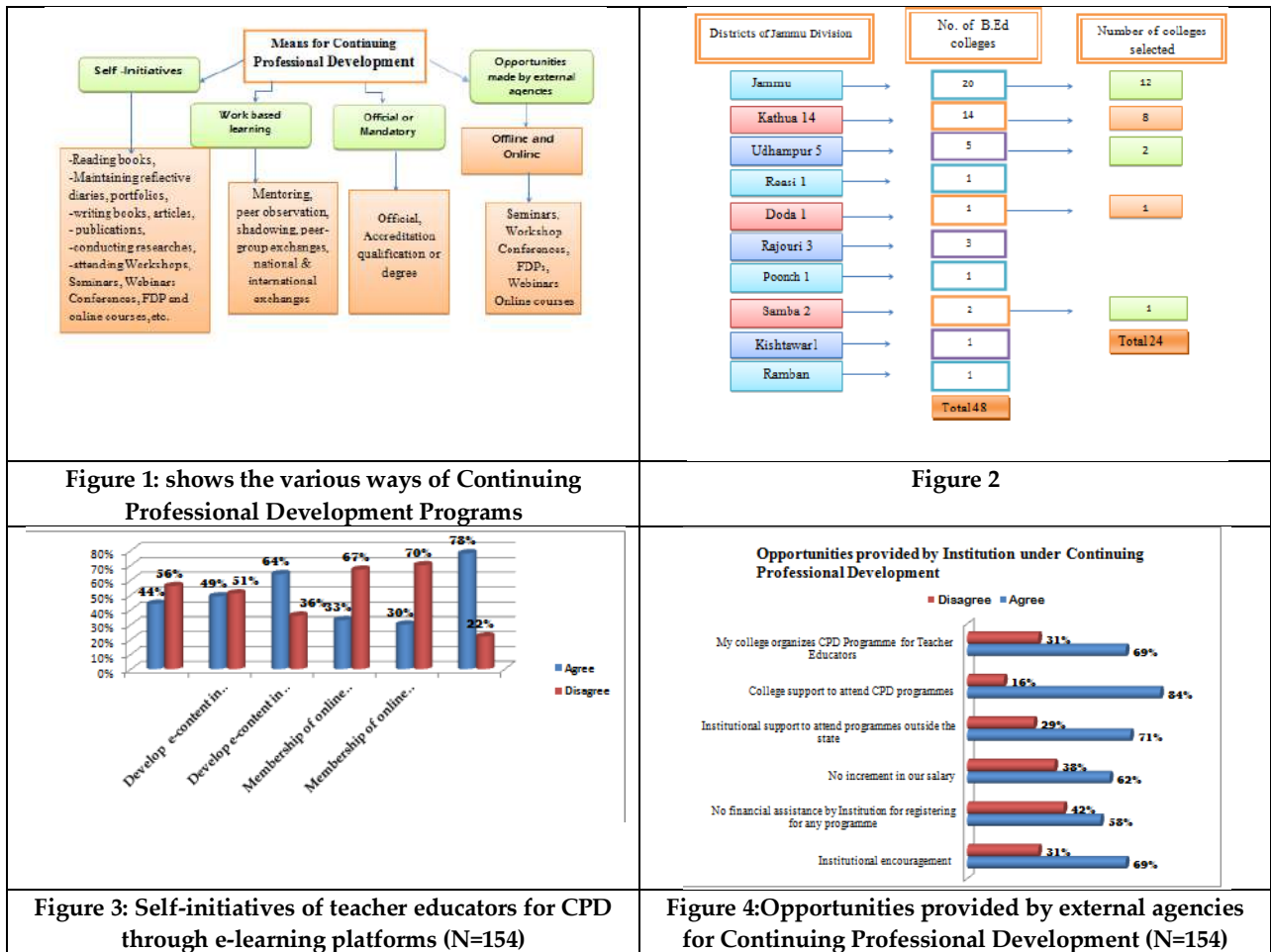
Table 3 Self-initiatives of teacher educators with respect to research and publications

S.No.	Items	Agree	Disagree
1	I have the habit of writing research papers	58%	42%
2	I am having the habit of Publishing articles/ideas in Newspapers/Journals	51%	49%
3	I do write chapters for Edited books	51%	49%
4	I am having the habit of preparing a portfolio for self-assessment	56%	44%





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In-silico and In-vitro Anticancer Activity of *Tragia involucrata* Extract

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 10 Jun 2024

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ABSTRACT

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body. *Tragia involucrata* Linn. (family: Euphorbiaceae) is a medicinal plant, which has been used for centuries in Sri Lankan Traditional Medicine as well as in the Ayurveda medical system. This plant is mainly found and used by South Asian countries such as Sri Lanka, India, and Bangladesh. *In-silico* activity of *tragia involucrata* was evaluated by Pass online and ADME prediction by Swiss ADME. *In-vitro* anticancer activity of *tragia involucrata* aqueous extract by trypan blue dye using Dalton's Lymphoma Ascites cells (DLA).Hence it was that the plant extract, *Tragia involucrata*, has anti-cancer activity.

Keywords: Cancer;*Tragia involucrata*; Pass online; ADME prediction; Trypan blue dye.



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INTRODUCTION

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body. Possible signs and symptoms include a lump, abnormal bleeding, prolonged cough, unexplained weight loss, and a change in bowel movements. [1] The most common types of cancer in males are lung cancer, prostate cancer, colorectal cancer, and stomach cancer. [2] Types of cancers are:

Lung cancer

Lung cancer is also known as lung carcinoma, malignant lung tumour characterized by uncontrolled cell growth in tissues of the lung. If left untreated, this growth can spread beyond the lung by the process of metastasis into nearby tissue or other parts of the body. Most cancers that start in the lung, known as primary lung cancers, are carcinomas.

Anal cancer

Anal cancer occurs in the anus the end of the gastrointestinal tract. Anal cancer is very different from colorectal cancer. Anal cancer is lump which is created by the abnormal & uncontrolled growth of cells in the anus.

Adrenal cancer

Adrenal cancer is a condition occurs when abnormal cells form in or travels to the adrenal glands. Our body has two adrenal glands, one located above each kidney. Adrenal cancer usually occurs in the outermost layer of the glands, or the adrenal cortex.

Bone cancer

Bone cancer can arise in any of the bones of the body but it is most commonly seen in the long bones of the arms and legs. It has the ability to attack the body within the first 20 years of life when maximum growth in the musculoskeletal system takes place. [3] *In silico* ADME, Toxicity, Biological activity prediction by using various suitable software's.

PLANT PROFILE OF *TRAGIA INVOLUCRATA*

Tragia involucrata Linn. (family: Euphorbiaceae) is a medicinal plant, which has been used for centuries in Sri Lankan Traditional Medicine as well as in the Ayurveda medical system. This plant is mainly found and used by South Asian countries such as Sri Lanka, India, and Bangladesh. *Tragia involucrata* L. belonging to family Euphorbiaceae is commonly known as Wel Kahambiliya, Helkahambiliya, Kahambiliya, or Kasambiliya in Sinhala and Indian stinging nettle or climbing nettle in English.

MORPHOLOGY

Tragia involucrata is a perennial, densely hispid-pubescent herb, with scattered, stinging hairs throughout. The stem is elongate, slender, and twining. Leaves are simple, alternate, serrate, stipulate, 2.5–12.5 cm long, 2–4.5 cm broad, densely hispid-pubescent. Regular, unisexual, and apetalous flowers are borne in terminal axillary. The flowering period is February, March, and June. Fruit is a capsule of 8 mm diameter, 3-lobed, more or less hispid. Seeds are subglobose, grayish brown, and smooth, with slight mottling. *Tragia involucrata* is geographically distributed in India, Sri Lanka, Burma, and China. In Sri Lanka, it is common in Jaffna, Anuradhapura, Minneriya, Galle, and Matara, as a weed of cultivation and waste grounds. [21]

MATERIALS AND METHODS

In Silico biological activity and toxicity prediction (PASS ONLINE)

A computer-aided software programme called PASS makes predictions about the range of biological activity of various substances based on those assumptions.





***In Silico* ADME Prediction**

We use the concept of 'biological activity spectrum' for a substance. It is the list of activity names, which reflects the result of the interaction of the chemical substance with different biological entities.

MACERATION

Apparatus Required: Beaker, funnel, Whatmann filter paper, glass rod, china dish

Reagents: Distilled water, crude drugs

***In Vitro* Cytotoxicity Test (TRYPAN BLUE ASSAY)**

Apparatus: Micropipette, Haemocytometer, sample tube, test tube stand, centrifuge apparatus, syringe, microscope.

Reagents: DMSO reagent, Phosphate buffered saline, trypan blue, drug extract

Cancer cell lines: Dalton's Lymphoma Ascites (DLA).

PROCEDURE

***In silico* biological activity and toxicity prediction (PASS ONLINE)**

Steps involved in PASS:

Step 1: Navigation of the PASS online web page: Any web browser can be used to access the pass directly by typing "PASS Prediction" into the search bar. Use the online program's prediction page for the free registration and log-in to use the component of interest prediction feature.

Step 2: Drawing the structure of molecule: The 2D structure of the components, which serves as the foundation for the prediction, is used by the PASS online prediction tool as an input; as a result, the structure can be created using Chem sketch version 12 and uploaded to the PASS website as a (*.mol) file, or it can be created directly on the website using JAVA, which makes use of the drawing programme Marvin Sketch.

Step 3: Prediction output: The input structure's activities, which were drawn in the second stage, are now compared with the structures in the program's database that have known activities. As the principal of estimation, the Bayesian approach, the prediction tool predicts the Pa: Pi ratio of the input substance. The result is shown as several biological activities ranked in descending order of their likelihood ratios.

***In silico* ADME prediction (CHEMDRAW)**

To obtain biological activity spectrum of substance, the user should send via internet a standard Molfile, or they may draw a structural formula using. The prediction result is returned in the form of a table containing the list of biological activities with appropriate probability values, If $P_a > 0.7$, the substance is very likely to exhibit the activity in experiment, but the chance of the substance being the analogue of a known pharmaceutical agent is also high. If $0.5 < P_a < 0.7$, the substance is likely to exhibit the activity in experiment, but the probability is less, and the substance is unlike known pharmaceutical agents. If $P_a < 0.5$, the substance is unlikely to exhibit the activity in experiment. However, if the presence of this activity is confirmed in the experiment the substance might be a new chemical entity.

SWISSADME

SwissADME web tool that gives free access to a pool of fast yet robust predictive models for physicochemical properties, pharmacokinetics, drug-likeness and medicinal chemistry friendliness, among which in-house proficient methods such as the BOILED- Egg, iLOGP and Bioavailability Radar. Easy efficient input and interpretation are ensured thanks to a user-friendly interface through the login-free website <http://www.swissadme.ch>. Specialists, but also non-expert in chem. informatics or computational chemistry can predict rapidly key parameters for a collection of molecules to support their drug discovery endeavours.





EXTRACTION

The whole plant was collected from in and around areas of Ernakulam and was dried under shade for 5 to 7 days. The whole dried plant was powdered with a blender. The extraction was done by aqueous maceration, in which 50g of the powdered drug is taken in a beaker and to this 1000ml of distilled water was added and stirred well. This is kept for 6 days covered. After 6 days the extract was filtered using Whatmann filter paper and the obtained filtrate was concentrated in a previously weighed china dish by placing on a water bath slowly.

IN VITRO CYTOTOXICITY PROCEDURE

The test compound was studied for short term in vitro cytotoxicity using Dalton's Lymphoma Ascites cells (DLA). The tumour cells aspirated from the peritoneal cavity of tumour bearing mice were washed thrice with PBS or normal cell line. Cell viability was determined by trypan blue exclusion method. Viable cells suspension (1×10^6 cells in 0.1ml) was added to tubes containing various concentrations of the test compounds and the volume was made up to 1ml using phosphate buffered cell line (PBS). Control tube contained only cell suspension. These assay mixtures were incubated for 3 hours at 37° C. Further cell suspension was mixed with 0.1ml of 1% trypan blue and kept for 2-3 minutes and loaded on a haemocytometer. Dead cells take up the blue colour of trypan blue while live cells do not take up the dye. The number of stained and unstained cells was counted separately.

RESULTS

IN-SILICO TOXICITY AND BIOLOGICAL ACTIVITY PREDICTION

Table 1 shows the chemical constituents present in the plant *Tragia involucrata* and their biological activity and toxicity is predicted. Table 1 it shows clearly.

IN-SILICO ADME PREDICTION

Table 3 shows the canonical smiles of the chemical constituents and table 4 shows the ADME predictions of the chemical constituents present in the plant *Tragia involucrata*.

IN-VITRO CYTOTOXICITY ASSAY

The table below (table 2) shows the percentage cell death in the different concentrations of the drug ranging from 12.5 µg/ml, 25 µg/ml, 50 µg/ml, 100 µg/ml, 150 µg/ml and 200 µg/ml.

DISCUSSION

IN-SILICO TOXICITY AND BIOLOGICAL ACTIVITY PREDICTION

From table 1 it is shown that the following chemical constituents that is friedelan-3-one and orientin has antineoplastic activity. The constituents iridin, orientin, rutin and 3-(2,4-dimethoxyphenyl)-6,7-dimethoxy-2,3-dihydrochromen-4-one has anticarcinogenic activity. Also iridin, orientin and rutin has chemopreventive property. Hence due to the presence of the above chemical constituents present in the plant, *Tragia involucrata*, it can be predicted that the plant has anti-cancer activity shows in table 2.

IN-SILICO ADME PREDICTION

The ADME of the chemical constituents of *Tragia involucrata* was predicted. It showed the GI absorption which gives an idea about the absorption, BBB permeation which predicts the distribution. The inhibitors of CYP1A2, CYP2C19, CYP2C9, CYP2D6 and CYP3A4, this family of isoenzymes is a key player in drug elimination through metabolic biotransformation.





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IN-VITRO CYTOTOXICITY ASSAY

On carrying out the in-vitro cytotoxicity assay using trypan blue dye it was found that the plant extract has anti-cancer activity. With increasing in concentration of the plant extract there was an increase in the percentage cell death. Hence it was that the plant extract, *Tragia involucrata*, has anti-cancer activity.

CONCLUSION

In-silico activity of *tragia involucrate* was evaluated by Pass online and ADME prediction by SWISS ADME. *In-vitro* anticancer activity of *tragia involucrate* aqueous extract by trypan blue dye using Dalton's Lymphoma Ascites cells (DLA). Hence it was that the plant extract, *Tragia involucrata*, has anti-cancer activity based on the *in-silico* results.

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Table 1: In-silico Toxicity and Biological activity prediction

Sl. No.	CHEMICAL CONSTITUENT	BIOLOGICAL ACTIVITY PREDICTION (Pa>0.7)			TOXICOLOGICAL ACTIVITY PREDICTION (Pa>0.7)		
		Pa	Pi	ACTIVITY	Pa	Pi	ACTIVITY
1.	Ar-TURMERONE	0.885	0.005	Mucomembranous protector	0.784	0.016	Hematemesis
		0.865	0.013	Ubiquinol-cytochrome-c reductase inhibitor	0.766	0.009	Withdrawal
		0.855	0.008	HIF1A expression inhibitor	0.769	0.025	Euphoria
		0.797	0.010	Glutamyl endopeptidase II inhibitor	0.734	0.006	Irritation
		0.783	0.005	Fatty-acyl-CoA synthase inhibitor	0.744	0.017	Occult bleeding
		0.799	0.021	CYP2J substrate	0.725	0.015	Non mutagenic, Salmonella
		0.785	0.022	CYP2J substrate	0.711	0.010	Pseudoporphyria
		0.762	0.004	Carminative	0.719	0.018	Hypercholesterolemia
		0.777	0.032	Testosterone 17beta-dehydrogenase (NADP+) inhibitor	0.707	0.023	Gastrointestinal hemorrhage
		0.770	0.042	Aspulvinone dimethylallyltransferase inhibitor	0.708	0.035	Toxic, respiration
		0.723	0.013	Phosphatidylcholine-retinol O-acyltransferase inhibitor	0.702	0.099	Twitching
		0.714	0.014	Apoptosis agonist			
		0.716	0.017	Fibrinolytic			
		0.718	0.029	Alkenylglycerophosphocholine hydrolase inhibitor			
		0.708	0.020	Omptin inhibitor			
		0.706	0.038	Polyporopepsin inhibitor			
		0.703	0.054	Gluconate 2-dehydrogenase (acceptor) inhibitor			
2.	FRIEDELAN-3-ONE	0.896	0.002	Transcription factor NF kappa B stimulant	0.756	0.009	Hypercholesterolemia
		0.896	0.002	Transcription factor stimulant	0.760	0.019	Inflammation
		0.883	0.009	Testosterone 17beta-dehydrogenase (NADP+) inhibitor	0.759	0.019	Nephrotoxic
		0.871	0.005	Apoptosis agonist	0.70	0.011	Cataract





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					2		
		0.867	0.008	CYP2J substrate	0.719	0.041	Toxic
		0.852	0.004	Oxidoreductase inhibitor	0.711	0.038	Behavioral disturbance
		0.850	0.007	Antineoplastic			
		0.851	0.010	Antieczemetic			
		0.829	0.012	Mucomembranous protector			
		0.798	0.007	Membrane integrity antagonist			
		0.793	0.005	Dermatologic			
		0.783	0.004	Hepatic disorders treatment			
		0.792	0.014	Acylcarnitine hydrolase inhibitor			
		0.776	0.002	Antinociceptive			
		0.777	0.008	Antiinflammatory			
		0.764	0.005	Hepatoprotectant			
		0.755	0.005	Antipruritic			
		0.757	0.008	Caspase 3 stimulant			
		0.742	0.006	CYP2B5 substrate			
		0.756	0.020	CYP2J2 substrate			
3.	VINYL HEXYL ETHER	0.964	0.001	Alkanal monooxygenase (FMN-linked) inhibitor	0.990	0.002	Eye irritation, moderate
		0.909	0.005	Polyporopepsin inhibitor	0.0982	0.002	Eye irritation, weak
		0.907	0.004	Sugar-phosphatase inhibitor	0.980	0.002	Skin irritation, weak
		0.897	0.003	Fucoesterol-epoxide lyase inhibitor	0.980	0.002	Eye irritation, high
		0.880	0.012	Aspulvinone dimethylallyltransferase inhibitor	0.975	0.002	Skin irritative effect
		0.871	0.004	GST A substrate	0.971	0.002	Skin irritation, moderate
		0.867	0.003	Glucan 1,4-alpha-maltotriohydrolase inhibitor	0.932	0.014	Toxic, respiration
		0.870	0.011	Phobic disorders treatment	0.908	0.004	Skin irritation, high
		0.859	0.004	Carboxypeptidase Taq inhibitor	0.892	0.004	Non mutagenic, Salmonella
		0.856	0.003	CYP2E1 inhibitor	0.857	0.004	Hypomagnesemia
		0.857	0.004	IgA-specific serine endopeptidase inhibitor	0.838	0.012	Acidosis, metabolic
		0.854	0.005	Alkylacetyl glycerophosphatase inhibitor	0.816	0.004	Carcinogenic, mouse, female
		0.857	0.010	Alkenyl glycerophosphocholine hydrolase inhibitor	0.808	0.005	Carcinogenic, mouse, male





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		0.842	0.003	Cyclomaltodextrinase inhibitor	0.813	0.011	Embryotoxic
		0.848	0.012	Saccharopepsin inhibitor	0.821	0.029	Shivering
		0.848	0.012	Chymosin inhibitor	0.801	0.013	Teratogen
		0.848	0.012	Acrocyldropepsin inhibitor	0.788	0.005	Carcinogenic, mouse
		0.838	0.003	Alkylglycerone-phosphate synthase inhibitor	0.773	0.005	Carcinogenic
		0.836	0.004	Gluconate 5-dehydrogenase inhibitor	0.713	0.008	Sensitization
		0.845	0.018	Ubiquinol-cytochrome-c reductase inhibitor	0.762	0.063	Twitching
4.	SHELLSOL	0.954	0.002	Sugar-phosphatase inhibitor	0.954	0.002	Shivering
		0.950	0.002	Saccharopepsin inhibitor	0.924	0.004	Twitching
		0.950	0.002	Chymosin inhibitor	0.932	0.014	Toxic, respiration
		0.950	0.002	Acrocyldropepsin inhibitor	0.922	0.004	Pure red cell aplasia
		0.942	0.002	Acylcarnitine hydrolase inhibitor	0.899	0.004	Demyelination
		0.941	0.002	Alkylacetyl glycerophosphatase inhibitor	0.900	0.007	Acidosis, metabolic
		0.940	0.002	Carboxypeptidase Taq inhibitor	0.896	0.003	Skin irritation, corrosive
		0.937	0.002	IgA-specific serine endopeptidase inhibitor	0.883	0.003	Hypomagnesemia
		0.935	0.002	Cutinase inhibitor	0.887	0.011	Euphoria
		0.936	0.003	Polyporopepsin inhibitor	0.880	0.004	Multiple organ failure
		0.935	0.003	Alkenylglycerophosphocholine hydrolase inhibitor	0.868	0.002	Acneiform eruption
		0.934	0.002	Acetylerase inhibitor	0.857	0.007	Ulcer, aphthous
		0.934	0.003	Ubiquinol-cytochrome-c reductase inhibitor	0.848	0.005	Thrombocytopoiesis inhibitor
		0.931	0.001	Glucan 1,4-alpha-maltotriohydrolase inhibitor	0.846	0.003	Visual acuity impairment
		0.930	0.002	Pullulanase inhibitor	0.841	0.004	Fibrosis, interstitial
		0.927	0.002	Gluconate 5-dehydrogenase inhibitor	0.833	0.005	Gastrointestinal hemorrhage
		0.929	0.004	Aspulvinone dimethylallyltransferase inhibitor	0.837	0.009	Hematemesi





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		0.926	0.002	All-trans-retinyl-palmitate hydrolase inhibitor	0.834	0.009	Fibrillation, atrial
		0.926	0.003	CYP2J substrate	0.836	0.015	Neutrophilic dermatosis (Sweet's syndrome)
		0.925	0.003	Taurine dehydrogenase inhibitor	0.820	0.003	Adrenal cortex hypoplasia
5.	2,4-DIMETHYL HEXANE	0.943	0.003	Phobic disorders treatment	0.883	0.009	Shivering
		0.936	0.003	Acrocyllindropepsin inhibitor	0.861	0.012	Pure red cell aplasia
		0.936	0.003	Saccharopepsin inhibitor	0.857	0.021	Toxic, respiration
		0.936	0.003	Chymosin inhibitor	0.840	0.004	Skin irritation, corrosive
		0.934	0.004	Testosterone 17beta-dehydrogenase (NADP+) inhibitor	0.845	0.019	Twitching
		0.914	0.005	Polyporopepsin inhibitor	0.818	0.007	Occult bleeding
		0.899	0.004	Pro-opiomelanocortin converting enzyme inhibitor	0.816	0.011	Hematemesis
		0.895	0.006	Ubiquinol-cytochrome-c reductase inhibitor	0.782	0.014	Multiple organ failure
		0.889	0.003	Fragilysin inhibitor	0.776	0.010	Gastrointestinal hemorrhage
		0.888	0.003	Cutinase inhibitor	0.770	0.010	Splenomegaly
		0.879	0.007	5 Hydroxytryptamine release stimulant	0.761	0.004	Acneiform eruption
		0.875	0.003	Acetylerase inhibitor	0.748	0.008	Respiratory impairment
		0.869	0.007	Sugar-phosphatase inhibitor	0.741	0.005	Adrenal cortex hypoplasia
		0.868	0.015	Aspulvinone dimethylallyltransferase inhibitor	0.736	0.004	Skin irritation, moderate
		0.857	0.008	Acylcarnitine hydrolase inhibitor	0.758	0.028	Ulcer, aphthous
		0.847	0.006	Alkylacetyl glycerophosphate inhibitor	0.732	0.004	Skin irritation, weak
		0.837	0.004	Limulus clotting factor B inhibitor	0.735	0.012	Hypomagnesemia
		0.836	0.004	Pseudolysin inhibitor	0.741	0.019	Hypotonia
		0.837	0.012	Antiseborrheic	0.723	0.004	Eye irritation, weak
		0.825	0.005	Carboxypeptidase Taq	0.71	0.005	Skin irritative





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				inhibitor	9		effect
6.	2-METHYL NONANE	0.959	0.002	Chymosin inhibitor	0.92 2	0.004	Shivering
		0.959	0.002	Acrocyndropepsin inhibitor	0.91 7	0.005	Pure red cell aplasia
		0.959	0.002	Saccharopepsin inhibitor	0.91 3	0.002	Skin irritation, corrasive
		0.947	0.003	Polyporopepsin inhibitor	0.92 4	0.015	Toxic, respiration
		0.941	0.003	Phobic disorders treatment	0.90 1	0.006	Acidosis, metabolic
		0.934	0.004	Testosterone 17beta- dehydrogenase (NADP+) inhibitor	0.87 2	0.010	Twitching
		0.932	0.003	Pro-opiomelanocortin converting enzyme inhibitor	0.83 2	0.018	Euphoria
		0.930	0.002	Cutinase inhibitor	0.81 8	0.007	Occult bleeding
		0.928	0.004	5 Hydroxytryptamine release stimulant	0.81 4	0.004	Methemoglobine mia
		0.928	0.004	Ubiquinol-cytochrome-c reductase inhibitor	0.81 3	0.006	Gastrointestinal hemorrhage
		0.921	0.002	Acetylerase inhibitor	0.81 6	0.011	Hematemesis
		0.915	0.004	Sugar-phosphatase inhibitor	0.80 5	0.007	Weight gain
		0.908	0.004	Acylcarnitine hydrolase inhibitor	0.79 7	0.011	Edema
		0.902	0.003	Alkylacetyllycerophosphatas e inhibitor	0.78 6	0.007	Hypomagnese mia
		0.889	0.003	Carboxypeptidase Taq inhibitor	0.79 7	0.023	Conjunctivitis
		0.890	0.006	Alkenylglycerophosphocholin e hydrolase inhibitor	0.78 2	0.014	Multiple organ failure
		0.882	0.003	IgA-specific serine endopeptidase inhibitor	0.76 1	0.004	Acneiform eruption
		0.883	0.006	CYP2J substrate	0.76 1	0.005	Irritation
		0.878	0.001	Sclerosant	0.76 4	0.009	Demyelination
		0.876	0.002	Glucan 1,4-alpha- maltotriohydrolase inhibitor	0.75 8	0.005	Pseudoporphyria
7.	2,6-DIMETHYL HEPTANE	0.954	0.002	Phobic disorders treatment	0.90 6	0.005	Shivering
		0.951	0.002	Acrocyndropepsin inhibitor	0.90 3	0.006	Pure red cell aplasia
		0.951	0.002	Saccharopepsin inhibitor	0.89 3	0.003	Skin irritation, corrasive





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		0.951	0.002	Chymosin inhibitor	0.88 5	0.019	Toxic, respiration
		0.948	0.003	Testosterone 17beta-dehydrogenase (NADP+) inhibitor	0.86 5	0.005	Hematemesis
		0.935	0.004	Polyporopepsin inhibitor	0.86 6	0.010	Acidosis, metabolic
		0.922	0.003	Pro-opiomelanocortin converting enzyme inhibitor	0.85 3	0.004	Occult bleeding
		0.922	0.004	Ubiquinol-cytochrome-c reductase inhibitor	0.85 3	0.016	Twitching
		0.915	0.002	Cutinase inhibitor	0.79 6	0.006	Hypomagnesemia
		0.912	0.004	5 Hydroxytryptamine release stimulant	0.79 8	0.007	Gastrointestinal hemorrhage
		0.906	0.002	Acetylcholinesterase inhibitor	0.78 9	0.004	Adrenal cortex hypoplasia
		0.898	0.005	Sugar-phosphatase inhibitor	0.79 3	0.008	Weight gain
		0.897	0.009	Aspulvinone dimethylallyltransferase inhibitor	0.79 3	0.011	Urine discoloration
		0.889	0.003	Fragilysin inhibitor	0.79 0	0.013	Multiple organ failure
		0.889	0.005	Acylcarnitine hydrolase inhibitor	0.77 6	0.005	Methemoglobinemia
		0.882	0.004	Alkylacetyl glycerophosphatase inhibitor	0.78 6	0.021	Ulcer, aphthous
		0.870	0.003	Pseudolysin inhibitor	0.76 8	0.004	Acneiform eruption
		0.869	0.003	Limulus clotting factor B inhibitor	0.78 5	0.023	Euphoria
		0.872	0.008	Alkyl glycerophosphocholine hydrolase inhibitor	0.76 3	0.010	Splenomegaly
		0.865	0.004	Carboxypeptidase Taq inhibitor	0.75 2	0.005	Irritation
8	IRIDIN	0.982	0.001	Cardioprotectant	0.93 1	0.007	Diarrhea
		0.981	0.001	Monophenol monooxygenase inhibitor	0.84 3	0.005	Hypothermic
		0.973	0.001	Hepatoprotectant	0.82 7	0.012	Inflammation
		0.960	0.001	Anticarcinogenic	0.76 0	0.009	Hypercholesterolemia
		0.958	0.001	Chemopreventive	0.75 4	0.020	Nephrotoxic
		0.955	0.003	Membrane permeability inhibitor	0.74 2	0.009	Ototoxicity





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		0.956	0.003	Antiinfective	0.73 0	0.039	Toxic
		0.951	0.006	Antiprotozoal (Leishmania)			
		0.948	0.002	Lipid peroxidase inhibitor			
		0.936	0.002	Anaphylatoxin receptor antagonist			
		0.931	0.004	Antihypercholesterolemic			
		0.926	0.006	CDP-glycerol glycerophosphotransferase inhibitor			
		0.919	0.002	Vasoprotector			
		0.898	0.002	Expectorant			
		0.895	0.004	Cytostatic			
		0.886	0.006	TP53 expression enhancer			
		0.880	0.002	Proliferative diseases treatment			
		0.877	0.002	Histidine kinase inhibitor			
		0.875	0.004	UDP-glucuronosyltransferase substrate			
		0.867	0.002	Free radical scavenger			
9.	ORIENTIN	0.974	0.003	TP53 expression enhancer	0.90 7	0.010	Diarrhea
		0.961	0.003	Membrane integrity agonist	0.85 3	0.009	Toxic, vascular
		0.955	0.001	Free radical scavenger	0.83 4	0.014	Neurotoxic
		0.952	0.002	Cardioprotectant	0.81 8	0.013	Inflammation
		0.940	0.004	HIF1A expression inhibitor	0.76 0	0.034	Toxic
		0.927	0.002	Hepatoprotectant	0.71 2	0.040	Hematotoxic
		0.904	0.004	Membrane permeability inhibitor			
		0.892	0.003	UGT1A9 substrate			
		0.888	0.003	2-Dehydropantoate 2-reductase inhibitor			
		0.884	0.003	Vasoprotector			
		0.884	0.005	Anaphylatoxin receptor antagonist			
		0.881	0.003	Chemopreventive			
		0.875	0.004	Cytostatic			
		0.872	0.003	Anticarcinogenic			
		0.862	0.003	UGT1A substrate			
		0.857	0.004	UDP-glucuronosyltransferase substrate			
		0.852	0.004	Kinase inhibitor			





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		0.844	0.007	Antineoplastic			
		0.835	0.003	Antimutagenic			
		0.832	0.002	Antihemorrhagic			
10.	10,13-Dimethoxy-17-(6-methylheptan-2-yl)-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta-phenanthrene	0.976	0.001	Prostaglandin-E2 9-reductase inhibitor	0.931	0.007	Sleep disturbance
		0.968	0.002	UGT1A substrate	0.921	0.009	Conjunctivitis
		0.967	0.002	Antihypercholesterolemic	0.907	0.008	Reproductive dysfunction
		0.964	0.002	Alkenylglycerophosphocholine hydrolase inhibitor	0.902	0.005	Teratogen
		0.959	0.001	Cholesterol antagonist	0.899	0.005	Embryotoxic
		0.958	0.001	Alkylacetyl glycerophosphatase inhibitor	0.898	0.009	Ocular toxicity
		0.954	0.001	UGT1A4 substrate	0.885	0.011	Drowsiness
		0.953	0.003	Testosterone 17beta-dehydrogenase (NADP+) inhibitor	0.871	0.008	Excitability
		0.944	0.002	Acylcarnitine hydrolase inhibitor	0.870	0.015	Behavioral disturbance
		0.929	0.004	CYP2C substrate	0.858	0.004	Irritation
		0.923	0.002	UGT2B substrate	0.850	0.003	Hypercholesterolemic
		0.924	0.003	Anesthetic general	0.862	0.017	Toxic
		0.921	0.002	Cholestanetriol 26-monooxygenase inhibitor	0.838	0.004	Cholestasis
		0.918	0.003	UDP-glucuronosyltransferase substrate	0.837	0.010	Asthma
		0.912	0.001	CYP4B substrate	0.827	0.009	Nephrotoxic
		0.911	0.000	CYP7 inhibitor	0.821	0.015	Necrosis
		0.905	0.001	CYP4B1 substrate	0.819	0.014	Toxic, vascular
		0.906	0.003	CYP3A inducer	0.818	0.019	Hepatotoxic
		0.904	0.003	Linoleate diol synthase inhibitor	0.809	0.014	Inflammation
		0.902	0.003	CYP3A4 inducer	0.80	0.015	Hypertensive





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					9		
11.	STIGMASTEROL	0.702	0.041	Nootropic	0.94 6	0.005	Sleep disturbance
		0.705	0.008	Antipruritic	0.92 7	0.008	Conjunctivitis
		0.706	0.005	Bone diseases treatment	0.91 5	0.007	Ocular toxicity
		0.714	0.005	Antiosteoporotic	0.91 3	0.008	Drowsiness
		0.715	0.004	UGT2B1 substrate	0.88 7	0.005	Teratogen
		0.716	0.005	Prostate disorders treatment	0.88 3	0.009	Hypertensive
		0.717	0.004	N-(long-chain-acyl)ethanolamine deacylase inhibitor	0.88 0	0.006	Embryotoxic
		0.728	0.005	Alkenylglycerophosphoethanolamine hydrolase inhibitor	0.87 5	0.014	Behavioral disturbance
		0.729	0.005	HMOX1 expression enhancer	0.86 8	0.009	Sweating
		0.739	0.002	DNA polymerase I inhibitor	0.87 2	0.015	Toxic
		0.746	0.005	CYP2C11 substrate	0.85 8	0.012	Headache
		0.751	0.004	Antipsoriatic	0.85 1	0.007	Nephrotoxic
		0.753	0.011	Apoptosis agonist	0.85 4	0.012	Pain
		0.755	0.004	Antitoxic	0.84 8	0.008	Weight loss
		0.761	0.003	UGT2B substrate	0.85 0	0.010	Inflammation
		0.763	0.030	Mucomembranous protector	0.85 4	0.017	Toxic, gastrointestinal
		0.775	0.007	27-Hydroxycholesterol 7alpha-monooxygenase inhibitor	0.84 5	0.012	Xerostomia
		0.775	0.004	Adenomatous polyposis treatment	0.83 7	0.016	Sensory disturbance
		0.781	0.008	CYP3A5 substrate	0.83 0	0.016	Dizziness
		0.782	0.007	Immunosuppressant			
12.	QUERCETIN	0.973	0.002	Membrane integrity agonist	0.79 7	0.018 13	Toxic, vascular
		0.969	0.002	HIF1A expression inhibitor	0.76 6	0.052	Shivering
		0.962	0.001	Peroxidase inhibitor	0.70 6	0.014	Endocrine disruptor





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		0.957	0.002	HMOX1 expression enhancer	0.71 9	0.032	Reproductive dysfunction
		0.951	0.001	CYP1A inducer			
		0.944	0.002	UGT1A6 substrate			
		0.945	0.004	CYP1A substrate			
		0.940	0.001	Antimutagenic			
		0.940	0.003	CYP1A1 substrate			
		0.939	0.002	UGT1A10 substrate			
		0.938	0.003	Membrane permeability inhibitor			
		0.934	0.001	Quercetin 2,3-dioxygenase inhibitor			
		0.933	0.001	MAP kinase stimulant			
		0.931	0.002	UGT1A9 substrate			
		0.930	0.001	CYP1A1 inducer			
		0.930	0.003	CYP1A inhibitor			
		0.928	0.002	NADPH oxidase inhibitor			
		0.924	0.001	Beta-carotene 15,15'-monoxygenase inhibitor			
		0.920	0.001	Chalcone isomerase inhibitor			
		0.924	0.007	CYP2C12 substrate			
13.	RUTIN	0.993	0.001	Hemostatic	0.95 2	0.004	Inflammation
		0.990	0.000	Membrane permeability inhibitor	0.88 7	0.010	Drowsiness
		0.988	0.001	Free radical scavenger	0.88 2	0.007	Neurotoxic
		0.988	0.001	Cardioprotectant	0.85 9	0.016	Sleep disturbance
		0.987	0.001	Lipid peroxidase inhibitor	0.85 7	0.017	Behavioral disturbance
		0.984	0.001	Membrane integrity agonist	0.85 0	0.017	Diarrhea
		0.983	0.001	CYP1A inducer	0.85 1	0.019	Toxic
		0.983	0.001	Anticarcinogenic	0.83 2	0.010	Teratogen
		0.980	0.001	Vasoprotector	0.83 1	0.010	Embryotoxic
		0.975	0.001	CYP1A1 inducer	0.82 5	0.022	Hematotoxic
		0.974	0.001	Xanthine dehydrogenase inhibitor	0.81 7	0.014	Toxic, vascular
		0.968	0.001	Hepatoprotectant	0.76 1	0.019	Nephrotoxic
		0.968	0.001	Chemopreventive	0.72 6	0.040	Toxic, gastrointestinal
		0.969	0.002	UDP-glucuronosyltransferase	0.70	0.022	Weight loss





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				substrate	2		
		0.965	0.001	Monophenol monooxygenase inhibitor			
		0.952	0.001	Proliferative diseases treatment			
		0.948	0.001	Histamine release stimulant			
		0.942	0.001	Morphine 6-dehydrogenase inhibitor			
		0.939	0.000	Capillary fragility treatment			
		0.928	0.003	Anaphylatoxin receptor antagonist			
14.	3-(2,4-DIMETHOXYPHENYL)-6,7-DIMETHOXY-2,3-DIHYDROCHROMEN-4-ONE	0.707	0.003	4-Coumarate-CoA ligase inhibitor	0.759	0.031	Diarrhoea
		0.958	0.001	APOA1 expression enhancer	0.738	0.029	Toxic, vascular
		0.819	0.008	Aldehyde oxidase inhibitor			
		0.731	0.020	Anaphylatoxin receptor antagonist			
		0.751	0.007	Anticarcinogenic			
		0.764	0.006	Antihypercholesterolemic			
		0.837	0.003	Antimutagenic			
		0.860	0.003	Antioxidant			
		0.710	0.014	Apoptosis agonist			
		0.789	0.037	Aspulvinone dimethylallyltransferase inhibitor			
		0.942	0.004	CYP1A substrate			
		0.944	0.0003	CYP1A1 substrate			
		0.929	0.004	CYP1A2 substrate			
		0.703	0.006	CYP2A4 substrate			
		0.808	0.006	CYP2B substrate			
		0.879	0.004	CYP2B6 substrate			
		0.876	0.018	CYP2C12 substrate			
		0.812	0.005	CYP3A inducer			
		0.847	0.005	CYP3A4 inducer			
		0.827	0.005	Caspase 3 stimulant			

Table 2: *In-vitro* cytotoxicity assay (trypan blue assay)

S.No	Drug concentration ($\mu\text{g/ml}$)	% Cell death
01	12.5	5.76 \pm 0.7
02	25	6.67 \pm 0
03	50	7.38 \pm 0.7
04	100	14.5 \pm 1
05	150	21.2 \pm 1.2





06	200	29.3 ± 2.3
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Table 3: Canonical smiles, Formula and Molecular weight

S. No.	MOLECULE	CHEMICAL CONSTITUENTS	CANONICAL SMILES
1	Molecule 1	Ar-TURMERONE	<chem>CC1=CC=C(C=C1)C(C)CC(=O)C=C(C)C</chem>
2	Molecule 2	FRIEDELAN-3-ONE	<chem>CC1C(=O)CCC2C1(CCC3C2(CCC4(C3(CCC5(C4CC(CC5)(C)C)O)C)C)C)C</chem>
3	Molecule 3	VINYL HEXYL ETHER	<chem>CCCCCCOC=C</chem>
4	Molecule 4	SHELLSOL	<chem>CCCCCCCC</chem>
5	Molecule 5	2,4-DIMETHYL HEXANE	<chem>CCC(C)CC(C)C</chem>
6	Molecule 6	2-METHYL NONANE	<chem>CCCCCCCC(C)C</chem>
7	Molecule 7	2,6-DIMETHYL HEPTANE	<chem>CC(C)CCCC(C)C</chem>
8	Molecule 8	IRIDIN	<chem>COC1=CC(=CC(=C1OC)O)C2=COC3=CC(=C(C(=C3C2=O)O)OC)OC4C(C(C(C(O4)CO)O)O)O</chem>
9	Molecule 9	ORIENTIN	<chem>C1(=C2C(=C(C=C1O)O)C(=O)C=C(O2)C3=CC=C(O)C(=C3)O)C4OC(CO)C(C(C4O)O)O</chem>
10	Molecule 10	10,13-DIMETHOXY-17-(6 METHYLHEPTAN-2-YL)-2,3,4,7,8,9,10,11,12,13,14,15,16,17-TETRADEACHYDRO-1H-CYCLOPENTAPHENANTHRENE	<chem>[H+].CC(C)CCCC(C)C1CCC2C1(CCC3C2CC=C4C3(CCC(C4)O)C)C</chem>
11	Molecule 11	STIGMASTEROL	<chem>CCC(C=CC(C)C1CCC2C1(CCC3C2CC=C4C3(CCC(C4)O)C)C)C(C)C</chem>
12	Molecule 12	QUERCETIN	<chem>O=C1C3C(O/C(=C1/O)C2CCC(O)C(O)C2)CC(O)CC3O</chem>
13	Molecule 13	RUTIN	<chem>CC1C(C(C(C(O1)OCC2C(C(C(C(O2)OC3=C(OC4=CC(=CC(=C4C3=O)O)O)C5=CC(=C(C=C5)O)O)O)O)O)O)O</chem>
14	Molecule 14	3-(2,4-DIMETHOXYPHENYL)-6,7-DIMETHOXY-2,3-DIHYDROCHROMEN-4-ONE	<chem>COC1=C(C=C(C=C1)C2C(C(=O)C3=C(O2)C=C(C=C3OC)OC)O)OC</chem>

Table 4: ADME

Molecule	Ali Class	GI Absorption	BBB Permeation	Pgp Substrate	CYP1 A2 Inhibitor	CYP2 C19 Inhibitor	CYP2 C9 Inhibitor	CYP2 D6 Inhibitor	CYP3 A4 Inhibitor	Log Kp (cm/s)	Bioavailability score





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Molecule 1	Moderately soluble	High	Yes	No	No	No	No	No	No	-4.79	0.55
Molecule 2	Insoluble	Low	No	No	No	No	No	No	No	-1.94	0.55
Molecule 3	Soluble	High	Yes	No	No	No	No	No	No	-4.84	0.55
Molecule 4	Moderately soluble	Low	Yes	No	No	No	No	No	No	-3.07	0.55
Molecule 5	Soluble	Low	Yes	No	No	No	No	No	No	-4.18	0.55
Molecule 6	Moderately soluble	Low	Yes	No	No	No	No	No	No	-3.38	0.55
Molecule 7	Moderately soluble	Low	Yes	No	No	No	No	No	No	-3.88	0.55
Molecule 8	Moderately soluble	Low	No	Yes	No	No	No	No	Yes	-8.93	0.17
Molecule 9	Soluble	Low	No	No	No	No	No	No	No	-9.14	0.17
Molecule 10	Poorly soluble	Low	No	No	No	No	No	No	No	-2.47	0.55
Molecule 11	Poorly soluble	Low	No	No	No	No	Yes	No	No	-2.74	0.55
Molecule 12	Soluble	High	No	No	Yes	No	No	Yes	Yes	-7.05	0.55
Molecule 13	Moderately soluble	Low	No	Yes	No	No	No	No	No	-10.26	0.17
Molecule 14	Soluble	High	Yes	No	Yes	Yes	Yes	Yes	Yes	-6.3	0.55





Leafy Vegetables: Nutritional and Medicinal Value - A Review

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

Leafy vegetables have long been recognized for their nutritional richness and potential medicinal benefits. This comprehensive review article aims to provide an in-depth analysis of the nutritional and medicinal value of various leafy vegetables, emphasizing their diverse phytonutrient profiles and their significant impact on human health. The review begins by exploring the wide array of essential nutrients present in leafy greens, including vitamins (A, C, K, and various B vitamins), minerals (iron, calcium, magnesium), dietary fiber, and antioxidants. It highlights the importance of these nutrients in promoting overall well-being, supporting digestion, bone health, and weight management. Furthermore, the review delves into the medicinal properties of leafy vegetables, discussing their potential in preventing and managing chronic diseases. It presents scientific evidence demonstrating the role of leafy greens in reducing the risk of heart disease through blood pressure regulation and cholesterol management. Additionally, the anti-inflammatory and antioxidant properties of these vegetables are examined in relation to their contribution to cancer prevention and the mitigation of chronic inflammation. The article also explores the impact of leafy vegetables on specific health conditions, such as diabetes and age-related macular degeneration, emphasizing their role in blood sugar control and eye health. Moreover, it discusses the potential cognitive benefits associated with the consumption of certain leafy greens, contributing to cognitive function and potentially reducing the risk of cognitive decline in older adults.



Kaushik Modak *et al.*,**Keywords:** Leafy vegetables, nutrition, medicinal value, phytonutrients, chronic diseases.

INTRODUCTION

Leafy vegetables are a diverse group of plants prized for their tender, leafy greens that are not only delicious but also packed with a plethora of essential nutrients. These vibrant greens come in various shapes, sizes, and colors, making them a versatile and essential part of a balanced diet. From spinach and kale to lettuce and collard greens, leafy vegetables offer a wide range of flavors and textures to satisfy even the most discerning palate. Beyond their culinary appeal, leafy vegetables are celebrated for their numerous medicinal benefits. These benefits are attributed to the rich array of vitamins, minerals, antioxidants, and other bioactive compounds they contain. Here are some of the remarkable health benefits of including leafy vegetables in your diet, supported by scientific research: Leafy greens are a powerhouse of essential nutrients such as vitamins A, C, K, and folate, along with minerals like iron, calcium, and potassium. These nutrients play crucial roles in maintaining overall health and wellbeing [1]. Leafy vegetables are packed with antioxidants, including beta-carotene, lutein, and zeaxanthin. These compounds help protect cells from oxidative stress and reduce the risk of chronic diseases like heart disease and cancer [2]. Leafy greens like kale and collard greens are excellent sources of vitamin K and calcium, which are vital for maintaining strong and healthy bones [3]. Regular consumption of leafy greens has been linked to a reduced risk of heart disease due to their high potassium content, which can help lower blood pressure, and their ability to improve blood vessel function [4]. Leafy vegetables are a good source of dietary fiber, promoting healthy digestion and preventing constipation. They also contain compounds that support a healthy gut microbiome [5]. Leafy greens are low in calories and high in fiber, making them an excellent choice for those looking to manage their weight. They provide a sense of fullness, reducing overall calorie intake [6]. Reduced Risk of Chronic Diseases: A diet rich in leafy greens has been associated with a lower risk of chronic diseases, including type 2 diabetes and certain types of cancer [7]. Lutein and zeaxanthin found in leafy greens are known to promote eye health by reducing the risk of age-related macular degeneration and cataracts [8].

RESULT AND DISCUSSION

Leafy vegetables are a diverse group of plants that are prized for their culinary versatility and numerous health benefits. These vegetables encompass a wide range of species, including spinach, kale, lettuce, Swiss chard, collard greens, and many others. In addition to their delicious flavors and vibrant colors, leafy greens are packed with essential nutrients, vitamins, minerals, and antioxidants that contribute to their significant medicinal benefits. This introduction will explore some of the key health advantages associated with leafy vegetables, supported by scientific citations. The availability of leafy vegetables in Assam can be influenced by various factors, including climate, geography, and agricultural practices. Assam, a state in northeastern India, has a diverse topography and climate, which can impact the types of leafy greens that are cultivated and available throughout the year.

Nutrient-Rich Powerhouses

Leafy greens are renowned for their exceptional nutrient content. They are an excellent source of vitamins A, C, and K, as well as essential minerals like calcium, iron, and magnesium. These nutrients play crucial roles in maintaining overall health and well-being [9].

Fiber for Digestive Health

Leafy vegetables are high in dietary fiber, which aids in digestion and promotes a healthy gut microbiome. The fiber in leafy greens can help prevent constipation and may reduce the risk of gastrointestinal disorders [10].



**Kaushik Modak et al.,****Heart Health**

Studies have shown that a diet rich in leafy greens may lower the risk of heart disease. The high levels of potassium and magnesium in these vegetables can help regulate blood pressure, while their fiber content helps lower cholesterol levels [11].

Anti-Inflammatory Properties

Leafy greens contain antioxidants such as flavonoids and carotenoids, which possess anti-inflammatory properties. Chronic inflammation is linked to various diseases, and including leafy vegetables in one's diet may help mitigate this risk [12].

Bone Health

Leafy greens like kale and collard greens are excellent sources of vitamin K, which plays a vital role in bone health by promoting calcium absorption and bone mineralization. This is essential for preventing osteoporosis [13].

Weight Management: Leafy vegetables are low in calories and high in water content, making them a fantastic choice for weight management and maintaining a healthy body weight. Their fiber content also helps keep you feeling full and satisfied [14].

Cancer Prevention

Some studies suggest that the antioxidants and phytochemicals found in leafy greens may have protective effects against certain types of cancer, including lung, colorectal, and breast cancer [15].

Vision Support

Leafy greens are rich in lutein and zeaxanthin, two antioxidants that are essential for eye health. These compounds may help protect against age-related macular degeneration and cataracts [16].

Diabetes Management

The high fiber content of leafy greens can help regulate blood sugar levels and improve insulin sensitivity, making them a valuable addition to the diet of individuals with diabetes [17].

Improved Cognitive Function

Some research suggests that the nutrients in leafy greens, such as folate and vitamin K, may support cognitive function and reduce the risk of cognitive decline in older adults [18].

CONCLUSION

Leafy vegetables are not just a culinary delight but also a nutritional powerhouse. Their wide array of vitamins, minerals, and bioactive compounds provide a multitude of health benefits, from promoting heart health to reducing the risk of chronic diseases. Their nutrient density, fiber content, and antioxidant properties make them valuable components of a healthy diet that can contribute to overall well-being and the prevention of various chronic diseases. Incorporating a variety of leafy greens into your diet can be a delicious and effective way to enhance your overall well being. This review underscores the diverse nutritional and medicinal value of leafy vegetables in promoting human health and preventing a range of diseases. It consolidates the existing scientific evidence, making a compelling case for the incorporation of leafy greens into a balanced diet to optimize health outcomes

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Table 1: Listed with overall nutritional and health benefit of common leafy vegetables

Nutrient/Health Benefit	Leafy Vegetables
Vitamins	
Vitamin A	Kale, Spinach, Swiss Chard, Collard Greens
Vitamin C	Kale, Broccoli, Brussels Sprouts, Spinach
Vitamin K	Kale, Spinach, Swiss Chard, Collard Greens
Folate (B9)	Spinach, Romaine Lettuce, Turnip Greens
Minerals	
Iron	Spinach, Kale, Swiss Chard, Mustard Greens
Calcium	Kale, Collard Greens, Turnip Greens
Potassium	Spinach, Swiss Chard, Kale, Collard Greens
Magnesium	Spinach, Swiss Chard, Kale, Collard Greens
Fiber	All Leafy Vegetables
Antioxidants	
Beta-carotene	Kale, Spinach, Collard Greens, Swiss Chard
Lutein	Kale, Spinach, Collard Greens, Swiss Chard
Quercetin	Kale, Spinach, Romaine Lettuce
Health Benefits	
Heart Health	Reduced risk of heart disease due to fiber and potassium content
Bone Health	Rich in calcium, vitamin K, and magnesium
Anti-Inflammatory	High antioxidant content
Weight Management	Low in calories and high in fiber
Eye Health	Lutein and beta-carotene support eye health

Table 2: The cultivation and agricultural scenario of common leafy vegetables of Assam.

Climate and Seasons	Geographical Diversity	Commonly Cultivated Leafy Vegetables	Local Agricultural Practices	Market Availability
Monsoons: Assam experiences a significant amount of rainfall during the monsoon season, which typically lasts from June to September. This abundant water supply is favourable for the growth of a variety of leafy vegetables.	Brahmaputra Valley: The Brahmaputra Valley, the largest geographical region in Assam, is known for its fertile plains. This area supports the cultivation of a wide range of crops, including various leafy vegetables.	Kachu Xaak: A leafy green native to Assam, often used in traditional Assamese cuisine.	Home Gardens: Many households in Assam have home gardens where a variety of leafy greens and other vegetables are cultivated.	Local Markets: Leafy vegetables are commonly found in local markets throughout Assam. The availability of specific greens may vary by season and region.





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<p>Winter: The winter season, from November to February, is relatively mild in Assam. Certain leafy greens may thrive during this period.</p>	<p>Barak Valley: This valley, located in the southern part of Assam, also contributes to agricultural production. The types of leafy greens cultivated may vary based on local preferences and climatic conditions.</p>	<p>Manimuni: Also known as water spinach, it is commonly grown in waterlogged areas and is popular in Assamese dishes. Dhekia Xaak: A fern with edible fronds, widely used in Assamese recipes.</p>	<p>Traditional Farming: Traditional farming practices, including terrace cultivation and jhum (slash-and-burn agriculture), may influence the types of leafy vegetables grown.</p>	<p>Urban Centres: In urban areas like Guwahati, markets often offer a diverse range of leafy vegetables, including those brought in from surrounding areas.</p>
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Table 3: Representing the Leafy vegetables of Assam and their reported bioactive constituents with ethnomedicinal uses.

English name	Local name	Scientific name	Family	Bioactive constituents	Ethnomedicinal use
Fiddlehead fern [19]	Dhekia (Assamese), Dheki shaag (Bengali)	<i>Diplazium esculentum</i>	Athyriaceae	D. esculentum leaves and the major volatile compounds were identified as β-pinene (17.2%), α-pinene (10.5%), caryophyllene oxide (7.5%), sabinene (6.1%), and 1,8-cineole (5.8%) ascorbic acid, eriodictyol 5-O-methyl ether 7-O-β-D-xylosygalactoside, tannins and phytates], α-tocopherol, quercetin, pterostromanin, ptaquiloside, terpenes, hopan-triterpene lactone, and lutein	diabetes, smallpox, asthma, diarrhea, rheumatism, dysentery, headache, fever, wounds, pain, measles, and high blood pressure.
Spinach [20,21]	Paleng Xaak (Assamese), Palong shaak (Bengali)	<i>Spinacia oleracea</i>	Chenopodiaceae	Spinach is a rich source of fiber, vitamins A, C, E, K, B6, B2 and also magnesium, manganese, iron, calcium, potassium, copper, phosphorous, zinc, selenium, folate, betaine, folic acid, protein, niacin, omega-	cooling, emollient, wholesome, antipyretic, diuretic, maturant, laxative, digestible, anthelmintic, urinary calculi, inflammation of the lungs and the bowels, sore throat, pain in joints, thirst, lumbago, cold and sneezing, sore eye, ring worm scabies, leucoderma, soiling urine, arrest vomiting, biliousness, flatulence and febrile





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				3 fatty acids, carotenoids beta-carotene and lutein, and bioflavonoid quercetin with many other flavonoids.	
Red vine spinach [22,23,24]	Pui xaak(Assamese), Pui shaak(Bengali) Kodip pasali (Tamil)	Malabar spinach	Basellaceae	Proteins, fat, vitamin A, vitamin C, vitamin E, vitamin K, vitamin B9 (folic acid), riboflavin, niacin, thiamine and minerals such as calcium, magnesium and iron.	a positive effect on total-body vitamin A storage in men, used for the treatment of hypertension, malaria, antifungal, anticonvulsant, analgesic, antiinflammatory and androgenic activities and for the treatment of anemia, topical application for irritant, bruise, ringworm and labour, mild laxative, diuretic and antipyretic.
Heart Leaf [25,26,27,28,29, 30,31,32,33]	Mosondori (Assamese), Mosondari Shaak(Bengali)	Houttuynia cordata Thumb	Saururaceae	cordifolide, heptacosanol, columbin, choline, tinosporide, clerodane furano diterpene, tembertarine, palmatine, magniflorine, β -sitosterol, cordifol, diterpenoid furano lactone, and Berberine, tinosporaside, tinosporine	Anti-diabetic, Anti-cancer, Antioxidant, Anti-microbial, Anti-osteoporotic, Immuno-modulatory, Memory enhancing activity, Antitoxic activity,
Indian Pannywort [34,35,36,37,38, 39,40,41]	Manimuni (Assamese), Thankuni Pata (Bengali)	Centella asiatica	Apiaceae	Asiatic acid, asiaticoside, and madecassoside, pentacyclic triterpenoid saponins, Centellin, asiatic, and centellicin	Anticancer activity, Antifungal activity, antibacterial Activity, Anti-Inflammatory Activity, Wound Healing, Antidepressant, Neuroprotective Activity, Antidiabetic Activity, Antioxidant Property
Drumstick leaves [42,43]	Sajina paat(Assamese), Jhola pata (Bengali)	Moringa oleifera L	Moringaceae	β carotene, protein, vitamin C, calcium, and potassium;	Moringa leaves treat asthma, hyperglycemia, Dyslipidemia, flu, heart burn, syphilis, malaria, pneumonia, diarrhoea, headaches, scurvy, skin diseases, bronchitis, eye and ear infections. The fresh leaf juice was found to inhibit the growth of human pathogens.
Curry Leaf[44]	Noro-Xingho (Assamese) Kari Pata	Murraya koenigii	Rutaceae	Fibre, Mineral, Calcium, Phosphorus, Iron, Carotene (as vitamin A), Nicotinic acid, Vitamin C,	Anti diabetic and cholesterol reducing property, antimicrobial activity, antiulcer activity, antioxidative property, cytotoxic activity, anti-diarrhoeal activity,





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	(Bengali)			Thiamine and riboflavin	phagocytic activity
Thai Coriander [45,46,47,48,49,50,51]	Maan Dhaniya (Assamese) Dhaniya (Bengali Dhaniya)	<i>Eryngium foetidum</i>	Epiaceae	Dodecenal, 13-Tetradecenal, Trans-2-tetradecenal, 2,4,6-Trimethylbenzaldehyde and 2,4,5-Trimethylbenzaldehyde, 5-Dodecene, Tetradecanal 3,4,5-Trimethylphenol, 2,4,6-Trimethylbenzaldehyde, 1-(2-Methylbutyl)-1-(1-methylpropyl)cyclopropane α -Pinene, Z)-13-octadecenal, Muurola 4,10(14)-dien-1 α -ol, Neophytadiene isomer, Hexahydrofarnesyl acetone, Neophytadiene isomer, Hexahydrofarnesyl acetone, Phytol, 2-Formyl 1,1,5-trimethyl 2,5-cyclohexadien-4-yl-2-methylbutenoate, Cadino, α -Cadinol, Caprylic alcohol, 1,4-Dihydrocarbazole-1,4-dione, Lauraldehyde, α -Pinene, M-Cymene, O-Cymene, Lasidiol p-methoxybenzoate.	Antibacterial and antifungal, Anthelmintic, Anti-leishmaniasis, Anti-inflammatory, Anticancer, Antidiabetic, Antioxidant.
Amaranth[52]	Morisa Xaak (Assamese)	<i>Amaranthus cruentus</i>	Amaranthaceae	Inositol, glucose, fructose, monosaccharides, disaccharides such as raffinose, sucrose, maltose, and stachyose.	Anti-inflammatory, Antioxidant, Antithrombotic, Embryotoxic, Enzyme inhibitor, Antihypertensive
Stinkvine[53,54,55,56,57,58]	Bhedailota (Assamese) (Bengali)	<i>Paederia foetida</i> L	Rubiaceae	Eiridoid glycosides, sitosterol, stigmasterol, alkaloids, carbohydrates, protein, amino acid and volatile oil, carotene	Antidiarrheal, Antiinflammatory, Antispasmodic, Anthelmintic, Antitussive Activity, Antioxidant Activity, Hepatoprotective Activity.





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				and vitamin C, beta-sitosterol and epifriedelinol.	
White goosefoot [59,60,61,62,63, 64,65,66,67,68]	Zilmil XaaK (Assamese)	<i>Chenopodium album</i>	Amaranthaceae	b-sitosterol, lupeol, 3 hydroxy nonadecyl hencosanoate, ascorbic acid, b-carotene, catechin, gallic acid, caffeic acid, p-coumaric acid, ferulic acid, campesterol, xanthotoxin, stigmasterol, imperatorin, ecdysteroid, cinnamic acid amide alkaloid, phenol, saponin, apocarotenoids, crytomerediol, n-trans-feruloyl-4-O-methyl dopamine and syringaresinol.	Hepatoprotective activity, Antibacterial activity, Spasmolytic and analgesic activity, Antimicrobial and anthelmintic activity, Antipruritic and antinociceptive effects, antibreast cancer bioagent, Sperm-immobilizing agent, Anti-inflammatory activity.

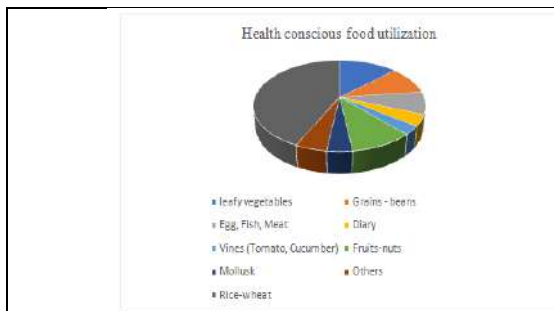


Figure 1: Dependency of health benefited food consumption in Assam



Dipiazium esculentum *Spinacia oleracea* *Malabar spinach*

Figure 2



Houttuynia cordata *Centella asiatica* *Moringa oleifera*

Figure 3



Murraya koenigii *Eryngium foetidum* *Amaranthus cruentus*

Figure 4





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Paederia foetida



Chenopodium album

Figure 5





Unveiling the Impact of Isopulegol in the Management of Diabetic Nephropathy: A Network Pharmacology based Approach

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

Diabetic nephropathy (DN) has become the most prevalent destructive complication of diabetes mellitus, due to inadequate treatment approaches. This study integrates molecular docking and network pharmacology to analyse the impact of isopulegol in the treating the complications of diabetic nephropathy (DN). The isopulegol and Diabetic nephropathy targets were obtained from databases and 61 common targets were identified through cytoscape analysis. Twenty seven genes involved in nine pathways was screened using Gene ontology (GO) analysis and Kyoto Encyclopedia of Gene and Genome (KEGG) pathway enrichment analysis. The topology of PPI network was analysed. Molecular docking shows that the 5 target proteins namely JAK1, MAPK8, EGFR, MMP2 and MMP9 associated with resistance to insulin, inflammation, apoptosis, oxidative stress, etc. have good interactions with isopulegol. The results of this study imply that isopulegol might be a useful medication for treating DN.

Keywords: Isopulegol; diabetic nephropathy; network pharmacology; molecular docking





INTRODUCTION

Diabetes mellitus ranking third among the non-communicable diseases in the globe is speculated to increase up to 642 million cases by the year 2040 [1]. Persistent hyperglycemic condition leads to damage of various organs of the body and thereby complications which comprises cardiovascular, cerebrovascular and microvascular diseases like diabetic cardiomyopathy, retinopathy and nephropathy[2]. Among the microvascular complications, diabetic nephropathy is the most prevalent and poses a great threat to public health globally [3]. Glomerular injury and tubulointerstitial fibrosis attributes to the deadly effect of diabetic nephropathy[4]. Though standard treatment procedures are in use, a novel therapeutic compound that can combat diabetic nephropathy progression has not been identified. Terpenoids are phytochemicals that possess a diverse range of pharmaceutical properties. Isopulegol is a monoterpene present in mint, rosemary oil and grapefruit [5] that possess good biological properties inclusive of anti-diabetic property [6]. However, the possible mechanism of action of isopulegol in ameliorating diabetic nephropathy has not yet been studied. Network pharmacology, a rich blend of huge data of systems biology and computing technology is an interactive network that has gained momentum in the last decade put forward by Hopkins[7]. It enables the identification of mechanism of action of compounds on diseases in a logical manner. The objective of this study is to identify the targets through which isopulegol ameliorates diabetic nephropathy (Fig.1)

MATERIALS AND METHODS

Physicochemical and structural attributes of Isopulegol

The 2D (Fig. 2) and 3D structures of isopulegol were acquired from Pub-Chem (<https://pubchem.ncbi.nlm.nih.gov/>). The physico-chemical characteristics of isopulegol are summarized utilizing pkCSM web server (<http://biosig.unimelb.edu.au/pkcsm/prediction>) in Table 1. The parameters with their characteristics such as absorption (solubility of water, Intestinal absorption, permeability of CaCo2, Skin, P-glycoprotein substrate, P-glycoprotein inhibitor I and II), Distribution (Volume Distribution, CNS permeability and BBB permeability), Metabolism (CYP substrates and inhibitors), Excretion (Renal OCT2 substrate and Total clearance) and Toxicity (AMES toxicity, hepatotoxicity, Skin sensitization) help us to determine the pharmacokinetics of isopulegol. Bioavailability and drug likeliness was speculated utilizing Swiss ADME (<http://www.swissadme.ch/index.php>)

Potential targets of isopulegol and DN

Isopulegol structure information (canonical smiles) was utilised to identify the targets from 5 databases and DN targets were identified from 3 databases (Table 2). The nomenclature was standardized using UniProtKB.

Overlapped targets and network construction

The overlapping targets from 2.2 were shortlisted, and a network based on the interactions between isopulegol and DN was developed by utilising the Cytoscape software (<http://cytoscape.org/ver.3.5.0>). The therapeutic targets of isopulegol that plays a role in DN pathogenesis was identified using this approach. The Target-biological processes (T-BP) network enabled the identification of potential common targets of isopulegol, DN and related biological processes (BPs). The major pathways in which the common targets of isopulegol and DN are involved was identified using Target-Pathway (T-P) network. The targets, associated biological processes with pathways were depicted using BP-Target-Pathway (BP-T-P) network.

Protein – protein interaction (PPI) network analysis

Using data from the STRING database (<https://string-db.org/>, Version: 11.0) and the organism set as "Homo sapiens," a PPI network of overlapping target genes was built and viewed in Cytoscape. The Network Analyzer tool in Cytoscape was utilised to assess the parameters and degree value of nodes within networks. In the PPI network, a node with a higher degree value represented potential significant constituents of herbs and important targets.





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Functional enrichment and pathway analysis

Gene ontology (GO) that comprises biological processes, molecular functions and cellular components, and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway enrichment analysis that enables to identify particular biological characteristics of a possible isopulegol target in DN were carried out with ShinyGO v.0.7.4.1. (<http://bioinformatics.sdstate.edu/go74/>), a tool for gene enrichment analysis. Statistical significance was approved for the cut-off values of $p < 0.05$.

Protein preparation and optimization

The crystal structure of Drug targets namely GSK3B, JAK1, JAK2, EGFR, INSR, TGFB2, MAPK1, MAPK8, MAPK14, MMP2, MMP3 and MMP9 from *Homo sapiens* were obtained from RCSB protein data bank. Using the Kollman united atoms force field and the Auto Dock Tool(ADT) –2.0. 2.2, proteins were assigned electronic charges and addition of solvation parameters, hydrogen atoms, and fragmental volumes was done.

Ligand preparation and optimisation

Using Chemscketch Software, Isopulegol structure was drawn, 3-D structure was generated and optimized. The open babel molecular converter programme was used to convert the chosen ligands stored in MDL-MOL format to PDB format.

Molecular docking and visualization

Docking analysis of 12 targets identified through pathway analysis against Isopulegol was done using AutoDock 4.2 tool to see the affinity [8]. Several intermediary procedures were conducted, including the creation of pdbqt files for the protein and ligand, construction of the grid, and generation of a grid map with a grid box. Genetic algorithm was used as a search parameter. Lamarckian GA was the output selected. Biovia Discovery Studio Visualizer software was utilized to visualize the protein-ligand interaction involving isopulegol and GSK3B, JAK1, JAK2, EGFR, INSR, TGFB2, MAPK1, MAPK8, MAPK14, MMP2, MMP3, MMP9.

RESULTS AND DISCUSSION

Diabetic nephropathy, a leading cause of end stage renal disease is linked to higher rates of cardiovascular morbidity and death. The pathophysiology of diabetes and diabetic nephropathy (DN) is intricate and involves interactions among hemodynamic and metabolic pathways, oxidative damage, and the release of cytokines and growth factors, eventually resulting in kidney damage. The current primary approach to pharmacotherapy is controlling the blood pressure, inhibition of the renin-angiotensin-aldosterone system (RAAS) using ACE inhibitors and/or ARBs, and using medicines to lower glucose levels. Disease-modifying practices like dietary restriction, weight loss, quitting smoking, and cholesterol control offer cumulative renal benefits, especially when it comes to lowering cardiovascular risk. The most common risk factors of DN are hyperglycemia, elevated blood pressure and genetic predisposition[9]. Novel approaches aimed at addressing supplementary pathophysiological pathways are required to prevent and manage DN[10]. Network pharmacology is an interdisciplinary field that combines knowledge from network science, bioinformatics, pharmacology, and systems biology to understand how medications interact with biological systems holistically. It seeks to investigate the intricate connections that exist between medications, their targets, and the biological processes that underlie a variety of illnesses. The traditional approach to drug discovery often focused on identifying single drug-target interactions, but network pharmacology takes a more comprehensive and systemic perspective. The application of network pharmacology has the potential to accelerate drug discovery and development, improve the understanding of drug mechanisms of action, and facilitate the identification of novel therapeutic targets. It is particularly valuable for addressing complex diseases where a holistic understanding of the underlying biological processes is essential. Applying network pharmacology and molecular docking techniques, this work examines the impacts of isopulegol on diabetic nephropathy (DN), given its antidiabetic properties as a monoterpene alcohol. Isopulegol (p-menth-8-en-3-ol), an intermediate obtained during the preparation of (-)-menthol is a monoterpene alcohol that belongs to p-menthane family [11]. The essential oils of *Eucalyptus citriodora* Hook [12]





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and *Zanthoxylum schinifolium* [13] contains isopulegol. The monoterpene alcohol has gastroprotective, anti-ulcer, antioxidant, and neuroprotective characteristics [14]. The present study involved GO and KEGG enrichment analyses on the therapeutic targets.

Potential targets of isopulegol and Diabetic nephropathy

The databases yielded a total of 1213 targets for DN and 392 targets for isopulegol (Table 3). On removal of duplicates, 340 targets of isopulegol and 1201 targets of DN were shortlisted for the study.

Overlapped targets and network analysis

Sixty one common targets of Isopulegol and DN were found. (Fig. 3). The network comprising these targets was found to have 1602 nodes (340 isopulegol targets, 1201 DN targets and 61 overlapping targets) in total and 1663 edges.

Protein – protein interaction (PPI) network analysis

Using string database, 61 targets with the minimal necessary interaction score and high confidence (0.70) were analysed based on their interactions with DN targets and isopulegol targets (Fig. 4). The total number of nodes was 61 with a mean node degree of 3.84. The number of edges (117) was found to be much greater than the expected number of edges (32). The average local clustering coefficient was 0.414 with the PPI enrichment p-value: < 1.0e-16. The PPI network shows that genes of multiple signaling pathways, *viz.*, PI3K-Akt, MAPK, IL-17, AGE-RAGE, FoxO, VEGF, mTOR, JAK-STAT and AMPK are associated with DN (Table 4)

Functional enrichment and pathway analysis

GO enrichment analysis was carried out to ascertain biological processes, molecular functions, cellular components and pathways in which the 61 overlapped targets had a pivotal role. (Fig. 5. a, b, c) The GO enrichment analysis of the sixty-one overlapped targets showed that protein kinase activity (GO:0004672), transferase activity (GO:0016740), transition metal ion binding (GO:0046914), protein kinase binding (GO:0019901) were the significant molecular functions. In terms of cellular components, the targets were found to be enriched in secretory granules (GO:0030141), extracellular matrix (GO:0031012) and cytoplasmic vesicle lumen (GO:0031410). The network of targets and biological processes revealed that the response to oxygen containing compound (GO:1901700) ranked first in association to targets (counts =36), homeostatic process (GO:0042592) the second (counts=29), cellular response to oxygen containing compound (GO :1901701) the third (counts=28), followed by positive regulation of molecular function (GO:0044093), positive regulation of cell communication (GO:0010647), positive regulation of signalling (GO:0023056), regulation of response to stress (GO:0006468), regulation of cell population proliferation (GO:0042127), regulation of intracellular signal transduction (GO:1902531), peptidyl- amino acid modification (GO:0018193) and response to organonitrogen compound (GO:0010243). On the basis of KEGG enrichment analysis of the 61 overlapped targets at a threshold of FDR < 0.01 and literature, the topmost signalling pathways in the treatment of DN was found to be PI3K-Akt (hsa04151), MAPK (hsa04010) and AGE-RAGE pathway in diabetic complications (hsa04933) (Table 4). The Biological process - Targets – Pathway network (Figure 6) showed that 27 overlapped targets MAPK1, RELA, EGFR, JAK2, PTGS2, MAPK14, IGF1R, INSR, MMP9, PTPN2, PRKCB, PARP1, PPARG, S100A8, GSK3B, PRKCE, MAPK8, IL2, TGFB2, KDR, MMP3, LCK, ITGB3, MMP2, JAK1, SETD7, CCNE1 were engaged in multiple biological processes and pathways.

Molecular Docking analysis

A total of 12 genes were chosen for molecular docking interaction after conducting molecular functions and pathway research. The targets namely GSK3B (PDB ID: 6V6L), JAK1 (PDB ID: 6N7A), JAK2 (PDB ID: 7LL4), EGFR (PDB ID: 8A27), INSR (PDB ID: 3BU6), TGFB2 (PDB ID: 6XM2), MAPK1 (PDB ID: 8AOJ), MAPK8 (PDB ID: 4QTD), MAPK14 (PDB ID: 6SFI), MMP2 (PDB ID: 3AYU), MMP3 (PDB ID: 4G9L) and MMP9 (PDB ID: 5UE3) was docked against isopulegol. According to the receptor-ligand docking theory, there exists a reciprocal correlation between docking energy and binding affinity. Greater negative docking energy shows a higher binding affinity linking the protein and the ligand. The binding affinity of isopulegol with different targets is summarized in Table 4 and the binding interactions are depicted in Fig. 7 and Table 5. Based on binding energy and hydrogen bond formed between



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the targets and isopulegol, top five targets were identified namely JAK1, EGFR, MAPK8, MMP2 and MMP9 (Table 5 and 6). Recent studies indicate that numerous signalling pathways are significant contributors to the development of DKD. The significance of epidermal growth factor receptor (EGFR) has been well investigated in this context [15-17]. The EGFR pathway is crucial for growth, differentiation and migration of cells. Its involvement in the advancement of chronic conditions like resistance to insulin, diabetic nephropathy and cardiomyopathy has been proved [18,19]. EGFR is widely expressed in several parts of the mammalian kidney, including glomeruli and proximal tubules. This expression includes renal epithelial cells, glomerular endothelium cells, podocytes, tubular cells, mesangial cells, and medullary interstitial cells [20,21]. Through reducing oxidative stress and inflammation, EGFR inhibitors have been found to attenuate kidney damage caused by angiotensin II [22,23]. Elevated glucose levels trigger EGFR transactivation, leading to the onset and progression of kidney damage. In STZ treated diabetic mice, reduction in kidney size occurs due to EGFR inhibition, without altering body weight, blood glucose or blood pressure [24]. The suppression of EGFR has significantly decreased oxidative stress and endoplasmic reticulum stress (ERS) in the kidneys, as well as reduced renal fibrosis and apoptosis in diabetes models caused by STZ [25]. These findings indicate that the function of EGFR extends beyond cell proliferation and fibrosis, encompassing its potential as a promising target for treating chronic or metabolic disorders like diabetes.

The presence of JAK/STAT signalling in renal cells, including podocytes, mesangial cells, and tubular epithelial cells, strongly indicates its significant role in the advancement of kidney disease [26]. The JAK/STAT signalling system is essential in multiple pathologic processes such as haematopoiesis, immunological response, inflammation, development and growth, regulation of stress response, gene expression, cell proliferation, differentiation, migration, and apoptosis [27]. Upon analysing the gene and protein expression in kidney biopsies from individuals with both early and late-stage DKD, it was observed that there was an upregulation and increased activity of the JAK-STAT signalling pathway throughout the entire range of DKD [28,29]. The upregulation and heightened functionality of JAK1 and JAK2 have been observed to promote the advancement and progression of DKD [30,31]. Inhibitors of JAK1 and JAK2 hold great promise as targets for therapeutic intervention in DN therapy. Several investigations have shown that the MAPK signalling pathway is primarily responsible for the cellular damage caused by elevated glucose levels and the initiation of inflammation [32,33]. It has been discovered that p38 MAPK is crucial for the epithelial–mesenchymal transition induced by elevated glucose in cultured human renal tubular epithelial cells [34]. In accordance with the literature, MAPK8 is found to be active in processes like cellular response to chemical stress, hormone, lipid, oxygen-containing compound, peptidyl-amino acid modification, protein phosphorylation and positive regulation of molecular function. Hence by inhibiting MAPK signalling pathway, the inflammatory response of DN can be reduced [35].

Recent research indicates that matrix metalloproteinases (MMPs), in conjunction with tissue inhibitors of metalloproteinases (TIMPs), have a substantial impact on the progression of diabetic nephropathy. Studies utilizing Western blot analysis and ELISA methods have revealed that the MMP2 protein and its related enzyme activity are augmented in the kidneys of individuals with diabetes [36]. In a study, non-specific pharmacological suppression of MMP9 with doxycycline reduced renal damage [37]. There has been increasing evidence in recent years of a strong link between the expression of MMPs and the course of renal disease in patients with diabetic nephropathy, both in humans and in several experimental animal models. Increased MMP9 activity induced by high glucose was contingent upon ERK1/2 MAPK signalling activation, which was subsequently linked to a reduction in collagen IV production. This suggests that MMP9 expression and its activity can be altered by blocking ERK pathway. The enrichment analysis reveals that MMP2 and MMP9 are actively involved in various biological processes and emphasizes the fact that MMPs may act as sensitive indicators for detecting pathological alterations in DN and prospective targets in treating DN [38]. According to enrichment analysis and *in silico* findings, isopulegol is found to have good interaction with JAK1, MAPK8, EGFR, MMP2 and MMP9 as confirmed via pathway and molecular function analysis. These genes have significant roles in nine pathways associated with DN. Therefore, our study suggests that isopulegol may attenuate DN by controlling a number of crucial elements in these signalling cascades.





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CONCLUSION

Our research utilized network pharmacology analysis and molecular docking technology to investigate the potential impacts of isopulegol against DN and obtained five key therapeutic targets namely JAK1, MAPK8, EGFR, MMP2 and MMP9. The main processes responsible for the therapeutic actions of isopulegol against DN have been identified. These *in silico* findings support the usage of isopulegol as a novel medicine for treating DN. Additionally, they establish a crucial scientific foundation for future investigations into the mechanism of isopulegol in DN treatment, which might be further validated through *in vivo* and *in vitro* experimentation.

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Table 1: Physicochemical characteristics of isopulegol

Name	MW	Bioavailability	CaCo 2	BBB 1	VDs s	AMES	Log P	Hdon	Hacc	RB N	TPS A
Isopulegol	152.253	0.55	1.4	0.561	0.17	No	2.35	1	1	1	69.1

Table 2. Target databases

Database	Website(Source)
Isopulegol	
STITCH	http://stitch.embl.de/ver.5.0
CHEMBL	https://www.ebi.ac.uk/chembl/
Binding database	https://www.bindingdb.org
Swissport	https://www.ebi.ac.uk/swissprot/
Pharm Mapper	http://lilab.ecust.edu.cn/
Diabetic Nephropathy	
Drug bank	https://www.drugbank.ca/
Therapeutic Target Database	https://db.idrblab.org/ttd/
DisGeNET	https://www.disgenet.org/

Table 3. Databases and number of targets

Database	Number of targets
Isopulegol	
STITCH	1
CHEMBL	28
Binding database	134
Pharm Mapper	177
Diabetic Nephropathy	
Drug bank	2
Therapeutic Target Database	22
DisGeNET	1189





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Table 4. Nine pathways associated with overlapped targets

KEGG pathway ID	Pathway description	Gene count	FDR	Genes within pathway
hsa04151	PI3K-Akt signaling pathway	12	2.00E-12	GSK3B, JAK2, MAPK1, CCNE1, IL2, KDR, IGF1R, EGFR, JAK1, INSR, RELA, ITGB3
hsa04010	MAPK signaling pathway	10	2.58E-09	TGFB2, MAPK1, MAPK8, MAPK14, KDR, IGF1R, EGFR, PRKCB, INSR, RELA
hsa04933	AGE-RAGE signaling pathway in diabetic complications	9	4.80E-11	MMP2, TGFB2, JAK2, MAPK1, MAPK8, MAPK14, PRKCB, PRKCE, RELA
hsa04657	IL-17 signaling pathway	9	1.3E-12	PTGS2, GSK3B, MAPK1, MMP9, MAPK8, MAPK14, MMP3, S100A9, RELA
hsa04068	FoxO signaling pathway	8	6.63E-09	TGFB2, MAPK1, MAPK8, MAPK14, IGF1R, SETD7, EGFR, INSR
hsa04370	VEGF signaling pathway	5	1.77E-07	PTGS2, MAPK1, MAPK14, KDR, PRKCB
hsa04150	mTOR signaling pathway	5	1.39E-05	GSK3B, MAPK1, IGF1R, PRKCB, INSR
hsa04630	JAK-STAT signaling pathway	5	1.69E-05	JAK2, IL2, EGFR, JAK1, PTPN2
hsa04152	AMPK signaling pathway	3	0.00063	PPARG, IGF1R, INSR

Table 5 . Isopulegol binding energy with different targets

Isopulegol docking with targets	Binding energy	Ligand efficiency	Intermolecular energy	vdW + Hbond + desolv Energy	Electrostatic energy	Torsional energy	Total internal Unbound
GSK3B	-5.72	-0.52	-6.31	-6.2	-0.12	0.6	-0.21
JAK1	-6.54	-0.59	-7.13	-7.03	-0.1	0.6	-0.05
JAK2	-5.84	-0.53	-6.44	-6.37	-0.07	0.6	0.0
EGFR	-6.44	-0.59	-7.04	-6.87	-0.16	0.6	-0.21
INSR	-5.57	-0.51	-6.16	-5.9	-0.26	0.6	-0.2
TGFB2	-5.51	-0.5	-6.11	-6.04	-0.07	0.6	-0.2
MAPK1	-6.34	-0.58	-6.93	-6.7	-0.23	0.6	-0.13





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MAPK8	-6.66	-0.61	-7.25	-6.93	-0.33	0.6	-0.19
MAPK14	-6.28	-0.57	-6.88	-6.82	-0.06	0.6	-0.19
MMP2	-6.53	-0.59	-7.13	-7.15	0.02	0.6	-0.17
MMP3	-5.67	-0.52	-6.26	-6.15	-0.11	0.6	-0.19
MMP9	-7.4	-0.67	-7.99	-7.91	-0.08	0.6	-0.17

Table 6. Binding interactions of key aminoacid residues of selected targets with isopulegol

Isopulegol docking with targets	Hydrogen bonds interactions	Distance (Å)	alkyl/ π -alkyl/ π - σ interactions	van der Waals interactions
JAK1	TYR940 (N...O) LEU929 (O...H) LEU932 (O...H)	3.11308 2.5156 1.69884	LYS939, ILE937, LYS939, LYS939, TYR933, TYR933, TYR940	VAL938 HIS934
EGFR	ASP855 (OD1...H) THR854 (OG1...C)	2.00747 3.2264	MET766 MET766 LEU777 LYS745 LEU788 PHE856	THR790 CYS775 ARG776 LEU858 GLY857
MAPK8	ARG69 (NH1...O) GLU73 (OE1...H) ARG69 (CD...O) ASP169 (OD2...C)	2.82388 1.70559 2.99294 3.03131	LEU168 LEU168	GLN37 ASN156 LYS55
MMP2	ALA139 (O...H)	1.98411	VAL117 LEU116 LEU137 HIS120 HIS120 TYR142 TYR142 PHE148	THR143 ALA136 ILE141 MET138
MMP9	ARG249 (O...H)	2.1661	VAL223 LEU243 ARG249 HIS226 HIS226	ALA242 PRO240 MET247 TYR245 PRO246 TYR248





<p>Fig. 1. Design of the study</p>	<p>Fig. 2. 2D and 3D structure of isopulegol</p>
<p>Fig. 3. Common targets of Diabetic Nephropathy and Isopulegol (a) Venn diagram of overlapped targets</p>	<p>Fig. 3 (b) Isopulegol – Targets – DN network : Isopulegol targets (Red),DN targets (Yellow) and overlapped targets (Green) counted to 340,1201 and 61 respectively</p>
<p>Fig. 4. PPI network of 61 common targets. Nodes indicate the genes and edges the protein – protein associations. The coloured nodes stand for first shell of interactors, the purple coloured lines are for experimentally determined interactions, cyan blue for known interactions from selective databases, green for gene neighbourhood, red for gene fusions, blue for co-occurrence of genes</p>	<p>Fig. 5. GO enrichment analysis of the overlapped targets. (a) Biological process</p>





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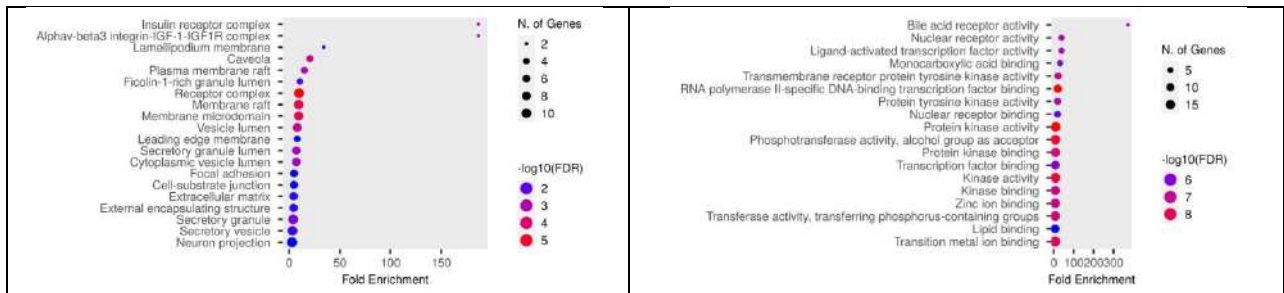


Fig. 5. (b) Cellular components

Fig. 5. (c) Molecular functions

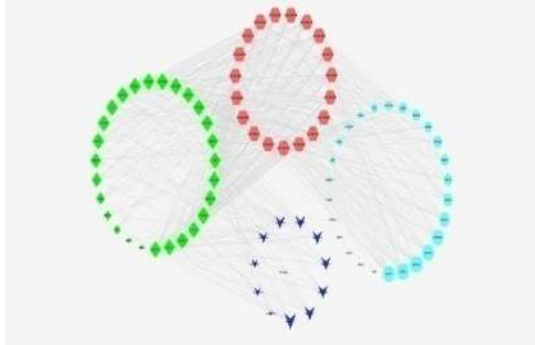


Fig. 6. Biological process - Targets – Pathway network (Green colour diamond shape represents common targets based on biological process and pathway; red colour hexagon represents biological process, cyan blue colour circle represents targets involved in biological process alone; blue colour arrow symbol represents novel pathways)

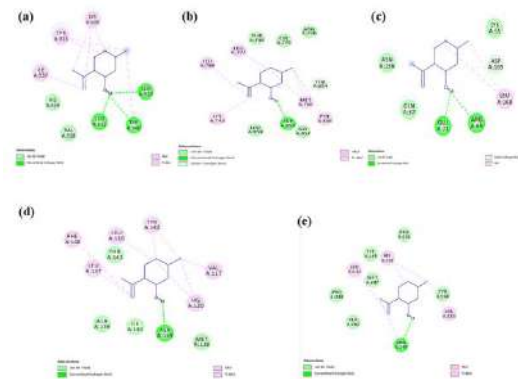


Fig. 7. 2D diagram of Isopulegol with (a) JAK1; (b) EGFR; (c) MAPK8; (d) MMP2 and (e) MMP9; hydrogen bond (green dotted lines), hydrophobic interactions (alkyl and pi-alkyl interactions in light pink colour dotted lines) and van der Waals interactions (light green colour circles). The interacting residues' solvent-accessible surfaces are shown as a blue halo surrounding the residues.





Does Physical Activity and Stress Level Impact Heart Rate Variability in Office Workers?

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

Physical inactivity and work-related stress are major health concerns among office workers. One of the mechanisms for the association between increase physical activity and decrease risk of cardiovascular disease may be alteration in cardiac autonomic nervous system function which can be assessed by heart rate variability (HRV). Heart rate (HR) is commonly considered as an outcome measure in clinical case scenario to assess changes related to physical activity in India. However, HRV measurements are more standard as compared to HR and provides an insight into the changes that occur in cardiovascular physiology relating to physical activity. The pilot study aimed to determine the correlation between physical activity levels and stress on heart rate variability. The pilot study included sixty (n=60) office workers, 11 females and 49 males, age between 30 – 50 years (mean age =37.43±5.6) volunteered for the study. Physical activity and subjective stress were measured using International Physical Activity Questionnaire (IPAQ - short form) and Perceived stress scale (PSS-10) respectively. 5 minute short-term HRV measurement was obtained by KubiosHRV smart phone application. Each Participants were rested in supine for 10 minutes before the HRV measurement and were instructed to remain relaxed, breathe normally, no talk and no sleep during the measurement. Time domain (Standard Deviation of Normal-to-Normal R-R interval – SDNN, Root Mean Square of Successive Differences - RMSSD) and frequency domain (Low frequency / High Frequency – LF/HF ratio) parameters were measured for HRV analysis. No significant correlation was found between physical activity and HRV parameters and stress showed moderate positive correlation with LF/HF ratio ($r = 0.427$, $p = 0.001$) and moderate negative correlation



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with RMSSD ($r = -0.455$, $p < 0.01$) and SDNN ($r = -0.270$, $p = 0.03$) Based on the results of this study clinical evaluation of HRV among individuals susceptible to occupational stress can be significant in the early detection of cardiac autonomic dysfunction thereby enabling health care professionals to devise risk-prevention strategies against cardiovascular diseases.

Keywords: Physical activity, Stress, Heart rate variability, HRV, Office workers.

INTRODUCTION

Physical activity (PA) is one of the factors that protects against stress [1]. Compared to other occupations, office workers have a higher chance of being physically inactive at work, and they do not typically engage in compensatory behaviour outside of work[2,3].It is significant to point out that lower levels of physical activity at work have been connected to greater levels of felt stress [4], a significant risk factor for cardiovascular disease, metabolic syndrome, and poor diet [5,6]. The benefits of physical activity may extend to psychological or mental health[7, 8]. People who are in good mental health can function independently while managing daily stresses [9].On the other side, mental health issues have a detrimental effect on social interaction, employment, and quality of life [10]. Stress is considered as the silent disease of the 21st century[11].There is no single cause of stress. In addition to relationships, families, or academic commitments, mental illnesses including burnout, stress, post-traumatic stress disorder, anxiety, and depression can also appear in the healthcare workplace[12].Over the past two decades, the psychological concept of perceived stress has received lots of attention. According to some studies, the PSS's measurement of perceived work-related stress has a big impact on workers' quality of life[13].Heart rate variability (HRV), one of the key indicators of autonomic processes, has a negative correlation with cardiovascular risk factors as inactivity[14].HRV is very useful in studying the cardiovascular response to stress on the body[15].The right amount of hormone release and the balance of the autonomic nerve system determine a person's physical and mental wellness. Any underlying cardio-metabolic disorder changes the course of the body's normal cardiac autonomic functioning, which has consequences for health[16,17,18]. Heart rate variability (HRV) assessment is recognised as an easy, non-invasive, and reliable method to assess cardiac autonomic function (CAF)[19,20] It has been hypothesised that reduced HRV is related to more reported stress[21]. The purpose of the study was to determine how physical activity levels and stress correlated with heart rate variability.

METHODS

The study was a cross-sectional survey design. A total 60($n = 60$) participants were randomly selected from the two office units of Surat-Gujarat, India for the study. The following are the inclusion criteria: office workers (both the gender), age between 30-50 years, working more than 6 months, understanding English language. Participants who had any cardiac-respiratory disease, endocrinal disease, implanted pacemaker were excluded from the study. All participants were informed the purpose of the study and informed consent was obtained. As this study is part of larger research project and the study procedures were approved by the Institution Ethical Committee. Self-administration mode was used to measure physical activity and perceived stress. The IPAQ (International Physical Activity Questionnaire)– short version [22] was used to examine the participant's physical activity levels. The questionnaire consists of 7 questions pertaining to all kinds of physical activity related to job, everyday life and leisure and especially to the time spent on vigorous and moderate activities, on walking and sitting. Weekly physical activity was computed by multiplying time (minutes of given activity in the reported week) by intensity (in MET units) corresponding to that activity. The PSS[23] is the most widely used psychological instrument for measuring the perception of stress. The questions in this scale ask about feelings and thoughts during the last few months. This scale having categories low, moderate and high stress. The HRV parameters were measured using the Polar H10 and the KubiosHRV smart phone application version 1.2.7(24) (iPhone 13 Pro Max). The app has good reliability, Intra-rater



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($\alpha = 0.868$) and Inter-rater ($\alpha = 0.890$) and excellent validity ($r = 0.94$). [24]RMSSD and SDNN were examined in the time domain, while the LF/HF ratio was examined in the frequency domain. All recordings were made in the morning, between 8 am and 12 pm, in a quiet, bright room with a constant, controlled temperature. Each participant remained in supine for 10 minutes prior to the measurement, and they were told to stay calm, breathe properly, refrain from speaking, and avoid sleeping during measurement. Following a 10-minute rest, the participant's chest was fastened with a Polar H10 chest strap that had been moistened with water at the level of the xiphisternum and KubiosHRV smart phone application pair up with the iPhone through the Bluetooth for recording. Before the measurement, there was a 30-second interval of relaxation, and a total of 5 minutes was recorded.

RESULTS

The data were analysed using SPSS version 28. Descriptive statistics with mean and SD were used to assess the continuous variables. For correlation analysis, Pearson's correlation was used. The correlation test's level of significance was set at $p < 0.05$, with a 95% confidence range.

DISCUSSIONS

The present study found no correlation between Physical activity and HRV. RMSSD and SDNN are negatively correlated with stress, while LF/HF is positively correlated. According to study findings, stress and LF/HF ratios are positively correlated, suggesting that when stress levels rise, increase the LF/HF ratios and vice versa. Sympatho-vagal balance is determined by the LF/HF ratio. A low LF/HF ratio reflects parasympathetic dominance. In contrast, a high LF/HF ratio indicates sympathetic dominance, which happens when we engage in fight-or-flight or parasympathetic withdrawal behaviour. Teisala T. (2014) discovered, in contrast to our study's findings, that physical activity, cardio-respiratory fitness, and body composition are associated with HRV-based stress, and the HRV-based approach utilised to assess work-related stress and recovery was related to self-reported burnout symptoms. Another conclusion from the study is that RMSSD and SDNN levels decrease as stress increases, both values are in the time domain, and the SDNN, or standard deviation of the IBI of normal sinus beats, is measured in milliseconds (ms), both SNS and PNS activity contribute to SDNN. The root mean square of successive differences between normal heartbeats (RMSSD). The RMSSD reflects the beat-to-beat variance in HR and is the primary time-domain measure used to estimate the vagally mediated changes reflected in HRV. As stress increases, parasympathetic regulation is reduced, which results in lowering RMSSD values, which are primarily impacted by the PNS. Kemp and colleagues (2010) conducted a meta-analysis of studies evaluating various HRV indices (including time domain, HF, LF, and LF/HF ratio) in order to determine the effect of HRV on depression.

Overall, the results of the meta-analysis showed that depression was connected to lower HF-HRV (RSA) levels and higher LF/HF ratios (i.e., lower HF-HRV), but there was no apparent distinction in LF-HRV between depressed and non-depressed people or in terms of the severity of depression. According to Rottenberg's (2007) reviews, there is a connection between decreased HRV and clinical depression, which is consistent with the theory that HRV is a marker of physiological sensitivity to the environment and reflects an organism's capacity to anticipate, respond to and adapt to stressors and challenges. This study also found that age has a negative correlation with RMSSD ($r = -0.338$, $p = 0.001$) and SDNN ($r = -0.331$, $p = 0.01$), indicating that sympathetic dominance increases with age while parasympathetic control decreases, which is consistent with a number of earlier studies [24, 25, 26, 27]. We found that females had higher RMSSD and SDNN values than males, as well as a lower LF/HF ratio, which indicates more parasympathetic and low sympathetic control in females. In line with previous few studies have indicated that female sex hormones influence autonomic modulation and oestrogen has a facilitating effect on cardiac vagal function [28]. Our finding is in agreement with the findings of Ramaekers et al., where the authors find out that decreased sympathetic activity in women compared to men may explain the protection against cardiovascular disease shown in women. Several prospective studies have shown that impaired HRV predicts the incidence of cardiovascular disease [29, 30]. In our study, majority of the study participants were physically inactive on self-



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administered IPAQ, with moderate level of stress on PSS. Lack of time, home management, family responsibilities, and exhaustion were frequently cited as barriers to physical activity. We all know that relying too heavily on technology—whether for transportation, housework, or other tasks—decreases daily physical activity. India is also expanding in the technological and digital fields, where long periods of inactivity are required, contributing to this trend. We found moderate level of stress which can be attributed to the workplace, workplace competitiveness, and family responsibilities, all of which are accumulating and compromising cardiac health.

CONCLUSION

The study revealed no association between office worker's physical activity and heart rate variability. As per study result majority of the participants were physically inactive which is major health concerns in office workers. To promote health and psychological benefits, people should engage in any regular physical exercise and work to eliminate sedentary behaviour. Since stress and HRV are linked, clinical evaluation of HRV in stressed persons may aid in the early identification of cardiac autonomic dysfunction and hence strengthen risk-reduction tactics for cardiovascular disease.

LIMITATIONS

1. Due to certain reporting bias, the subjective assessment method of the physical activity assessment and perceived stress may have influenced our study outcomes.
2. Future studies, however, might make use of tools like pedometers and accelerometers to quantify PA objectively.
3. HRV is influenced by several confounding factors such as sleep, diet, hormone levels, and metabolic biomarkers, which were not assessed in the present study. However, these results must be confirmed with more robust data in larger prospective studies due to smaller sample size.

Source of Funding

This study received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Author's contribution

Vaishali Gabani: Conceptualization, methodology, Writing -review&editing, writing-original draft preparation, funding. **Saravanan M;** Conceptualization, methodology, data analysis &interpretation.

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Table 1. Demographic details

Variables	Mean (SD)
1. Age (years)	37.5±5.5
2. BMI (Kg/m ²)	23.8±3.6
3. Silting hours (week)	65.7±6.6
4. RHR	77.6±10.5
5. Sleep hours per day	7.1±0.9
6. Work experience (years)	12.24±8.4
7. PSS	21.5±6.1
8. RMSSD	30.31±14.9
9. SDNN	32.1±14.23
10. LF/HF	1.9±1.99
11. MET	283.57±468.76

Table 2. HRV parameters in male

Parameters	Mean(SD)
RMSSD	27.51±12.57
SDNN	29.83±11.71
LF/HF	2.1±2.1

Table 3. HRV parameters in female

Parameters	Mean(SD)
RMSSD	42.81±18.63
SDNN	42.49±19.83
LF/HF	1.1±0.96

Table 4. Correlation between MET and HRV parameters

HRV parameters	r-value	p-value
RMSSD	-0.104	0.430
SDNN	-0.69	0.598
LF/HF	0.08	0.951

Table 5. Correlation between PSS and HRV parameters

HRV parameters	r-value	p-value
RMSSD	-0.455	<0.001
SDNN	-0.270	0.03
LF/HF	0.427	0.001

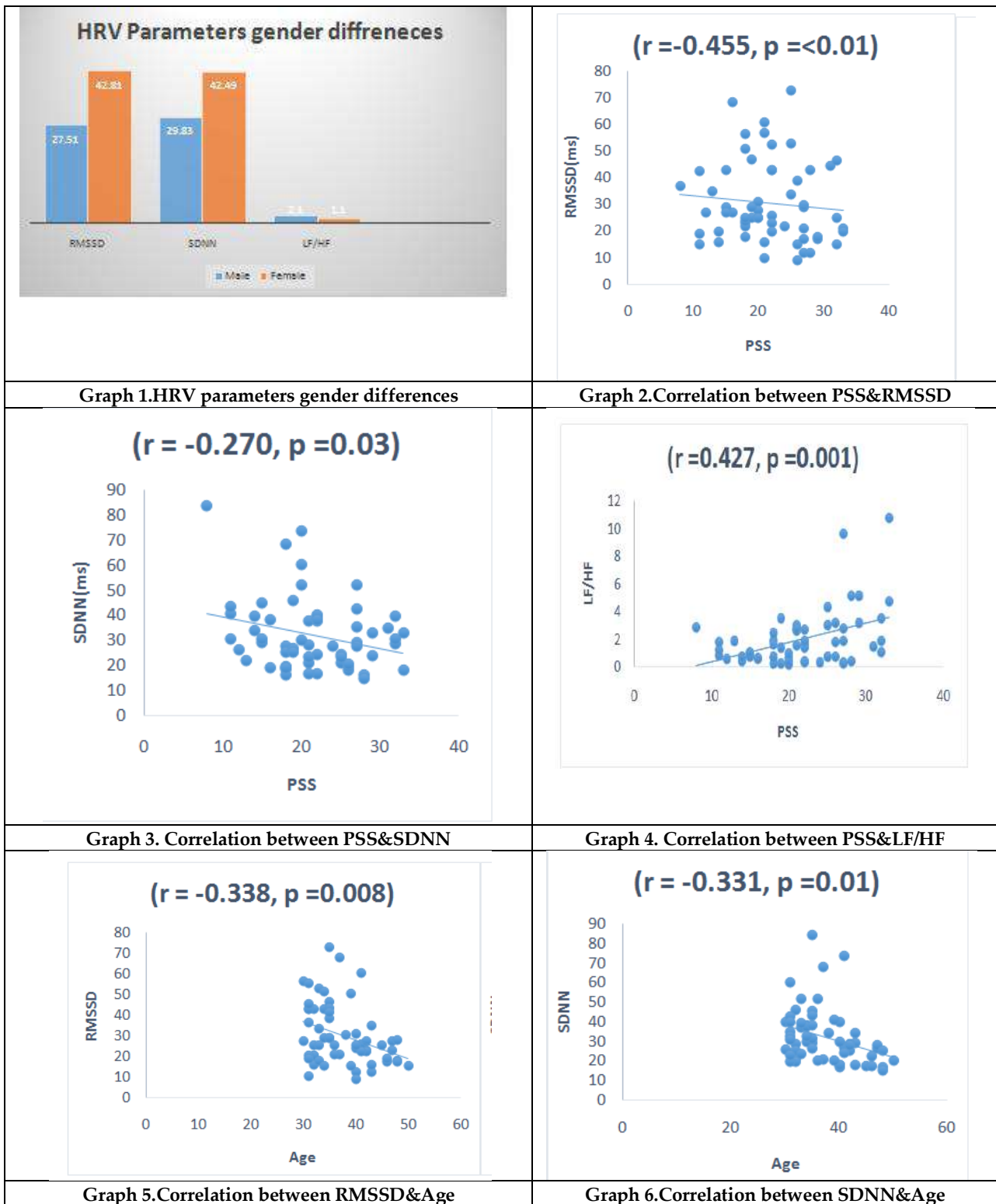
Table 6. Correlation between Age and HRV parameters

HRV parameters	r-value	p-value
RMSSD	-0.338	<0.001
SDNN	-0.331	0.01





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Effect of Intracanal Cryotherapy on Fracture Resistance of Teeth that have Undergone Endodontic Treatment With Different Irrigating Solutions - An *In-vitro* Study

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

The study aims to evaluate the effect of applying intracanal cryotherapy on the fracture resistance of teeth that have undergone endodontic treatment with different irrigating solutions. Thirty single rooted teeth with single root canal were selected and randomly divided into groups A & B & C (n=10). The specimens were kept in distilled water at 37°C that simulated mouth temperature during the procedures. The biomechanical preparation of the samples was done till the apical size of 50 and assigned to either of the 3 groups. The surfaces of the specimen were covered with silicone upto 2 mm below Cementoenamel junction to simulate periodontal ligament and immersed in selfcuring resin. The specimens in the cryotherapy group (group C) were irrigated with 20mL sterile cold (2.5°C) saline solution for 5 min, whereas specimens in the control group (Group A) received a sterile saline solution at room temperature and control group (Group B) received 5.25% sodium hypochlorite solution. The fracture resistance of the specimens was tested with a universal testing machine. The statistical analysis was done. The results showed that the cryotherapy specimen group had lower fracture resistance as compared to that of control group specimens. The study concluded that intracanal cryotherapy as a final irrigant reduces the vertical fracture resistance of roots.





Keywords: Cryotherapy, Fracture resistance

INTRODUCTION

Pretreatment pain, the existence of periradicular radiolucency, the state of the pulp and perirapical tissues, and other factors can all contribute to postoperative pain, which can be problematic for both the patient and the surgeon [1-3]. Injuries to the periradicular tissues caused by mechanical, chemical, and/or microbiological means are the main sources of pain following treatment [2,4-6]. Prophylactic medication prescription, long-lasting anaesthesia administration, crown-down preparation, occlusal reduction, and most recently, intracanal cryotherapy, are some of the treatment choices for lessening this pain [4,5,7-10,11]. It has been observed that cryotherapy reduces tissue temperature and extracts heat from the treated tissues, causing vasoconstriction and preventing edoema. Vasoconstriction also prevents the generation of tissue free radicals by inhibiting cellular metabolism, which lowers the oxygen demand of cells. [12,13]. Higher temperatures are said to cause the release of inflammatory enzymes, which exacerbates postoperative discomfort. Additionally, cryotherapy reduces nerves' conducting ability, which lowers the likelihood of postoperative pain. It is evident that variations in temperature affect dentin's mechanical characteristics. It is crucial to understand if intracanal cryotherapy affects the mechanical behaviour of teeth since it is a potentially effective pain management technique with few adverse effects. Thus, the goal of this study was to determine the fracture resistance of endodontically treated teeth by using intracanal cryotherapy as a last irrigant. The null hypothesis states that, independent of the cryotherapy applications, there would be no variation in the specimens' fracture resistances.

MATERIAL AND METHODOLOGY

This present study was conducted by PG student of Department of Conservative Dentistry and Endodontics Rural Dental College, Loni. Thirty single-rooted teeth that were extracted for periodontal reasons were included in this investigation. Excluded teeth included those with partial apices, decay, fractures, unusual anatomical features, and prior endodontic therapy. After being thoroughly cleaned, each tooth was decoronated to a uniform 15 mm length. To keep the specimens from becoming dehydrated until the experiment called for it, they were submerged in distilled water. Using a #10k file, the working length was ascertained, and the crown down approach was employed for biomechanical preparation. The #50 K file was the master apical file. Every time a file was used, copious irrigation was performed using 3% sodium hypochlorite and regular saline. All root canals were irrigated for a minute with a final rinse using 17% EDTA, and then they were dried with sterile paper points. To replicate the periodontal ligament, silicon was applied to the specimens' surface down to two millimetres below the CEJ. After that, the specimens were preserved in self-curing acrylic resin up to two millimetres below the CEJ, and they were given an hour to polymerize. Three groups of ten each—CONTROL GROUP (A), GROUP (B), and EXPERIMENTAL GROUP (C)—were formed from the specimens. Three separate irrigation treatments were applied to the specimens. While the specimens in the control group (Group A) received a sterile saline solution at room temperature and Group B received 5.25% sodium hypochlorite, the specimens in the cryotherapy group (group C) were irrigated with 20 mL of sterile cold (2.5°C) saline solution for five minutes (the saline solution was kept in a calibrated refrigerator at 2.5°C until used). The acrylic part of the specimens, or their base, was stored at 37°C in distilled water. Irrigation was carried out from the exposed 2 mm tooth structure through the aperture during the process. Using a universal testing apparatus, the specimens' fracture resistance was evaluated. The outcomes were statistically analysed.

STATISTICAL ANALYSIS

Independent Sample T-Test showed that the p value is <0.05, hence there is significant difference between groups and we can reject the null hypothesis.





RESULTS

Table shows Comparison of Load at peak, Elongation at peak and Compression strength on fracture resistance in three specimens: The results showed that the specimens in the cryotherapy group had lower fracture resistance as compared to that of specimens in control group.

DISCUSSION

This study sought to determine how intracanal cryotherapy affected endodontically treated teeth's ability to withstand fractures. The study's findings demonstrated that, in comparison to the control group, the specimens in the intracanal cryotherapy group had considerably lower fracture strength values. Temperature variations are one of the causes of mechanical stress in the tooth structure. The temperature differential between the tooth and the medium, the tooth's geometry, the heat transfer coefficient, and the physical characteristics of the tooth, such as age or prior mechanical stress, all affect how much stress is there (16). In particular, tensile stress in enamel and compressive stress in dentin are caused by excessive heat stresses in the tooth structure, and these stresses can further induce structural deformation as soon as one second after exposure (16). Because of the distinct tubular microstructure of the dentin near the pulp space and the absence of enamel structure, applying cold water inside the pulp space may generate excessive thermal stress in the dentin material (13,14, 15). Therefore, we can state that, similar to a coin having two sides, intracanal cryotherapy has a significant drawback in that it negatively affects teeth's mechanical properties by decreasing their resistance to fracture. This is true even though it's an effective technique for managing post-operative pain. All of the specimens included in this study were single-rooted teeth that were chosen and grouped based on similar size. Using the same kinds of tools and methods, the specimens' length was standardised to 15 mm, and the root canals were mechanically extended to the same size. Uncontrollable physiological differences, like as the patient's unknown age or prior dental mechanical stressors, could still affect the outcome, nevertheless.

CONCLUSION

Within the limitations of the present study, it can be concluded that if we use intracanal cryotherapy as a final irrigant, it reduces the vertical fracture resistance of roots.

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Table 1

	Group A (Normal saline) (n=10)	Group B (Sodium hypochlorite) (n=10)	Group C (Cold saline) (n=10)
	Mean ± SD	Mean ± SD	Mean ± SD
Load at peak	0.77±0.15	0.64±0.15	0.33±0.13
Elongation at peak	3.44±0.92	3.75±0.71	2.91±0.73
Compression strength	52.15±14.05	39.71±13.28	16.90±6.81

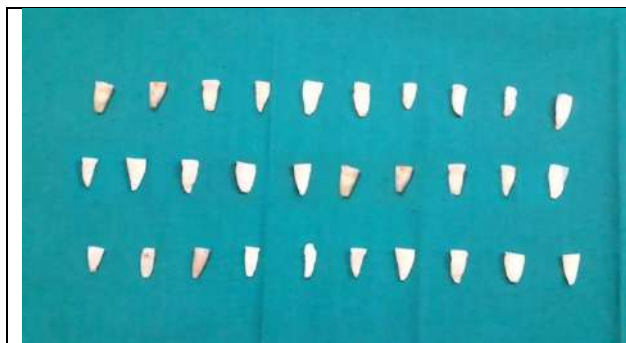


Fig 1

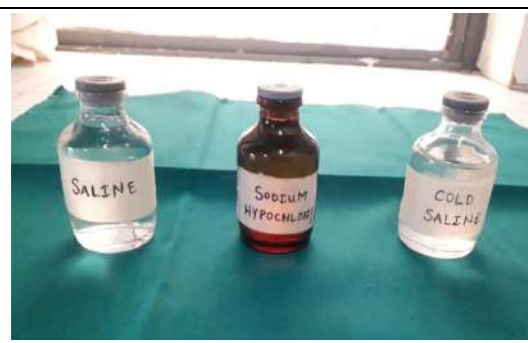


Fig 2





Fig: 3 Sample Specimen



Fig: 4 Calibrated Refrigerator



Fig: 5 UTM Machine



Fig: 6

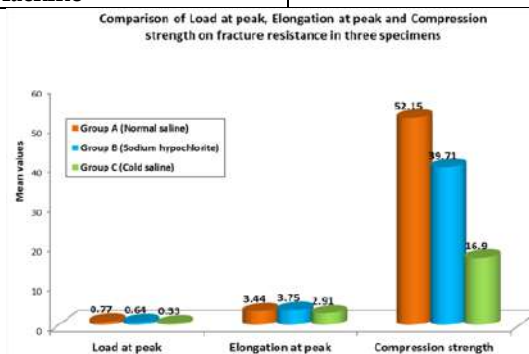


Fig 7





Occurrence and Distribution of Emerging Chemical Compounds from the Ambient Air of Surat, Gujarat, India

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

The aim of this study was to investigate the seasonal fluctuations and geographical distribution of organic chemical compounds in Surat City, which is known as the industrial hub of Gujarat. In this study, ambient air samples were obtained from three distinct locations: the Industrial, Urban, and Rural areas of Surat. The collection of these samples was carried out through using a NON-PNS-Combo Sampler. The elemental composition of particulate matter was determined through the utilization of EDAX (Energy dispersive X-ray) analysis. The predominant elements observed in the sample were C, Na, Zn, K, Al, Ti, Ca, S, Cl, Fe, and Mg, as determined from the analysis of the EDAX spectra. Additionally, the organic chemical compounds present in the particulate matter were identified through the utilization of GC-MS techniques. In this investigation, a comprehensive analysis was conducted to identify and quantify organic chemical compounds in various areas of the city. A total of 156 compounds were detected, comprising 127 aliphatic compounds and 29 aromatic compounds. The identification and classification of these compounds were carried out using established analytical techniques. The data obtained from this research provides valuable insights into the composition and distribution of organic chemicals in different regions of the city. During the investigation, a significant abundance of chemical compounds was observed in the post-monsoon season.



**Himalay Bhakhar et al.,****Keywords:** Chemical Compounds, PM_{2.5}, Ambient air, Organic pollutants, Elemental Composition

INTRODUCTION

The phenomenon of air pollution presents a significant challenge for the global population, as it is known to have a diverse range of adverse effects on human health[1,2]. The ongoing process of urbanisation and industrialization has been observed to have a significant impact on the formation of highly populated urban regions that have poor air quality[3,4]. In developing nations, where there are huge economic and social differences, people may also be exposed to high concentrations of indoor air pollution because of the use of biomass fuels (coal, wood, and other solid fuels) as a source of energy, especially in rural areas [5,6]. The issue of outdoor air pollution has frequently been identified as a significant concern in urban areas [7]. In the developing world, a million of people premature mortality due to outdoor air pollution, primarily attributed to particulate matter (PM_{2.5}). Recent epidemiological research has yielded compelling evidence indicating that the presence of heavy metals within airborne particles creates a significant risk to human health [8,9,10]. According to a study conducted by the World Health Organisation [11], it was found that in 2012, ambient air pollution was responsible for an estimated seven million deaths. This alarming figure accounted for over 10% of all deaths caused by air pollution during that year. Previous studies have provided evidence that air pollution is an important factor in different types of health problems. It has been found that air pollution contributes to 9% of lung cancer deaths worldwide. Additionally, it is associated with 17% of deaths caused by chronic obstructive pulmonary disease.

Moreover, air pollution is responsible for over 30% of deaths resulting from ischemic heart disease and stroke. Furthermore, it has been observed that air pollution contributes to 9% of deaths caused by respiratory infections. Atmospheric fine particles have been found to contain a different group of contaminants, including heavy metals, various microbes, and other organic compounds [12,13,14,15,16,17,18,19]. Respiration creates a pathway for the entry of particulate matter into the human body, potentially leading to various adverse health effects, including teratogenicity, mutagenicity, and carcinogenicity[20,21]. Organic compounds, containing an important portion of particulate matter (PM), are generated by both natural and anthropogenic sources. These sources include fossil fuel combustion, biomass combustion, plastic combustion, secondary organic transformations, and marine sources[22]. However, the organic composition of aerosol particles encompasses various compounds such as alkanes, alkenes, alkanolic acids, aromatic hydrocarbons, aromatic acids, and plasticizers. These compounds act as tracers for volatile and organic chemical substances, playing a role in their source, transit, and receptor dynamics[23]. Recent studies have indicated that metallurgical activities have the potential to release a significant number of elements into the atmosphere. These elements include silicon (Si), carbon (C), oxygen (O), chlorine (Cl), sodium (Na), aluminium (Al), potassium (K), calcium (Ca), titanium (Ti), zinc (Zn), and copper (Cu). These such elements emissions may have connections to various sources such as vehicle emissions, as well as both anthropogenic and natural origins of trace elements[24,25]. [26] Studied the occurrence and distribution of organic pollutants in Gujarat state and reported that their bioaccumulation can cause severe toxicity to human health. The current research focuses around an examination of diverse aliphatic (including alkanes, alkenes, and N-alkanoic acids) and aromatic (such as aromatic acids, polycyclic aromatic hydrocarbons (PAHs), simple aromatics, and plasticizers) chemical compounds present in the ambient air across various study locations.





MATERIALS & METHODOLOGY

Study Area

Surat (21.1702° N and 72.8311° E), is a hold the honour being the second-largest city in Gujarat and has become known as the world's largest diamond-producing centre. The city is renowned for its diverse industries, including textiles, chemicals, dyeing and printing, zari production, manufacturing, and machine and equipment production. Additionally, the city is strategically situated along the Tapi River. The sampling procedure was conducted within three distinct sectors (Fig.1). In this study, we examine two distinct geographical locations: (1) Industrial area (S1) - 21.0931° N, 72.8575° E (2) Urban area (S2) - 21.2469° N, 72.8515° E (3) Rural area (S3) - 21.1014° N, 73.0361° E. These locations have been chosen for their contrasting characteristics and will serve as the focal points of our research. By analysing these areas, we aim to gain insights into the various aspects that differentiate industrial and urban environments. In order to assess the levels of pollutants in various regions of the city. The objective of this research was to determine the current status of pollutants generated in different parts of the city.

Collection Air Sample

In this study, samples of Atmospheric Particulate Matter (PM_{2.5}) were collected by utilising a NON-PNS-Combo Sampler from three distinct locations during the monsoon, pre-monsoon, and post monsoon seasons. The collection of particulate matter samples was conducted using a micro-Glass Fibre Filter (GFF) 47 mm and the collection of PM_{2.5} samples was done with a flow rate of 16.7 L/min over a duration of 24 hours. The particles concentration was determined using the gravimetric technique. In order to remove organic contaminants, a pre-baking process was conducted on the filters at a temperature of 100°C for a duration of 1 hour prior to their exposure [27]. The net mass concentration was determined by weighing each filter paper twice, both before and after sampling. The PM_{2.5} filter papers were stored in a container made of polypropylene (PP) material, which is commonly used for its durability and resistance to chemical degradation. To ensure the filter papers protection from external factors, such as light and moisture, they were carefully wrapped in aluminium foil. This packaging method helps to maintain the integrity and effectiveness of the filters during storage. To prevent the loss of volatile components, the samples were stored at a temperature of 4°C in a refrigerator until they were ready for further analysis [28]. Measurement of meteorological parameters like Temperature, Wind speed, Light intensity, and Relative Humidity was carried out with the help of 4 in 1 Instrument (Anemometer, Humidity meter, Light meter, and Thermometer) Model: LM-8100.

Determination of Organic Chemical compound and elemental composition

The quantification of the morphological and elemental composition was performed on the filter paper using Energy Dispersive X-ray Analysis (EDAX) technique. This analysis was conducted at the Sophisticated Instrumentation Centre for Applied Research and Testing (SICART), Vallabh Vidyanagar, Anand.

Extraction of Organic Compound

The PM_{2.5} filter papers (Particles) were transferred to 15 ml PP tubes for further analysis after being allowed to cool at room temperature. The solvent mixture consisting of Methanol and Dichloromethane (DCM) in a 1:1 ratio was used. However, some modifications were made to the solvent composition [29]. In the process of extracting the desired compounds, a volume of 2 ml of solvent was added to a





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polypropylene (PP) tube, followed by ultrasonication (Sonicator, USA) at 50% frequency for 15 minutes. The sample tubes were thoroughly mixed using a Vortexer for a duration of 1 minute. Following the mixing step, the tubes were placed under centrifugation for a period of 5 minutes. This centrifugation process allowed for the separation of the supernatant from the rest of the sample. The obtained supernatant was carefully transferred to new polypropylene (PP) tubes and transfer step was repeated twice in order to accumulate a total volume of 6 ml of extract. The evaporation of the extract was conducted by putting it to a hot water bath, with a volume of up to 1 ml. Afterwards, the evaporated extract was stored in a refrigerator until the analysis[30]. To determine the presence of organic contaminants, the extract was submitted to analysis using a Gas Chromatography-Mass Spectrometry (GCMS) technique.

RESULTS & DISCUSSIONS

The concentration of Particulate Matter (PM) has been identified as an important indicator of air quality conditions. According to the data presented in **(Table 1)**, the maximum concentration of $PM_{2.5}$ was observed to be $164.96 (\mu\text{g}/\text{m}^3)$, $161.96 (\mu\text{g}/\text{m}^3)$, and $77.48 (\mu\text{g}/\text{m}^3)$ during the post-monsoon, Pre-monsoon, and Monsoon seasons, respectively, in the Industrial area. The analysis of all the samples indicated concentrations that exceeded the acceptable limit set by the National Ambient Air Quality Standards (NAAQS). The observed rise in particulate matter concentrations at the selected sampling locations may be attributed to a combination of climatic factors and anthropogenic emissions originating from various local sources including industrial activities, vehicle exhaust emissions, waste incineration, and the combustion of fossil fuels[20].

Elemental Concentration

To understand the distribution process of pollutants, it is essential to analyse EDAX-spectra, which can provide valuable information on vehicular pollution. The concentration of elements in the Industrial area (S1) was determined and found to be in the following order: silicon (Si) > carbon (C) > sodium (Na) > zinc (Zn) > potassium (K) > aluminium (Al) > calcium (Ca) > sulphur (S) > chlorine (Cl) > iron (Fe) > magnesium (Mg) **(Fig. 2)**. In the urban area, the concentration of elements (%) was found to be in the following order: Si > C > Na > Zn > K > Al > Ca > S > Fe > Mg > Cl **(Fig.3)** and in the rural area (S3), the recorded concentration of elements (%) exhibited the following sequence: C > Si > Na > Cl > Zn > K > Al > S > Ca > Fe > Mg **(Fig.4)**. Throughout all three seasons, the dominant elements observed in all sites were Si, C, and O. The presence of biological particles in the atmosphere, including microorganisms and various fragments of living matter such as viruses, bacteria, fungal spores, pollen, plant debris, and animal matter, has been observed in relation to carbon (C). In addition, it is hypothesised that the elevated levels of C can be attributed to the emissions from vehicles. The origin of pure Si can be attributed to both natural and anthropogenic factors [28]. Silica is a significant component in various construction materials, including cement, glass, bricks, clay, pottery, and other similar substances. The origin of these particles might be attributed to both building construction and demolition activities. In the analysed sample, only minute quantities of additional essential tracers, including iron (Fe), aluminium (Al), chlorine (Cl), magnesium (Mg), calcium (Ca), sulphur (S), potassium (K), zinc (Zn), and sodium (Na), were detected[31, 32, 33, 34, 35, 36, 37].





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Qualitative analysis of Organic chemical compounds

The analysis of filter paper using gas chromatography-mass spectrometry (GC-MS) demonstrated the presence of 156 organic chemical compounds within the PM_{2.5} size fraction. A total of 127 compounds were identified as aliphatic compounds, while 29 compounds were identified as aromatic compounds.

Total aliphatic hydrocarbon (TAHs)

The increase in aliphatic compounds can be attributed to the incomplete combustion of fossil fuels, petroleum wastes, and wood combustion, as well as road crustal emissions. The possible contribution of ceramic dust as an important source of n-alkanes during in the winter season [38]. Out 127 aliphatic compounds, it was observed that 100 of these compounds were categorised as n-alkanes, which encompassed both short-chain and long-chain variants ranging from C₆ to C₅₄. Additionally, the remaining 27 compounds were identified as n-alkanoic acids. The total number of short-chain alkanes, specifically those with carbon chain lengths equal to or less than 26 ($C_n \leq C_{26}$), was found to be 113. These alkanes are primarily sourced from anthropogenic activities and the input of fossil fuels. This contribution from anthropogenic and fossil fuel sources plays a significant role in the production of short-chain n-alkanes [39]. These organic compounds are classified into four distinct categories, each representing a specific range of peak heights. In the atmospheric composition, a number of alkane compounds were found to be dominant. These compounds include [Hexacosane], [Heptadecane, 2,6,10,15-tetramethyl-], [Eicosane], [Hexadecane], [Heneicosane] were dominant in the atmosphere (**Table 2**). Alkanoic acid such as [Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester], [Heptacosanoic acid, methyl ester], [Decanedioic acid, bis(2-ethylhexyl) ester], [Eicosanoic acid] and [Sulfurous acid, hexyl octyl ester] were predominant in the atmosphere. During the pre-monsoon season in the Industrial area, a higher concentration of short-chain alkane was observed. The levels of long chain alkanes and N-alkanoic acid exhibited variations across different seasons, with higher concentrations observed in the post-monsoon season, followed by the monsoon and pre-monsoon seasons. The levels of long chain alkanes and N-alkanoic acid exhibited variations across different seasons, with higher concentrations observed in the post-monsoon season, followed by the monsoon and pre-monsoon seasons (**Fig. 5**). The number of n-alkane compounds varied across different areas, with the Industrial area having the highest count, followed by the Urban area, and the Rural area. This trend was consistent across all three seasons (**Fig. 6&7**).

Total aromatic hydrocarbons

A total of 29 aromatic compounds belonging to various groups, such as polycyclic aromatic hydrocarbons (PAHs), aromatic acids, and plasticizers were effectively detected and characterised. These findings provide useful perspectives into the presence and composition of aromatic compounds in the atmosphere. The compound shows a low level of water solubility, along with melting and boiling points, as well as a considerably reduced vapour pressure. In the atmosphere, the presence of phenol, specifically [2,4-bis(1,1-dimethylethyl)-phenol, phosphite], [Phthalic acid, bis(7-methyloctyl) ester], [Silane, cyclohexyl dimethoxy methyl], [Tris(2,4-di-tert-butylphenyl) phosphate] and [Bis(2-ethylhexyl) phthalate] was detected with high peak heights, indicating their abundance. In the extracted sample, the presence of aromatic acids such as [Benzenepropanoic acid [3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester], [1,3-Benzenedicarboxylic acid, bis(2-ethylhexyl) and [1H-Imidazole, 4,5-dihydro-2-(phenylmethyl)] was observed. In numerous studies, researchers have consistently identified [Phthalic acid, bis(7-methyloctyl) ester], [Bis(2-ethylhexyl) phthalate] and [Di-n-octyl phthalate] as the plasticizers that are most prevalent and normally detected. In the different areas of study, the arrangement of aromatic compounds is



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categorised as follows: Simple aromatics > Polycyclic aromatic hydrocarbons (PAHs) > Aromatic acids > plasticizers. A greater number of Simple aromatics was observed in every site, during all seasons. The industrial area contains maximum number of Aromatic acids (**Fig. 5**). The number of PAHs compounds was maximum in the urban area (**Fig.6**). In conducting a comparative analysis between the rural, industrial, and urban areas, it was observed that all the compounds in the rural region showed lower levels in comparison to their other areas (**Fig. 7**). Due to the incomplete combustion of organic materials which releases polycyclic aromatic hydrocarbons, from home heating, coal gasification, liquefying plants, coal-tar pitch and asphalt manufacture, and coke aluminium production are the main anthropogenic sources[26].

CONCLUSION

During the winter season, the vertical movement of winds suffers as a result of pressure variations, which may be caused by high pressure at ground level. Therefore, pollutants tend to accumulate and remain concentrated at the surface for extended periods, leading to higher levels of pollution. The investigation of the elemental composition of atmospheric particles was conducted using the Energy Dispersive X-ray Analysis (EDAX) system. The findings of the study indicate that the composition of airborne particles primarily consisted of elements such as silicon (Si), carbon (C), sodium (Na), zinc (Zn), potassium (K), aluminium (Al), calcium (Ca), sulphur (S), chlorine (Cl), iron (Fe), and magnesium (Mg). These particles were found to originate from both natural sources and human-induced activities. The organic chemical analysis was conducted using a Gas Chromatography-Mass Spectrometry (GC-MS) instrument. The obtained data was organised according to indices scale, which was determined based on the percentage of peak height (%) of the particulate matter. A total of 156 organic chemical compounds were identified and quantified in the three designated study locations in Surat. These compounds exhibited a varied distribution pattern across the study areas. The present study aims to present crucial findings regarding the occurrence and spatial dispersion patterns of organic compounds in ambient air. During the course of this research, the presence of [Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite], [1-Monopalmitin, 2TMS derivative], [Octadecane, 1-iodo], [Hexadecane] and [Octadecane, 5-methyl] was consistently observed and these types of compounds came from various anthropogenic activity like Diesel engine, Tobacco smoke, biomass combustion etc. Specifically, the compounds Phenol, 2,4-bis(1,1-dimethylethyl) phosphite were found to be common across all sites and throughout all three seasons. These compounds are derived from naturally occurring substances that are known to serve a variety of purposes in food, medicine, and agriculture.

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Table 1: Sampling Information & Mass Concentration

No.	Area Type	Sampling season	Latitude ° N Longitude ° E	Concentration (µg/m ³)	Light Intensity (Lux)	Temp. (°C)	R. Humidity (%)	Wind Speed (km/h)
1	Industrial	Post monsoon	21.0931°, 72.8575°	164.96	14248	40.7	35.2	6.27
2	Urban		21.2469°, 72.8515°	157.35	16225	43.2	22.8	7.56





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3	Rural		21.1014°, 73.0361°	91.66	13565	39.6	39.16	5.71
4	Industrial	Pre monsoon	21.0931°, 72.8575°	161.96	14890	44.9	34	6.49
5	Urban		21.2469°, 72.8515°	142.97	15548	46.5	30.3	6.91
6	Rural		21.1014°, 73.0361°	128.85	13115	37.5	42.63	5.41
7	Industrial	Monsoon	21.0931°, 72.8575°	77.48	13256	35.7	35	6.77
8	Urban		21.2469°, 72.8515°	58.95	14535	40.7	31.3	4.85
9	Rural		21.1014°, 73.0361°	31.95	12487	34.3	48.54	8.54

Table: 2 The PM_{2.5} fine particulate matter associated with Organic chemical compounds.

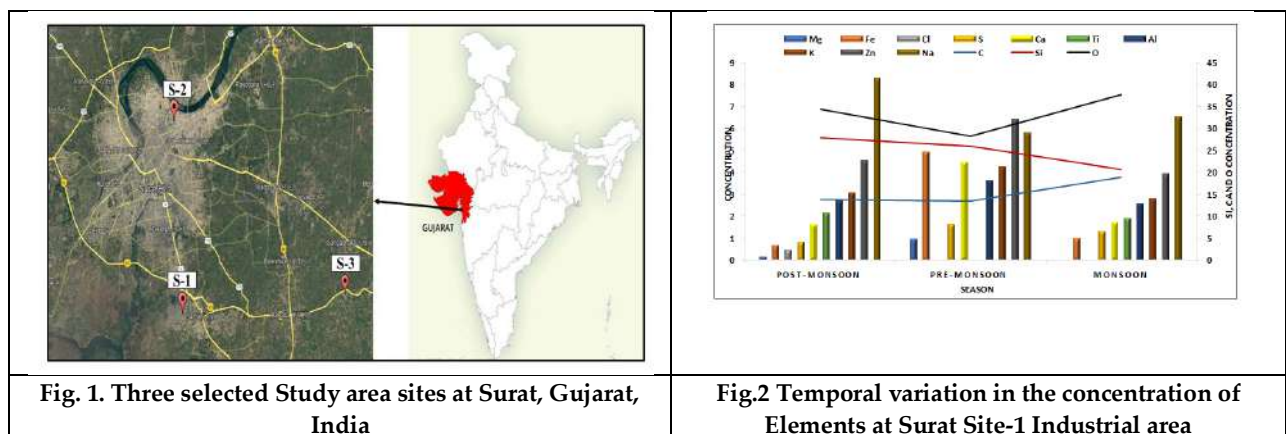
Season	site	Peak height (%)	No. of Compounds	Dominant compounds
Post-Monsoon	Industrial area	0.0-0.5	24	Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester
		0.51-1.0	14	Dodecane, 2,6,11-trimethyl
		1.01-2.0	7	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester
		≥2.0	6	Hexadecane
	Urban Area	0.0-0.5	34	10-Methylnonadecane
		0.51-1.0	15	Dibutyl phthalate
		1.01-2.0	10	Octadecane, 1-iodo
		≥2.0	9	Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite
	Rural area	0.0-0.5	11	Undecane, 4,8-dimethyl
		0.51-1.0	9	Octadecane, 5-methyl
		1.01-2.0	6	Silane, cyclohexyldimethoxymethyl
		≥2.0	5	Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite
Pre-Monsoon	Industrial area	0.0-0.5	33	Tetracosane
		0.51-1.0	10	Decanedioic acid, bis(2-ethylhexyl) ester
		1.01-2.0	9	Hexadecane
		≥2.0	6	Eicosane
	Urban Area	0.0-0.5	26	Nonane, 4,5-dimethyl
		0.51-1.0	15	Tridecane





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Monsoon		1.01-2.0	7	Eicosane, 1-iodo-	
		≥2.0	7	Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite	
		Rural area	0.0-0.5	6	Octacosane
			0.51-1.0	7	Decane, 3,7-dimethyl
	1.01-2.0		8	1-Monopalmitin, 2TMS derivative	
	≥2.0		9	Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite	
	Industrial area	Industrial area	0.0-0.5	26	Phthalic acid, nonyl pentadecyl ester
			0.51-1.0	11	Octadecane, 5-methyl
			1.01-2.0	9	Bis(tridecyl) phthalate
			≥2.0	8	Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite
		Urban Area	0.0-0.5	19	Dotriacontane, 1-iodo
			0.51-1.0	8	Octadecane, 1-iodo
			1.01-2.0	7	Heptacosanoic acid, methyl ester
			≥2.0	4	Phenol, 2,4-bis(1,1-dimethylethyl)-, phosphite
		Rural area	0.0-0.5	7	Dodecane
			0.51-1.0	6	Octadecane
1.01-2.0			4	1-Monopalmitin, 2TMS derivative	
≥2.0			4	Heneicosane	



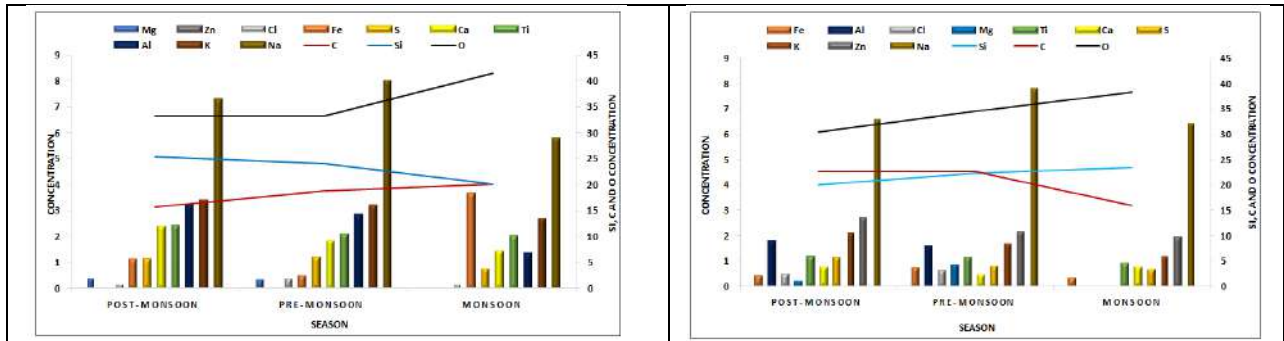


Fig.3 Temporal variation in the concentration of Elements at Surat Site-2 Urban area

Fig.4 Temporal variation in the concentration of Elements at Surat Site-3 Rural area

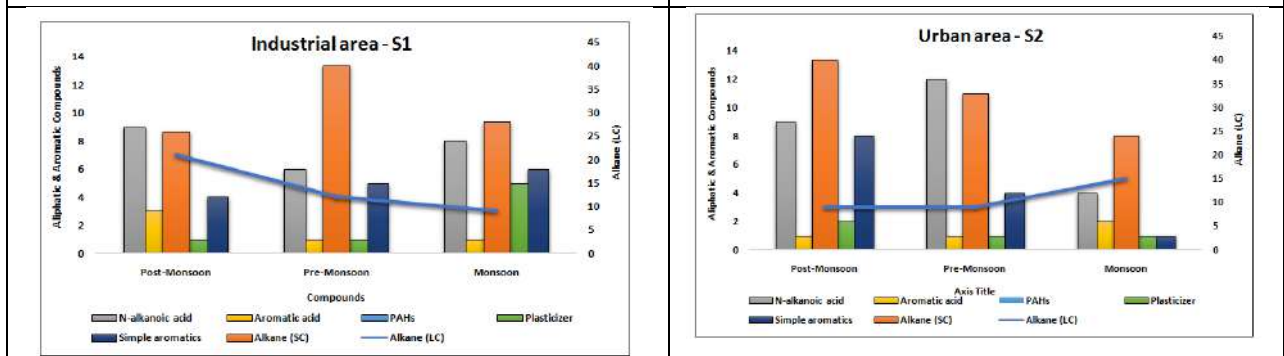


Fig.5 Organic pollutants at Site-1 Industrial area

Fig.6 Organic pollutants at Site-2 Urban area

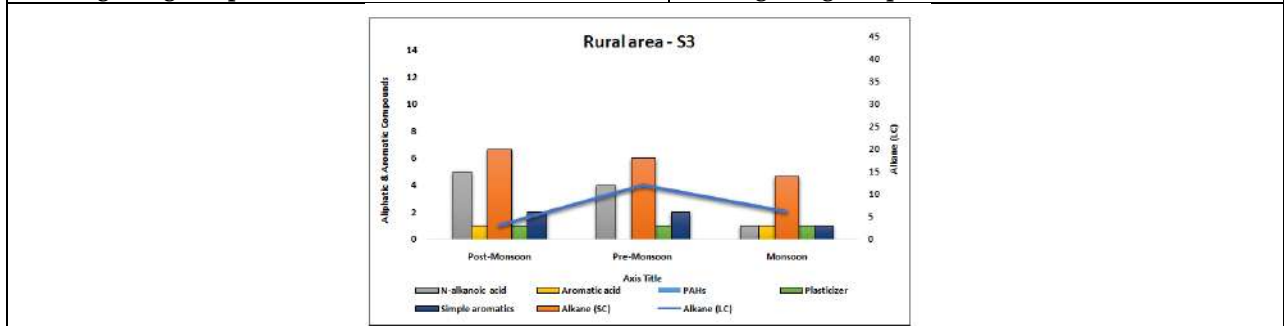


Fig.7 Organic pollutants at Site-3 Rural area





Revolutionizing Pharmaceutical Analysis through Nanotechnology: An In-depth Exploration

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

This review focuses on the transformative impact of nanotechnology on pharmaceutical analysis. It highlights how nanotechnology improves the sensitivity, specificity, and speed of analytical methods, leading to more accurate and detailed insights into drug properties, quality, and safety. By manipulating matter at the nanoscale, nanotechnology enables the development of novel analytical tools and techniques, such as Nano sensors and nanoparticles, enhancing drug purity analysis, delivery, and real-time monitoring. The article emphasizes nanotechnology's pivotal role in advancing pharmaceutical sciences, ensuring safer and more effective therapeutic agents.

Keywords: Nanotechnology, Pharmaceutical Analysis, Nanoparticles, Nano sensors, Drug Delivery.





INTRODUCTION

Definition and scope of nanotechnology in pharmaceutical analysis

Nanotechnology, a field that manipulates matter at the nanometer scale (1 to 100 nm), is increasingly pivotal in pharmaceutical analysis. This domain leverages the unique properties of nanomaterials, which differ significantly from their bulk counterparts, to enhance the sensitivity, specificity, and speed of analytical methods used in pharmaceutical sciences. Nanotechnology's scope in pharmaceutical analysis is broad, encompassing the development of innovative techniques for drug characterization, quality control, and safety assessment.[1] At the nanoscale, materials exhibit distinct physical, chemical, and biological properties, such as increased surface area-to-volume ratio, quantum effects, and enhanced reactivity. These properties are harnessed in pharmaceutical analysis to achieve more sensitive detection limits, improved analytical throughput, and the ability to conduct analyses in complex biological matrices where conventional methods might falter. For instance, nanoparticles can be engineered to target specific molecules or cellular structures, facilitating the precise detection and quantification of drugs, their metabolites, and impurities.[2] Nanotechnology enables the miniaturization of analytical devices, leading to the development of portable, field-deployable diagnostic tools that can provide rapid and on-site analysis, crucial for point-of-care testing and real-time monitoring of therapeutic drug levels. Nanotechnology also contributes to the advancement of non-invasive techniques for monitoring drug release and distribution *in vivo*, offering a clearer understanding of a drug's pharmacokinetics and pharmacodynamics.[3] Nanotechnology in pharmaceutical analysis represents a frontier in the precise, accurate, and efficient measurement of pharmaceutical substances. Its integration into pharmaceutical sciences not only enhances the capabilities of traditional analytical methods but also paves the way for novel approaches in the detection, quantification, and monitoring of pharmaceutical compounds, thereby playing a critical role in the development of safer, more effective therapeutic agents.[4]

Overview of the transformative impact of nanotechnology on the methodologies and capabilities of pharmaceutical analysis

Nanotechnology has fundamentally transformed pharmaceutical analysis, introducing methodologies that provide unprecedented precision, sensitivity, and efficiency. By manipulating materials at the nanoscale, researchers have unlocked new capabilities that surpass the limitations of conventional analytical techniques. Nanotechnology's impact on pharmaceutical analysis is profound, influencing drug discovery, formulation, delivery, and monitoring, thereby ensuring enhanced therapeutic efficacy and safety.[5] One of the most significant advancements brought about by nanotechnology is the enhanced sensitivity and specificity in the detection of pharmaceuticals. Nanoparticles, with their large surface area-to-volume ratio, offer increased reactive sites for analyte interaction, facilitating the detection of substances at extremely low concentrations. This is crucial for identifying trace impurities and metabolites that could influence drug safety and efficacy.[6] Moreover, nanotechnology has enabled the development of novel drug delivery and release monitoring methods. For instance, nanoscale carriers can be designed to release drugs in a controlled manner, and their distribution and degradation can be tracked in real time, providing invaluable data on the pharmacokinetics and pharmacodynamics of therapeutics. This not only aids in optimizing drug formulations but also enhances personalized medicine approaches by allowing real-time adjustments to dosages.[7] In addition to enhancing existing analytical methods, nanotechnology has paved the way for the invention of innovative techniques. Nanosensors, for example, offer the capability for rapid, on-site analysis of biological samples, which is vital for point-of-care diagnostics and monitoring therapeutic drug levels in patients. The integration of nanotechnology in pharmaceutical analysis has also led to the miniaturization of analytical equipment, making sophisticated analyses more accessible and cost-effective.[8] Nanotechnology has revolutionized pharmaceutical analysis by enhancing the capabilities of analytical methodologies, thereby improving the precision, efficiency, and applicability of pharmaceutical testing. This transformation is pivotal in advancing drug development and ensuring patient safety, underscoring the essential role of nanotechnology in the future of pharmaceutical sciences.[9]





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Foundational Concepts of Nanotechnology

Basic principles of nanotechnology, focusing on the nanoscale (1 to 100 nm) and its significance in pharmaceuticals

Nanotechnology, centered on engineering and manipulating materials at the nanoscale, typically within the range of 1 to 100 nanometers (nm), embodies a significant shift in scientific approach and technological capabilities. At this scale, materials exhibit unique properties that are not present at the macro or microscale, fundamentally due to the quantum effects and increased surface area-to-volume ratio. These distinctive features have substantial implications in the field of pharmaceuticals, offering innovative solutions and enhancing the efficacy and safety of therapeutic interventions.[10] The quantum effects observed at the nanoscale influence the optical, electrical, and magnetic properties of materials, which can be harnessed to develop more sensitive diagnostic tools and targeted drug delivery systems. For example, the optical properties of gold nanoparticles change with their size, allowing them to be used for precise imaging and targeting in cancer therapy. The increased surface area-to-volume ratio enhances the reactivity of nanoparticles, enabling more efficient interactions with biological molecules. This property is pivotal in designing drug delivery systems that can interact specifically with targeted cells or tissues, thereby reducing side effects and improving therapeutic outcomes.[11] In pharmaceuticals, the nanoscale offers a platform for engineering drug particles to improve solubility, stability, and bioavailability. Nanoparticles can be designed to cross biological barriers, such as the blood-brain barrier, that are typically impermeable to conventional drug molecules, opening new avenues for treating neurological disorders. Moreover, the ability to tailor the surface chemistry of nanoparticles allows for the conjugation of specific ligands, facilitating targeted drug delivery and controlled release mechanisms.[12] The fundamental principles of nanotechnology provide a versatile toolkit for enhancing drug formulation, delivery, analysis, and monitoring, thereby playing a crucial role in the advancement of pharmaceutical sciences. Through the manipulation of matter at the nanoscale, nanotechnology offers the potential to revolutionize medical treatments and improve patient outcomes significantly.[13]

Overview of the key physical and chemical properties of nanomaterials that are exploited in pharmaceutical analysis

Nanomaterials, with their distinct physical and chemical properties at the nanoscale, offer unique advantages in pharmaceutical analysis. These properties, which differ significantly from those of bulk materials, are pivotal in enhancing the sensitivity, specificity, and efficiency of analytical methods.[14] One of the key physical properties of nanomaterials is their size, which falls within the range of 1 to 100 nanometers. This small size results in a high surface area-to-volume ratio, increasing the reactive surface available for interactions with analytes. This property is particularly beneficial in enhancing the sensitivity of detection methods, as more molecules can interact with the surface of the nanomaterial, leading to a more pronounced analytical signal.[15] The size of nanomaterials also influences their quantum properties, which can be exploited in pharmaceutical analysis. For example, quantum dots have size-dependent optical properties that can be utilized for highly sensitive fluorescence-based detection methods. These quantum effects enable the tuning of nanomaterials for specific applications, providing versatility in their analytical use.[16] Chemically, nanomaterials can exhibit enhanced reactivity due to their increased surface energy compared to bulk materials. This enhanced reactivity can be harnessed for more effective catalysis in biochemical reactions, potentially reducing the time and improving the efficiency of analytical assays.[17] Additionally, the surface of nanomaterials can be modified with various functional groups, allowing for the customization of their chemical properties. This functionalization can be designed to promote specific interactions with target molecules, enhancing the selectivity of analytical methods. For example, nanoparticles can be functionalized with ligands that bind selectively to a drug or metabolite, facilitating its precise detection and quantification in complex biological matrices.[18] The unique physical and chemical properties of nanomaterials at the nanoscale are critically leveraged in pharmaceutical analysis, offering advancements in the sensitivity, specificity, and versatility of analytical techniques. These properties facilitate the development of innovative approaches to detecting, quantifying, and monitoring pharmaceutical compounds, contributing significantly to the field's progress.[19]





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Nanomaterials in Pharmaceutical Analysis

Types of Nanomaterials

Description of various nanomaterials used, such as metallic nanoparticles, quantum dots, dendrimers, and carbon nanotubes, detailing their unique properties and advantages

Nanomaterials, with their diverse structures and compositions, play a pivotal role in enhancing the field of pharmaceutical analysis. Each class of nanomaterials, including metallic nanoparticles, quantum dots, dendrimers, and carbon nanotubes, offers unique properties and advantages.[20]

Metallic Nanoparticles

These nanoparticles, made from metals like gold and silver, exhibit exceptional optical properties due to their surface plasmon resonance. This characteristic is exploited in various analytical techniques, such as surface-enhanced Raman spectroscopy (SERS), providing enhanced sensitivity for detecting trace amounts of pharmaceutical substances. Moreover, the ease of functionalization of metallic nanoparticles allows for targeted binding to specific analytes, improving the specificity of detection methods.[21]

Quantum Dots

Quantum dots are semiconductor nanoparticles that have size-dependent optical and electronic properties, a phenomenon attributable to the quantum confinement effect. Their tunable fluorescence emission, based on size, enables multiplexed analysis, where different sized quantum dots can be used simultaneously to detect multiple targets. Quantum dots' high photostability is advantageous for long-term imaging applications in pharmaceutical analysis.[22]

Dendrimers

These are highly branched, tree-like polymers with a well-defined, monodisperse structure, offering numerous terminal functional groups that can be modified for specific interactions with pharmaceutical targets. Their size, shape, and surface functionality can be precisely controlled, making dendrimers versatile carriers for drugs and probes in analytical applications, enhancing solubility and stability of pharmaceutical agents.[23]

Carbon Nanotubes (CNTs)

CNTs are cylindrical structures with unique mechanical, thermal, and electrical properties. Their high aspect ratio and surface area make them excellent candidates for adsorption-based separation and detection techniques in pharmaceutical analysis. Functionalized CNTs can offer selectivity towards specific analytes, and their conductive properties are utilized in electrochemical sensors, providing sensitive and rapid analysis.[24] These nanomaterials, with their distinct and tunable properties, significantly contribute to advancing the methodologies in pharmaceutical analysis, offering enhanced detection, specificity, and multifunctionality in various analytical applications.

Synthesis and Functionalization

Discussion on synthesis methods of nanomaterials and their functionalization to enhance biocompatibility and specificity in pharmaceutical analysis.

The synthesis and functionalization of nanomaterials are critical steps that define their applicability in pharmaceutical analysis, influencing their biocompatibility and specificity. Various synthesis methods have been developed to tailor the size, shape, and surface properties of nanomaterials, while functionalization strategies are employed to enhance their interaction with biological systems and target analytes.[25]

Synthesis Methods:[26]

1. **Top-down approaches:** These involve breaking down larger pieces of material into nanoscale particles through methods like ball milling or lithography. While these methods are straightforward, controlling the size and shape of the nanoparticles can be challenging.



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2. **Bottom-up approaches:** These involve assembling atoms or molecules into nanoscale structures through chemical or biological processes, such as chemical reduction, sol-gel synthesis, or biological synthesis using microorganisms or plant extracts. Bottom-up methods are more favored for their ability to precisely control the nanoparticle's size, shape, and crystallinity.

Functionalization Strategies:[27]

1. **Surface modification:** To enhance biocompatibility and specificity, the surface of nanomaterials can be modified with various molecules, such as polymers, peptides, or antibodies. For instance, polyethylene glycol (PEG) is commonly used to enhance biocompatibility and circulation time in the bloodstream by providing a 'stealth' characteristic to nanoparticles.
2. **Ligand attachment:** Specific ligands can be attached to the surface of nanoparticles to target and bind to particular molecules or cells. This specificity is crucial for applications like targeted drug delivery or specific detection of biomarkers in pharmaceutical analysis.
3. **Encapsulation:** Nanomaterials can be used to encapsulate drugs, protecting them from degradation and controlling their release. This encapsulation can be tailored by modifying the surface properties of the nanomaterial, affecting the interaction with the drug and the surrounding biological environment. By carefully designing the synthesis and functionalization of nanomaterials, researchers can produce nanoparticles that are not only biocompatible but also highly specific to their target analytes, significantly enhancing the capabilities of pharmaceutical analysis.

Technological Advances in Nanotechnology for Pharmaceutical Analysis

Nano-Enabled Analytical Techniques

Exploration of how nanotechnology enhances traditional analytical techniques like chromatography, mass spectrometry, and spectroscopy

Nanotechnology significantly enhances the capabilities of traditional analytical techniques such as chromatography, mass spectrometry, and spectroscopy, by improving sensitivity, selectivity, and resolution.

Chromatography

Nanomaterials have been integrated into chromatographic techniques, where they serve as advanced stationary phases in liquid chromatography (LC) or as sorbents in gas chromatography (GC). For instance, nanoparticles improve the separation efficiency due to their high surface area and unique interactions with analytes. Carbon nanotubes and silica nanoparticles, when used as stationary phases, offer enhanced chromatographic resolution and faster analysis times, facilitating the separation of complex mixtures and the detection of low-abundance compounds in pharmaceutical samples.[28]

Mass Spectrometry

In mass spectrometry (MS), nanotechnology has been employed to develop novel ionization techniques, such as nano-electrospray ionization (nano-ESI), which offers improved sensitivity and reduced sample consumption. Nanoparticles also play a crucial role in matrix-assisted laser desorption/ionization (MALDI) MS, where they can act as matrix materials to enhance ionization efficiency, reduce background noise, and facilitate the analysis of large biomolecules, improving the characterization of pharmaceutical compounds and their metabolites.[29]

Spectroscopy

Nanotechnology enhances spectroscopic methods by increasing the interaction between light and matter. In surface-enhanced Raman spectroscopy (SERS), for example, metallic nanoparticles enhance the Raman signal of molecules adsorbed on their surface, allowing for the detection of trace amounts of pharmaceutical substances. Similarly, in fluorescence spectroscopy, quantum dots are used as fluorescent probes, offering superior brightness and photostability compared to conventional dyes, which is advantageous for long-term imaging and quantitative analysis in pharmaceutical research.[30] The integration of nanotechnology into traditional analytical techniques offers profound improvements in pharmaceutical analysis, enabling more precise, sensitive, and rapid



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characterization and quantification of pharmaceuticals, which is essential for drug development, quality control, and safety monitoring.

Nanoparticle-Enhanced Sensitivity

In-depth look at how nanoparticles increase the sensitivity and limit of detection in pharmaceutical analysis

Nanoparticles play a pivotal role in enhancing the sensitivity and detection limits in pharmaceutical analysis due to their unique physical and chemical properties at the nanoscale. Their small size and high surface area-to-volume ratio provide a larger surface for interaction with analytes, facilitating greater sensitivity in detecting low concentrations of pharmaceutical substances. The application of nanoparticles in analytical techniques like chromatography, mass spectrometry, and spectroscopy significantly improves the limit of detection (LOD). For example, in chromatographic methods, nanoparticles can serve as stationary phases with increased surface area, leading to better separation and more effective interaction with analytes, which enhances signal detection and reduces LOD.[31] In mass spectrometry, nanoparticles like those used in nano-electrospray ionization (nano-ESI) enhance ionization efficiency, allowing for the detection of molecules at lower concentrations. This is crucial for identifying trace impurities or metabolites in pharmaceutical products, ensuring their safety and efficacy.[32] Surface-enhanced Raman spectroscopy (SERS) is another technique where nanoparticles, particularly metallic ones, create "hot spots" that significantly amplify the Raman signal. This enhancement enables the detection of pharmaceutical compounds at concentrations that were previously undetectable, offering a powerful tool for analyzing complex biological matrices and studying drug interactions at the molecular level.[33] Furthermore, nanoparticles can be engineered to have specific affinities for target analytes, enhancing the selectivity of detection methods. By attaching specific ligands or antibodies to nanoparticles, analysts can target specific drugs or metabolites, which improves the specificity of the detection and quantification process, minimizing interference from other substances.[34] Nanoparticles enhance the sensitivity and detection limits in pharmaceutical analysis by providing a larger reactive surface area, improving ionization efficiency, amplifying detection signals, and enabling targeted analysis, thus playing a crucial role in the accurate and precise quantification of pharmaceutical compounds.

Applications of Nanotechnology in Pharmaceutical Analysis:

Drug Purity and Composition Analysis:

Detailed discussion on using nanotechnology for assessing drug purity, identifying impurities, and determining composition

Nanotechnology plays a pivotal role in advancing the methodologies for assessing drug purity, identifying impurities, and determining the composition of pharmaceuticals. Utilizing the unique properties of nanoscale materials, nanotechnology enhances the sensitivity, specificity, and speed of analytical processes, thereby providing more accurate and detailed insights into the quality of pharmaceutical products.

Assessing Drug Purity

Nanotechnology-based methods, particularly those employing nanoparticles and nanosensors, offer enhanced detection capabilities for analyzing drug purity. Metallic nanoparticles, for instance, can enhance the signal in spectroscopic methods, making it possible to detect even trace amounts of impurities that conventional methods might miss. Quantum dots, with their size-tunable fluorescence, can be used to tag specific drug molecules in a mixture, allowing for the precise quantification of the active pharmaceutical ingredient (API) and the detection of unwanted by-products or contaminants.[35]

Identifying Impurities

The high surface area-to-volume ratio of nanomaterials facilitates greater interaction with analytes, enabling the detection of low-concentration impurities. Nanoparticles functionalized with specific ligands can selectively bind to impurities, allowing for their identification and quantification through techniques like nanoparticle-enhanced spectroscopy or chromatography. This capability is crucial for ensuring the safety and efficacy of pharmaceuticals, as even minute amounts of impurities can significantly affect drug behavior and patient safety.[36]





Determining Composition

Nanotechnology aids in the comprehensive analysis of pharmaceutical compositions, including the identification of all constituents and their concentrations. Nanoscale analytical tools can dissect complex formulations, providing detailed insights into the interactions between different components. For instance, nanotechnology-enhanced mass spectrometry can elucidate the molecular structure and composition of drugs, offering a deeper understanding of their pharmacological properties.[37] Nanotechnology significantly augments the analytical tools available for pharmaceutical analysis, enabling more thorough and precise assessments of drug purity, impurity identification, and composition determination. This technological advancement is essential for the development, regulation, and quality control of pharmaceutical products, ensuring their safety and effectiveness.

Drug Delivery System Analysis

Examination of how nanotechnology aids in analyzing and optimizing drug delivery systems, including nanoparticle-based drug carriers

Nanotechnology plays a critical role in the analysis and optimization of drug delivery systems, particularly through the use of nanoparticle-based carriers. These nanoscale carriers offer unique advantages in delivering therapeutic agents effectively to the target site while minimizing systemic side effects and improving pharmacokinetic profiles.

Analyzing Drug Delivery Systems

Nanotechnology enables the detailed characterization of drug delivery vehicles, including their size, charge, surface properties, and drug encapsulation efficiency. Techniques such as dynamic light scattering (DLS) and transmission electron microscopy (TEM) are employed to analyze the physical attributes of nanoparticle carriers, while spectroscopic methods assess their chemical composition and stability. This comprehensive analysis is crucial for understanding how these properties influence the interaction of nanoparticles with biological systems, determining their biodistribution, cellular uptake, and eventual drug release profile.[38]

Optimizing Drug Delivery

Nanoparticle-based carriers can be engineered to optimize drug release kinetics, targeting capabilities, and biodegradability. By adjusting the size, surface chemistry, or composition of nanoparticles, researchers can tailor the drug release rate to achieve sustained or controlled release, enhancing therapeutic efficacy. Functionalization of nanoparticle surfaces with targeting ligands or antibodies allows for the specific binding to cell receptors or diseased tissues, enabling targeted drug delivery that reduces off-target effects and improves therapeutic outcomes.[39]

Evaluating In Vivo Performance

Nanotechnology facilitates the in vivo evaluation of drug delivery systems through imaging and tracking techniques. Nanoparticles can be labeled with fluorescent markers or radioisotopes, allowing researchers to monitor their biodistribution, accumulation at the target site, and clearance from the body using various imaging modalities. This real-time tracking provides invaluable insights into the performance of drug delivery systems, guiding the optimization of nanoparticle design for enhanced efficacy and safety.[40] Nanotechnology significantly contributes to the advancement of drug delivery systems, providing the tools and methodologies for detailed analysis and optimization. Through the design and functionalization of nanoparticle-based carriers, nanotechnology enables more precise, effective, and safe delivery of therapeutic agents, marking a significant step forward in the field of pharmaceutical sciences.

Bioavailability and Pharmacokinetics

Insight into how nanotechnology is used to study the bioavailability and pharmacokinetics of drugs

Nanotechnology offers innovative approaches to studying the bioavailability and pharmacokinetics of drugs, providing insights that are crucial for optimizing therapeutic efficacy and safety. By utilizing nanoscale materials and tools, researchers can gain a more detailed understanding of how drugs are absorbed, distributed, metabolized, and excreted in the body.





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Enhancing Bioavailability

Nanoparticle-based drug formulations can significantly improve the solubility and stability of poorly water-soluble drugs, enhancing their bioavailability. By encapsulating drugs in nanoparticles, such as liposomes or polymeric nanoparticles, their dissolution rate and absorption through biological membranes are increased. Nanoparticles can also protect drugs from premature degradation in the gastrointestinal tract, ensuring a higher proportion reaches the systemic circulation.[41]

Studying Pharmacokinetics

Nanotechnology enables the precise tracking and monitoring of drug distribution and metabolism in the body. Drugs conjugated to quantum dots or metallic nanoparticles can be traced using imaging techniques, allowing researchers to visualize and quantify their distribution in real-time. This provides valuable data on the drug's biodistribution, identifying potential accumulation sites and enabling the adjustment of dosing regimens to minimize toxicity and enhance therapeutic action.[42]

Targeted Drug Delivery

Nanoparticles can be engineered to target specific tissues or cells, which not only improves the drug's efficacy but also provides a means to study its pharmacokinetics and bioavailability in targeted sites. By attaching targeting ligands or antibodies to the surface of nanoparticles, the drug can be directed to specific receptors or cell types, minimizing systemic distribution and side effects.[43]

Evaluating Metabolism and Excretion

Nanotechnology can also be applied to study the metabolism and excretion of drugs. Nanoparticles labeled with isotopes or fluorescent markers can be used to track the metabolic pathways and excretion of drugs, providing insights into their clearance rates and identifying potential metabolites.[44] Nanotechnology significantly enhances the study of drug bioavailability and pharmacokinetics, offering tools and methodologies that provide a deeper understanding of drug behavior in the body. This not only aids in the design of more effective and safer drugs but also contributes to personalized medicine, where treatments can be tailored based on individual pharmacokinetic profiles.[45]

Nanotechnology-Enabled Sensors in Pharmaceutical Analysis

Development and application of nanosensors for real-time monitoring and analysis of pharmaceuticals, emphasizing their increased sensitivity and specificity

Nanosensors, leveraging the unique properties of nanoscale materials, represent a transformative advancement in the real-time monitoring and analysis of pharmaceuticals. These devices offer unprecedented sensitivity and specificity, attributes that are essential for the accurate detection and quantification of drugs and their metabolites in various environments.

Development of Nanosensors

Nanosensors are engineered by integrating nanomaterials with transducer elements to produce signals in response to specific chemical or biological stimuli. The high surface area-to-volume ratio of nanomaterials, such as nanoparticles, nanotubes, or nanowires, enhances the interaction with target analytes, leading to increased sensitivity. These materials can be functionalized with specific receptors or ligands that bind selectively to a particular pharmaceutical compound, conferring high specificity to the nanosensor.[46]

Application in Pharmaceuticals

In the pharmaceutical sector, nanosensors are utilized for a range of applications, including drug discovery, quality control, and patient monitoring. They can detect trace amounts of active pharmaceutical ingredients, impurities, or degradation products in formulations, contributing to stringent quality control. In clinical settings, nanosensors facilitate the real-time monitoring of drug concentrations in biological fluids, enabling personalized dosing regimens to optimize therapeutic efficacy and minimize side effects.[47]





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Advantages of Nanosensors

The key advantages of nanosensors lie in their miniaturized size, allowing for in situ and non-invasive measurements, and their potential for multiplexing, where a single device can monitor multiple targets simultaneously. Furthermore, the rapid response time of nanosensors ensures immediate feedback, critical for real-time applications in clinical diagnostics and therapeutic monitoring.[48] Nanosensors stand at the forefront of pharmaceutical analysis, offering tools with enhanced sensitivity and specificity for the real-time monitoring of drugs. Their development and application significantly contribute to advancing personalized medicine, ensuring optimal therapeutic outcomes, and maintaining stringent quality control in pharmaceutical manufacturing.[49]

Case Studies and Practical Examples:

Presentation of case studies illustrating successful applications of nanotechnology in pharmaceutical analysis, highlighting key findings and methodologies

Nanotechnology has seen successful applications in pharmaceutical analysis, as illustrated by various case studies that highlight its impact on enhancing drug development and monitoring. These studies demonstrate the practical benefits and innovative methodologies enabled by nanotechnology in this field.

Case Study 1: Enhanced Drug Purity Assessment A study involved the use of gold nanoparticles in surface-enhanced Raman spectroscopy (SERS) for the detection of impurities in a drug sample. The gold nanoparticles amplified the Raman signal, allowing for the identification of trace impurities that were not detectable using conventional methods. This application showcased the ability of nanotechnology to enhance the sensitivity and specificity of pharmaceutical purity assessments, ensuring higher safety standards in drug manufacturing.[50]

Case Study 2: Nanoparticle-based Drug Delivery System Another case study focused on the development of a liposomal nanoparticle system for targeted cancer therapy. The liposomes were engineered to encapsulate a chemotherapeutic agent, with surface modification to target cancer cells specifically. This targeted delivery system reduced side effects and improved the therapeutic efficacy of the drug. The study highlighted the use of nanotechnology in optimizing drug delivery systems, providing a methodology for enhancing the precision and effectiveness of treatments.[51]

Case Study 3: Real-time Monitoring with Nanosensors A groundbreaking study introduced nanosensors capable of monitoring therapeutic drug levels in real-time within the bloodstream. These nanosensors provided continuous data on drug concentration, enabling immediate adjustment of dosages for optimal therapeutic effect. This application of nanotechnology demonstrated its potential to revolutionize patient care through personalized and adaptive treatment strategies.[52]

These case studies exemplify the transformative impact of nanotechnology in pharmaceutical analysis, showcasing its potential to enhance drug purity assessment, optimize drug delivery systems, and enable real-time therapeutic monitoring, thereby significantly contributing to the advancement of pharmaceutical sciences and patient care.

Challenges and Future Perspectives:

Current Challenges:

Discussion on the challenges such as standardization, scalability, and regulatory issues facing nanotechnology in pharmaceutical analysis

Nanotechnology offers transformative potential in pharmaceutical analysis, it also encounters significant challenges, including standardization, scalability, and regulatory hurdles, that must be addressed to fully harness its benefits.

Standardization

A primary challenge is the lack of standardized methodologies for the synthesis, characterization, and application of nanomaterials in pharmaceutical analysis. The unique properties of nanomaterials can vary significantly with slight changes in their size, shape, surface chemistry, or aggregation state, influencing their behavior and interactions with



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pharmaceuticals. Standardization is crucial to ensure consistency and reliability in the results of nanotechnology-based analyses, facilitating their acceptance and adoption in the pharmaceutical industry.[53]

Scalability

Another challenge is the scalability of nanotechnology applications from laboratory settings to industrial-scale production. Many nanomaterial synthesis methods are complex, requiring precise control over conditions and often yielding low quantities of material. Scaling these processes while maintaining the quality and characteristics of nanomaterials is essential for their widespread application in pharmaceutical analysis, ensuring that the benefits of nanotechnology can be realized on a larger scale.[54]

Regulatory Issues

The regulatory landscape for nanotechnology in pharmaceutical analysis is still evolving. Regulatory agencies face the challenge of developing frameworks that adequately address the novel aspects of nanomaterials, ensuring their safety, efficacy, and quality. The lack of specific guidelines for the evaluation and approval of nanotechnology-based pharmaceutical products and analytical methods can hinder their development and implementation. Moreover, there is a need for clear labeling and disclosure of nanomaterial use in pharmaceutical products to inform consumers and healthcare providers.[55] The challenges of standardization, scalability, and regulatory compliance is essential for advancing the integration of nanotechnology in pharmaceutical analysis. Overcoming these hurdles will enable the pharmaceutical industry to fully exploit the advantages of nanotechnology, leading to improved drug development, quality control, and patient outcomes.

Future Trends

Predictions and insights into future developments and potential breakthroughs in nanotechnology for pharmaceutical analysis:

The future of nanotechnology in pharmaceutical analysis is poised for significant breakthroughs and developments, driven by ongoing research and technological advancements. Here are some predictions and insights into potential future directions in this dynamic field.

Integration with Artificial Intelligence and Machine Learning

The integration of nanotechnology with artificial intelligence (AI) and machine learning (ML) will revolutionize pharmaceutical analysis. AI and ML algorithms can analyze vast datasets generated from nanoscale analytical processes, enhancing the interpretation of complex data, improving the prediction of drug behavior, and optimizing nanoparticle design for targeted drug delivery and analysis.[56]

Advancements in Nanosensor Technology

Future developments in nanosensor technology will likely focus on multi-analyte detection, enabling simultaneous monitoring of various drug parameters and biomarkers. Enhanced sensitivity and selectivity, coupled with real-time analysis capabilities, will facilitate personalized medicine, providing tailored therapeutic strategies based on individual patient profiles.[57]

Next-Generation Nanomaterials

The synthesis of novel nanomaterials with enhanced functionalities is on the horizon. These materials will offer improved biocompatibility, targeted delivery, and controlled release mechanisms. Innovative materials like stimuli-responsive nanoparticles, which alter their behavior in response to specific biological signals, will provide precise control over drug release and activity.[58]

Global Collaboration and Standardization

Increased collaboration across academia, industry, and regulatory agencies worldwide will drive the standardization of methodologies and protocols in nanotechnology. This global effort will facilitate the translation of



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nanotechnological innovations from the lab to the market, ensuring broader access to advanced pharmaceutical analysis techniques.[59]

The future of nanotechnology in pharmaceutical analysis is bright, with potential breakthroughs that promise to enhance drug development, personalize medicine, and improve patient outcomes through more sophisticated and precise analytical methods.

Ethical and Regulatory Considerations**Examination of the ethical implications and regulatory landscape governing the use of nanotechnology in pharmaceutical analysis**

The integration of nanotechnology into pharmaceutical analysis brings forth a set of ethical implications and regulatory challenges that necessitate careful consideration. As nanotechnology offers profound capabilities in detecting, analyzing, and delivering pharmaceuticals, it also raises questions regarding safety, privacy, and environmental impact, which are intertwined with the regulatory frameworks governing its application.

Ethical Implications:[60]

1. **Safety Concerns:** The unique properties of nanomaterials, while beneficial, also pose potential risks to human health and the environment, which are not entirely understood. Ethical considerations demand rigorous assessment of nanomaterial toxicity, long-term stability, and their interaction with biological systems to prevent unintended consequences.
2. **Privacy and Data Security:** Advanced nanosensors capable of real-time monitoring of patients' biological parameters could raise privacy concerns. Ensuring the confidentiality and security of the sensitive health data collected by these devices is paramount to protect individuals' privacy rights.
3. **Accessibility and Equity:** The benefits of nanotechnology-enhanced pharmaceutical analysis should be accessible to all sectors of society. There is an ethical imperative to ensure that these advancements do not widen the healthcare disparity gap but rather contribute to equitable healthcare improvements.

Regulatory Landscape:[61]

1. **Evolving Guidelines:** Regulatory agencies are tasked with evolving their frameworks to address the unique challenges posed by nanotechnology. This includes establishing guidelines for the synthesis, characterization, application, and disposal of nanomaterials, ensuring their safe and effective use in pharmaceutical analysis.
2. **Standardization and Validation:** Developing standardized methods for evaluating nanotechnology applications in pharmaceuticals is crucial for ensuring consistency and reliability across studies and products. Regulatory bodies must also set benchmarks for the validation of nanotechnological methods in drug analysis and delivery.
3. **International Collaboration:** Given the global nature of pharmaceuticals, international regulatory collaboration is essential to harmonize standards and practices related to nanotechnology. This cooperation ensures that innovations can be seamlessly integrated into the global pharmaceutical industry, benefiting a worldwide population. The ethical considerations and adapting the regulatory landscape are crucial steps in harnessing the full potential of nanotechnology in pharmaceutical analysis, ensuring its responsible and beneficial application in advancing healthcare.

CONCLUSIONS

Nanotechnology significantly enhances pharmaceutical analysis, offering novel methodologies that improve the sensitivity, specificity, and efficiency of analytical processes. This technological advancement enables a deeper understanding and control over drug properties, delivery, and monitoring, thus playing a pivotal role in the development of safer and more effective pharmaceuticals.





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Enhanced Analytical Capabilities

Nanotechnology, through its application in creating advanced materials and devices, revolutionizes traditional analytical techniques. Nanoparticles and Nano sensors amplify the detection capabilities, allowing for the identification and quantification of substances at previously undetectable levels. This increased sensitivity is crucial for ensuring drug purity, identifying impurities, and understanding the complex interactions within drug formulations.

Drug Delivery Optimization

Nanoparticle-based carriers are engineered to improve the bioavailability and targeted delivery of therapeutics. This not only maximizes the therapeutic efficacy of drugs but also minimizes side effects, facilitating the development of personalized medicine approaches that cater to individual patient needs.

Real-time Monitoring

The integration of Nano sensors in pharmaceutical analysis introduces the capability for real-time, in vivo monitoring of drug levels and pharmacokinetics, offering a dynamic understanding of drug efficacy and safety. This real-time data collection is instrumental in adjusting dosages and treatment plans to optimize therapeutic outcomes.

Addressing Challenges

While nanotechnology presents vast opportunities, it also brings challenges in standardization, scalability, and regulatory compliance. Ethical considerations regarding safety, privacy, and accessibility need to be thoroughly addressed to ensure the responsible advancement of nanotechnology in pharmaceuticals. In conclusion, nanotechnology stands as a cornerstone in the evolution of pharmaceutical analysis, driving forward the development of innovative analytical techniques, optimizing drug delivery system, and enabling real-time therapeutic monitoring. Addressing the associated challenges will further solidify the role of nanotechnology in paving the future of pharmaceutical sciences.

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Table 1: Types of Nanomaterials Used in Pharmaceutical Analysis

Nanomaterial Type	Properties	Advantages in Pharmaceutical Analysis
Metallic Nanoparticles	Optical properties due to surface plasmon resonance	Enhanced sensitivity for detecting trace amounts of pharmaceutical substances
Quantum Dots	Size-dependent optical and electronic properties	Multiplexed analysis capability and high photostability
Dendrimers	Highly branched, monodisperse structure with functional groups	Versatility in drug and probe delivery, enhancing solubility and stability
Carbon Nanotubes	Unique mechanical, thermal, and electrical properties	Useful in adsorption-based separation and electrochemical sensors

Table 2: Nano-Enabled Analytical Techniques in Pharmaceutical Analysis

Analytical Technique	Enhancement through Nanotechnology	Impact on Pharmaceutical Analysis
Chromatography	Nanomaterials as advanced stationary phases or sorbents	Improved separation efficiency and faster analysis times
Mass Spectrometry	Novel ionization techniques like nano-ESI and use of nanoparticles in MALDI	Increased sensitivity and reduced sample consumption
Spectroscopy	Enhanced interaction between light and matter (e.g., SERS, fluorescence)	Enhanced detection capabilities for pharmaceutical substances

Table 3: Applications of Nanotechnology in Pharmaceutical Analysis

Application Category	Description	Benefit
Drug Purity and Composition Analysis	Utilizing nanoparticles and nanosensors for enhanced detection and identification	Improved accuracy in assessing drug purity and composition
Drug Delivery System Analysis	Detailed characterization and optimization of nanoparticle-based drug carriers	Enhanced drug delivery effectiveness and safety
Bioavailability and Pharmacokinetics	Studying drug absorption, distribution, metabolism, and excretion using nanotechnology	Informed optimization of therapeutic efficacy and safety

Table 4: Regulatory Considerations for Nanotechnology in Pharmaceutical Analysis

Regulatory Aspect	Key Considerations
Safety and Toxicity Testing	- Comprehensive assessment of nanomaterial toxicity and long-term effects on human health and the environment - Establishment of safety guidelines for nanomaterial handling and





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	disposal
Product Labeling	- Clear labeling of pharmaceutical products containing nanomaterials to inform consumers and healthcare providers - Disclosure of potential risks associated with nanotechnology use in drug formulations
Quality Control Standards	- Development of standardized methodologies for evaluating the quality and performance of nanotechnology-based analytical methods - Implementation of validation protocols for nanomaterial synthesis and characterization
Regulatory Harmonization	- International collaboration among regulatory agencies to harmonize standards and practices related to nanotechnology in pharmaceuticals - Alignment of regulatory frameworks to facilitate global market access for nanotechnology-enhanced pharmaceutical products





Application Software for Species Identification and displaying their Ecosystem Roles using Convolutional Neural Network

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

Raising public recognition of the identity and usefulness of various plant and animal species is an essential step towards wildlife conservation and sustaining a well-balanced ecosystem. In this paper, we describe a state-of-the-art, deep learning model-based tool for classifying species from their images and displaying their ecosystem roles. We use the MobileNetV2 architecture for classifying all of the 430 wildlife classes of the 1000 total classes in the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) validation dataset. A python-based Graphical User Interface (GUI) was designed, featuring a user-friendly concept for selecting images and displaying results. The python application was converted into a stand-alone executable that can run on Windows (64 bit) computers. The application is open-source, compact, and does not require internet connectivity.

Keywords: Species Identification, Image Classification, Convolutional Neural Networks, Ecosystem Roles



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INTRODUCTION

Every species, however small, plays a key role in maintaining and structuring the ecosystem. Loss of biodiversity can influence ecosystem functions and services [1,2]. Since our society is progressively becoming less concerned about wildlife conservation, access to necessary information like the importance of various species is crucial, not only for professional stakeholders, ecologists, researchers, activists, teachers, and students but also for the general public [3]. In this context, with advancements in image acquisition technology, providing an open-source, image-based classification tool for various plant and animal images can be a worthwhile solution. Classifying similar-looking species from an image is a demanding task. Also, other interference factors like the posture of the species, and angle of view, call for consideration. However, in recent times, there have been significant advances in the field of deep learning. Convolutional Neural Networks (CNNs) are increasingly being employed for Image classification [4, 5], Target detection [6, 7], and Recognition tasks [8, 9]. They have improved the ability to extract higher-level image information compared to the traditional image processing methods. Although earlier CNNs like AlexNet [10] and VGG [11] delivered a good performance, testing the network needed a lot of computation. Networks, such as Inception [12], ResNet [13], and DenseNet [14], used unique methods to reduce the network parameters. The fundamental idea of newer lightweight networks is to design more efficient network computing methods to reduce network parameters and computational cost. Therefore, some efficient networks emerged, such as MobileNet [15] and Xception [16]. Training on a large dataset is a challenging task hence weights of pre-trained models are used. We have used the weights of MobileNetV2 [17] trained on the ILSVRC dataset [18] since it provides a memory-efficient, fast, and accurate mobile visual recognition that includes classification, object detection, and semantic segmentation. Typically, using transfer learning, the weights are updated for a new, relatively smaller dataset, but to preserve the 430 wildlife classes that the pre-trained model can accurately classify, we retained the core model. However, the classifier discarded the remaining classes, and biological information on the retained classes was included. Using the Tkinter library of Python, a GUI was designed, and the script was bundled into an executable. The application is available for free on the web 1. The rest of the paper is structured as: The related work is presented in Section 2. Section 3 presents the dataset, and the approach used to build our image classifier. Results and discussion have been presented in Section 4. Section 5 concludes the paper.

RELATED WORK

Before deep learning, computer vision technology was applied to process wildlife images [19, 20]. With the continuous improvement of machine learning, CNNs has proved a powerful ability in image processing. More and more researches have applied the CNNs to the field of image processing and obtained satisfactory results. ImageNet [21] is the widest structured dataset until now with over 14 million images. Some other datasets for large-scale visual recognition are Microsoft COCO [22] and Google's Open Images [23] with more than 2.5 million and 9 million images. There are attempts from research groups all over the world to provide improved designs for these datasets. The publicly available pre-trained models for these datasets form a basis for prediction, feature extraction, and fine-tuning. Deep learning models are extensively used for animal surveillance [24, 25]. These methods perform real-time classification of species from their video or images. Aquatic species classification was also achieved through deep learning [26]. A drawback of these methods is that they can classify only a few species. To the best of our knowledge, we are the first to design an image-based classifier for species belonging to all of the following three categories: animal; plant; and fungi, that also display their ecological significance. Most of the image-based classification and evaluation in the recent past is based on plants and leaves as it is still regarded as a challenging and unsolved problem. A notable work in this field is Leafsnap2 [27]. This application identified 184 plant species based on curvature-based shape features of the leaf by utilizing integral measure to compute functions of the curvature at the perimeter. Another noticeable initiative is by ImageCELF3 [3], which has been organizing plant identification tasks since 2011 in context to a worldwide evaluation forum that it aims to provide. Finally, PlantNet4 is the widest





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existing automated identification tool (with imperfections) that identifies about 2200 plant species [28]. Very few studies have come for image-based classification for fruit [29] and saprophytes [30]. Since we keep all the layers of the MobilenetV2 model in our tool, it can classify some from those categories as well.

Proposed Approach

In this section, we present our proposed image classification framework. First, we describe the dataset, the MobileNetV2 model, and later the implementation details are explained.

ILSVRC

ImageNet Large Scale Visual Recognition Challenge (ILSVRC) is a standard in object category classification and detection on hundreds of object groups and millions of images. The challenge has been run annually from 2010 to present, attracting participation from over fifty institutions [18]. Its dataset is built up upon a subset of an openly accessible computer vision dataset known as ImageNet [21]. The general challenge tasks for most years are a) Image classification (2010–2014): Predict the classes of objects present in an image. b) Single- object localization (2011–2014): Image classification and drawing a bounding box around one example of each object present. c) Object detection (2013–2014): Image classification and drawing a bounding box around each object present. The datasets have 1,461,406 images among 1,000 classes. They are occasionally modified (depending on the task) and are released publicly to promote widespread participation from academia. Among the 1000 classes, we recognized 430 classes of species falling into one of the following categories: a) Aquatic animals (38), b) Birds (59), c) Terrestrial reptiles, invertebrates, and amphibians (83), d) Terrestrial mammals (213) e) Plants and fungi (37). Over the years, there has been widespread involvement in the ILSVRC [18], with many significant developments and a massive number of academic publications. AlexNet [10], a CNN-based architecture comprising 8 layers with 5 convolutional layers and 3 fully connected layers, achieved top results on the ILSVRC-2010 and ILSVRC-2012 image classification tasks. A variation of AlexNet generally called as ZFNet [31] won the ILSVRC-2013 image classification task. Inception [12] won the ILSVRC-2014 by reducing the number of computation parameters drastically. ResNet [13], a residual learning framework with a depth of up to 152 layers, achieved the best results in the ILSVRC-2015 competition. DenseNet [14] eased the gradient vanishing problem and strengthened the feature propagation to achieve better performance with fewer parameters and calculation costs. Later models like MobileNet [15] and Xception [16] used Depthwise Separable Convolution to build small and efficient networks. MobileNetV2 [17], a significant improvement over MobileNet [15] proposed Inverted Residual Block, which enhanced the Depthwise separable convolution to deliver better performance. Table 1 compares MobileNetV2 [17] to other popular architectures. Accuracy represents the model's top-1 accuracy on the ImageNet validation dataset [18]. The depth denotes the largest number of sequential, convolutional, or fully connected layers on a path from the input layer to the output layer. Parameters are in million. MobileNetV2 [17] is a memory-efficient, low power, low latency model with reduced computations. However, it does not compromise on accuracy. Because of the aforementioned advantages, we have used it for image classification.

Implementation Details

Our implementation is in Keras5, a high-level neural networks API, with TensorFlow backend [32]. Rather than training a new CNN architecture, we re-used the pre-trained MobileNetV2 network because a) Our application requires a training set that comprises a wide range of species, with a large number of diverse images for each species, upon which the performance of the CNN is dependent [33]. This model can classify 430 wildlife species with high accuracy. c) Training a deep model requires skills, experience, and resources (GPU/TPU, high processor clock speed, time, etc.) As depicted in Figure 1, we designed a GUI for selecting the species image saved on the computer using Tkinter, a python standard GUI package. The selected image was converted into a NumPy array and resized to fit in the network topology input resolution of MobileNetV2 (224, 224, 3). The image is preprocessed before making predictions. Images can be preprocessed only if they have the extensions: PNG, JPG, JPEG, BMP, PPM, TIF, and TIFF.



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RESULTS AND DISCUSSION

In this section, we present the assessment of our application software for the identification of species and displaying their ecological roles. The application holds a mere 303MB of storage on the device. The simple, user-friendly GUI gives instantaneous results upon selecting an image, taking an average of 2-3 seconds for obtaining the result of the first selected image after launching the application; subsequent results are retrieved much quicker (taking less than a second). This result was achieved when running on Windows (64-bit) computer, with the Intel CORE i5 processor. As shown in Figure 2, the result window displays a resized image of the species, probability of resultant class in percentage, species class, and its ecosystem role(s). In terms of accuracy, the MobileNetV2 [17] manages state-of-the-art results with a Top-1 accuracy of 70.1% (Table 1) on the ILSVRC validation dataset [18]. The application was publicly released in May 2020, and as of now, in June 2020, it has been downloaded by 52 users, in 6 countries. The tool is compatible only with Windows (64-bit) computers so far, but our next step is to increase our outreach, as we plan to create a version for iOS (desktop and mobile), and Android devices. We are also working towards the possibilities of classifying more species and providing a deeper insight into their ecosystem roles.

CONCLUSIONS

This paper introduces a simple, quick, and interactive application for the classification and evaluation of various plant and animal species from their images, built using a convolutional neural network. The tool is compact, accurate, and free to use. Although only a limited number of species (430) can be classified so far, we believe that this is an effective and efficient means for creating awareness about the importance of biodiversity conservation, an issue which is often neglected but is crucial for attaining a sustainable world. We further plan on introducing more species to our application, and also extending its availability to mobile devices. We believe that it will provide for a helpful tool in research and academia.

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Table 1. Comparison of popular architectures with Mobile Net V2

Architecture Depth Parameters Accuracy

MobileNetV2	53	3.54M	71.3%
Xception	71	22.91M	79%
InceptionV3	48	23.85M	77.9%
Resnet-152	152	60.38M	78%
VGG16	16	138.36M	71.3%
AlexNet	8	60.97M	57%





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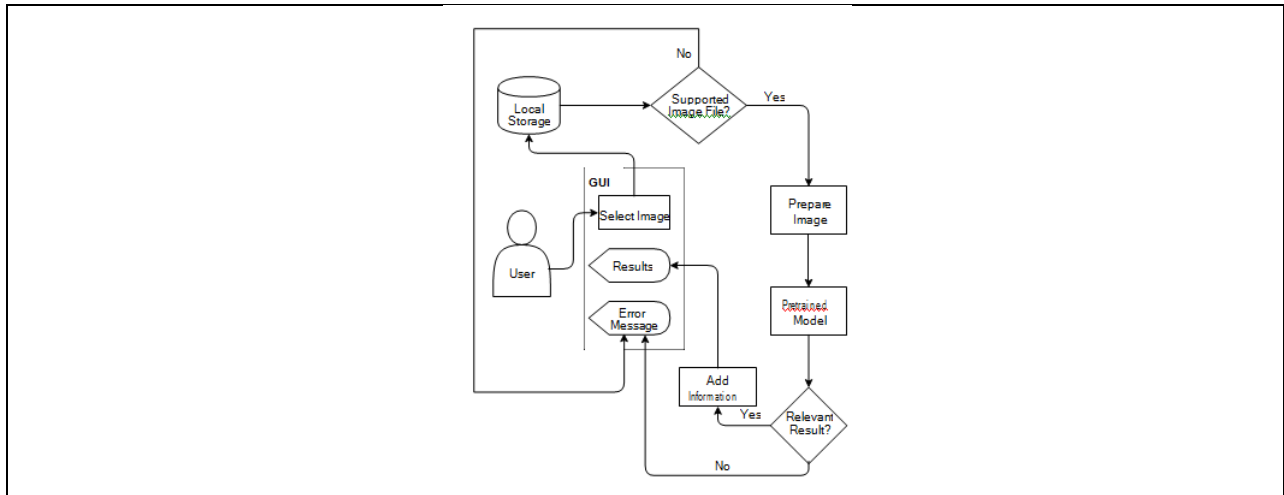


Fig. 1. Key steps in the proposed framework.

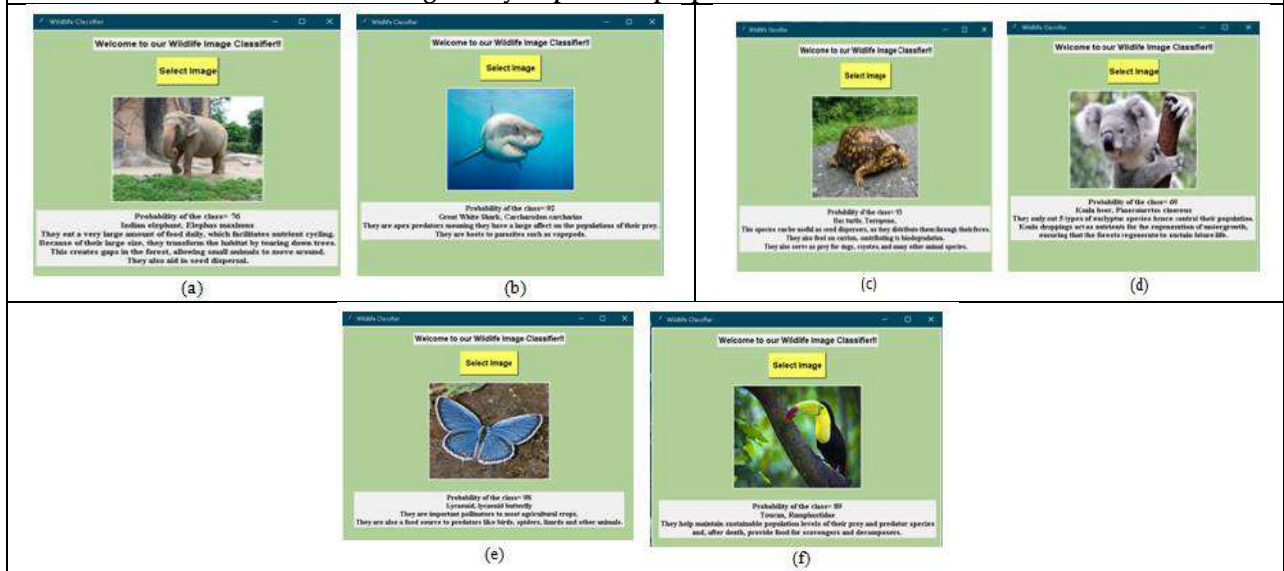


Fig.2.(a),(b),(c),(d),(e), and (f) Classification of Various species





A Randomized Clinical Study Protocol on the Add-on Effect of *Ardraka Arka* along with Standard Care in the Management of *Tamaka Shwasa* Vis-a-Vis Bronchial Asthma in Children

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Tamaka Shwasa is an illness of *Pranavaha Srotas* (respiratory tract), caused due to the vitiation of *Vata* and *Kapha Doshas* and afflicting the *Rasa Dhatu* (lymph tissue). Characterized by the symptoms like *Shwasa Kricchrata* (difficulty in breathing) and *Kasa* (cough), the clinical symptomatology resembles to the condition of bronchial asthma in modern science and is a commonest chronic illness during childhood. This randomized clinical study explores the potential of, *Ardraka Arka*, as an adjuvant to standard care in the management of *Tamaka Shwasa* (bronchial asthma) in children. With a rising prevalence of asthma in India, especially among children, the study addresses the limitations of conventional treatments, emphasizing the need for alternative or complementary approaches. This trial has been approved by the IEC (JSSAMC/1196/2022-23) and duly registered in clinical trial registry of India (CTRI/2023/08/056522). Already diagnosed subjects of the age group 5-16 years of age, of bronchial asthma subjects who are on the standard care according to IAP, of either gender with no any other lung pathology and severe type of asthma are being randomized into two treatment groups to receive the adjuvant therapy (group A is on standard care and given *Ardraka Arka* and group B is only given standard care). The primary outcome is to evaluate and compare the effect of *Ardraka Arka* as an Add-on therapy along with standard care on the subjective parameters of *Tamaka Shwasa* at 29 days. Secondary outcome is to evaluation and comparison of the changes in spirometry values before and after treatment of *Ardraka Arka* along with the Standard care at 56 days. A sample size of 40 (20 subjects in each group) with mild



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persistent, mild intermittent and moderate persistent types of bronchial asthma will be included in the study.

Keywords: Pediatric asthma, *Tamaka Shwasa*, *Ayurveda*, *ArdrakaArka*.

INTRODUCTION

Tamaka Shwasa is an illness of *PranavahaSrotas*, originating in the *Pittasthana*, caused due to the vitiation of *Vata* and *KaphaDoshas* and afflicting the *Rasa Dhatu*. It is characterized by *ShwasaKruchrata*, *Kasa*, *Ghurghuraka*. *Ayurveda* describes *Tamaka Shwasa* as *YapyaVyadhi* (difficult to cure) [1]. The clinical symptomatology of *Tamaka Shwasa* is similar to that of Bronchial asthma in contemporary science, which is one among the commonest chronic illnesses in childhood period[2]. Bronchial asthma is defined as heterogenous disease characterized by the symptoms of recurrent episodes of wheezing, breathlessness, chest tightness and cough which vary over time intensity. The airways show chronic inflammation, hyperresponsiveness, and airflow limitation which is reversible, recurrent and variable[3]. Among the 1.3 billion people in India, about 6 % of children and 2% of adults are affected with Bronchial asthma.[4] The prevalence of asthma is increasing with time and additional 100 million people are expected to develop asthma by the year 2025.[5] In a recent study (2021), overall prevalence of Asthma, in the rural areas of North Karnataka was 4% among 5-16 years aged children.[6] Study from Mysore has reported a prevalence of 17.14% Asthma in children in the age group of 6–14 years also.[7] This alarming raise in the prevalence of Bronchial Asthma can be accounted to factors such as Atmospheric pollution (*Rajodhuma*), rapid environmental changes, an adaptation of newer dietic preparations, excessive exercise (*VyayamaKarma*), and tremendous psychological stress.[8] Childhood Asthma is responsible for school absenteeism, restricted activities, and psychological impact on the family also, there is impact on socio-economic status, since there is increased unscheduled hospital visits. Some of the common complications of bronchial asthma if left unattended, are sinusitis, allergic rhinitis, urinary incontinence and psychological problems like anxiety, depression and panic attacks.[9] In contemporary science, current challenges in pediatric asthma management include Inhaled corticosteroids which may result in Growth delay, irritable or difficult behavior and oral candidiasis.[10] From 18th century A.D. onwards *ArkaKalpana*, the method of extracting essence from medicinal plants, was extensively adopted in *Ayurveda* medicine.[12] The text *Arka Prakasha* has mentioned that, *ArdrakaArka* if consumed cures *ShwasaRoga*. [11] Since *Ardraka* has *UshnaVirya*, *Vataanulomana* properties and works on *KaphaDosh* in *Tamaka Shwasa* it removes the obstruction present in the *PranavahaSrotas* caused by *Kapha*. It is also proved to have Anti-Asthmatic[13] property. *Arka* is *Shighrakari*, does not vitiate *Dosha* and is devoid of all the *Dosha*. [14] Asthma is a condition where invasive interventions are necessary, and if not, it might result in emergency condition. Hence, it may require the continuation of consuming standard medications for children, devoiding them of standard medications would be unethical. With this backdrop, this study is designed to evaluate the add-on efficacy of *ArdrakaArka* in *TamakaShwasa* along with standard care of management.

OBJECTIVES OF THE STUDY

1. To evaluate and compare the effect of *Ardraka Arka* as an Add-on therapy along with standard care on the subjective parameters of *Tamaka Shwasa*
2. To evaluate and compare the changes in spirometry values before and after treatment of *Ardraka Arka* along with the Standard care.

METHODOLOGY

Patients, of both genders, will be selected from the pediatric OPD and IPD of department of *Kaumarabhritya* JSS *Ayurveda* Medical College and Hospital, Mysuru, special health camps and other referrals. The study will include children fulfilling the inclusion criteria (Table no:1). The study will be started after obtaining the ethical clearance



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from the Institute of Ethics Committee (IEC). The collected data will be presented in the form of tables will be considered for drawing conclusion of the study.

GROUPING

- Group A Trial Group (20 Subjects)- Will receive Trail drug + Standard Care Intervention as per Modern medicine.
- Group B Control Group (20 Subjects)- Will receive Standard Care Intervention as per Modern medicine.

DIAGNOSTIC CRITERIA

Already diagnosed patients of Bronchial Asthma are included.

INTERVENTION

The intervention details are depicted in Table no 2

Standard Control group

Only standard intervention as per Modern medicine.²⁸will be given to group B. (standard intervention is depicted in table no 4) 1st Follow up will be done on 29th day of the studyand 2nd Follow up will be done on 56th day.

Criteria for assessment

The results of the medicine will be assessed on the basis of clinical signs and symptoms mentioned in Ayurveda classics. Functional capacity will also be assessed and laboratory investigations will be repeated at the end of the treatment schedule. All the signs and symptoms will be given scoring pattern depending upon severity as below.

Objective parameters(investigations)

Include Complete blood count, Erythrocyte Sedimentation Rate, Absolute Eosinophil Count, Lung function test (spirometry), Childhood asthma control test, these will be assessed before and after the treatment for every patient.

Subjective parameters

Includes *ShwasaKruchrata*, *GhurghurakShabda*, *KashtenShleshma Moksha*, *AsinoLabhateSukha*, *UshnabhinandathiKasa*, *Peenasa*, *Vishushkasya*, *Anidra*, these will be assessed before and after the treatment for every patient.

Statisticalanalysis

The data will be analyzed by using appropriate parametric and non- Parametric Tests: Wilcoxon Sign Rank Test, Paired 't' Test, Unpaired 't' Test and Man Whitney Test

Hypothesis

- **H₀:** There is no difference in the effect of the Ardrakaarka as an add-on therapy along standard care on the subjective parameters of *Tamaka Shwasa*.
- There is no significant difference between before and after evaluation in the changes of spirometry of ArdrakaArka along with standard care. along with the Standard care.
- **H₁:**There is significant difference in the effect of the ArdrakaArka as an add-on therapy along standard care on the subjective parameters of *Tamaka Shwasa*.
- There is significant difference between before and after evaluation in the changes of spirometry of ArdrakaArka along with standard care. along with the Standard care.





RESULTS

Results of the study will be collected and analyzed based on the changes in subjective and objective parameters before and after intervention.

DISCUSSION

Status of the condition

The study addresses the growing prevalence of bronchial asthma in children, emphasizing the impact of this condition on various aspects of life, including school attendance, daily activities, and the psychological well-being of both the child and the family. The limitations of current pediatric asthma management, such as potential side effects of inhaled corticosteroids, underscore the need for alternative or adjunct therapies.

Status of the management of the condition

In contemporary science, current challenges in pediatric asthma management include Inhaled corticosteroids which may result in Growth delay, irritable or difficult behavior and oral candidiasis. According to ayurveda, the herbs that are having mucolytic properties will be given in the form the classic formulation that helps relieve the symptoms of the condition. The therapies like *Abhyanga* and *swedana* that are helpful in the bronchodilation are indicated. *Ardraka* has *Ushma virya*, *Vataanulomana* properties and works on *Kapha* dosha in *Tamaka Shwasait* removes the obstruction present in the *PranavahaSrotas* caused by *Kapha*. It is also proved to have anti-asthmatic (12) property. The randomized controlled design of the study enhances the inclusion of subjective and objective parameters provides a comprehensive evaluation of the therapeutic impact. The study's focus on assessing both short-term (28 days) and relatively longer-term (56 days) outcomes adds depth to the analysis.

CONCLUSION

The randomized clinical study aims to assess the effectiveness of *Ardraka Arka* as an add-on therapy for pediatric Asthma. the study with the sample size of 40 will be conducted for the period of (28) days where in, the subjects of the either group (group A and B) will be given the standard care and standard care along with the adjuvant therapy respectively. The *ArdrakaArka* will be given for three times per day. The assessment will be done on the 29th and 56th day.

Expected action

Ardraka Arka, combined with standard care, is expected to significantly improve subjective symptoms like *ShwasaKruchrata*, *Ghurghurak Shabda*, and *Kashten Shleshma Moksha* and spirometry values compared to standard care alone. The study is also expected to assess the safety and tolerability of *Ardraka Arka* as an add-on therapy. If the results indicate good safety profiles, it would support the consideration of *Ardraka Arka* as a complementary therapy in pediatric asthma management.

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Table No: 1 Showing inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1.Subjects who are known cases of Bronchial Asthma / <i>Tamaka Shwasa</i> and are already on the treatment of modern medications.	1.Subjects admitted to the hospital due to Asthma exacerbation within 4 weeks prior to the visit.
2.Subjects of age group 5-14years irrespective of gender, religion, caste and socio-economic status.	2.Anyknown uncontrolled systemic disease.





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3.Subjects having clinical symptoms of <i>Tamaka Shwasa/</i> Bronchial Asthma:	3.Severe persistent type of asthma
4.Subjects falling under the mild persistent, mild intermittent and moderate persistent types of bronchial asthma.	4.Patients with a history of any other diagnosed lung pathology.
	5.Subjects incompatible for Spirometric evaluation.

Table no 2: Drug Intervention

Group A	<i>ArdraKaArka</i>
<i>Anupana</i>	<i>Madhu</i>
Route of administration	Oral
Dose	Acc to chart given below (table no: 3)
Duration of the clinical trial	28 days
<i>AushadhaSevanaKala</i>	3 times a day (after food)

Table no: 3 Dosage calculation according to young's formula

5 – 6 years	3.5 ml	10 -11years	6 ml
6 -7 years	4 ml	11-12 years	6.5 ml
7 - 8 years	4.5 ml	12-13 years	7 ml
8 - 9 years	5 ml	13-14 years	7.5 ml
9 - 10 years	5.5ml		

Table no: 4 Standard treatment of the bronchial asthma

<p>Quick relievers Used for acute attacks to relieve bronchospasm as and when needed. Short acting beta 2 agonists</p> <ul style="list-style-type: none"> • Salbutamol • Terabutaline • Adrenaline • Aminophylline 	<p>Controller Used for long term to control the inflammation and to prevent further attacks Leukotriene receptor antagonists</p> <ul style="list-style-type: none"> • Steroids -oral inhaled corticosteroids (ICS) • Theophylline 	<p>Long term symptom relievers Used to relieve bronchospasm for longer hours Long-acting beta 2 agonists</p> <ul style="list-style-type: none"> • Salmeterol • Formoterol • Bambuterol <p>Always used with steroids.</p>
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Analyzing Antisocial Behavior among College Students using Fuzzy Logic Concept

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 18 Jul 2024

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ABSTRACT

Antisocial behavior is a multifaceted concept that includes various behaviors. It ranges from physical aggression like bullying and fighting to disobedient actions like lying, stealing, vandalism, arson, and running away from home. This concept also covers oppositional behaviors like irritability and stubbornness. The concept of antisocial behavior is studied in multiple fields, including sociology, criminology, and psychology, leading to a multitude of definitions, labels, and assessment methods that vary depending on the specific context. Antisocial behavior among college students can have adverse outcomes for individuals and the academic community. The proposed study analyzes the occurrence, root cause, and substantial factors that result in antisocial behavior among college students, by employing the innovative concept of the Fuzzy Logic System (FLS). Conventional methods of studying and addressing this psycho-social issue often fail to capture human behavior's complexity. The fuzzy logic system provides an optimum platform to address ambiguity, uncertainty, and imprecision present in human behavior, which also offers a promising approach for understanding and predicting such types of human behavior.

Keywords: Fuzzy logic, psycho-social issue, antisocial behavior, psychological well-being.





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INTRODUCTION

Antisocial behavior generally refers to actions or behaviors that are destructive, harmful, or negative towards other individuals or society. These behaviors often involve unlawful activities and can negatively affect people in interpersonal ways. Such behaviors can result from inadequate social, ethical, moral, and psychological development during childhood, particularly within the home, school, and society, which may be influenced by several factors such as school-related factors, parental factors, parental support, and socioeconomic factors. The purpose of this study is to explore and identify the major causes of antisocial behavior among students. Therefore, this study aims to uncover and emphasize the factors to better understand and address antisocial behavior, with a focus on school-related factors, parental factors, parental support, and socioeconomic factors that impact antisocial behavior among students. Antisocial behavior can have significant social, interpersonal, and financial costs for the individuals engaging in such behavior and their families, communities, and society. Some of the costs associated with antisocial behavior include:

1. **Individual Well-being:** Antisocial behavior can harm the well-being of the individuals engaging in such behavior. This can increase stress, emotional distress, and mental health issues.
2. **Impact on Families:** Antisocial behavior often disrupts family dynamics and can lead to strained relationships, broken families, and a negative impact on the well-being of family members, especially children who may be exposed to such behavior.
3. **Community Disruption:** Antisocial behavior can disrupt the peace and safety of communities. Crimes, vandalism, and disturbances caused by antisocial individuals can destroy a community's sense of security and well-being.
4. **Healthcare Costs:** Antisocial behavior is often associated with substance abuse and mental health issues. Such behavior may require medical and psychiatric treatment, further burdening the healthcare system.
5. **Loss of Productivity:** Antisocial behavior can result in lost productivity, both in terms of the individuals engaging in such behavior and their victims.
6. **Educational Costs:** Antisocial behavior among students can disrupt the learning environment and affect the academic progress of the individuals involved and their peers. This can lead to lower educational outcomes and reduced future opportunities.

Efforts to prevent and address antisocial behavior often involve a combination of social programs, mental health services, rehabilitation, and law enforcement. By reducing antisocial behavior, society can reduce these associated costs and work towards creating safer and more harmonious communities.

LITERATURE REVIEW

Anti-social behavior can exert adverse effects on individuals, families, and communities. They can harm both mental and physical health and are linked to significant social and economic burdens on society. This review aims to collect and consolidate high-quality peer-reviewed literature, concerning anti-social behavior. In this process, **Gaik et al. (2010)** focused on the role of family relations, especially parent-child attachment, as a crucial factor in the development of antisocial behavior among adolescents. Also showed that insecure attachment, particularly when it is associated with parental negativity and rejection, can have significant implications for a child's behavioral and emotional development. **Jevtic (2011)** stated that the issue of antisocial behavior in contemporary society is indeed complex and can arise from various factors. While material conditions and socioeconomic disparities can contribute to antisocial behavior. **Morgado & Dias (2013)** presented a review of developmental literature regarding antisocial behaviors among adolescents by identifying some of the peculiarities of the antisocial phenomenon. They also focused on several individual variables that undergo considerable development during this stage of life and that may play an important role in the adoption of risk behaviors in adolescence. **Thornberry et al. (2014)** investigated whether the adolescent antisocial behavior of a parent raises the likelihood of their child engaging in antisocial behavior, and, if such a connection exists, to what extent various aspects of parenting influence this association. **Ojo (2015)** studied the causes and prevalence of antisocial behavior among secondary school students with hearing impairment in Ibadan, Nigeria. He adopted a descriptive survey research design to carry out the study. **Piotrowska et al.**



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(2015) aimed to summarise evidence on the relationship between socioeconomic status and broadly conceptualized antisocial behavior and investigated the range of antisocial subtypes and other potential moderators, including age, sex, and informant. **Hashmani & Jonason (2017)** aimed to detail modern thinking on evolutionary models of antisocial behavior. They reviewed how life history theory addresses the theoretical vacuum in classic and most modern research on antisocial behavior and traits. They also attempted to research antisocial behavior and highlighted that such behaviors might have undesirable consequences or potentially “positive” outcomes as well. **Jurado et al. (2017)** analyzed the characteristics of antisocial behavior and interpersonal values of students with high levels of antisocial behavior regarding interpersonal values, and the possible protection from antisocial behavior. They used the Interpersonal Values Questionnaire to assess interpersonal values, and the Antisocial-Delinquent Behaviors Questionnaire to assess antisocial behaviors. **Garcia et al. (2019)** analyzed the effect of family and friends on adolescent antisocial behavior, as well as the mediating role of adolescent impulsivity and empathy on these relationships. **Girma et al. (2019)** analyzed the relationship between academic achievement and anti-social behavior of high school students. They also showed no significant difference between government and private schools in the correlation between antisocial behavior and academic performance.

Jain et al. (2020) presented an innovative method for detecting aggressive and violent tendencies using handwriting analysis. This research aimed to explore and analyze the correlation between handwriting patterns and behaviors associated with violence. **Otto et al. (2021)** investigated the elements contributing to antisocial behavior in children and adolescents. They discovered that higher levels of self-efficacy and a poorer family climate were individually associated with increased instances of antisocial behavior. **Reid et al. (2022)** investigated changes in psychological distress and antisocial behavior among 557 probationary youths who underwent two evaluations before the COVID-19 era and two evaluations following the onset of COVID-19. The findings emphasized a rise in markers of psychological distress and antisocial behavior among both the entire sample and specific groups categorized during post-COVID-19 conditions in contrast to pre-COVID-19 conditions. **Vadivel et al. (2023)** investigated the scholastic achievements of adolescents, the influence of educational institutions, and factors contributing to antisocial conduct. They explored the connection between antisocial behavior and a group of 127 participants, aged 13–15. The findings indicated an inverse correlation between the academic performance of teenagers and their engagement in antisocial behavior. **Lohmann et al. (2023)** investigated the immediate effects of being exposed to a public health crisis on antisocial behavior and economic decision-making. They indicated that individuals who experienced higher levels of exposure to the virus outbreak tended to display increased antisocial behavior compared to those with lesser exposure, while various other elements of economic and social preferences remained relatively consistent.

Fuzzy logic and Antisocial behavior

Conventional approaches to understanding human behavior frequently rely on binary logic, potentially causing challenges in practical use. A common problem with the traditional method is the insistence on clearly defining relationships between elements and sets, rather than allowing for ambiguity. Employing fixed statements to describe reality can lead to unjustifiable hypotheses, also many responses extend beyond simplistic classifications like “yes” or “no,” “good” or “bad,” “right” or “wrong,” and so on. Zadeh (1965) introduced the concept of the “fuzzy theory” to better align with real-life scenarios, proposing that human cognition and emotions operate in a fuzzy manner. Complex problems can benefit from fuzzy mathematical analysis, which involves transforming semantic or informal statements into fuzzy sets and establishing a membership function. Therefore, principles and elements of the fuzzy logic system, emphasize its appropriateness for the modeling and analysis of complex social behaviors.

METHODOLOGY

Antisocial behavior is a complex, multi-dimensional issue, and a multidisciplinary approach can provide a more comprehensive understanding, making it difficult to define and measure precisely. This research comprised multiple stages, commencing with data collection. During this initial stage, information gathering was conducted to acquire the necessary data for the research. The data utilized in this study were the results of the questionnaire. The





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questionnaire results formed the dataset, serving as input data that was subsequently according to the system's needs. This method involved statistical calculations and artificial intelligence techniques aimed at extracting and identifying information from the extensive dataset. Research involving human behavior, and susceptible topics like antisocial behavior, requires careful attention to ethical considerations. Traditional binary (yes/no) classifications may not adequately capture its nuances. Fuzzy logic allows for the representation of uncertainty and ambiguity by assigning degrees of membership to various characteristics or factors associated with antisocial behavior. This is particularly useful when categorizing behaviors that do not fit neatly into predefined categories. It allows us to use linguistic variables like "high", "medium", and "low" to describe the degree of antisocial behavior. In this research study, the proposed basic structure of the fuzzy mamdani process is illustrated in Figure 1. There are several elements that contribute to the emergence of antisocial behavior among students. Through investigation, major factors identified as inputs influencing antisocial behavior include individual factors, family environment, peer influence, sociological factors, and school environment. In the proposed fuzzy logic system, the subfactors derived from these major factors act as inputs, while the resulting antisocial behavior is considered as the output. These derived subfactors hold considerable importance within the proposed fuzzy model. For the fuzzification process, these subfactors that are considered as input (*i.e.* Antagonistic Nature, Parental Supervision, Peer Pressure, Socio-Economic Status, and Academic Supervision) in the proposed fuzzy logic system, are categorized into three distinct linguistic labels, which are shown in Table 1, using the trapezoidal membership function. Following the fuzzification process, the fuzzy mamdani method is employed to analyze antisocial behavior among students. Figure 2. illustrates the suggested fuzzy mamdani inference system. Figure 3, Figure 4, Figure 5, Figure 6, and Figure 7 exhibit the plotting of membership functions for five input variables, which are displayed below. While Figure 8 illustrates the membership function plotting for the output variable, and the trapezoidal membership function equations for all input and output factors are as follows:

Antagonistic Nature

$$\mu_L(\alpha_1) = \begin{cases} \frac{\alpha_1 - 0}{0.15} & 0 \leq \alpha_1 \leq 0.15 \\ 1 & 0.15 \leq \alpha_1 \leq 0.25 \\ \frac{0.40 - \alpha_1}{0.15} & 0.25 \leq \alpha_1 \leq 0.40 \end{cases}$$

$$\mu_M(\alpha_1) = \begin{cases} \frac{\alpha_1 - 0.30}{0.15} & 0.30 \leq \alpha_1 \leq 0.45 \\ 1 & 0.45 \leq \alpha_1 \leq 0.55 \\ \frac{0.70 - \alpha_1}{0.15} & 0.55 \leq \alpha_1 \leq 0.70 \end{cases} \dots(1)$$

$$\mu_H(\alpha_1) = \begin{cases} \frac{\alpha_1 - 0.60}{0.15} & 0.60 \leq \alpha_1 \leq 0.75 \\ 1 & 0.75 \leq \alpha_1 \leq 0.85 \\ \frac{1 - \alpha_1}{0.15} & 0.85 \leq \alpha_1 \leq 1 \end{cases}$$

Parental Supervision

$$\mu_G(\alpha_2) = \begin{cases} \frac{\alpha_2 - 0}{0.10} & 0 \leq \alpha_2 \leq 0.10 \\ 1 & 0.10 \leq \alpha_2 \leq 0.30 \\ \frac{0.40 - \alpha_2}{0.10} & 0.30 \leq \alpha_2 \leq 0.40 \end{cases}$$

$$\mu_M(\alpha_2) = \begin{cases} \frac{\alpha_2 - 0.25}{0.15} & 0.25 \leq \alpha_2 \leq 0.40 \\ 1 & 0.40 \leq \alpha_2 \leq 0.60 \\ \frac{0.75 - \alpha_2}{0.15} & 0.60 \leq \alpha_2 \leq 0.75 \end{cases} \dots(2)$$





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$$\mu_p(\alpha_2) = \begin{cases} \frac{\alpha_2 - 0.60}{0.10} & 0.60 \leq \alpha_2 \leq 0.70 \\ 1 & 0.70 \leq \alpha_2 \leq 0.90 \\ \frac{1 - \alpha_2}{0.10} & 0.90 \leq \alpha_2 \leq 1 \end{cases}$$

Peer Pressure

$$\begin{aligned} \mu_p(\alpha_3) &= \begin{cases} \frac{\alpha_3 - 0}{0.125} & 0 \leq \alpha_3 \leq 0.125 \\ 1 & 0.125 \leq \alpha_3 \leq 0.275 \\ \frac{0.40 - \alpha_3}{0.125} & 0.275 \leq \alpha_3 \leq 0.40 \end{cases} \\ \mu_N(\alpha_3) &= \begin{cases} \frac{\alpha_3 - 0.25}{0.15} & 0.25 \leq \alpha_3 \leq 0.40 \\ 1 & 0.40 \leq \alpha_3 \leq 0.60 \\ \frac{0.75 - \alpha_3}{0.15} & 0.60 \leq \alpha_3 \leq 0.75 \end{cases} \dots(3) \\ \mu_{Ng}(\alpha_3) &= \begin{cases} \frac{\alpha_3 - 0.60}{0.125} & 0.60 \leq \alpha_3 \leq 0.725 \\ 1 & 0.725 \leq \alpha_3 \leq 0.875 \\ \frac{1 - \alpha_3}{0.125} & 0.875 \leq \alpha_3 \leq 1 \end{cases} \end{aligned}$$

Socio-economic Status

$$\begin{aligned} \mu_H(\alpha_4) &= \begin{cases} \frac{\alpha_4 - 0}{0.175} & 0 \leq \alpha_4 \leq 0.175 \\ 1 & 0.175 \leq \alpha_4 \leq 0.225 \\ \frac{0.40 - \alpha_4}{0.175} & 0.225 \leq \alpha_4 \leq 0.40 \end{cases} \\ \mu_M(\alpha_4) &= \begin{cases} \frac{\alpha_4 - 0.25}{0.15} & 0.25 \leq \alpha_4 \leq 0.40 \\ 1 & 0.40 \leq \alpha_4 \leq 0.60 \\ \frac{0.75 - \alpha_4}{0.15} & 0.60 \leq \alpha_4 \leq 0.75 \end{cases} \dots(4) \\ \mu_L(\alpha_4) &= \begin{cases} \frac{\alpha_4 - 0.60}{0.175} & 0.60 \leq \alpha_4 \leq 0.775 \\ 1 & 0.775 \leq \alpha_4 \leq 0.825 \\ \frac{1 - \alpha_4}{0.175} & 0.825 \leq \alpha_4 \leq 1 \end{cases} \end{aligned}$$

Academic Supervision

$$\begin{aligned} \mu_G(\alpha_5) &= \begin{cases} \frac{\alpha_5 - 0}{0.15} & 0 \leq \alpha_5 \leq 0.15 \\ 1 & 0.15 \leq \alpha_5 \leq 0.25 \\ \frac{0.40 - \alpha_5}{0.15} & 0.25 \leq \alpha_5 \leq 0.40 \end{cases} \\ \mu_M(\alpha_5) &= \begin{cases} \frac{\alpha_5 - 0.30}{0.10} & 0.30 \leq \alpha_5 \leq 0.40 \\ 1 & 0.40 \leq \alpha_5 \leq 0.60 \\ \frac{0.70 - \alpha_5}{0.10} & 0.60 \leq \alpha_5 \leq 0.70 \end{cases} \dots(5) \end{aligned}$$





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$$\mu_p(\alpha_5) = \begin{cases} \frac{\alpha_5 - 0.60}{0.15} & 0.60 \leq \alpha_5 \leq 0.75 \\ 1 & 0.75 \leq \alpha_5 \leq 0.85 \\ \frac{1 - \alpha_5}{0.15} & 0.85 \leq \alpha_5 \leq 1 \end{cases}$$

Antisocial Behavior

$$\begin{aligned} \mu_L(\beta) &= \begin{cases} 1 & \beta \leq 0.20 \\ \frac{0.40 - \beta}{0.20} & 0.20 \leq \beta \leq 0.40 \end{cases} \\ \mu_M(\beta) &= \begin{cases} \frac{\beta - 0.20}{0.20} & 0.20 \leq \beta \leq 0.40 \\ 1 & 0.40 \leq \beta \leq 0.60 \\ \frac{0.80 - \beta}{0.20} & 0.60 \leq \beta \leq 0.80 \end{cases} \dots(6) \\ \mu_H(\beta) &= \begin{cases} \frac{\beta - 0.60}{0.20} & 0.60 \leq \beta \leq 0.80 \\ 1 & 0.80 \leq \beta \end{cases} \end{aligned}$$

Following a thorough system analysis, the next step involves the establishment of the fuzzy rule base. The fuzzy rule base encompasses numerous rules, expressed as "if-then" statements, elucidating the connection between input and output variables. In the presented system, there are a total of 243 rule bases, involving five input variables and one output variable, with a selection illustrated in Figure 9. After the establishment of the rule base, the process of defuzzification is executed utilizing the centroid method outlined below. This approach enables the rule viewer to effortlessly analyse the antisocial behavior of college students.

$$\delta_{Centroid} = \frac{\sum_{i=0}^n \mu(\delta_i) \cdot (\delta_i)}{\sum_{i=0}^n \mu(\delta_i)} \dots\dots\dots(7)$$

During this procedure, Figure 10 illustrates the status of a case based on input and output variables. If the input variables—Antagonistic Nature at 71.8% (high), Parental Supervision at 81.6% (poor), Peer Pressure at 50% (Neutral), Socio-economic Status at 78% (low), and Academic Supervision at 50% (moderate) indicate these values, the student is undergoing Antisocial Behavior level of 83.9% (high). A three-dimensional representation of two input variables and an output variable can be presented using a surface viewer. Several instances of such visualizations are demonstrated in Figure 11, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18, Figure 19, and Figure 20.

RESULTS

For this research study, we got in touch with some colleges situated in both rural and urban regions, affiliated with Dr. Bhimrao Ambedkar University Agra. The ultimate sample of 600 B. Sc. students was obtained through an offline survey. Out of the 600 participants, 396 (66%) were male, and 204 (34%) were female. Examining the outcomes related to levels of antisocial behavior, it is noted that within the sample of 600 students, 150 (25%) exhibit a low risk of antisocial behavior, 234 (39%) demonstrate a moderate risk, and 216 (36%) are at a high risk. The analysis further reveals that boys exhibit a higher susceptibility to antisocial behavior compared to girls. Below is the visual representation of these findings in graphical form.

CONCLUSIONS AND DISCUSSIONS

This paper introduced the notion of a fuzzy logic system and outlined its potential advantages in analysing complex behavioral phenomena. The innovative application of the fuzzy logic system has the potential to shed new light on the complex nature of antisocial behavior among college students. However, careful planning, ethical considerations, and a robust methodology are essential to ensure the validity and utility of the study. Understanding and finding other prominent factors causing antisocial behavior (such as extensive exposure to media violence via television,





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movies, internet, video games, and cartoons) can help educators, parents, and communities to identify students at risk and implement targeted interventions that address underlying issues. As indulging in antisocial behaviors presents a substantial threat to the mental and physical health of students. It increases the susceptibility to so many issues such as alcoholism, cigarette smoking, drug use, a heightened risk of depression, and involvement in violent acts towards own self and others. So, early intervention, supportive environments, counselling, and positive reinforcement of pro-social behaviors are essential in addressing and mitigating antisocial behavior among college students. Thus, findings of this antisocial behavior research study by using fuzzy logic research successfully be applied practically. The insights gained from this study is very helpful for colleges and universities to address and prevent antisocial behavior among students. Thus, fuzzy logic system is proved as a valuable tool to understand and address antisocial behavior among college students by offering practical recommendations for college administrators, counsellors, and policymakers on how to use the insights gained from this study to develop more efficacious intervention and prevention strategies.

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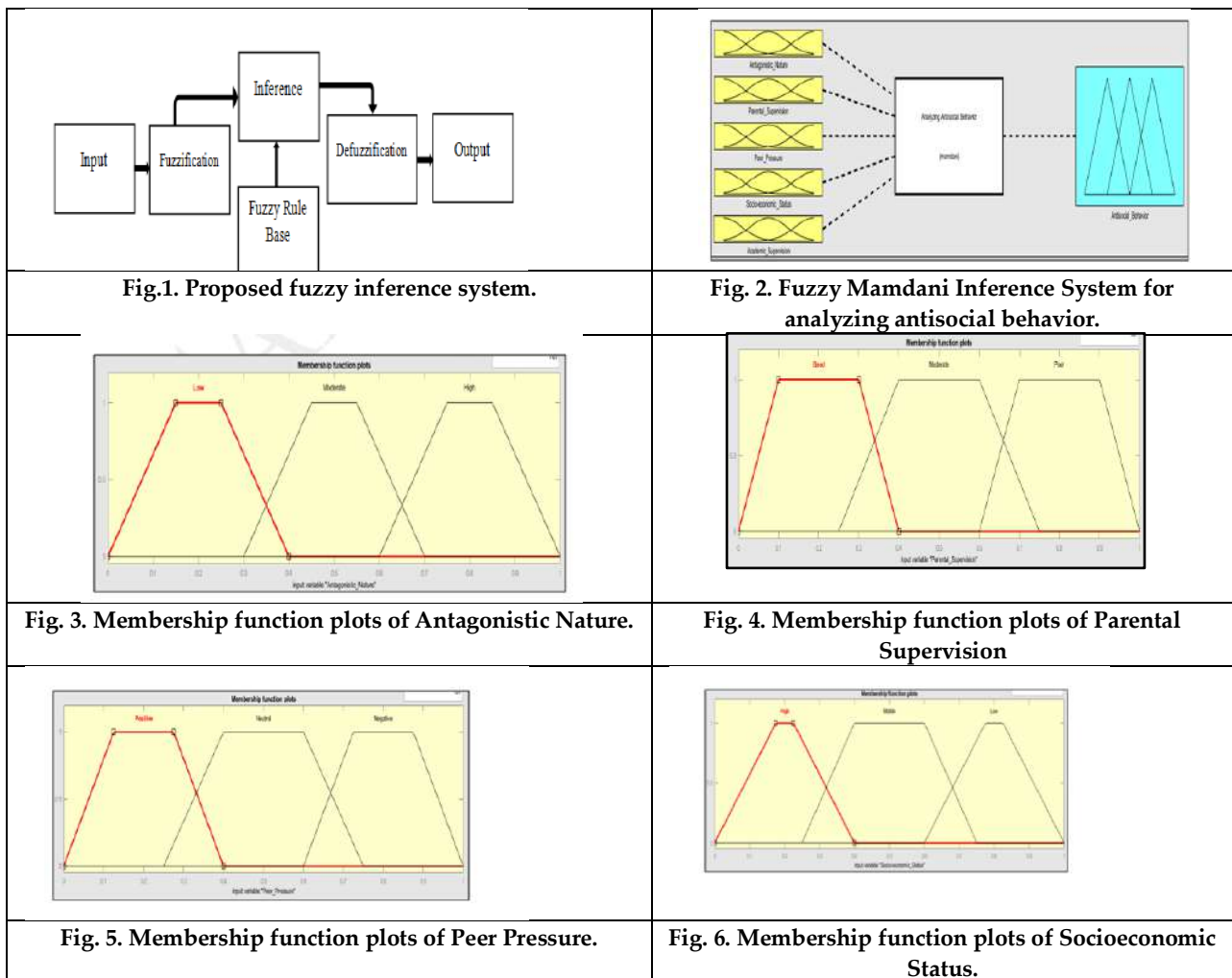
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Table. 1. Subfactors with their linguistic labels.

Major factors	Subfactors	Linguistic labels
Individual Factors	Antagonistic Nature	Low, Moderate, High
Family Environment	Parental Supervision	Good, Moderate, Poor
Peer Influence	Peer Pressure	Positive, Neutral, Negative
Sociological Factors	Socio-Economic Status	High, Middle, Low
School Environment	Academic Supervision	Good, Moderate, Poor





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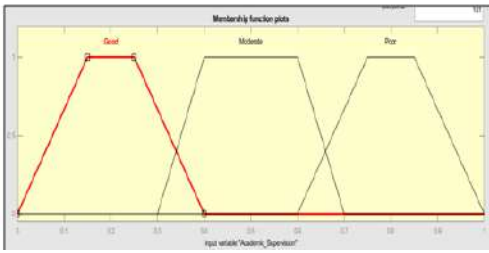


Fig. 7. Membership function plots of Academic Supervision.

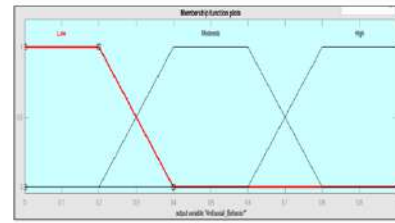


Fig. 8. Membership function plots of Antisocial Behavior.

227. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is High and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
228. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is High and Academic_Supervision is Poor then Antisocial_Behavior is High (1)
229. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Positive and Socio-economic_Status is Middle and Academic_Supervision is Good then Antisocial_Behavior is High (1)
230. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Positive and Socio-economic_Status is Middle and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
231. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Positive and Socio-economic_Status is Low and Academic_Supervision is Good then Antisocial_Behavior is High (1)
232. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Positive and Socio-economic_Status is Low and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
233. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is High and Academic_Supervision is Good then Antisocial_Behavior is High (1)
234. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is High and Academic_Supervision is Poor then Antisocial_Behavior is High (1)
235. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is High and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
236. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is Middle and Academic_Supervision is Good then Antisocial_Behavior is High (1)
237. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is Middle and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
238. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is Low and Academic_Supervision is Good then Antisocial_Behavior is High (1)
239. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is Low and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
240. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Positive and Socio-economic_Status is Low and Academic_Supervision is Good then Antisocial_Behavior is High (1)
241. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Positive and Socio-economic_Status is Low and Academic_Supervision is Moderate then Antisocial_Behavior is High (1)
242. If Antisocial_Behavior is High and Parental_Supervision is Poor and Peer_Pressure is Negative and Socio-economic_Status is Low and Academic_Supervision is Poor then Antisocial_Behavior is High (1)

Fig. 9. Fuzzy rule bases for system analysis.

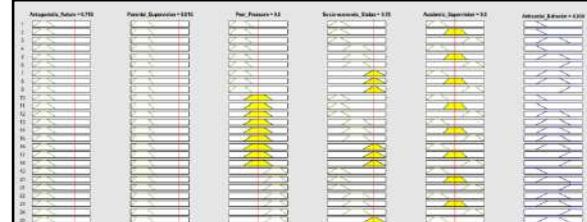


Fig. 10. Antisocial Behavior analysis with rule viewer.

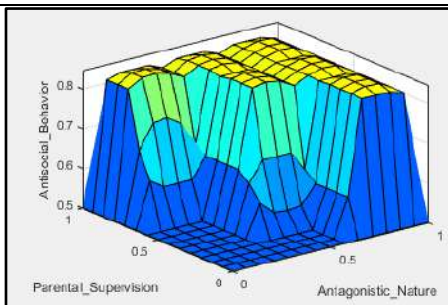


Fig.11. 3-D surface view 1.

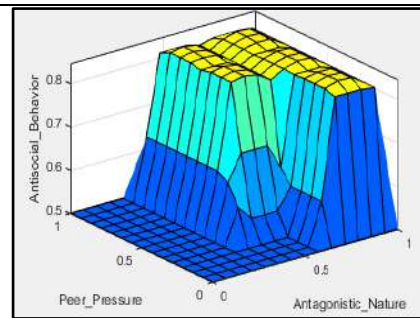


Fig.12. 3-D surface view 2.

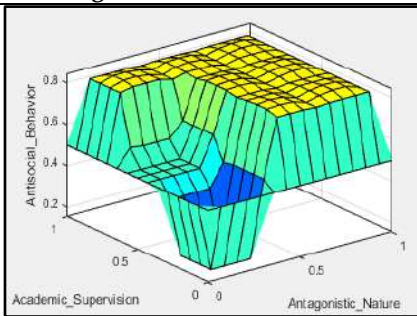


Fig.13. 3-D surface view 3.

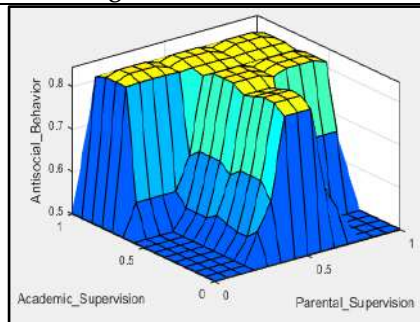


Fig.14. 3-D surface view 4.





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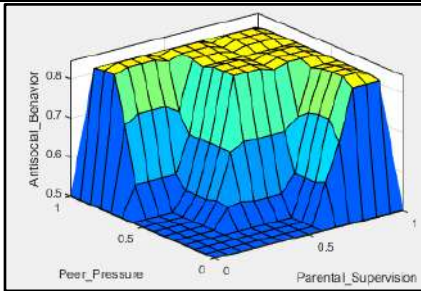


Fig.15. 3-D surface view 5.

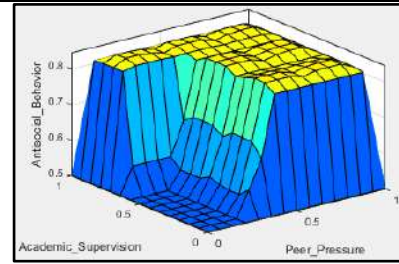


Fig.16. 3-D surface view 6.

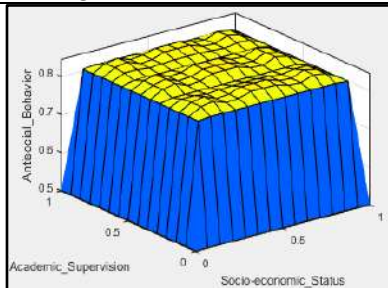


Fig.17. 3-D surface view 7.

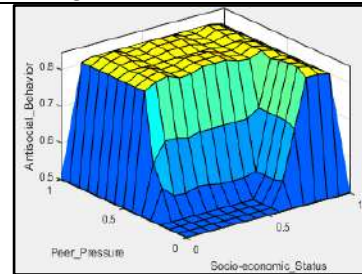


Fig.18. 3-D surface view 8.

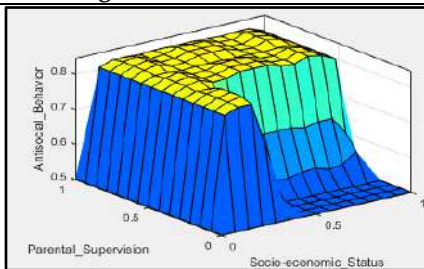


Fig.19. 3-D surface view 9.

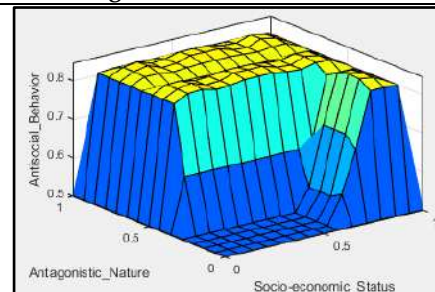


Fig.20. 3-D surface view 10.

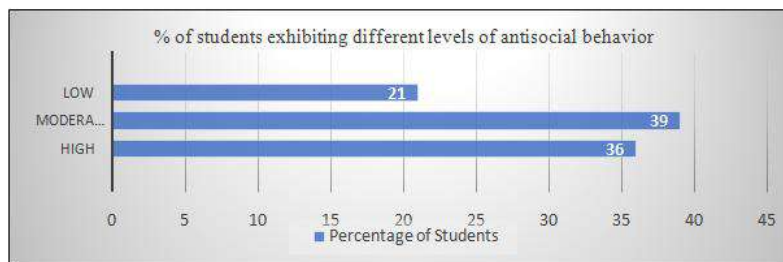


Fig. 21. Graphical representation of % of students exhibiting different levels of antisocial behavior.





Food Product Development and Antioxidant Analysis of *Moringa oleifera* Flower"

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

Throughout human history, reliance on plants for survival and health has persisted, with approximately 80% of the global population depending on plant-derived medications. Edible flowers, a tradition spanning diverse civilizations, not only enhance the aesthetic appeal of food but also contribute to health benefits by serving as an excellent source of phytochemicals, including phenolic compounds. These compounds, such as flavonoids and phenolic acids, act as naturally occurring antioxidants. Flowers of the *Moringa oleifera* plant provide a number of health advantages, including as hepatoprotective, anti-inflammatory, hysteric, and triglyceride, phospholipid, and blood cholesterol reductions. In a recent study focused on *Moringa oleifera* flowers, a premix was developed and analysed for total antioxidant capacity, including phenolic and DPPH, as well as Vitamin-C. The study aimed to determine the highest overall acceptability through sensory evaluation. For Khakhra, chocolate, and energy balls, the results revealed varying levels of total phenolic content 30mg%, 30mg%, and 15mg%, respectively. DPPH content was found to be 25mg% Khakhra, 40mg% chocolate, and 50mg% energy balls. Vitamin-C content was measured at 10mg% Khakhra, 20mg% chocolate, and 15mg% energy balls in the products with the highest overall acceptability. Sensory evaluations indicated that in Khakhra sample A scored the highest mean overall acceptability (17±1.77). In chocolate sample A also achieved the highest mean score (20±0.65). For energy balls, sample C emerged with the highest mean overall acceptability score (18±1.46). These findings underscore the potential of *Moringa oleifera* flowers in creating not only nutritionally rich products but also those with high sensory appeal, offering a holistic approach to both health and palatability.

Keywords: moringa oleifera, antioxidant, khakhra, medicinal and pharmaceutical, Sensory evaluation.



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INTRODUCTION

It is difficult to define the term "antioxidant" in a purely chemical sense because it is always associated with oxidative stress and the environment of cells or organisms [1]. A diet rich in antioxidants overall may provide protection against diseases linked to oxidative stress [1]. Reactive oxygen and nitrogen species (ROS) and other free radicals are products of regular oxidative metabolic processes in cells. It is now believed that oxidative stress plays a major role in all inflammatory, ischemic diseases, cancer, hemochromatosis, AIDS, emphysema, organ transplantation, gastric ulcers, hypertension, and preeclampsia, neurologic diseases, alcoholism, smoking-related diseases, and many more [1]. The flower kingdom is quite large. Based on the reason they are cultivated, flowers may be roughly categorised into four primary groups: edible/kitchen/vegetable flowers, medicinal/commercial flowers, ornamental flowers, and commercial flower [2]. Flowers play a significant role in our lives and are connected to some of the most poignant times in human history, such as holidays and funerals. They are used for their nutritional and therapeutic qualities in addition to their appearance [3]. Edible flowers have long been a staple of human diets, having been thoroughly discussed in antiquated writings [4]. A green tree in the Moringaceae class that is full of nutrients, drumstick plants are grown all over the world, including in the US [5]. In English, this plant is known as horseradish tree, drumstick tree, or *Moringa oleifera* (*M. oleifera*). It is used by human beings as well as animals and has several commercial uses [6]. This tree's leaves, fruit, blossoms, and young branches are used as a very nutritious vegetable in a variety of countries, includes numerous African nations, Pakistan, the Hawaiian Islands, the Philippine islands, and India. For almost 5000 years, people have used it as a daily source of sustenance, especially in India [7]. It started in the north of India and quickly moved south, where two of the most often consumed vegetable sources are "Murungai keerai" (drumstick leaves) and "Murungaikaai" (drumsticks). Nearly all of Asia, almost all of Africa, South America, a small portion of the US, and a few regions of Europe have been colonised by the moringa tree [8]. The flowers are 2.5 cm diameter, bisexual, and have an excellent smell. They have a cream or white colour, with dots of yellow at the base. The whole economics are reportedly handled via a way of presenting pollen. 6–9. October to November is the rainy season, while April to May is the summer season, when flowers peak [9]. Das said that *M. oleifera* flowers have significant medical benefits, including hepatoprotective, anti-inflammatory, hysteric, and lowering of blood cholesterol, phospholipid, and triglyceride etc [10]. *M. oleifera* can be used as a galactagogue, rubefacient, antiscorbutic, diuretic, stimulant, purgative, antimicrobial, antibacteri [11], anti-inflammatory, antitumor, antioxidant, anti-aging agent, hypoglycemic, antipoetryroidism, anti-cellular [12], hypocholesterolemic, and antispasmodic.

The following is a list of the pharmacological properties of *Moringa oleifera* flowers as described by [10]:

1. *Moringa oleifera* flowers have diuretic, antihypertensive, and cholesterol-lowering properties.
2. As the well-known flavonoid quercetin is included in the alcohol and aqueous extracts from *Moringa oleifera* flowers, it was also discovered that these extracts significantly hepatoprotected the liver.
3. Pterigospermin on *Moringa oleifera* flower exhibits strong antibacterial and fungicidal properties.
4. The flowers are also thought to have strong anthelmintic properties, making them valuable medicinally.
5. At a dosage of 4 g/kg body weight, the methanolic extract of flower buds demonstrated antiulcerogenic effect against gastric ulcers caused by aspirin.
6. Flower infusions mixed in hot water have antispasmodic properties.

Numerous medical applications for the *M. oleifera* tree exist, including both therapy and prevention. It uses its bark, pods, oil, sap, leaves, roots, and flowers in traditional medicine [13]. Flowers can aid to improve bile flow by acting as a cholagogue, stimulant, tonic, and diuretic. The herb is also antimicrobial and may be used to make a heart circulation tonic [14].

Nutraceutical properties

Antioxidant Activity



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The plant is useful in the preservation sector because of its antioxidant properties [15]. Polyphenol content in plant flowers is considerable (19.31 mg/g of GAE of dry extract) [16]. It can be utilised as a naturally occurring chemical to stop the disease from starting and from progressing. The anti-inflammatory qualities of *M. oleifera* flower extract, as shown by [16], support the flower's historic usage in Oman and other Asian nations.

Neuroprotective Activity

Numerous studies have demonstrated a favourable association between oxidative stress and neurological illnesses, such as cerebral ischemia, autism, depression, and Alzheimer's disease [17]. It has been determined that plants with high antioxidant contents may be used as medicinal agents to combat ROS and stop neuronal damage. Because of its strong antioxidant properties, moringa oleifera may be utilised to treat neurological conditions.

Anti-inflammatory Activity

Serious medical diseases including cancer, ulcerative colitis, diabetes, atherosclerosis, sepsis, and arthritis can result from any prolonged infection [18]. In several areas, *M. oleifera*'s anti-inflammatory properties have been proven.

Anti-cancer Activity

The anticancer capabilities of the moringa oleifera tree have been proven by prior studies [19]. Cancer can result from oxidative stress caused by an imbalance in the body's antioxidant and free radical levels [20]. Consequently, *M. oleifera*'s abundance of antioxidants allows the plant to reduce oxidative stress, which in turn prevents cancer. In the present study the of premix of moringa oleifera flower was developed and it was analysed for total antioxidant capacity i.e phenolic and DPPH which contain with highest overall acceptability level through sensory evaluation. For khakhra there is incorporated on moringa oleifera flower powder along with wheat flour, bajra flour. High in protein, bajra flour is an excellent choice for vegans. It is also devoid of gluten and contains fibre, which is beneficial to heart health and diabetes. Although whole wheat flour has a low GI, it won't cause a spike in blood sugar, making it a great option for diabetics. For taste we have added red mirch powder, ajwain, salt, haldi and kasturi methi. For chocolate there is incorporated on moringa oleifera flower powder along with dark chocolate & nuts. Zinc, iron, and magnesium are among the minerals that are abundant in dark chocolate. It can lower inflammation and lower the risk of cardiovascular disease, among other health advantages. The plant used to make chocolate, cacao, has a lot of nutrients and antioxidants. Flavanols and polyphenols are among the substances found in dark chocolate that have antioxidant qualities. While the macronutrient profiles of protein, carbohydrates, and fat are generally similar in all nuts, the micronutrient profiles, which include vitamins and minerals, may vary significantly between varieties. Nuts are rich in phytochemicals that function as antioxidants, high in dietary fibre, low in saturated fats, and high in healthy fats. For energy bars there is incorporated on moringa oleifera flower powder along with dates, oats, nuts and flex seeds. Wet dates are higher in natural sugars and calories due to their moisture content, while dry dates are slightly lower in natural sugars and calories due to the dehydration process. Flax seeds have been associated with several health advantages, including better digestion and a lower risk of cancer, heart disease, and type 2 diabetes.

MATERIALS AND METHODS

The present study will be carried out to investigate the nutraceutical and functional property of *Moringa Oleifera*. The research work was conducted at the food and nutrition laboratory, M.Sc nutrition and dietetics, parul university, Vadodara, during the year.

Procurement of Raw Materials

The drumstick flower (*Moringa Oleifera*) was plucked from the drumstick tree. The drumstick flower was procured from the krishna farm.



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Flower of moringa oleifera was separated from branches then it was cleaned and then it was sundried for 10-15 days with consistent timing from 10am to 4pm. After that the dried flowers were formed in powder form through mixture and sieve a powder and store at -20°C to use further for analysis. That moringa flower powder was utilized to developed additional products i.e. khakhra, Chocolate and Energy Balls.

Development of Khakhra

The variant Sample A for wheat flour 45g, oats flour 40g, bajra flour 5g, moringa flower powder 10g, ajwain 2.5g, kasuri methi 5g and ghee 5g were added. Mix all ingredients and prepare a dough and make khakhra and roast on medium flame. The variant Sample B for wheat flour 45g, oats flour 42g, bajra flour 5g, moringa flower powder 7g, ajwain 2.5g, kasuri methi 5g and ghee 5g were added. Mix all ingredients and prepare a dough and make khakhra and roast on medium flame. The variant Sample C for wheat flour 45g, oats flour 45g, bajra flour 5g, moringa flower powder 5g, ajwain 2.5g, kasuri methi 5g and ghee 5g were added. Mix all ingredients and prepare a dough and make khakhra and roast on medium flame. The standard Sample D for wheat flour 50g, oats flour 45g, bajra flour 5g, ajwain 2.5g, kasuri methi 5g and ghee 5g were added. Mix all ingredients and prepare a dough and make khakhra and roast on medium flame (Table 1 and Figure 1).

Development of Chocolate

The variant Sample A for dark chocolate 75g, mix seeds 15g and moringa flower powder 10g were added. Mix all ingredients and prepare a batter put into molds and refrigerate it. The variant Sample B for dark chocolate 70g, mix seeds 15g and moringa flower powder 15g were added. Mix all ingredients and prepare a batter put into molds and refrigerate it. The variant Sample C for dark chocolate 80g, mix seeds 15g and moringa flower powder 5g were added. Mix all ingredients and prepare a batter put into molds and refrigerate it. The standard Sample D for dark chocolate 85g, mix seeds 15g were added. Mix all ingredients and prepare a batter put into molds and refrigerate it (Table 1 and Figure 2).

Development of Energy Balls

The variant Sample A for dates 35g, roasted oats 40g, mix nuts 20g, flax seeds 5g, and moringa flower powder 20g. Mix all ingredients and roast for 5 minutes and make balls and refrigerate it till 2 hours. The variant Sample B for dates 35g, roasted oats 40g, mix nuts 20g, flax seeds 5g, and moringa flower powder 15g. Mix all ingredients and roast for 5 minutes and make balls and refrigerate it till 2 hours. The variant Sample C for dates 35g, roasted oats 40g, mix nuts 10g, flax seeds 5g, and moringa flower powder 15g. Mix all ingredients and roast for 5 minutes and make balls and refrigerate it till 2 hours. The standard Sample D for dates 35g, roasted oats 40g, mix nuts 20g, flax seeds 5g. Mix all ingredients and roast for 5 minutes and make balls and refrigerate it till 2 hours (Table 1 and Figure 3).

Sensory evaluation

The jury consisted of 15 panellists each, who conducted sensory evaluation of the developed Khakhra on composite scoring test [16]. The panellists were in the range of 18-35 years. The panellists constituted of UG-PG students and professors of Parul university, Vadodara. The former response comprised a score of 9 whereas the latter carried a score of 1. Along with this, a composite rating score is termed as the 7-point composite rating score applied to ascertain the most suitable variant characterized from the specific organoleptic attributes namely; colour, flavour, taste, texture, and overall.

Antioxidant analysis

The Antioxidant analysis of Khakhra was performed at Biomes Laboratory located at Gujarat. A standard approach was used to analyse total phenol, DPPH and Vitamin-C. The analysis of Total phenol was performed by using Folin-Ciocalteu method, DPPH and Vitamin-C was estimated by Spectrophotometric method.





Statistical analysis

The statistical analysis was carried out using the MS office16s [excel]. Through sensory evaluation by ANOVA it was conclude that there is no significance between total phenol and DPPH.

RESULT

Sensory evolution of khakhra

In khakhra all the parameters have been tested according to the colour, taste, flavour, texture and overall acceptability the following result were obtained where, Colour sample C > sample B > sample D > sample A result is $17\pm 1.06 > 17\pm 1.25 > 17\pm 1.55 > 17\pm 2.10$ respectively. The criteria for the flavour showed that sample A > sample C > sample B > sample D result is $17\pm 2 > 16\pm 1.51 > 16\pm 1.81 > 16\pm 1.92$ respectively. The criteria for the taste showed that sample A > sample C > sample D > sample B result is $17\pm 1.85 > 16\pm 1.25 > 16\pm 1.41 > 16\pm 1.64$ respectively. The criteria for the texture showed that sample A > sample B > sample C > sample D result is $18\pm 1.55 > 17\pm 1.46 > 17\pm 1.46 > 17\pm 1.73$ respectively. The criteria for the overall acceptability showed that sample A > sample D > sample C > sample B result is $17\pm 1.77 > 17\pm 1.82 > 16\pm 1.06 > 16\pm 1.64$ respectively. The overall acceptability of khakhra is high in sample A which is having (45% Whole Wheat flower+ 40% Oats flower+ 5% Bajra flower+ 10% Moringa flower powder). As sample A has highest percentage of moringa flower powder i.e 10% than rest of others so it concludes that it has high in anti-oxidant, anti-diabetic, anti-urolithic, anti-ulcer and anti-asthmatic.

Sensory evolution of chocolate

In chocolate all the parameters have been tested according to the colour, taste, flavour, texture and overall acceptability the following result were obtained where, Colour sample A > sample C > sample D > sample B result is $19\pm 1.13 > 19\pm 1.13 > 19\pm 1.19 > 19\pm 1.36$ respectively. The criteria for the flavour showed that sample A > sample C > sample D > sample B result is $19\pm 0.84 > 18\pm 1.51 > 18\pm 1.92 > 17\pm 2.13$ respectively. The criteria for the taste showed that sample A > sample D > sample C > sample B result is $19\pm 0.84 > 18\pm 1.30 > 18\pm 1.46 > 18\pm 2.49$ respectively. The criteria for the texture showed that sample A > sample D > sample C > sample B result is $19\pm 0.84 > 18\pm 1.46 > 18\pm 1.81 > 18\pm 2.10$ respectively. The criteria for the overall acceptability showed that sample A > sample D > sample C > sample B result is $20\pm 0.65 > 18\pm 0.92 > 18\pm 1.60 > 18\pm 2.13$ respectively. The overall acceptability of chocolate is high in sample A which is having (70% Dark chocolate+ 15% Mix seeds+ 15% Moringa flower powder). As sample A has highest percentage of moringa flower powder i.e 15% than rest of others so it concludes that it has high anti-oxidant, anti-diabetic, anti-urolithic, anti-ulcer and anti-asthmatic.

Sensory evolution of energy balls

In energy balls all the parameters have been tested according to the colour, taste, flavour, texture and over all acceptability the following result were obtained where, Colour sample C > sample D > sample B > sample A result is $18\pm 1.84 > 18\pm 1.88 > 17\pm 1.73 > 17\pm 1.88$ respectively. The criteria for the flavour showed that sample C > sample D > sample A > sample B result is $17\pm 1.84 > 17\pm 2.23 > 15\pm 1.77 > 15\pm 2$ respectively. The criteria for the taste showed that sample C > sample D > sample B > sample A result is $17\pm 1.68 > 17\pm 2.41 > 16\pm 2.03 > 15\pm 1.81$ respectively. The criteria for the texture showed that sample B > sample D > sample C > sample A result is $17\pm 2.26 > 17\pm 2.36 > 17\pm 2.38 > 16\pm 1.60$ respectively. The criteria for the overall acceptability showed that sample C > sample D > sample B > sample A result is $18\pm 1.46 > 18\pm 2.06 > 17\pm 1.88 > 16\pm 1.30$ respectively. The overall acceptability of energy balls is high in sample C which is having (35% Dats+ 40% Rosted oats+ 20% Mix nuts+ 5% Flax seeds+ 10% Moringa flower powder). sample C has moringa flower powder contain 10%.

Antioxidant Parameters

Total phenol

In the present study, total phenol compound was analysed from three different food product development from drumstick flower i.e khakhra, chocolate & energy balls. In khakhra the value of phenol for sample A which has high acceptably value evaluated by sensory evaluation is 30mg% the khakhra sample A, 30mg% the chocolate sample A



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and 15mg%. Through sensory evaluation by ANOVA it was conclude that there is no significance between total phenol and DPPH.

DPPH

In the present study, DPPH compound was analysed from three different food product development from drumstick flower i.e khakhra, chocolate & energy balls. In khakhra the value of DPPH for sample A which has high acceptably value evaluated by sensory evaluation is 25mg% the khakhra sample A, 40mg% the chocolate sample A and 50mg% the energy balls sample C. Through sensory evaluation by ANOVA it was conclude that there is no significance between total phenol and DPPH.

Vitamin-C

In the present study, Vitamin-C compound was analysed from three different food product development from drumstick flower i.e khakhra, chocolate & energy balls. In khakhra the value of Vitamin-C for sample A which has high acceptably value evaluated by sensory evaluation is 10mg% the khakhra sample A, 20mg% the chocolate sample A and 15mg% the energy balls sample C.

DISCUSSION

The result of total phenolic contain of three different products of moringa oleifera flower having highest overall acceptability evaluated by sensory evaluation is 30mg% for Khakhra, 30mg% for chocolate and 15mg% for energy balls. Through sensory evaluation by ANOVA it was conclude that there is no significance between total phenol and DPPH. The result of DPPH contains of three different products of moringa oleifera flower having highest overall acceptability evaluated by sensory evaluation is 25mg% for Khakhra, 40mg% for chocolate and 50mg% for energy balls. Through sensory evaluation by ANOVA it was conclude that there is no significance between total phenol and DPPH. The result of Vitamin-C contains of three different products of moringa oleifera flower having highest overall acceptability evaluated by sensory evaluation is 10mg% for Khakhra, 20mg% for chocolate and 15mg% for energy balls. The findings of sensory evaluation revealed that the highest mean score of colour was observed in khakhra sample C (17 ± 1.06) and lowest in khakhra sample A (17 ± 2.10). However, no significant difference was seen in colour score of khakhra sample. The lowest mean score of flavour was seen in khakhra sample D (16 ± 1.92) and highest in khakhra sample A (17 ± 2). khakhra sample A showed a significant difference with khakhra sample D. The highest mean score of taste was observed in khakhra sample A (17 ± 1.85) and lowest in khakhra sample D (16 ± 1.64). khakhra sample A showed a significant difference with khakhra sample D. The highest score of texture was observed in khakhra sample A (18 ± 1.55) and lowest in khakhra sample D (17 ± 1.73). khakhra sample A showed a significant difference with khakhra sample D.

The mean score of overall acceptability was highest in khakhra sample A (17 ± 1.77) and lowest was in khakhra sample B (16 ± 1.64). The findings of sensory evaluation revealed that the highest mean score of colour was observed in chocolate sample A (19 ± 1.13) and lowest in chocolate sample B (19 ± 1.36). However, no significant difference was seen in colour score of chocolate sample. The lowest mean score of flavour was seen in chocolate sample B (17 ± 2.13) and highest in chocolate sample A (19 ± 0.84). chocolate sample A showed a significant difference with chocolate sample B. The highest mean score of taste was observed in chocolate sample A (19 ± 0.84) and lowest in khakhra sample B (18 ± 2.49). chocolate sample A showed a significant difference with chocolate sample B. The highest score of texture was observed in chocolate sample A (19 ± 0.84) and lowest in chocolate sample B (19 ± 2.10). However, no significant difference was seen in texture score of chocolate sample. The mean score of overall acceptability was highest in chocolate sample A (20 ± 0.65) and lowest was in chocolate sample B (20 ± 2.13). However, no significant difference was seen in overall acceptability score of chocolate sample. The findings of sensory evaluation revealed that the highest mean score of colour was observed in energy balls sample C (18 ± 1.84) and lowest in energy balls sample A (17 ± 1.88). energy balls sample C showed a significant difference with energy balls sample A. The lowest mean score of flavour was seen in energy balls sample B (15 ± 2) and highest in energy balls sample C (17 ± 1.84).





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energy balls sample C showed a significant difference with energy balls sample B. The highest mean score of taste was observed in energy balls sample C (17 ± 1.68) and lowest in energy balls sample A (15 ± 1.81). energy balls sample C showed a significant difference with energy balls sample A. The highest score of texture was observed in energy balls sample B (17 ± 2.26) and lowest in energy balls sample A (16 ± 1.60). energy balls sample B showed a significant difference with energy balls sample A. The mean score of overall acceptability was highest in energy balls sample C (18 ± 1.46) and lowest was in energy balls sample A (16 ± 1.30). energy balls sample C showed a significant difference with energy balls sample.

Acknowledgements

The authors express gratitude to the Department of Nutrition and Dietetics of Parul University, Vadodara for their support to complete the work.

Conflict of Interest

There is no conflict of interest between author regarding the paper publishing.

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Table 1: formulation in moringa oleifera flower of khakhra, chocolate and energy balls premixes

Ingredients	Khakhra sample A	Khakhra sample B	Khakhra sample C	Khakhra sample D
Wheat flour	45g	45g	45g	50g
Oats flour	40g	42.5g	45g	45g
Bajra flour	5g	5g	5g	5g
Moringa powder	10g	7g	5g	-
Ajwain	2.5g	2.5g	2.5g	2.5g
Kasuri methi	5g	5g	5g	5g
Ghee	5g	5g	5g	5g
Ingredients	chocolate sample A	chocolate sample B	chocolate sample C	chocolate sample D
Dark chocolate compound	70g	75g	80g	85g
Mix seeds	15g	15g	15g	15g
Moringa powder	15g	10g	5g	-
Ingredients	Energy balls sample A	Energy balls sample B	Energy balls sample C	Energy balls sample D
Dates	35g	35g	35g	35g
Oats	40g	40g	40g	40g
Mix nuts	20g	20g	20g	20g
Flax seeds	5g	5g	5g	5g
Moringa powder	20g	15g	10g	-





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Table 2: Sensory evolution khakhra, chocolate and energy balls

Khakhra	Colour	Flavour	Taste	Texture	Overall acceptability
Sample A	17±2.10	17±2	17±1.85	18±1.55	17±1.77
Sample B	17±1.25	16±1.81	16±1.64	17±1.46	16±1.64
Sample C	17±1.06	16±1.51	16±1.25	17±1.46	16±1.06
Sample D	17±1.55	16±1.92	16±1.41	17±1.73	17±1.82
Chocolate	Colour	Flavour	Taste	Texture	Overall acceptability
Sample A	19±1.13	19±0.84	19±0.84	19±0.84	20±0.65
Sample B	19±1.36	17±2.13	18±2.44	18±2.10	18±2.13
Sample C	19±1.13	18±1.51	18±1.46	18±1.81	18±1.60
Sample D	19±1.19	18±1.92	18±1.30	18±1.46	18±0.92
Energy Balls	Colour	Flavour	Taste	Texture	Overall acceptability
Sample A	17±1.88	15±1.77	15±1.81	16±1.60	16±1.30
Sample B	17±1.73	15±2	16±2.03	17±2.26	17±1.88
Sample C	18±1.64	17±1.84	17±1.68	17±2.38	18±1.46
Sample D	18±1.88	17±2.23	17±2.41	17±2.36	18±2.06

Table 3: Antioxidant parameter of khakhra, chocolate and energy balls

Parameters	Khakhra	Chocolate	Energy Balls
Total phenol	30 mg%	30 mg%	15 mg%
DPPH	25 mg%	40 mg%	50 mg%
Vitamin-C	10 mg%	20 mg%	15 mg%





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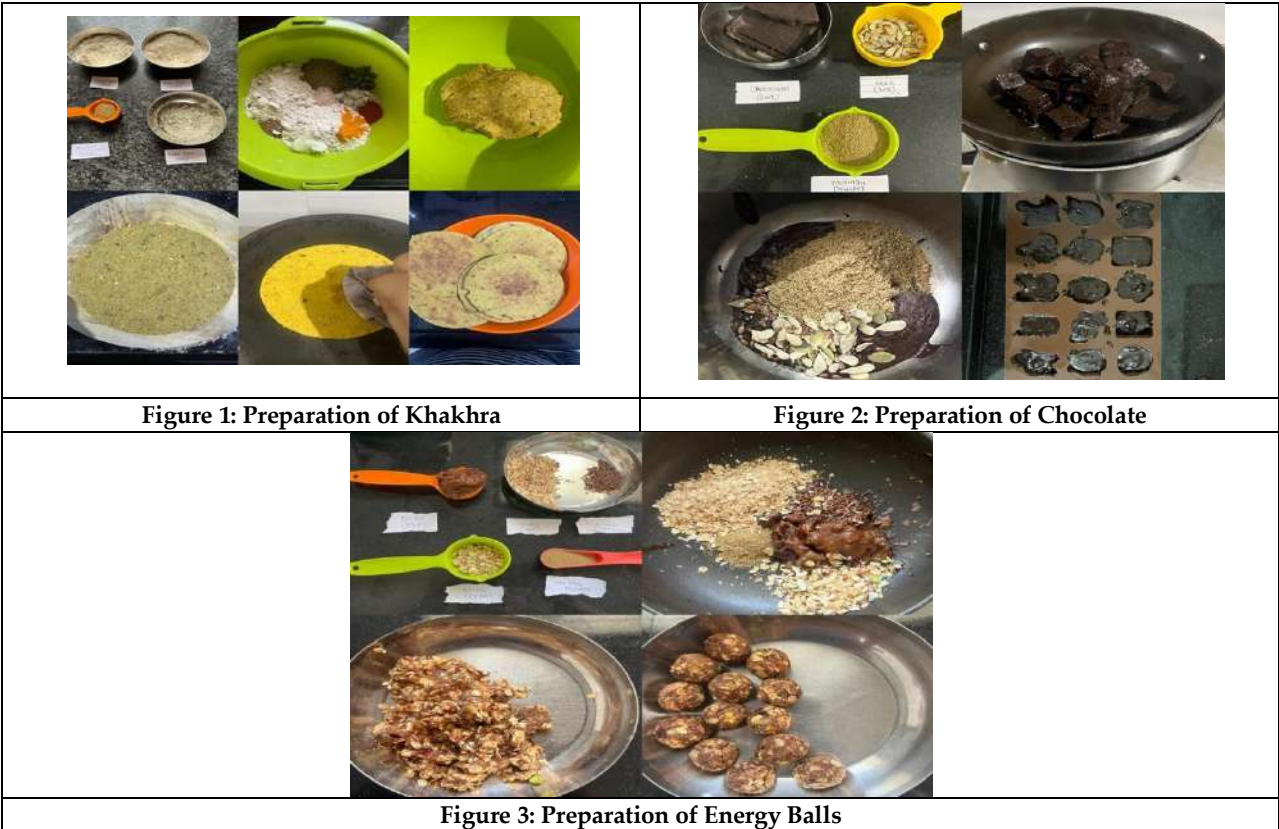


Figure 1: Preparation of Khakhra

Figure 2: Preparation of Chocolate

Figure 3: Preparation of Energy Balls





Characterization, and Biological Activity Identification of *Chloroxylon swietenia* Leaf Extract against an Opportunistic Pathogen *Escherichia coli* using GC-MS Analysis, and *In vitro* Assays

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

Chloroxylon swietenia is one of an important plant species used in the field of traditional medicine to treat the ailments like cataract, common cold, cough, skin fungal infections, and ophthalmic infections. *C. swietenia* belongs to the dry deciduous forests as a tropical aromatic tree (also known as east indian satin wood). In the present study, we showed the biological characterization, antibacterial, anticandidal, antioxidant, antibiofilm activities of *C. swietenia* leaf extracts [*C. swietenia* leaf methanolic (CSLM) extract, and *C. swietenia* leaf ethanolic (CSLE) extract]. Results of the present study showed the presence of active biochemical compounds present in CSLM, and CSLE extracts with the help of gas chromatography - mass spectroscopic (GC-MS) analysis. Thus GC-MS analysis showed the presence of presence of 12 different compounds with different retention time in the chromatogram. Followed by the identification of active biochemical compounds, *in vitro* assays (antibacterial, anticandidal, antioxidant, *invitro* thrombolytic activity, and antibiofilm) were performed to determine the biological activities of CSLM, and CSLE extracts against different bacterial and fungal species. Results of *in vitro* assays were showed that CSLE has strong anti bacterial, anti candidal, and anti oxidant activity compared to CSLM against different bacterial and fungal species. Other than this, CSLM has a strong *in vitro* thrombolytic activity against CSLE in the laboratory conditions. Collectively, *in vitro* assays showed the presence of anti bacterial, anti candidal, anti oxidant, *in vitro* thrombolytic, and anti biofilm activities of *C. swietenia* leaf extract. The



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present study also reported that anti biofilm activity of *C. swietenia* leaf extract may also act as a potential target for treating *Escherichia coli* induced biofilm formation in the oral cavity.

Keywords: *Chloroxylon swietenia*, GC-MS analysis, *In vitro* assays, *Escherichia coli*

INTRODUCTION

In recent years, antibiotic resistance (AR) is rising to highly dangerous in different parts of the earth. This AR results in the inability to cure/suppress the disease progression. As a result of AR development, there is an increased mortality across the globe due to the spread of infectious diseases (ID) and its treatment failure. Many of these ID shows high resistance to antibiotics used for the treatment of various diseases (1-6). As per the need of the hour, now a day's more amount of research was underwent in the field of traditional medicine to cure the disease without any side effects. On the other side, finding of suitable medicinal plant for a particular disease is easy but some bimolecular identification and its *in vitro* assays has to be done for several plants (7-15). *Chloroxylon swietenia* is a tropical, deciduous, and medium-sized tree belongs to southern india, sri lanka, and madagascar. *C. swietenia* has a strong cylindrical stem with a girth of 3-4 feet, leaf of 15-23 cm long which showing pinnate leaflets. Most of the *C. swietenia* plant parts were used in the traditional medicine of india (siddha, and ayurveda). Compared to other parts, leaf paste is mostly used for the treatment of headache, burns, cuts, wounds, skin diseases, and rheumatism due to their antifungal and antibacterial activities (16-22). Other than antifungal and antibacterial activity, *C. swietenia* leaf extract also have hepatoprotective, anti-inflammatory, antioxidant, antifeedant, antihelminthic, ovicidal, larvicidal, and insecticidal properties (16, 23-28). The present study was designed to identify the presence of active biochemical substances present in *C. swietenia* leaf extract using GC-MS analysis and *in vitro* assays was performed to check the presence of antibacterial, anticandidal, antioxidant, *in vitro* thrombolytic, and antibiofilm activities of *C. swietenia* leaf extract using customized assays in laboratory conditions.

MATERIALS AND METHODS

Collection of Plant Material and its Extract Preparation

Fresh leaf materials of *Chloroxylon swietenia* were collected locally from Palakkad, Kerala District, India. After collection, plant material was washed to remove debris and dust particles followed by shade drying for 5 days. After 5 days, shade dried plant material was grounded into a moderate fine powder. Ethanolic and methanolic leaf extracts of *C. swietenia* were prepared using soxhlet apparatus (SA).

Gas Chromatography - Mass Spectroscopic (GC-MS) analysis of leaf extracts

GC-MS analysis was performed to unravel the chemical profile of *C. swietenia* leaf methanol extracts (CSLME), and *C. swietenia* leaf ethanol extracts (CSLE). For this study, GC-MS was performed using varian 3800 gas chromatography equipped with 1200 L single quadruple mass spectrometer. In this study, mass spectrometer (MS) operated with the electron impact of 70 ev. Ion source and transfer line temperature was maintained at 250°C. The compounds was identified based on comparisons of their retention indices (RI), retention time (RT) and mass spectra.

In vitro assays

Anti bacterial screening assay

Anti bacterial activity of CSLME and CSLE were tested against three different bacterial pathogens (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*) acquired from PSG Medical College, Coimbatore, Tamil Nadu, India. For the detection of antibacterial activity, agar well diffusion method was employed in this study. Initially, pure cultures were grown in nutrient broth for arousal of overnight cultures. Later on, rised overnight cultures were swabbed over nutrient agar using sterile cotton swabs in a uniform manner. Subsequently, wells of 5 mm diameter



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were punctured using a sterile well borer. Methanolic plant extract of 40 microlitre (μl), 50 μl , and 80 μl with silver nanoparticles were aseptically loaded into the well. Standard antibiotic ampicillin was used as a positive control.

Anti fungal Activity

The inoculums of fungal test organisms were prepared by growing pure isolates (*Candidal albicans*, *Candidal glabarrata*, *Candidal tropicalis*) in sabouraud dextrose broth at 37°C for overnight. The sterile potato dextrose agar medium is cooled and then poured into sterile plates and allow to solidify. Test organisms were swabbed in the plate using sterile cotton swabs. Wells are made with sterile cork –border and 40 μl , 50 μl , 80 μl of AgNPs and methanolic extracts was added corresponding wells. Flucanazole is used as standard anti-fungal agents. The agar plates were incubated at room temperature for 24 hours. The diameter of zone of inhibition was measured in millimeter(mm) method.

Anti oxidant Assay**DPPH radical scavenging activity**

The antioxidant activity of the sample was determined was determined using 2,2-Diphenyl-1-picrylhydrazyl (DPPH), hydroxyl radical scavenging (HRS), and ferric reducing antioxidant power (FRAP) assays. Initially, DPPH assay was performed to identify the radical scavenging ability of the sample using the radical DPPH assay. Varying concentration of 20-100 μl samples were taken. All samples were adjusted to the volume of 100 μl using non-polar solvent (methanol). DPPH assay was performed according to the protocol mentioned (29).

Ferric reducing antioxidant power (FRAP) assay

Ferric reducing antioxidant power (FRAP) assay was performed to identify the ferrous ions chelation by the extract. In this FRAP assay, four different concentration of extract was used (20 μl , 40 μl , 60 μl , and 100 μl) along with 50 μl of 2mM ferric chloride (FeCl_2). Later on, 250 microlitre of 5 millimole mM ferrozine solution was added to the reaction mixture for the initiation of reaction along with vigorous shaking. Further incubation time of 10 minutes was given for the completion of reaction. Absorbance was measured at 562 nanometer nm with the help of positive control (Na_2EDTA).

Hydroxyl radical scavenging (HRS) activity

Hydroxyl radical scavenging (HRS) activity was performed to identify the capability of samples to form hydroxyl radicals. Prepared reaction mixture contains 60 μl of 1.0 mM FeCl_2 , 90 μl of 1mM 1, 10- phenanthroline, 2.4 millilitre mL of 0.2 molar M phosphate buffer (pH 7.8), 150 μl of 0.17 M H_2O_2 , and various concentration of plant extract. Different concentration of these extracts (20 μl , 40 μl , 60 μl , and 100 μl) was examined using 96-well microplate method. Later on, hydrogen peroxide (H_2O_2) was added to the reaction mixture after the completion of incubation in the room temperature for 5 minutes. Finally, sample absorbance was measured at the wavelength of 517 nm. HRS activity was used to calculate the inhibitory percentage of IC_{50} against different concentrations of sample extract.

In vitro Thrombolytic Activity

In vitro Thrombolytic Activity (ITA) assay was performed to evaluate thrombolytic activity of sample extracts. In ITA assay, 500 μl of fresh blood was taken in sterile microfuge tubes and incubated for 45 minutes at 37°C. Incubation time results in the formation of clot with the presence of serum as a top layer. After incubation, weight of serum free formed clot was taken to identify initial clot weight. Later on, 10, and 20 microgram (mg)of methanolic extracts and silver nanoparticles were added along with 200 μl of aspirin and 100 μl of double distilled water to the initial clot tubes. After addition, all tubes were incubated for a period of 90 minutes at 37°C for the identification of clot lysis. Followed by incubation, final clot disruption weight was taken by removing the fluids present in the tubes. Difference between the initial and final clot weight was used to express the clot lysis in percentage form.

In vitro Cytotoxicity Assay

Cytotoxicity was measured by performing MTT assay.





Anti Biofilm assay

Anti biofilm assay (ABA) was performed to identify the effect of sample extracts against the *E.coli* induced biofilm formation. In ABA assay, 100 µl of luria-bertani broth were taken along with 10 µg/ml of plant extract in 96 well plates. Later on, 10 µl of *E.coli* overnight culture was added to all the wells and incubated at 37°C for 24 hours. After incubation, wash the wells with 1 % NaCl by removing all floating liquid present in it. Then, formed biofilms were stained with the help of 0.4 % crystal violet for 10 minutes. Finally, absorbance was measured at 550 nm with the help of enzyme linked immunosorbent assay (ELISA) reader.

RESULTS AND DISCUSSION

Role of gas chromatography-mass spectroscopic (GC-MS) analysis in the identification of chemical constituents in the leaf extract of *Chloroxylon swietenia*

The methanol and ethanol leaf extract of *C. swietenia* subjected to GC-MS analysis revealed the chemical composition which is shown in table 1. The chromatogram showed peaks which confirmed the presence of 12 different compounds with different retention time. It was also gave a clear picture regarding the presence of chemical constituents and its concentration in the sample. From these 12 compounds 6 compounds found to be have highest peak value. The peak intensity of Benzaldehyde, 2-nitro-diaminomethylidenhydrazone was found to be higher with a retention time of 28.16 minutes compared to other 5 compounds (Table 1).

Anti microbial activity of *Chloroxylon swietenia* leaf extract against different bacterial (*Escherichia coli*, *Staphylococcus aureus*) and fungal (*Candida albicans*, *Candida glabrata*, *Candida krusei*, and *Candida tropicalis*) species

In the first phase of antimicrobial activity, antibacterial property of *C. swietenia* leaf extract was tested against two different bacterial pathogens i.e. *E. coli*, and *S. aureus*. Two different solvent extracts (methanol, and ethanol) of *C. swietenia* were tested for antibacterial activity. Results of antibacterial activity showed that *C. swietenia* ethanol leaf extract was found more effective against *E. coli* and *S. aureus* compared to methanol extract. For the antibacterial activity, antibiotic named as streptomycin and ampicillin were used as positive controls (Figure 1). Second phase of antimicrobial activity was carried out to determine the anticandidal effect of *C. swietenia* leaf extract was tested against *Candida albicans*, *Candida glabrata*, *Candida krusei*, and *Candida tropicalis*. Results of anticandidal assay showed that ethanolic extract was found to be more effective against all four fungal species compared to methanolic extract. Surprisingly, methanolic extract does not show any effect against *C. tropicalis* compared to other three different fungal species. In this assay, antibiotic flucanazole was used as a positive control (Figure 2).

Detection of *invitro* thrombolytic activities of methanolic and ethanolic *Chloroxylon swietenia* leaf extracts

Thrombolytic activity of *C. swietenia* leaf extracts (ethanolic, methanolic) were tested for the percentage of clot lysis. Among the plant extracts, ethanolic extract has highest thrombolytic activity of 28 % in the concentration of 50 µl (10 mg/ml). Compared to ethanolic extract, methanolic extract has a reduced thrombolytic activity of 20 % in the concentration of 10 mg/ml and also have the lowest thrombolytic activity of 8.5 % in 5 mg/ml (Figure 3).

Use of 2,2-Diphenyl-1-picrylhydrazyl (DPPH) assay, Hydroxyl radical scavenging (HRS) activity, and Ferric reducing antioxidant power (FRAP) analysis methods in identification of total antioxidant capacity (TAC) analysis

The TAC analysis were carried out in three different phases using DPPH, FRAP, and TAC methods. In first phase, DPPH assay was used to determine the antioxidant potential of *C. swietenia* leaf extracts prepared using ethanolic and methanolic solvents. Results of DPPH assay showed that ethanolic extract has better antioxidant potential compared to the methanolic extract. It was also showed that in higher concentration plant extract forms more number of free radicals compared to the IC₅₀ value. Followed by the DPPH assay, HRS activity was performed to understand the better antioxidant scavenging activity of leaf extracts. Results of this assay validated the results of DPPH assay and stated IC₅₀ values for ethanolic (80 µl) and methanolic (100 µl) extracts. Using the FRAP analysis, It was proved that ethanolic and methanolic leaf extract of *C. swietenia* has the most active extract which is interfered



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with the formation of ferrous and ferrozine complex. It was also stated that it may act as chelating agent and captures ferrous ion before the formation of ferrozine. Results of FRAP analysis showed that IC₅₀ value for both extract shown as 10 mg/ml, which is lower than the positive standard (Figure 4).

Impact of synthesized silver nanoparticles on anticancerous activity of *Chloroxylon swietenia* leaf extract against HeLa cell line

Anti cancerous activity (ACA) of synthesized silver nanoparticles from the leaf extract of *C. swietenia* (CS-AgNPs) was investigated against human cervical cancer cells. ACA of CS-AgNPs were tested in three different concentrations i.e. low (control), medium (12 µg/mL), and high (25 µg/mL). Results of ACA showed that inhibition percentage differ in all three sample concentrations. Control did not show any inhibition, compared to control 12 µg/mL showed an moderate level of inhibition (8.65 %), and high level of inhibition present in the concentration of 25 µg/mL (Figure 5).

Identification of antibiofilm properties of *Chloroxylon Swietenia* leaf extract against *Escherichia coli*

Ethanollic and methanollic extracts of *C. swietenia* was tested for their antibiofilm properties against *E. coli*. Results of antibiofilm assay showed that both ethanollic and methanollic leaf extract demonstrated moderate anti-biofilm activity, and the influence was the best on ethanollic extract were the IC₅₀ value was 67.84 % which is present in the concentration of 60 µl. The extract inhibitory effect was also studied using different concentrations (20µl, 40µl, 60µl, 80 µl and 100 µl) against *E. coli*. Results of inhibitory studies showed that percentage of inhibition was high at the concentration of 20 mg/mL (Figure 6).

CONCLUSION

In the present study, shade dried *C. swietenia* leaves were used for the preparation of methanollic and ethanollic extracts. Collected extracts were subjected to the GC-MS analysis for unraveling the chemical constituents present in it. Results of GC-MS analysis showed the presence of 12 different compounds in both the extracts and its highest level was observed for benzaldehyde, 2-nitro- diaminomethylidenedihydrazone by the retention time of 28.16 minutes. Followed by GC-MS analysis, Anti microbial activity of *C. swietenia* leaf extract was tested against two different bacterial (*E. coli*, *S. aureus*) and three different fungal (*C. albicans*, *C. glabrata*, *C. krusei*, and *C. tropicalis*) species. Observed results were proved that ethanollic leaf extract was found more effective against bacterial and fungal species compared to methanollic extract. Thrombolytic assay also showed that methanollic extract has a reduced thrombolytic activity compared to ethanollic extract. Later on, results of antioxidant and anti-biofilm assay proved that ethanollic and methanollic leaf extract of *C. swietenia* has both antioxidant and antibiofilm activity in an efficient manner. Outcome of the present study elucidated the role of *C. swietenia* ethanollic extract in the development of antimicrobial, antioxidant, and antibiofilm activities with an anticancerous property for its usage in the treatment of cancerous outgrowth.

ACKNOWLEDGMENTS

This work is supported by the SEED MONEY grant of Sri Ramakrishna College of Arts & Science (SRCAS), Coimbatore sanctioned to MM and SRK. Authors thank Department of Science and Technology, Government of India for sanctioning DST-FIST facility for Genomics and Proteomics [Under DST-FIST PG College Level – A Program (SR/FST/COLLEGE-/2022/1203) - for the Department of Biotechnology, Sri Ramakrishna College of Arts & Science (Autonomous), Coimbatore, Tamil Nadu, India.

Author Contributions

MM and MD carried out experimentation, and formal analysis, MA, BKK, and SG performed data validation, PS, MM, and SRK contributed to the development of study design, manuscript preparation, and revision of this manuscript. Author agrees with the content of the manuscript.





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Conflicts of Interest

The author declare no conflict of interest

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Table 1. Active chemical compounds identified from methanol and ethanol leaf extract of *chloroxylon swietenia* by the GC-MS analysis.

S.NO	R.TIME	AREA%	MOLECULAR FORMULA	COMPOUND NAME
1.	19.515	54.239	C14H26O8	Mannitol,1,3,4,5-tetra-o-methyl-,diacetate
2.	25.132	1.696	C18H23N3S	1-[Alpha.-adamanty]benzylidene] thiosemicarbazide
3.	26.058	1.368	C27H58OSi	Tetracosan-1-OL Trimethylsilyl Ether
4.	26.898	1.425	C8H9O2N5	Benzaldehyde,2-Nitro-,Diaminomethylidenhydrazone
5.	27.118	3.482	C8H9O2N5	Benzaldehyde,2-Nitro-, Diaminomethylidenhydrazone
6.	28.169	19.643	C8H9O2N5	Benzaldehyde,2-Nitro-, Diaminomethylidenhydrazone

Table 2

Bacteria	Methanol (µl)			Ethanol (µl)		
	Zone of inhibition (mm)					
	Control	20	40	Control	20	40
<i>E. coli</i>	22	12	18	24	15	14
<i>S. aureus</i>	27	18	14	25	17	12

Table 3

Bacteria	Ethanol (µl)			Methanol (µl)		
	Zone of inhibition (mm)					
	Control	20	40	Control	20	40
<i>C. albicans</i>	21	16	12	20	12	14
<i>C. glabratta</i>	16	12	14	22	17	19
<i>C. krusei</i>	22	14	12	19	14	16





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Table 4

S.NO	Clot weight	Lysis clot	% of lysis
1.	0.47	0.43	8.5%
2.	0.49	0.39	20%
3.	0.49	0.39	28%

Table 5

Sample concentration(µg/mL)	OD value at 570 nm	% of inhibition
Control	0.589	-
12	0.538	8.65%
25	0.519	11.88%

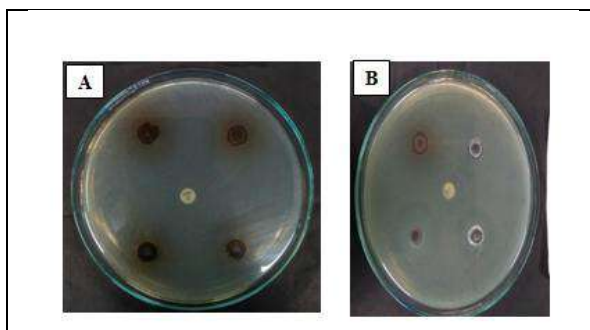


Figure 1. Antibacterial activities (ABA) of *Chloroxylon swietenia* leaf extracts were tested against two different bacterial species (*Escherichia coli*, *Staphylococcus aureus*). Results of ABA proved that that ethanolic extract was found to be more effective than methanolic extract against the two bacterial species.

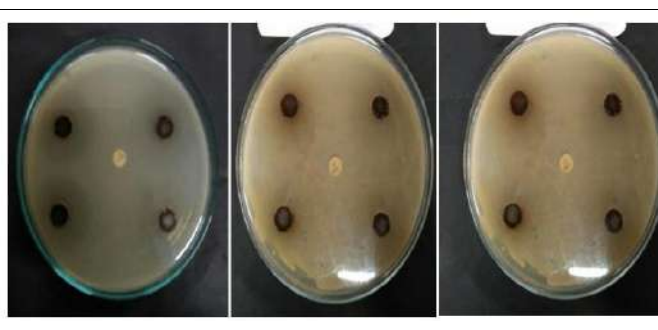
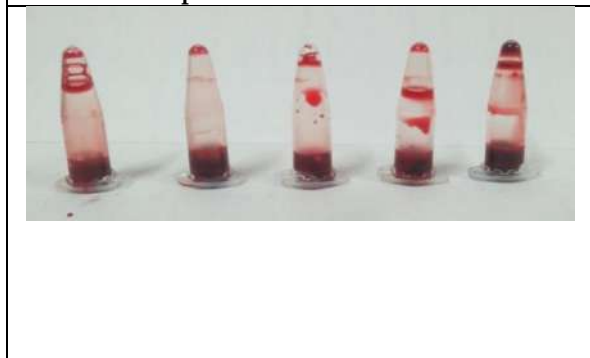


Figure 2. Anti candidal property (ACP) of *Chloroxylon swietenia* leaf extract were tested against four candida species (*Candida albicans*, *Candida glabrata*, *Candida krusei*, and *Candida tropicalis*). Results of *chloroxylon swietenia* leaf extract ACP showed that ethanolic extract found more effective than methanolic extracts.



1. Control (Asprin);
 2. AgNO₃ (100µl);
 3. methanol extract (50µl);
 4. Methanol extract (100µl);
 5. Ethanol extract (50µl).

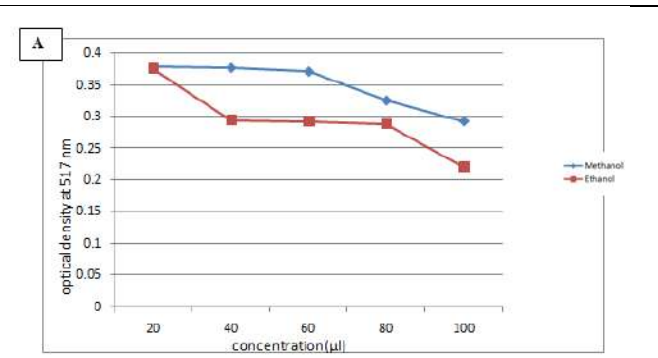


Figure 4.





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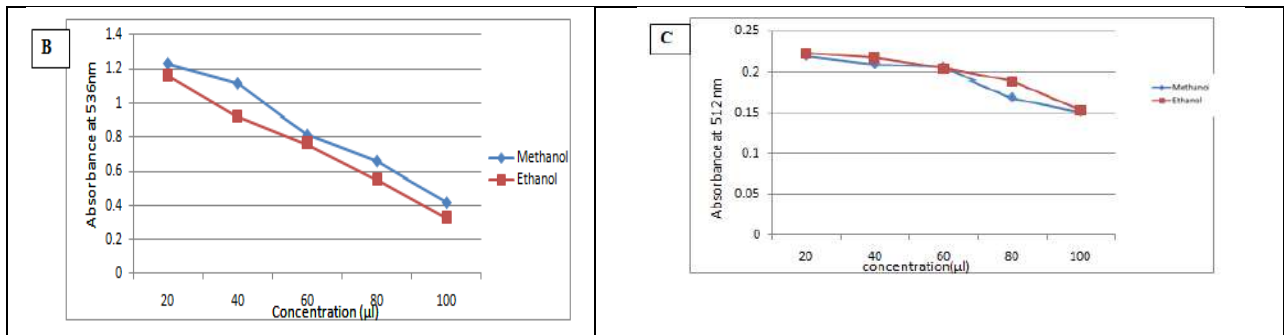
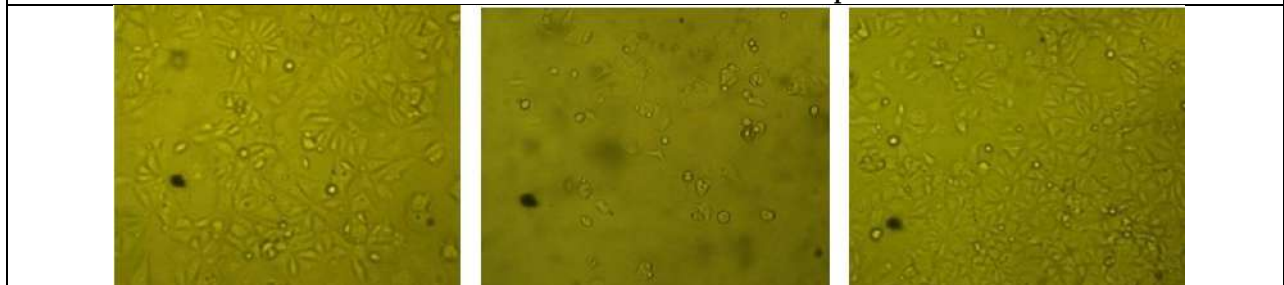


Figure 4. Antioxidant activity was tested against ethanol, methanol leaf extracts of *Chloroxylon swietenia*. Results of DPPH assay, and hydroxyl radical scavenging activity showed that ethanol leaf extract has better antioxidant activity against methanolic leaf extract (A & B). FRAP analysis showed that both leaf extracts has interfered with the formation of ferrous and ferrozine complex (C).



Agno3 (low)

Agno3 (Medium)

Agno3 (High)

Figure 5. Anti cancerous activity of synthesized silver nanoparticles from the leaf extract of *Chloroxylon swietenia* was tested against the HeLa cell line. Results of anti cancerous activity showed that inhibition percentage of inhibition was high at the concentration of 25 µg/mL.

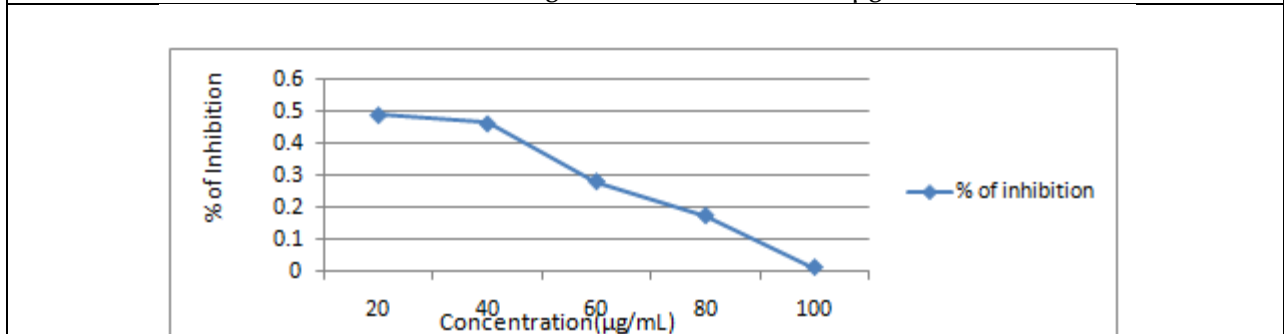


Figure 6. Anti biofilm activity of *Chloroxylon swietenia* leaf extract was tested against *Escherichia coli* induced biofilm formation. Results of anti biofilm activity showed that percentage of inhibition is high at the concentration of 100 microgram/microlitres.





Evaluation of *In-vitro* Anti-Inflammatory Property of Ethanolic Stembark Extract of *Psychotria dalzellii* Hook.f. (Rubiaceae) by using Membrane Stabilization and Protein Denaturation Method

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 28 Jun 2024

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ABSTRACT

The aim of present work is to assess the *in-vitro* anti-inflammatory property of ethanolic stembark extract of *Psychotria dalzellii* Hook.f. from Western Ghats region, Karnataka, India. *In-vitro* anti-inflammatory potential was evaluated by Human red blood cell (HRBC) membrane stabilization assay and protein denaturation assay. The ethanolic stembark extract of *P. dalzellii* exhibited considerable membrane stabilization activity with $60.31 \pm 0.66\%$ of membrane stabilization at $500 \mu\text{g mL}^{-1}$ concentration and showed significant protein denaturation with $80.95 \pm 1.71\%$ of inhibition of protein denaturation at $250 \mu\text{g mL}^{-1}$ concentration with regards to standard Aspirin. The results obtained in the present study indicate that ethanolic stembark extract of *P. dalzellii* possesses promising anti-inflammatory property. Which can be used to design the anti-inflammatory medication.

Keywords: *Psychotria dalzellii*, Anti-inflammatory, Protein denaturation, HRBC.





INTRODUCTION

Inflammation is a defensive reaction exhibited by the body to injury, infections or destructions characterised by redness, pain, heat, swelling and loss of function in the injured area. This response is triggered by chemical mediators released by injured tissue and migratory cells. i.e., the injuries cause tissue cells to secrete vasoactive amines (histamine, serotonin), arachidonic acids (prostaglandins, leukotrienes) and cytokines (tumour necrosis factor and interleukin-1). All these factors collectively cause greater vasodilation (widening of blood capillaries) and capillary permeability, which results in more blood flow to the injured area. These substances operate as chemical messengers that attract some of the body's natural defence cells known as chemotaxis [1]. Thus, it was a complex mechanism, which is frequently associated with pain and involves occurrences such as: membrane alteration, increase in protein denaturation and increased vascular permeability[2]. There are two kinds of inflammation: acute and chronic inflammation. Acute inflammation is the first reaction to injury and it is brought on by increase in the flow of plasma and leukocytes from the bloodstream into the injured tissues. This process of acute inflammation gets started by the cells already existing in tissues. The inflammatory mediators cause significant vascular alterations, such as vasodilation and increased capillary permeability [3]. Chronic inflammation, also known as prolonged inflammation, is the ongoing response to injury that results in a progressive shift in the type of cells present at the point of inflammation. It is distinguished by the simultaneous destruction and healing of the tissues caused by the inflammatory process [2].

To treat the consequences of inflammation, anti-inflammatory medicines, such as steroids or nonsteroidal anti-inflammatory drugs (NSAIDs) are commercially accessible. They work by inhibiting cyclooxygenases (COX) enzymes, which involved in the production of prostaglandins, a substance that promote inflammation, pain and fever. However, the use of these typical NSAIDs leads to various side effects [4]. As an alternative, plant-based medicines are getting increased therapeutics marked share due to their mild action and fewer adverse effects. Species from *Psychotria* are used in folk medicine against inflammatory diseases [5]. In this sense, considering the folk use of *Psychotria* genus against process regulated by inflammatory mediators, but without scientific evidence of this potential therapeutic application, prompted research of *Psychotria dalzellii*. Thus, this study aimed at evaluating the anti-inflammatory effect. Among this *Psychotria* genus, *Psychotria dalzellii* is most abundant and commonly found plant in forest as undergrowth endemic to the western Ghats region. *P. dalzellii* large shrubs, up to 6 m tall, leaves up to 12-25×5-10 cm long, obovate-oblong, obtuse at apex, coriaceous, gradually narrowing towards the petiole at the base; petiole up to 2.5 cm long, stipules 1.5-2 cm long. Lower cyme branches 3-5 together in 1-2 distant whorls; bracts and bracteoles are large and persistent. Flowers white, sessile, 2-5 together at the termination of the branches in terminal peduncled cymes up to 15cm long. The calyx is generally campanulate, with ovate-oblong lobes that are sharp. Fruits; a drupe, black when ripe, albumen ruminant. May to October is the flowering and fruiting season [6].

MATERIALS AND METHODS

Plant sample collection and authentication

P. dalzellii fresh stem bark samples were collected from Western Ghats, Karnataka, India. The plant was identified by taxonomy experts and a specimen was deposited in the Department of Applied Botany, Kuvempu University, Shivamogga

Extraction process

The collected *P. dalzellii* stem bark samples were washed with water and shade dried, later they were mechanically ground well to powder. The powdered stem bark of *P. dalzellii* was extracted with Soxhlet extractor using ethanol. After filtration, obtained crude extracts were air-dried and then stored in tight vials at 4°C temperature.





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***In vitro* Anti-inflammatory activity**

Human Red Blood Cells (HRBC) Membrane Stabilization Assay

In-vitro anti-inflammatory activity of ethanolic stem bark extract of *P.dalzellii* was evaluated by using HRBC membrane stabilization technique is incorporated by following Gandhidasan *et al* [7]. Fresh blood sample (2 ml) was collected from healthy human volunteers who had not taken any NSAIDs for 2 weeks prior to the experiment and it was combined with equal volume of sterilized Alsevers solution (0.8% sodium citrate, 2% dextrose, 0.5% citric acid and 0.42% NaCl in distilled water). This blood solution was centrifuged about 10 minutes at 3000 rpm, and the packed cells were separated. The packed cells were washed three times with isosaline (0.85%, pH 7.2). The volume of the blood was measured and reconstituted as 10% v/v suspension with isosaline. This HRBC solution has been utilised to estimate the anti-inflammatory property. The varying concentrations like 100, 200, 300, 400 and 500 µg/ml of *P. dalzellii* extract were made. The reference sample (Aspirin) and control were separately blended with 2 ml of hyposaline (0.36 %), 1 ml of phosphate buffer (pH 7.4, 0.15 M) and 0.5 ml of HRBC suspension (10% v/v). All the assay mixtures were incubated at 37°C for 30 min and centrifuged at 3,000 rpm for 20 min. The supernatant solution was decanted and the hemoglobin content in the suspension was estimated by a spectrophotometer at 560 nm [8]. Percentage of stabilization was determined by following formula.

$$\% \text{ of stabilization} = [(A_c - A_s) / A_c] \times 100$$

Where, A_c = Absorbance of control and A_s = Absorbance of test sample

Protein Denaturation Assay

The anti-inflammatory activity of ethanol stem bark extract of *P. dalzellii* was studied by using inhibition of protein denaturation method [9]. The 5 ml of reaction mixture was prepared by adding 0.2 ml of fresh hen's egg albumin with the 2.8 ml phosphate-buffered saline (pH: 6.4) and 2 ml of varying concentration of ethanol stem bark extract (50-500 µg/mL). Double distilled water 2 ml was served as control. The mixture was incubated for 15 minutes at $37 \pm 2^\circ\text{C}$ and then heated for 5 minutes at 70°C . After cooling, their absorbance was measured on spectrophotometer at 660 nm by using vehicle as blank. Aspirin was used as standard and treated similarly for determination of absorbance. The percentage of inhibition of protein denaturation was analysed by the given formula as follow:

$$\% \text{ of inhibition of protein denaturation} = [(A_c - A_s) / A_c] \times 100$$

Where, A_c = Absorbance of control and A_s = Absorbance of test sample

Statistical analysis

The experimental data were expressed as mean \pm SEM. The values were calculated using statistical software Graph Pad PRISM 6.

RESULT

Anti-inflammatory activity

HRBC membrane stabilization assay

The ethanolic stem bark extracts of *P. dalzellii* was effective in inhibiting the hypotonicity induced hemolysis of HRBC membrane stabilization of 11.68 ± 0.25 , 26.45 ± 1.09 , 37.25 ± 0.92 , 47.71 ± 1.12 and $60.31 \pm 0.66\%$ at different concentrations 100, 200, 300, 400 and 500 µg/mL respectively. Whereas, for Aspirin it was found to be 34.14 ± 1.09 , 42.42 ± 0.50 , 52.03 ± 1.25 , 60.31 ± 0.66 and $75.37 \pm 1.04\%$ for same doses respectively as shown in the Table 1 and Figure 1. Dose dependant increase in the percentage of membrane stabilization was observed. It showed the considerable percentage of membrane stabilisation $60.31 \pm 0.66\%$ at concentration of 500 µg/ml. As compared to extract, Aspirin showed $75.37 \pm 1.0\%$ protection at same concentration. These results provide evidence for the membrane stabilizing effect of ethanolic extract of *P.dalzellii* as an additional mechanism for their anti-inflammatory activity.





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Protein denaturation

The *in-vitro* anti-inflammatory test, the ethanolic stem bark extract of *P. dalzellii* showed mean inhibition of protein denaturation of 28.99 ± 1.57 , 41.89 ± 0.98 , 50.81 ± 1.39 , 66.44 ± 1.17 and $80.95 \pm 1.17\%$ for doses of 50, 100, 150, 200 and 250 $\mu\text{g/mL}$ respectively. Whereas, for Aspirin it was found to be 40.75 ± 0.58 , 52.12 ± 0.34 , 65.52 ± 0.39 , 79.56 ± 0.91 and $92.56 \pm 0.85\%$ for same doses respectively (Table 2 and Figure 2). It elicited profound concentration dependent inhibition of protein denaturation. The ethanolic stem bark crude extract of *P. dalzellii* exhibited a significant inhibition of protein denaturation with $80.95 \pm 1.7\%$ effect at 500 $\mu\text{g/mL}$ and standard medication Aspirin showed $92.56 \pm 0.85\%$ of protein denaturation at the same concentration.

DISCUSSION

There are many difficulties in employing animals in experimental pharmacological research, including ethical issues and lack of rationale for their usage in the early stages of drug discovery for anti-inflammatory diseases [10]. *In-vitro* investigations are useful for studying the cellular response in a closed system where the experimental conditions are kept constant. These *in-vitro* studies aid in improving an understanding of the mechanism of anti-inflammatory effect of herbal constituents [11]. In previous studies with several species of *Psychotria* genus have been reported to have anti-inflammatory properties [12-13]. In the present study, the *in-vitro* anti-inflammatory activity of stem bark ethanolic extract of *P. dalzellii* was evaluated, indexed via the protective activity of the extract against protein denaturation. In the assay of denaturation method, the egg albumin is denatured. Since, it occurs when proteins lose their tertiary and secondary structures due to external stress, such as strong acids or bases, concentrated inorganic salts, organic solvents or heat, thus leading them to lose their biological functionality. Therefore, denaturation of tissue proteins is recognized as a marker of inflammation [14]. The result showed that ethanolic stem bark extract of *P. dalzellii* inhibited albumin denaturation. i.e., $80.95 \pm 1.17\%$ at the concentration of 250 $\mu\text{g/mL}$. Whereas, standard Aspirin drug showed $92.56 \pm 0.85\%$ at the same concentration. It can be observed from the present study that ethanolic stem bark extract of *P. dalzellii* significantly inhibit the protein denaturation. Agents that can inhibit protein denaturation would be beneficial for anti-inflammatory medication development [15].

The *in-vitro* anti-inflammatory activity of stem bark ethanolic extract of *P. dalzellii* was also indexed via HRBC membrane stabilization assay [16]. The integrity of the cell membranes influences the viability of the cell. When RBCs are subjected to injurious substances, including hypotonic media, causes the membrane to lyse, resulting in hemolysis and hemoglobin oxidation [17]. The hemolytic action of hypotonic solution is associated with an excessive anticipation of fluid inside the cell, which causes the rupture of membrane. Such type of membrane degradation results in secondary damage through lipid peroxidation due to free radicals. Therefore, it is expected that substances with membrane-stabilizing qualities will provide a considerable level of protection for cell membranes against injurious substances [18-19]. In our study, absorbance of hemoglobin is taken. The hemoglobin is released as a result of lyses of RBC membrane. Due to stabilization of membrane less absorbance is noted in spectrometer results. From the result, the successive ethanolic stem bark extract of *P. dalzellii* exhibited membrane stabilizing effect by inhibiting hypotonicity induced lysis of erythrocyte membrane. Since, the RBC membrane has a similar structure to the lysosomal membrane. Its stabilization suggests that the extract might also be able to maintain lysosomal stability. It showed concentration dependant membrane stabilization activity. The highest percentage of membrane stabilization activity $60.31 \pm 0.66\%$ was observed at higher concentrations of the extract 500 $\mu\text{g/mL}$, as compared with $75.37 \pm 1.0\%$ membrane stabilization activity produced by standard drug Aspirin. Concerning to the anti-inflammatory activity, the findings of this investigation revealed that the phytoconstituents present in the *P. dalzellii* either alone or in combination, are responsible for having anti-inflammatory effect [20-21].

Abbreviations

P. dalzellii: *Psychotria dalzellii*.

HRBC: human red blood cell

NSAIDs: non-steroidal anti-inflammatory drugs





Acknowledgement

The authors are grateful to the Dept. of Applied Botany, Kuvempu University, Jnana Sahyadri, Shankaraghatta, Shivamogga for providing the facilities for conducting research activities and also thankful CytixonBiosolutionsPvt. Ltd, for providing *in-vitro* anti-inflammatory facilities.

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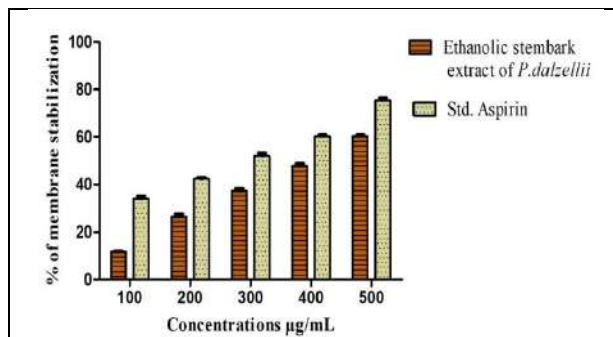
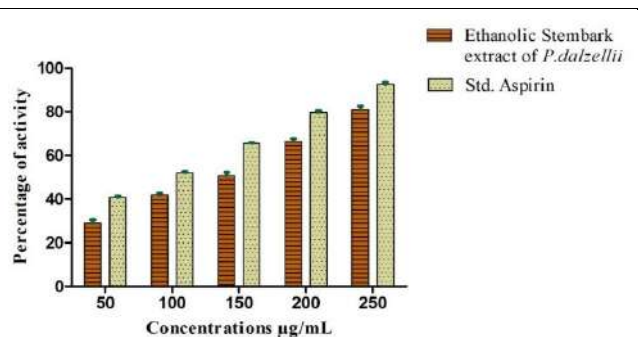
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Table 1. Effect of stembark ethanolic extract of *P. dalzellii* on HRBC membrane stabilization (mean \pm SEM, n=3).

Sl. No	Concentration ($\mu\text{g/mL}$)	Stembark extract of <i>P. dalzellii</i> membrane stabilization %	Std. aspirin membrane stabilization %
1	100	11.68 \pm 0.25	34.14 \pm 1.09
2	200	26.45 \pm 1.09	42.42 \pm 0.50
3	300	37.25 \pm 0.92	52.03 \pm 1.25
4	400	47.71 \pm 1.12	60.31 \pm 0.66
5	500	60.31 \pm 0.66	75.37 \pm 1.04

Table 2. Effect of stembark ethanolic extract of *P. dalzellii* on inhibition of protein denaturation (mean \pm SEM, n=3).

Sl. No	Concentration ($\mu\text{g/mL}$)	Stembark extract of <i>P. dalzellii</i> % inhibition of protein denaturation	Std. aspirin % inhibition of protein denaturation
1	50	28.99 \pm 1.57	40.75 \pm 0.58
2	100	41.89 \pm 0.98	52.12 \pm 0.34
3	150	50.81 \pm 1.39	65.52 \pm 0.39
4	200	66.44 \pm 1.17	79.56 \pm 0.91
5	250	80.95 \pm 1.17	92.56 \pm 0.85

Figure 1. HRBC membrane stabilization activity of ethanolic stembark extract of *P. dalzellii*Figure 2. Inhibition of protein denaturation activity of ethanolic stembark extract of *P. dalzellii*



Investigation on means to Transform Orange Peel byproduct into Candied and Powdered Forms for its Valorization in Dairy Products

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 29 Jun 2024

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ABSTRACT

Orange peel is a byproduct produced primarily from citrus fruit juice industry. The present study was planned to investigate the operational parameters required to transform orange peel into candied orange peel (COP) and orange peel powder (OPP). Such ingredients can be effectively used as valued ingredients in various dairy (i.e. Ice cream, Frozen yoghurt) and food products. The initial moisture content of fresh orange peels was 76.25 percent. Blanching and debittering treatment to the peels led to an increase in their moisture content (i.e to 78.51 percent). When peels were treated osmotically in a hypertonic sugar solution (40–70°Brix) for 72 h maintained at 45±2°C sugar was gained with simultaneous loss of water. The sugar gain (SG) and water loss (WL) for such treated orange peels at 72 h were 818.38 g/kg peel and 150.58 g/kg peel, respectively. The conversion of orange peels into OPP helped to reduce its bulk, increase shelf-stability and ensured its availability throughout the year. The yield of OPP, considering osmo-treated peels as raw material was 49.85 percent. Such OPP was rich in β-carotene and fiber; the values were 77.40 µg/100 g and 4.10 percent, respectively. The average moisture content of COP and OPP was





36.75 and 7.21 percent, respectively. The findings will enable us to know the technological protocol involving osmo-dehydration coupled with other dehydration technique to develop valued food ingredient from citrus byproduct.

Keywords: Candied orange peel, Orange peel powder, Sugar gain, Valorization, Water loss

INTRODUCTION

Orange (*Citrus sp.*) is one of the citrus fruits that are abundant in India, and orange residue is a byproduct of the fruit industry that was previously restricted to animal feed but nowadays other avenues are being explored. Orange residue, like other citrus fruit residues, is composed of peel and pulp (the fraction screened from the juice). Citrus fruits are widely consumed globally, generating a substantial quantum of byproducts, especially peels. Traditionally, these peels were discarded or used for low-value applications, leading to environmental and economic concerns. However, orange peels containing several bioactive compounds, dietary fiber, and essential oils has immense potential for their valorization (Satari and Karimi, 2018). Orange peels, which represent between 50 - 65 percent of total orange fruit, are largely composed of cellulose, pectin, hemicellulose, lignin, chlorophyll pigments, and other low-molecular-weight compounds such as limonene (Pathak *et al.*, 2017). Improper disposal of these peels contributes to environmental pollution through landfilling or incineration, generating greenhouse gases and leachate (Kalengyo *et al.*, 2023). Valorization, the process of converting waste into valuable products, represents a sustainable solution by mitigating environmental impact and creating economic opportunities. Orange peels are rich in bioactive compounds, including phenolic acids, flavonoids, limonene, and dietary fiber (De La Torre *et al.*, 2019).

These compounds possess antioxidant, anti-inflammatory, and antimicrobial properties, making them valuable functional ingredients in food and pharmaceutical applications. Orange peel fiber also offers potential prebiotic benefits, promoting gut health (Zhou *et al.*, 2023). Transforming orange peels into candied and powdered forms presents a promising approach for their valorization. Candied peels are obtained by impregnating the peels in sugar solutions, resulting in a sweet and chewy product. Such ingredient can very well be used in bakery goods, confectionery, certain dairy products and desserts (Patel, 2017; Adil *et al.*, 2023). Powdered peels are produced by drying the peels and subsequent milling, yielding a versatile ingredient applicable in various food formulations, including dairy products (Anant Kumar *et al.*, 2019; Adil *et al.*, 2023). Dairy products, such as yogurt, ice cream, and cheese, offer a suitable matrix for incorporating candied or powdered orange peels. These peels can enhance the sensory attributes of dairy products by conferring flavor, color, and texture (Chandgude, 2019). Additionally, they can enrich the nutritional profile of dairy products by contributing ascorbic acid, β -carotene, other bioactive compounds and dietary fiber (Adil *et al.*, 2023). Osmotic dehydration is a key processing step for producing candied peel. It involves immersing the peels in a hypertonic sugar solution, drawing water out of the peels, and simultaneous ingress of sugar within the tissue. Such process influences the final edible product's sweetness, texture and enhances shelf life (Yadav and Singh, 2014). Understanding the SG and WL dynamics taking place during osmotic dehydration is required for optimizing the product quality and the resultant yield (Phisut, 2012). This research investigates the operational parameters for transforming orange peels into COP and OPP for their subsequent application in varied dairy products. The focus will be laid on optimizing these parameters to enhance product quality, having improved functionality at the same time preserving the bioactive compounds.

MATERIAL AND METHODS

Fresh oranges (*Citrus sinensis* cv. Valencia) were procured from M/s. Dev Exotica, Anand (Gujarat). Cane sugar of 'Madhur' brand was obtained from a local market in Anand. The equipment used were (a) temperature-controlled bath and (b) vacuum tray dryer of M/S. Perfect Engineering and Allied Works Pvt. Ltd., Vadodara.



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Preparation of COP

Fresh oranges were washed and peeled. The peel was cut into strips [5.00 x 1.5 x 0.3 cm: length(l) x width(w) x height(h)]. Such strips were subjected to blanching (77°C for 2-5 min; Peel: water of 1:2 w/v) in potable water (Magangana *et al.* 2021), in order to inactivate polyphenol oxidase and peroxidase enzymes to preserve nutrients and phytochemicals. The orange peel strips were soaked in sodium bicarbonate (NaHCO₃) solution (2.0 per cent strength) for 3-4 min at 95°C in order to eradicate bitterness and soften the tissue (Pinzon *et al.* 2013). Such blanched peels were treated with sugar syrup (incremental increase in sucrose concentration from 40 to 70°Brix in 3 days); syrup temperature maintained at 40°C. After 3 days, COP was separated from sugar syrup and the excess syrup was allowed to drain off. The COP was packaged in pre-sterilized polyethylene bags (80.0 µm thick) and stored under refrigeration (6±2°C).

Preparation of OPP

The strips of orange peel were prepared as mentioned earlier for COP, except that they were portioned into smaller sizes (i.e. 4.0 x 1.0 x 0.3 cm; l x w x h). Such peel strips were subjected to similar blanching treatment as mentioned earlier for COP. The blanched peel strips were treated with sugar syrup (50°Brix for 4 h at 50°C temperature) and later drained off from excess syrup. The osmotically dehydrated peels were subjected to drying (45±2°C for 8 h; vacuum of 670 mm of Hg column) in a vacuum tray drier (M/s. Perfect Engineering and Allied Works Pvt. Ltd., Vadodara). The dried orange peel pieces (7.21 per cent moisture) were milled in a food processor and sieved through 35 No. U.S. stainless steel sieve to obtain OPP with mean particle size of ≤ 250 µm.

The photographs of COP and OPP are shown in Fig. 1A and 1B respectively

Analysis

Fruit peel solids

The COP and OPP were analysed for moisture, total carbohydrates, ash, crude fiber and β-carotene content. The moisture content of the peel products was analysed using Mojonnier method (Ranganna 2018), while total carbohydrates was determined using Lane and Eynon's volumetric method (Ranganna 2018). Ash was determined as per AOAC (1984) method. The crude fiber (as per European Community No. 152, 2009) and β-carotene by HPLC-UV were analysed by an external laboratory viz., Centre of Analysis and learning in Livestock and Food (CALF) laboratory, Anand. The SG and WL were determined following the method of Chandgude (2021).

RESULTS AND DISCUSSIONS

Parameters Studied During Preparation of Orange Peel Solids

Changes during conversion to COP

The particulars of orange peel during its conversion into COP are shown in Table 1. The fresh orange peels had 76.25 per cent moisture. Blanching and debittering of peels led to a slight increase in the moisture content (i.e. 78.51 per cent). The osmotic treatment in a hypertonic sugar solution of incremental strength (40-70°Brix in 72 h) maintained at 45±2°C led to SG and WL as shown in Table 2. The SG and WL (g/kg peel) from orange peels at 72 h were 818.38 and 150.58 respectively. Osmotic treatment of orange peels led to an increase in their weight (owing to sugar gain), even taking into consideration the WL. The COP so obtained appeared like any glazed fruit and had a tangy orange taste with tolerable bitterness.

Changes during conversion to OPP

Drying has become a widely used method of food processing, permitting the shelf-life extension of fresh produce (fruit, vegetables, etc.) and their byproducts. The principle of drying is to reduce the moisture content of the product to a level at which the growth of microorganisms and enzyme activity are restricted, enhancing the product's storage stability. It is recommended to reduce the moisture content of fruit peel to ≤ 8.0 percent (i.e. powder form) in order to attain the desired shelf life, even at ambient temperature conditions (Pinzon *et al.*, 2013). The orange (*Citrus sinensis* cv. *Valencia*) peel was converted into OPP, after osmotic treatment of the blanched fruit peels. To improve the sensory





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acceptability of OPP, the peels were subjected to osmotic treatment. The conversion of orange peels into OPP helped to reduce the bulk, increased shelf life (6 months when stored at $6\pm 0^{\circ}\text{C}$) and ensured its availability throughout the year. Table 3 shows the changes in the weight and moisture content of orange peels as a result of osmo-dehydration and vacuum tray drying. The yield of OPP considered from osmo-treated peels as starting material was 49.85 per cent. The OPP obtained had intense yellowish orange colour and had typical taste of orange peel, free from bitterness. The composition of the two forms of orange peel is shown in Table 4. The proximate composition and a few phytochemical components of orange peel products (*viz.*, COP and OPP) are collated in Table 4. This indicated that OPP is a rich source of β -carotene and fiber. The average moisture content of COP and OPP was 36.75 and 7.21 per cent, respectively. The β -carotene and fiber content of OPP were 77.40 ($\mu\text{g}/100\text{ g}$) and 4.10 respectively. Raj and Masih (2014) reported proximate composition (per cent) of OPP as follows: 2.00 fat, 2.67 protein, 6.69 ash, 2.35 fiber, and 96.5 TS. Zaker *et al.* (2017) reported 5.17 per cent protein and 90.50 per cent TS in OPP; without subjecting to osmo-dehydration.

CONCLUSION

The present study investigated operational parameters involved in transforming orange peel into COP and OPP for feasible valorization of such valued ingredients in dairy and food products. During the conversion of orange peel to COP, the SG, WL and yield, SG were 818.38 g/kg peel, 150.58 g/kg peel and 166.78 percent respectively. In preparing OPP having 7.21 per cent moisture, the yield was 49.85 percent. The utilization of orange peel derivatives in dairy products could contribute to flavour, body & texture along with the health benefits conferred by the peel components. The purported usage of transformed orange peel products as fat substitute and viscosity modifier in food products is in the offing. Utilization of peel products will enable the farmers to reap more returns through sale of such valued byproducts.

Acknowledgements

Authors are grateful to ShoDH Scheme, Education Department, Gujarat for providing financial support through the project to carry out this study and also thankful to Principal, SMC College of Dairy Science, Anand for providing lab-facilities during the course of endeavour.

Conflict of Interest

The authors declare no conflicts of interest relevant to this article.

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Table 1: Particulars of orange peel during its conversion into COP

Material	Treatment	Weight (kg) after treatment	Moisture content (%)
Orange peels	Washing	50.00	76.25
	Sorting and cutting into strips	47.63	76.25
	Blanching and debittering	51.35	78.51
	Osmotic treatment [#]	83.39	36.75
Yield of COP (%) on the basis of peels		166.78	

[#]Orange peels were osmotically treated with incremental sugar syrup strength (40-70°Brix) over a period of 72 h maintaining temperature of 45±2°C.





Table 2: Sugar gain and water loss in orange peel during osmotic treatment

Particulars	Values during osmotic treatment (72 h)
Sugar Gain (g/kg orange peel)	818.38
Water Loss (g/kg orange peel)	150.58

Table 3: Particulars of orange peel during its conversion into OPP

Materials	Treatment	Weight (kg) after treatment	Moisture content (%)
Fresh orange peel	Washing	50.00	76.25
	Sorting and portioning into strips	48.86	76.25
	Blanching and debittering	50.39	78.51
	Osmotic treatment*	56.16	38.75
Candied peels	Vacuum tray drying and milling	28.17	7.21
	Sieving	28.00	7.21
Yield (%) of OPP on the basis of peels#	Osmotically treated orange peels	49.85	

* Orange peels were per centosmotically treated in sugar syrup (50° Brix, 50°C) for 5 h; # Yield on the basis of osmotically treated peels having 38.75 % moisture

Table 4: Proximate composition of treated orange peels, including phytochemicals

Constituents	COP	OPP
Moisture (%)	36.75	7.21
Total sugar (%)	54.53	65.67
Crude fiber (%)	7.53	4.10
Ash (%)	2.36	3.51
β-carotene (µg/100 g)	45.74	77.40

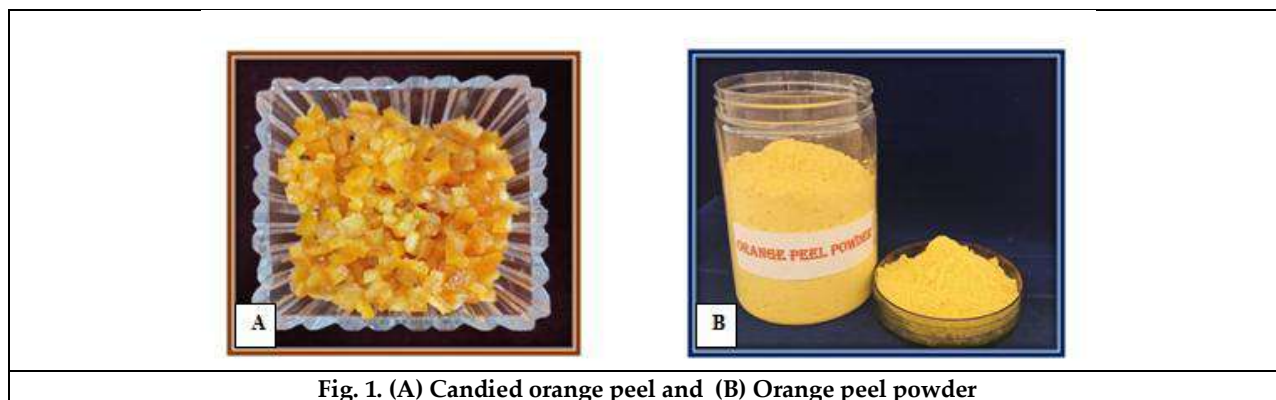


Fig. 1. (A) Candied orange peel and (B) Orange peel powder





An Empirical Study on Implementing Automated Manufacturing Practices in Textile Industry with Special Reference to Silk Textile at Ramnagar

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 18 Jun 2024

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ABSTRACT

The paper focuses on the process in the sericulture industry, automated manufacturing techniques in the textile industry, and how they differ from conventional manufacturing techniques. The study contrasted automated practices with traditional practices, demonstrating the superiority of the former and the numerous advantages it offers to consumers, workers, producers, and society at large. The purpose of the study was to determine the factors influencing the adoption of automated and conventional manufacturing techniques, as well as the correlations between such variables alongside the automated techniques used in the Ramnagar textile industry. 50 manufacturing textile industries in Ramnagar provided responses, and the stratified sampling technique was used to gather those responses. The research encompasses the motivations beneath and goals of implementing automated techniques, as well as various aspects of integrating and evolving automated manufacturers in Textile Industry at Ramnagar.

Key Words: Automated Manufacturing Practices, Textile Industry, Environment Sustainability.

INTRODUCTION

Silk Industry also known as Sericulture in India, is the second largest producer of silk in the World. This industry encompasses entire process of silk production by rearing silkworms into cocoons, woven into textiles. This process consists of Cocoon Harvesting, Reeling, Twisting and Spinning and finally Dyeing and Weaving. In recent times, the



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industry has evolved in a wide array of silk products beyond traditional fabrics including accessories, home furnishings and Industrial applications. Sericulture is an intricate process that consists of transforming the silkworms into the fabrics. This is a process that consists of 4 sequential order.

Cocoon Harvesting

The first step in the procedure is the raising of silkworms. Sericulture farms provide a controlled environment for the housing of silkworms. Silkworms consume mulberry leaves, which are their main food source. These leaves serve as food for the silkworms, which go through multiple molting stages. Silkworms create silk by secreting a fluid through specialized glands that solidifies into threads when exposed to air. Silkworms create silk by secreting a fluid through specialized glands that solidifies into threads when exposed to air. Its goal is to gather healthy, undamaged cocoons without causing harm to the silk strands within.

Reeling

This process involves unwinding silk threads from the cocoon. This step is essential for obtaining continuous silk fibers, which can then be processed into various silk products. Post cocoon harvesting, these cocoons are boiled for two reasons, firstly to soften the Sericin gum which makes it easier to unwind the silk fibers. Secondly to kill the pupa. After boiling the softened cocoons are mounted onto reeling machines

Twisting and Spinning

Twisting and spinning refer to processes that transform silk fibers into a more durable and workable form, typically silk yarn. The resultant output of reeling i.e Silk Filament is twisted together to form a thicker and stronger strand. It imparts strength and is more suitable for weaving. Spinning is further twisting of multiple strands together to create thicker and more substantial yarn. This process contribute to the strength, durability and overall quality of silk.

Dyeing and Weaving

Post twisting and spinning in sericulture, the silk yarn to be dyed and woven to create various silk products. Dyeing involves cleaning and degumming of residual Sericin, this is vital as it improves the absorption of dyes. After dyeing the silk is treated with colours which involves modrants or other chemicals. These dyed yarns are arranged in lengthwise threads known as wrap which creates patterns forming fabrics.

India has a solid industrial foundation and is positioned to lead the textile sector going forward. The following are the main elements supporting the continued growth of the Indian textile industry:

Promotional Schemes and support from government: The Finance Minister's union budget announcement has given the industry a significant boost. The government intends to establish 7 Mega Textile Parks throughout India with the dual goals of bolstering MSME growth and job creation. Because of the initiatives, the industry's competitiveness and exports have both increased. India's textile industry is primarily export-oriented, shipping a variety of products to many different countries throughout the globe.

Textile Exports: India is the world's second-largest exporter of apparel and textiles. India's textile industry is a major driver of the nation's economy, accounting for 15% of its export revenue. Bangladesh, the UAE, Europe, and the USA are India's major export destinations. Because of the initiatives, the competitiveness of the sector and exports have both increased. India's textile industry is primarily export-oriented, shipping a variety of products to many different countries throughout the globe.

Advancement in Digital Textile Technologies: Intricate designs and styles can now be produced with digital weaving, which also offers increased strength and durability. The development of digital textile technologies has also facilitated the production and sourcing of textiles with a range of characteristics, including antimicrobial, fire- and water-retardant qualities. The production of fabrics that are both aesthetically pleasing and highly functional has been made possible by these advancements, which have revolutionized the textile industry.



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Scope of Self-employment Opportunities: The sector's potential for growth will be further enhanced by its ability to enter untapped markets because of technological advancements. As a result, people in this field who possess both a creative eye and an entrepreneurial spirit can succeed. People can use a variety of platforms to present their work and reach a wider audience thanks to the growth of the internet. A variety of tools and resources are also available to assist individuals who are interested in starting their own product creation business.

More Jobs for Women: In the last few decades, women have made significant progress in the textile industry. Furthermore, because they are frequently more receptive to novel concepts and methods, women are assuming leadership roles and contributing significantly to economic growth. In the end, it's critical to make sure that there are more positions in the textile sector accessible for women, as this will contribute to the development of a more just and successful sector. Women make up between 60-70% of the workforce in the textile and apparel industry, according to a Times of India report.

Manufacturing Practices

Automation has been embraced by the textile sector in an effort to boost productivity, cut expenses, and increase efficiency. In the textile industry, automated procedures are used at many phases of the production process, from design and manufacturing to quality assurance and logistics.

Advantages of automation in textile

1. More production in less time: Due to automation in textiles, it is becoming possible to produce more products in less time. Where previously work was done by workers, workers could not work non-stop, at one time they would get tired and needed a break. But as a result of automation, products are now being produced non-stop.
2. Product quality enhancement: Automation is producing higher quality and flawless products than before. When working with workers, there was always the risk of errors for various reasons. But automation has greatly reduced that fear.
3. Low labour wages: Reducing the number of workers in the various stages of automation in the textile sector. In some cases, this automation has reduced the number of workers by 50-60 percent and in some cases up to 90 percent. As a result, the same work is being done with less workers than before, but in less time. Therefore, the amount of labour wages in the production of goods in any sector has decreased.
4. Reduce working hours for the same production: Automation made it possible for the same tasks to be performed but with fewer hours of labour for employees. For example, inventions such as Eli Whitney's cotton gin made it possible to separate the seeds from cotton without using manual labor.
5. Reduce production costs: Company leaders signed a development agreement to obtain an automated machine that handles multiple fabric processing steps, including cutting, and sewing the material. The most impressive aspect is that it only needs 22 seconds to complete a T-shirt. A representative said that each garment's labour cost is just 33 cents, which is cheaper than any market in the world can offer.
6. Increased job security for workers: We know that in textile industry, fabrics are made from yarn and yarn from fiber. Then dyeing and printing is done to make the fabric more attractive. Every step of it, especially the spinning, weaving and dyeing process, can be dangerous for anyone. So, automation has created automatic machine equipment to handle most of these processes by securing working conditions for all in the textile industry.
7. Increasing demand for skilled workers: As automation has reduced the number of workers / workers in the textile industry and where 150-200 workers were needed earlier, it is now working with only 10-12 workers/operators. Technically skilled personnel are required to operate this equipment with modern technology and high quality. So, the demand for skilled textile workers is increasing with automation.

Need for the study

The silk and textile industry in Ramnagar have been compelled to abandon their conventional methods due to the overwhelming demand for automated friendly procedures. Over the past decade, traditional practices have led to massive environmental disasters. The primary goal of this paper is to determine whether or not green manufacturing



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practices have benefited manufacturers, and if so, how these benefits extend to entire organizations as well as the environment and society.

Research questions

- What made you to choose the particular topic / why automated manufacturing is need of the hour?
- Why is the silk textile industry's adoption of automated manufacturing practices necessary? What effect does it have on Ramnagar's environment?
- How different is traditional manufacturing practice as against automated manufacturing practices in Ramnagar?

REVIEW OF LITERATURE

Luis Almeida wrote in "Ecolabels and Organic Certification for Textile Products," which was published in 2014(Almeida, 2014), that the fashion supply chain is placing an increasing amount of emphasis on sustainability, requiring textile producers to adhere to strict environmental and social standards throughout the textile-clothing chain. The primary objective was to determine what customers wanted in terms of environmentally friendly products, which included "Organic Textiles." It also provided an overview of the requirements for the most widely used eco-labels was given, including the Fairtrade, Oeko-Tex 100 (including the new Sustainable Textile Production certification scheme), Bluesign, European Union Ecolabel (flower label), Fairtrade, Fairtrade, and labels from retail chains (Clear to Wear and Ecosafe). As stated in "Perspectives, Drivers, and a Roadmap for Corporate Social Responsibility in the Textile Industry" (Monica Cavalcanti, 2015), provides an overview of the theories, motivations, results, and methods associated with corporate social responsibility (CSR) and also Social, Economic, Political, and Legal factors affect countries differently and result in different institutional dynamics and organizational behaviours. It offers managers a road map for implementing CSR in their businesses. the apparel and textile industries have grown more globally competitive in their pursuit of advancing and realizing social and economic development as well as environmental sustainability.

Anupriya Desore and Sapna A. Narula(Desore, August 2018), "A summary of the textile industry's corporate response to sustainability issues," 2018. In order to address the goals, challenges, and responses of textile sector businesses in favor of sustainability, the writers organize the literature into categories. Additionally, they assert that many managerial strategies have been used to urge industries to incorporate sustainable practices into their production processes. At the same time, studies on managers' perceptions of new technologies and procedures are given careful consideration.

Parthiban Manickam and Gopalakrishnan Duraisamy(Parthiban Manickam, 2019), "4-3Rs and circular economy," 2019. Planning and strategic policies that guarantee that the products could be used for reengineering or to produce components of refashionable material in every production cycle could minimize the amount of waste generated in the textile and apparel industry. The fashion and textile industries have the potential to divert textile waste from landfills and grow the apparel sector, which in turn can recycle and reuse textiles.

The 2020 work "Textile Industry in a Changing World: Challenges of Sustainable Development" by Catarina Costa, Nuno G. Azoia, Carla Silva, and Eduardo F. Marques(Catarina Costa, 2020) focused on sustainable practices to reduce the harmful effects of the textile industry's production and excessive consumption on the environment. The issues raised included the massive amount of water resources used, the carbon and greenhouse gas emissions that are released before reaching the consumer, and strategies for resolving these through environmentally friendly measures adopted by the industry to supportably manufacture clothing.





RESEARCH METHODS

Research Design

This study's data comes from various textile industries located in Ramnagar, Karnataka, India. Due to the intricacy of the goal, the textile data, convenient random sampling was particularly used to select textile industries in Ramnagar. The research mainly focuses to know the factors of green and conventional manufacturing practices adopted in textile sector in Ramanagar. Also, to find out the correlation between the factors of automated manufacturing practices. The major goal of this study is to analyse the difference between the automated manufacturing practices and conventional manufacturing practices in textile industry. I've used KMO and Bartlett's Test, Factor Analysis and Regression for data analysis.

Objectives

1. To know the factors of Automated and Conventional manufacturing practices adopted in textile sector in Ramnagar.
2. To study the correlation between the factors of Automated Manufacturing Practices.
3. To analyse the difference between the Automated Manufacturing Practices and Conventional Manufacturing Practices in Textile Industry.

Data Collection Method

In this research, the Stratified Sampling technique is used to collect the required data and conduct the research. Structured Close-ended questionnaires were prepared to collect the data. The sample size of the research conducted was 50 respondents comprising employees from 13 textile companies in Ramnagar, Karnataka.

Hypothesis

H10: There is no latent factors manifested.

H1a: There are latent factors manifested.

H20: There is no standardized impact of measured variables on the factors.

H2a: There are standardized impact of measured variables on the factors.

H30: There is no correlation between the factors (F1, F2, F3 and F4).

H3a: There is a correlation between the factors (F1, F2, F3 and F4).

H40: The data doesn't fit the conceptual model.

H4a: The data fits into the conceptual model (no difference between the conceptual model and the measured model).

Analysis

- 36% of Respondents have inferred that Financial Incentives by the Government & Sale of Finished Goods; Employee training program, and Traditional manufacturing practices are the reason for Textile companies to adapt Automatic manufacturing practices as it ensures them to long run business sustainability and also greater amount of productivity.
- 60% of the respondents inferred that consumer's preference is moderately significant on the decision making on the textile companies as customers have the buyer power in the market and 12% have inferred to have highly significant and neutral significance on the decision making process in textile industries.
- 32% of the respondents conjecture increasing in Production and 28% of respondents conjecture Maximising profit margins is the primary objective for adapting Automatic Manufacturing and 36% of respondents inferred cost saving, and 12% of respondents inferred customer preference and market competition shall be the driving force from adapting automatic manufacturing over traditional manufacturing.
- According to the study, 32% of respondents have an opinion that it shall result in more energy consumption, 24% have pinioned that it shall result in minimum usage of resources and 20% state that it shall enhance the raw material extraction on adoption of automatic manufacturing as these are to be working on electricity along with which shall ensure better utilisation of Raw Materials.





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- It is inferred that 52% of respondents discern customers preference is significant to shift to automated practices over traditional practices as they have an opinion that automated silk looms are resulting in long lasting sustainability in comparison with traditional manufactured looms.
- 42% of the respondents have inferred cost saving is having a neutral effect on automated practices over traditional practices as it shall result in the huge initial investment on machinery and labour cost over the period of existence.
- 48% of the respondents State that there is significant impact on employee satisfaction on the shift from tradition to automation as employees rate on getting infected with various diseases of breathing problem, hearing loss, physical injuries, and many more have reduced on a huge basis.
- 40% of the respondents have stated that there is highly significant and 40% of the respondents have stated that there is significant impact on the speed of production as it shall benefit the producers to produce more numbers in quantity at better quality and usage of resources more effectively.
- 48% of the respondents inferred that there is significant impact on the environment which shall emphasis on the sustainability on shift of usage from traditional practice to automated practices.
- 36% of respondents have inferred that Market forces is the vital reason for integration of automated practices, and 32% of respondents have inferred that government policies like Subsidy, National Silk policy 2020, MGNREGA scheme are organisational factor for producer to integrate traditional and automated Practices, and 24% of respondents conjecture that Technological Advancement, Market Forces are the encouraging factor.
- 64% of respondents have inferred that employees in the organisation sense a positive change and 8% of the respondents are highly positive and have complete satisfaction and wellbeing at the workplace concerning their Job on conversion to Automated Practices.
- 60% of the respondents’ state that consumers are positive on perceiving the automated produced products than the traditional manufactured products as these provide assurance of durability, better quality of product.
- 44% of the respondents inferred that they are collaborative with each other and external entities and 16% of the respondents are highly collaborative with each other and external entities in traditional business for shared resources and knowledge of manufacturing practices in Textile Industry.

Data collection methods- Sample design, size, techniques

At the outset, the data is collected and analyzed to develop the model confirming the relationship between the variables. Thus, the researcher adopts factor analysis to check statistical factors and vet with theoretical purview. The first table analysis is the KMO and Bartelsts test for checking the suitability of the data set.

Analytical tools		
KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.813
Bartlett's Test of Sphericity	Approx. Chi-Square	2347.149
	Df	105
	Sig.	.000

From the above test result, the data is suitable for further analysis with a p-value is < 0.05 (0.00); and sampling adequacy is significant with > 0.813.

Secondly, the researcher applies the Total variance explained to ascertain no. of components generated.





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Total Variance Explained									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.747	31.648	31.648	4.747	31.648	31.648	3.723	24.823	24.823
2	3.381	22.543	54.191	3.381	22.543	54.191	3.643	24.284	49.107
3	3.152	21.017	75.208	3.152	21.017	75.208	3.613	24.089	73.196
4	2.304	15.359	90.566	2.304	15.359	90.566	2.606	17.370	90.566
5	.283	1.889	92.455						
6	.235	1.570	94.025						
7	.190	1.265	95.290						
8	.162	1.077	96.366						
9	.139	.926	97.293						
10	.111	.741	98.034						
11	.078	.518	98.552						
12	.073	.486	99.038						
13	.066	.442	99.480						
14	.048	.319	99.799						
15	.030	.201	100.000						

Extraction Method: Principal Component Analysis.

With the above test result, there are 4 components generated with 90% of variance explained in the given data set. Thus, the results support H1a.

This also visually explained in the 'component plot in rotated space'.

It is evident that there are 4 components and all measured indicators are loaded to the 4 factors significantly. In the third phase, the researcher adopts to assess the no. of measured indicators loading to each component. This is carried by the 'Rotated Component Matrix'.

Rotated Component Matrix

	Component			
	1	2	3	4
VAR00001	.977	.057	.027	.083
VAR00002	.943	.024	.030	.031
VAR00003	.957	.051	.073	.035
VAR00004	.962	.128	.028	.020
VAR00005	.056	.946	.054	.090
VAR00006	.038	.942	.031	.041
VAR00007	.076	.941	.015	.026
VAR00008	.085	.957	.089	.088
VAR00009	.059	.051	.961	.131
VAR00010	.026	.126	.944	.017
VAR00011	.041	-.019	.900	.070
VAR00012	.031	.035	.973	.085
VAR00013	.030	.044	.096	.923
VAR00014	.001	.099	.102	.923
VAR00015	.113	.065	.061	.918





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The above table shows the significant loading of variables (indicators) to component 1 with 4 indicators, component 2 consists of 4 indicators, the component included with the loading of 4 indicators, and the final component is loaded with 3 indicators. These components are renamed as Constructs for examining the relationships. In the final phase, the researcher adopts to develop the confirmatory model to suffice the observed matrix of a conceptual matrix with a measured indicator matrix. During this Confirmatory Factor Analysis (CFA) model, the study envisaged regression weights.

Regression Weights: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
VAR00004 <--- F1	1.000				
VAR00003 <--- F1	.968	.040	24.417	***	
VAR00002 <--- F1	.963	.048	20.269	***	
VAR00001 <--- F1	1.030	.033	31.360	***	
VAR00008 <--- F2	1.000				
VAR00007 <--- F2	.922	.043	21.389	***	
VAR00006 <--- F2	.911	.042	21.726	***	
VAR00005 <--- F2	.971	.042	22.920	***	
VAR00012 <--- F3	1.000				
VAR00011 <--- F3	.839	.050	16.837	***	
VAR00010 <--- F3	.931	.036	26.002	***	
VAR00009 <--- F3	.976	.030	32.584	***	
VAR00015 <--- F4	1.000				
VAR00014 <--- F4	.959	.069	13.958	***	
VAR00013 <--- F4	1.030	.076	13.639	***	

With all indicators are significant and with < 0.05 p value support statistically the CFA model. The table result supports the H2a, asserting that there exists the regression value on the constructs/latent factors.

As per the model fit concerned the below fitness are considered – Baseline comparison, and CMIN (chi-square to degrees of freedom).

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.948	.935	.982	.977	.981
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	36	127.926	84	.001	1.523
Saturated model	120	.000	0		
Independence model	15	2464.006	105	.000	23.467

The output suggests that the CFI > 0.95 (0.981); TLI > 0.95 (0.977) and CMIN/DF < 3 (1.523), thus, these results infer the fitness of the CFA Model. Since the model fit, this supports the H4a.



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In the final phase, the researcher exhibits the visual representation of the causal relationship between the latent factors/constructs. This phase uses the Path analysis, wherein the measurement model is explained with the loading of measured indicators (VaAR0001 to VAR00015) to constructs (F1 to F4). It also explains the relationship with double-headed arrows.

From the path analysis, it is evident that there exists a correlation among the factors, thereby the researcher rejects the null hypothesis and accepts H3a.

FINDINGS

For an assortment of reasons, the majority of businesses in the textile industry are more inclined to adopt automated technologies than traditional ones. The primary factors that drive a business to transition from traditional manufacturing practices to automated manufacturing practices are financial incentives, employee training programs, traditional manufacturing techniques, and the preferences of the majority of customers. The primary objective and enticing factors are to increase production speed and reduce costs, respectively. These actions will ultimately enhance the utilization of resources, raw material extraction, and the sustainability of the environment. The vast majority of the Employees are benefited from the integration and transformation into automated practices, which was facilitated by technological advancements, government policies, and market forces, in accordance to the study.

Future Implications and Directions

There are about 1334 reeling manufacturers working in the textile industry in Ramnagar; only 33 of them employ traditional methods; the remainder of manufacturers have shifted to automated manufacturing. This indicates that the traditional manufacturers must shift to automated manufacturing in order to survive and be sustainable in the market over a longer period of time. A method to do this would be by assisting government initiatives like the Silkworm Seed Production Centres (SSPCs), which are aimed at supplying farmers with the best seeds possible to raise healthy eggs.

The report also emphasizes on the sustainability of Environment, Increase in production of the organisation which shall be resulted from the transformation to automated production. On transformation of automated practices employees needs to be provided training on the same as it is resulted in higher satisfaction of the employees. Though the initial cost is high on investment with automated practices, there are various government schemes provided by the government for establishing automated machines in place of traditional machinery. According to current statistics, the majority of machines are semi-automated. It is recommended that the organization switch to full automation, despite the fact that it will require a larger initial investment as a result of lower labour costs and more effective and efficient use of raw materials.

CONCLUSION

The study's findings revealed that automated produced silk is in much higher demand than traditional manufactured silk. It is apparent that automated production has fewer drawbacks than traditional methods, however, at the same time, substantial benefits for the company, the client, and society are recognized. The primary purpose of the research also indicates that automated processes have improved customer happiness, output, and the effective and efficient utilization of resources





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<p>Fig. 1. Showing: Process of Sericulture</p>	<p>Fig. 2 showing Harvested Cocoon</p>
<p>Fig. 3. showing Reeling using Automated Machines</p>	<p>Fig. 4. Showing Spinning of Reels</p>
<p>Fig.5 Showing Dyeing and weaving process if spinned Reels</p>	<p>Fig.6. Component plot in rotated space'</p>





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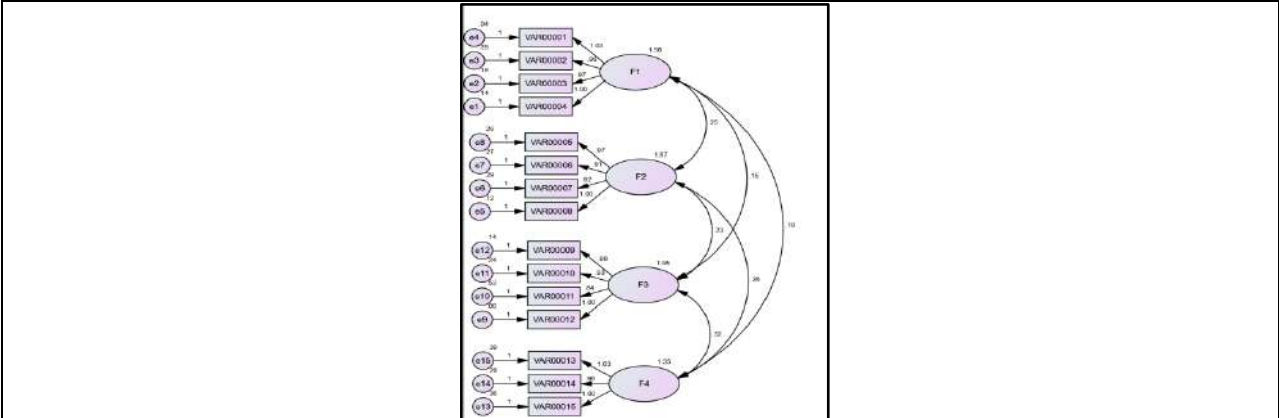


Fig. 7. Analysis





A Comprehensive Survey of Machine Learning Approach to Detect Stress based on Facial Expression

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 27 Jun 2024

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ABSTRACT

Stress detection is a crucial aspect of mental health monitoring, with facial expression analysis promising as a non-invasive way of evaluation. Identifying individuals who suffer from stress and providing them with appropriate support and treatment is required. According to the famous statement "Face is a mirror of mind," a person's mental state or emotions can be seen on their face. In recent years machine learning methods have demonstrated encouraging results in the recognition of stress from a variety of sources including facial expressions. This study presents an extensive review of how computer vision techniques were used to forecast stress and related aspects using machine learning algorithms. Moreover, it examines and reviews work done on various assessment criteria that are frequently employed in this field. This paper focuses on a variety of algorithms that are used for feature extraction and facial expression analysis, including SVM, CNN, Naïve Bayes, Random Forest, and a few more. Lastly, we have discussed a gap analysis and offered a scope for additional research in this area.

KEYWORDS: -Face, Facial expression, Emotions, Stress, Machine learning.





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INTRODUCTION

Nowadays stress is a major public health concern among individuals and it can have significant impact on quality of life. The precise detection of stress and management of stress have become increasingly important in supporting mental health and well-being. Traditional methods of stress detection, such as self-reporting and physiological measurements, have limitations in terms of accuracy, reliability, and invasiveness. The development of automated systems for stress detection based on facial signals has been made possible by advances in machine learning (ML) techniques. Facial expressions are powerful markers of emotional states, including stress.

An event or situation that can potentially induce stress in an individual is referred to as a stressor. Stress can have both positive and negative effects on a person. "Eustress" is a type of stress that has good effects. An individual experiences this form of stress when they anticipate that a stimulating incident will occur in their immediate area. "Distress", a type of stress that has negative effects, is characterized by anxiety or a significant degree of concern. [13]. Employees are more prone to feeling stressed out when their lifestyles and workplace culture change. The problem still exists despite the fact that many organizations and sectors offer programs connected to mental health and seek to improve the workplace environment. The computer vision methods used to extract visual proof, the machine learning model used to forecast stress, and related parameters[23].

Automated methods for assessing stress and anxiety levels based on facial cues can provide a non-intrusive and unbiased tool to assess mental health issue. There are different parameters to detect stress based on Face [9].

Facial expression and emotions: - Evaluate stress level on the basis of heart rate and facial expression during Internet usage. Also some other studies [2][5] that investigate Facial Expressions Recognition under stress condition.[18]

Facial Action Unit: - In order to differentiate between a neutral and stress/anxiety state, the study found that automated identification of facial Action Units (AU). The UNBC and BOSPHORUS datasets, two readily available annotated facial datasets, are used to train a model for autonomous recognition of facial action units.[25]

Head Pose: -Stress detection and head motion patterns were correlated. To examine various stress effects, a scientific experiment with neutral and stressful situations was conducted. Two datasets (SRDSA '14 and SRDSA '15) with 23 and 24 individuals, respectively, were employed in this research project. In study [31] discussed about the good and negative impact, or emotional state of a person can be revealed through head and facial movements [26].

This study examines different techniques to identify emotions from facial expressions. The study is organized as follows: Section 2 discuss the systematic literature review technique. Section 3 explains how the literature review study was conducted and how the papers were categorized based on several characteristics. Research Gap & Analysis in Section 4, and the study's conclusions are finally highlighted in Section 5.

METHODOLOGY OF THE SYSTEMATIC LITERATURE REVIEW

A Systematic Literature Review (SLR) is a method employed to assess the significant components of literature within a specific field.

Systematic Literature Review Methods

Research questions:

RQ1. What are the different techniques used for Face Recognition.

RQ2. What methods can be employed for recognizing facial expressions and different datasets?

RQ3. What are the relation between Facial Expression and Stress Detection?

RQ4.What are Different techniques to detect Stress Using Facial Expression?





Search Strategy and Data collection

For this study, a literature review was performed as a primary task, which involved searching for relevant research papers. A keyword search was conducted on papers published in IEEE Xplore, ScienceDirect, and SpringerLink in the last decade. The basic set of keywords were “Face Detection”, “Facial Expression” and “stress detection using machine learning”. A total of 75 papers were collected using all the keywords, and among these, 55 papers were finally selected.

LITERATURE SURVEY

In this section, we provide a brief overview of related research on face recognition, facial expression recognition, stress detection based on emotions using machine learning technique. According to the review, a method for identifying stress based on facial expressions consists of three key steps: face detection, facial expression recognition, and its classification for stress detection. Table 1 lists various machine learning methods used by other researchers that could be applied to identify facial expressions, along with the datasets that were utilized and the level of accuracy attained.

In a similar manner, Table 2 summarizes the data input formats used to train the model and tabulates details about the study that uses Face as an attribute for stress detection in various contexts, such as driving a car or by watching video footage the degree of accuracy attained.

- Table 3 lists the algorithms that were most commonly utilized in the most recent review study.
- Fig-1 Represents the working flow of FER system and its classification.
- Fig-2 provides a summary of the ML Algorithm-wise reference paper count.

Answer to RQ1: Different Techniques of Face Recognition

Face detection is widespread in people’s daily life. As per the study, Researchers discussed computer vision and have developed a number of face identification tools that are based on various face detection techniques, including haar feature-based cascade classification systems, deep neural networks, and machine learning algorithms using the CelebA dataset. And well-known face identification tools were evaluated and carried out within the scope of the work: OpenCV and YOLOFace. The results show that YOLOFACE has the highest accuracy (98.93%) of the two tools. And the best result in terms of processing time is provided by Open CV. For future work, more tools are required to be included for comprehensive analysis [17]. An improved Region-based CNN is used on dataset Wider Face and FDDB. Compared to other machine learning methods such as the Haar Cascade, HOG (Histogram of orientated Gradient) based face detection provides more accurate results [42]. Built-in features of the open source computer vision library (Open CV) that can quickly identify human faces by detecting them and then comparing them to training sets (facial photos stored in the database). Using standard library techniques, image handling and processing are performed. These library functions can take pictures with a webcam, make windows to hold them while they’re being used, store them in a database, and then process them to verify exact similarity. Face detection is achieved with the help of Cascade Classifier and Haar Cascade[43].

The Viola-Jones algorithm used for face detection with dataset of 40K real-time image [44]. As per study discussed about two approaches for face detection are Features based and Image based approach. In feature based approach used edge detectors, the eyes, nose, mouth, and hairline. A statistical model is created based on the features that were retrieved to characterize their correlations and confirm the presence of a face. Example of techniques are ViolaJones, edge, motion etc. In general, appearance-based methods use statistical analysis and machine learning techniques to identify the relevant aspects of face and non-facial images. Technique used for image based approach are SVM, Neural-networks, AdaBoost learning etc [45]. A sliding window approach is used to search for potential face regions in the image. A boosted classifier is used to classify each region as a face or non-face based on Haarlike features [46].





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Answer to RQ2:- What methods can be employed for recognizing facial expressions.

As per study [54] methods employed for recognizing facial expressions is bidirectional LSTM-CNN (Long Short-Term Memory). With this hybrid design, unique features from face photos may be extracted by leveraging the strengths of both CNN and LSTM networks. In the experiment, CK+ datasets are employed, and to prevent overfitting and enhance model performance, data augmentation is also applied to the dataset. 99.43% accuracy is attained using data augmentation.

The A-MobileNet architecture, which is CNN based, is also utilized for face expression recognition. Here, Facial expressions captured using mobile devices. This approach uses lightweight architecture which balances model complexity, accuracy and also suitable for real time applications with less no. of resources. It provides promising solution for implementing facial expression recognition using mobile device. On datasets FERPlus and RAF-DB, the A-Mobile Net model performs better than the others [52]. As per study EmotionNet Nano retains a high degree of accuracy in facial expression recognition, It can be applied to many real-world scenarios where accurate and timely facial photo emotion recognition is required.

3.3 Answer to RQ3 Relation between Facial Expression and Stress Detection

Facial expressions can be used to measure anxiety and stress in comparison to neutral and relaxed states. The final facial cues employed in this study were those related to the eyes (blinks, eye aperture), the mouth (VTI, ENR, median, variance, skewness, kurtosis, and Shannon entropy), the head (head movement amplitude, head velocity), and the heart (heart rate estimation derived from variations in facial skin color). In contrast to other relevant research using semi-invasive measurements like ECG, EEG, galvanic skin response (GSR), and skin temperature, all these aspects offer a contactless method of stress detection that doesn't interfere with the human body. On the other hand, it was concluded that the length of the facial recording could have an impact on the outcomes, particularly if it is very brief, and the analysis of particular facial cues that follow could be questionable. According to our observations, it is advised that a video clip last at least one minute. Future recordings should make use of duration, which could produce more accurate estimations. This study also underlines the need for further testing and validation of these methodologies, particularly in real-world scenarios with more complicated and varied data [9].

Machine learning and computer vision techniques are used to analyze facial expressions that are collected by in-car cameras. The goal is to recognize particular facial expressions and patterns that signify emotional stress, like anger, irritation, or anxiety, and to find links between facial expressions and emotional states related to stress by gathering and analyzing face data from drivers in various driving situations. The objective is to create a strong model based on these facial cues that can recognize and categorize various levels of emotional stress [7]. Researchers want to develop a model that can accurately predict the personality characteristics and felt stress of undergraduate students based on a set of input features using machine learning techniques. This mapping may help in understanding the relationships between personality and stress levels as well as the factors that affect stress in students. Uses a variety of machine learning techniques to train and assess predictive models, including decision trees, support vector machines (SVM), and random forests. These models seek to discover patterns and connections between the personality qualities of the students and their perceived levels of stress [6].

As per the study, many facial expressions are related to depression. A training dataset of happy photos was created using the JAFFE database. For face detection, the Kanade-Lucas-Tomasi algorithm was used. Different features were extracted from the photos using the Gabor filter. And for training, a feature vector was used to create a feature set. For the testing phase, a video of the student's face is taken as they complete the questionnaires. A testing dataset is created from the video after it has been converted to frames. An SVM classifier is used for classification, and it makes a prediction about whether the person is depressed or not. Depending on the outcome, it can be advised that the student seek counseling support [20].

Stress recognition using facial images and facial landmarks has some issues with using biological signals or thermal images. In this study, stress is recognized from an image that is captured by a general camera, and the movement of



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the eye, mouth, and head under stress conditions is analysed using a deep neural network. As a result, it was concluded that a facial land mark is a better option for stress recognition, and accuracy could be achieved if using a gray face image of the appropriate size [27]. Facial stress recognition is divided into three stages: image registration, feature extraction, and classification. In image registration, consider only eyes, nose, and mouth for feature extraction. Gabor filter and HOG features are used. The novel architecture used is SVM and the Slant binary tree algorithm. It employs SVM as the base classifier at each level of the tree. And the proposed architecture achieves an accuracy of about 86.7% and concludes that the nose is the best indicator of stress [28].

Answer to RQ4 Different techniques to detect Stress Using Facial Expression.

A real-time stress detection system consists of a module for face identification, facial expression recognition using a connected CNN, and a module for the detection of negative emotional stress. Data augmentation is used to expand datasets to prevent overfitting caused by a lack of training data. In numerous experiments, CNN architecture achieves competitiveness in the CKG and Oulu-CASIA datasets for facial expression recognition. Additionally, run a simulation experiment on stress identification, counting the number of FE frames that are identified as stress expressions. If the number of stress frames rises above a certain level, the suggested framework will issue a warning. Additionally, the system delivers excellent stress detection accuracy and quick processing in real-world driving environments like the KMU-FED dataset [1].

A convolutional neural network (CNN) is a deep learning approach that is used to identify stress from facial expressions. Deep neural network types, known as CNNs, are frequently employed for image identification and classification applications. CNN is trained in this study to distinguish between stressed and non-stressed facial aspects using extracted facial features. Multiple convolutional layers, pooling layers, and fully linked layers make up the network architecture. To decrease inaccuracy in classification, the CNN's weights are iteratively changed via back propagation and gradient descent optimization. The trained CNN is then used with new input images to detect stress [3].

Computer vision techniques could be used to analyze facial expressions and identify signs of stress and anxiety. This is done by tracking a set of facial features and applying multiple methods to analyze each feature, like dataset acquisition and video selection. ROI detection, head motion estimation etc. [10]. Data from the 2017 OSMI Mental Health Survey of Working Professionals in the Technology Industry. The model was trained using a variety of machine-learning methods. Boosting produced the highest level of accuracy [22]. Facial landmarks for stress recognition and discovered that the ability to recognize stress-related information could be enhanced. Here, the system reads the information from the face using the CNN architecture [23].

Research Gap Analysis

As per literature study in this paper we have observed following findings in this research area:-

1. More standardized method for data collection is required. Along with it, there is a need for more extensive validation studies to test the accuracy and reliability of the algorithms used to analyze facial expression.
2. Additionally Facial expression identification and classification are independent of characteristics including gender, age, ethnic group, beard, background, and birthmarks [29].
3. In some studies Facial action Unit like AU09 (Nose wrinkle), AU10 (Upper lip raiser), AU04 (Brow lowerer), AU23 (Lip tightener), and AU14 (Dimpler) used for stress detection. How complex facial expression are created by combining the AU as well as how these expression reflected on human face[9].
4. Facial landmarks improve the effectiveness of stress recognition. In addition, using a grey face image and employing an acceptable image size yields the best performance [27].
5. Lack of physiological data gathering techniques and which algorithm provides greater accuracy are significant research area.





CONCLUSION

Everyday incident or demand may cause stress, which is a physiological response. One or more stressors can cause stress, which can be seen in the facial expressions. The creation of a highly accurate, efficient, and cost-effective model is the ultimate goal of stress detection. The review discussed here includes key details about earlier research benefits, drawbacks, problems, as well as information on the model's methodologies. However, there is still a great need for further research and improvement because of issues such as dataset bias, generalization to diverse populations, and the requirement for real-time applications. The overall accuracy and dependability of stress detection systems could be improved by including multimodal data sources, such as physiological signals & many more. To improve model accuracy, pre-processing methods and feature extraction techniques for facial expression analysis are reviewed. Overall, this review article serves as a comprehensive resource for any individual interested in using facial expressions to detect stress.

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Table 1. Summary of Facial expression recognition techniques.

Ref. No.	Year	Technique	Input Format	Database Used	Accuracy Achieved
[7]	2014	SVM	Recorded video using NIR camera	set 1 :Frontal View (office settings) set 2:- up-tilted view (car settings)	90.5% of in-door 85% of in-car
[48]	2015	KNN Classifier	Large no. Images	Created database using multiple images	94.5 to 97%
[33]	2016	SVM,KNN,Random Forest	Distance between certain facial features including eyes,lips and eyebrows	Extended Cohn Kanade (CK+),Luxand FaceSDK	KNN - 98.85% SVM -90% Random Forest - 98.85%
[8]	2017	Deep Neural Network	AffectNet	AffectNet	Not Mentioned
[32]	2017	SVM	Images of angry, happy and neutral state	Datasets of 7 people	Not Mentioned
[21]	2018	Viola-Jones Algorithm(Face detection) 2DPCA (Feature Extraction) KTL (Face Tracking)	Face captured by computer webcam	Face94	90%
[34]	2018	RBF Kernel Support Vector machine (RSVM),Neural Network, SSVM,Random Forest,Logistic Regression,K-Nearest Neighbour	CK+ dataset, Local Images	Both CK+ & Dataset collected locally 'in the wild'	RBF SVM achieves 0.94
[1]	2019	Multi-Task CNN	Image Frame	Deep Learning Tensor Flow	Not Mentioned
[38]	2019	CNN	CK+	CK+	Not Mentioned
[20]	2020	Kanade-Lucas-Tomasi(KLT) Algorithm (FaceDetection/Tracking)	Video Footage of college Students	JAFPE	Not Mentioned
[25]	2020	Facial Action Coding System	UNBC, Bosphorus	UNBC, Bosphorus,SRD'15	Not Mentioned





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[4]	2020	CNN	In the wild	CK+, JAFFE, FER'13	Not Mentioned
[47]	2020	CNN	FERC-2013, JAFFE	FERC-2013, JAFFE	70.14 (FERC-2013) 98.65 (JAFFE)
[50]	2020	DCNN	Image Datasets gathered manually.	Image Datasets gathered manually.	78.04%
[35]	2021	SVM ,Navie Bayes	FER2013	FER2013	Not Mentioned
[37]	2021	SVM, ANN	Eye Aspect Ratio (EAR),Mouth Aspect ratio (MAR)	Eye Aspect Ratio (EAR),Mouth Aspect ratio (MAR)	90.50%
[36]	2022	SVM,AdaBoost,Logistic Regression	FER-2013	FER-2013	Not Mentioned
[49]	2022	ResNet50, VGG16 and DCNN,	FER2013	FER2013	83.9%
[51]	2022	ESCNN	FER2013	FER2013	85.54%

Table -2 Accuracy achieved by different techniques for stress recognition

Ref. No.	Year	Techniques	Attribute	Datasets	Accuracy
[7]	2014	SVM	Facial Expression	set 1 :Frontal View (office settings) set 2:- up-tilted view (car settings) or real data	In door -90.5% In car -85%
[19]	2015	CNN	Facial Expression &Body Movements	FABO (Face And Body) dataset	60.80%
[9]	2017	K-NN, Navie Bayes,AdaBoost,SVM	Facial Cues	Video Recording	90.50%
[22]	2018	Boosting ,Bagging, Decision Tree	Mental health	OSMI mental health	Boosting 75.13 bagging 69.43
[26]	2018	K-NN,GLR,SVM	Head Pose Features	SRDSA '14 and SRDSA '15	Not mentioned
[1]	2019	CNN	Facial Expression	CK+, Oulu-CASIA ,KMU-FED	Ck+ - 91.2 OuluCASIA 80.4 KMU-FED 99.3
[25]	2020	Support Vector Regression (SVR)	Facial Action Unit (AU)	UNBC and BOSPHORUS dataset	74.6
[3]	2021	CNN (VGG16,VGG19, Inception-ResNet V2) classifier	Facial Expression	KDEF,CK+	92.10%
[23]	2021	CNN	Facial Photos and Landmark	Real time video captured data	Not mentioned





Table 3: Usage of ML algorithm

Algorithm	Ref No.
ANN	37
CNN	1,3,4,19,23,47,52,53,54
SVM	7,9,26,33,32,35,36,37
KNN	9,26,33,34,48
Navie Bayes	9,35
Ada Boost	9,36
Random Forest	33,34
DCNN	8,49,50
Decision Tree	22

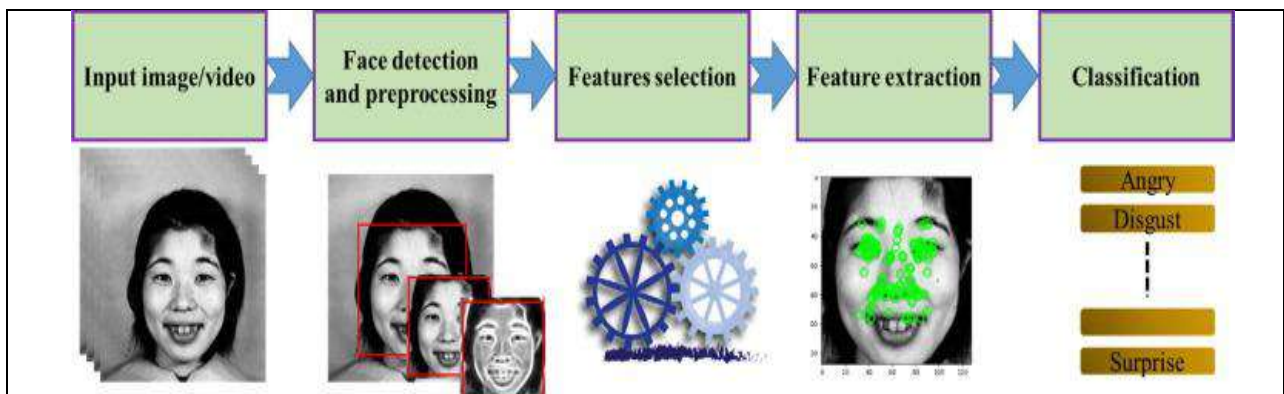


Fig 1. Represents the working flow of Facial Expression Recognition and Classification [55].

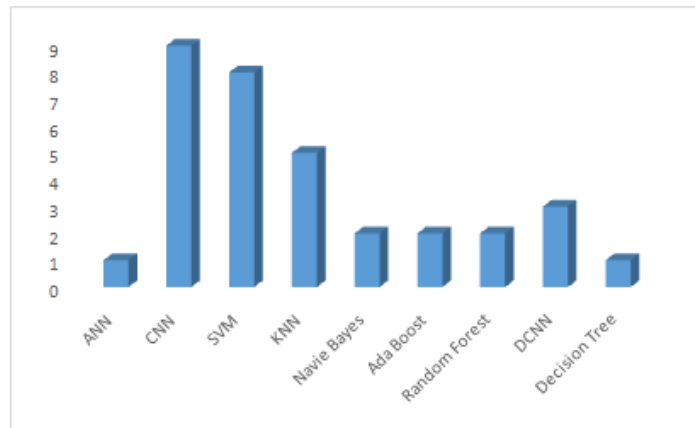


Fig 2. ML Algorithm-wise Reference Paper Count.





To Study the Effect of Strengthening Exercises along with Therapeutics Aquatic Exercises (TAE) on Patients with Knee Osteoarthritis: A Narrative Review

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 24 Jun 2024

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ABSTRACT

To make a narrative review on the effectiveness of strengthening exercise along the therapeutic aquatic exercise (TAE) on knee osteoarthritis. Osteoarthritis is a degenerative disease which mainly affects weight bearing joints. The knee OA represents the most frequent cause of disability in the world and it also impacts on social, psychological demand and economic problems to the people. There are different treatments available according to the stage of disease, pharmacological and non-pharmacological. The treatment should always approach from the safest, least invasive and less expansive to the more advanced ones. The non pharmacological treatment like physical therapy is always choosing not only for treatment but also for preventive measurement of the OA. The strengthening exercise and therapeutic aquatic exercise are often prescribed to the OA patient, but there are very few studies which proved its effectiveness, so this narrative review study aims to bring more informative results for future references. The databases were searched - Global health, COCHRANE Library, Medline, Scopus, EMBASE, CINAHL, PubMed and Web of science for reviewing the articles related to interventions for Knee OA. studied from 24 eligible articles, it was concluded that there was a positive result of strengthening exercises along the aquatic exercise for knee OA. The strengthening exercise along the aquatic exercise reduced pain, functional disability and reduced speed in joint space narrowing. Both strengthening exercises and therapeutic aquatic exercise yielded positive results in reducing pain, disability and functional problems related to knee OA.

Keywords: Osteoarthritis, strengthening exercises, aquatic therapy.



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INTRODUCTION

Osteoarthritis is one of the chronic degenerative conditions featured by pain in the joint, tenderness, inability to move, crepitus sound, sometimes effusion, and different degrees of localized inflammation. The OA attacks the articular cartilage and also the entire joint, which include the sub chondral bone, ligaments, capsule, synovial membrane, and periarticular muscles (3). Osteoarthritis (OA) is very popular degenerative musculoskeletal conditions in the old age population worldwide, and its prevalence is very high and interpreted to go up significantly in the future as the population get old. Currently knee OA affects about 40% of people older than 75 years and hip OA about 10% (13, 19). Variety of therapeutic interventions and busy and sedentary lifestyle changes may reduce the risk of physical damage and hence slow down the risk of disease activity. Weight reduction plays an important role in reducing the load on the knee joint in overweight patients. Educating patients to place their joints properly would be helpful to reduce limitations and relapse (2). OA patients treated with strengthening exercises had resulted in pain relief, prevention of disability, and improvement in walking speed as compared to their initial status (20). There are two different types of Osteoarthritis – Primary and Secondary Primary OA- It is commonly related with the aging. Progression from adult to elderly population water content of cartilage increased and protein make up of cartilage decreases. The Space between the femoral and tibial condyles reduces due to which symptoms appears (1). Secondary OA- It happens when the person is having another disease like Obesity, joint diseases, diabetes, endocrine disorders etc. and that will lead to OA is termed as Secondary OA (1,7). There are various factors contributing in primary as well as secondary OA. The primary factors such as repetitive weight bearing, trauma, competitive sports without rest periods and excessive sedentary lifestyle whereas secondary reasons classified as obesity, varus/valgus deformity, intra articular injuries, infections such as Rheumatoid arthritis, Tuberculosis and Diabetes Hydrotherapy has plenty of advantages over land-surface physiotherapy for people with OA. Effervescences of the water lessen weight bearing across joints affected by pain (10). Randomized controlled trial studies conducted research in context to patients with OA and concluded that efficacy of the treatment is weak because of lesser research (10, 11). The goal of the present study was to determine whether strengthening exercise along the therapeutic aquatic exercise in people with knee OA has effective results or not through narrative review study. The Presenting signs and symptoms are Pain, muscle stiffness, activity limitation, participation restriction, swelling and crepitus sounds (3, 24). On examination there will be synovial thickening as indicated by a joint line tenderness with effusion, crepitations are felt on movement. [9, 21]. Knee OA mainly influences and affects the three part of Knee complex (Fig.1) and generally progresses slowly over 10-15 years, obstructs day to day activities. Now it is updated that OA is multifactorial in origin clinically (19,21).

Search Methods

The various sources used for obtaining this information represented in table 1. Various search engines and databases were visited for reviewing the articles. Data have been taken from PubMed, Cochrane Library, Science Direct, Research gate, Oxford Academy of Physical Therapy.

Selection Criteria

Type of studies

Randomized control trials, clinical trials compared with control group (Usual care, education, social attention, medication, lifestyle modification) (1,15,17).

Types of participants

Inclusion criteria

OA in one or both knee/ hip- by American college of rheumatology criteria

Participants with all degree of OA.

Hip / knee pain.

Osteophytes on radiographs.

Joint space narrowing on X – rays.



**Tarandeep Kaur**

Pain Intensity- <4 cm on VAS.

Struggling In climbing the chairs, walking and lift up from chair.

Age criteria – 60 years or above

Exclusion criteria

Mix OA and RA.

Other arthritic conditions.

Diseases which affects other joints, other inflammatory joints diseases.

Lower limb joint replacement surgery.

Recent history of lower limb trauma, Peri-articular Knee fracture

Skin disease or open wounds, Heart and Lung diseases

Hydrophobia ,Urinary and fecal incontinence , Language and intellectual problems

Intervention

The focus on strengthening exercises should be on the major muscles of both the hip and the knee even though the focus is on the knee (4,5). Researchers are still trying to pin point what the difference in effects would be if strengthening exercises were done in water and not only on land (8,17). The use of aquatic equipment's for strength along with the water itself makes it more effective (6). Often times the quadriceps muscles undergo muscle atrophy due to the decreased workability (20, 21). The hamstring, muscles are a predictor of any activities such as struggling in stair climbing sit to stand and should not be ignored in the intervention (14). Strengthening exercises can be performed in the water with the use of therapeutic equipment's such as resistance bands, ankle weights, aqua resistant fins, aqua bench (16, 22). Before performing these exercises, a 10-15 minutes session of warm up and cool down is required, such as walking in the pool front ways and backwards, sideways and high stepping the temperature of the water is also checked (9,13).

Design of Intervention

The study consisted of a seven week intervention (Table 3). The participants underwent a thorough assessment before and after the intervention. Additionally the experimental group received an after effect assessment at 13 weeks (7 weeks post completion of intervention). This procedure was done to see if the outcomes of the intervention were short term or long term.

Two groups of study were taken: Group 1: Control group, Group 2: Experimental group.**Control group**

These are the participants that did not receive either therapeutic aquatic therapy or strengthening exercises during the period of the study, on the less these participants were offered another kind of intervention.

Participants were assessed (fig.2) before starting of the treatment part and make them eligible for take part in the intervention procedure (19,21).

Experimental group

This is the trail group that had to follow procedure for the two exercises being studied. Some participants can withdraw their treatment from control group and switch to experimental group. More people were taking part in the interventional group after completion of more than 3 months after seeing the positive effects.

Outcomes Measures

Primary Outcomes

Pain – Visual analog scale (VAS) Patients who mark their improvement level as 4, 5, 6 and intensity of pain is less showed positive results whereas who scored their improvement level as 1,2,3 and pain severity is more showed less improvement.

Range of Motion – Movements like Hip abduction, Knee flexion/extension, e external / internal rotation was assessed using 'Goniometry'.



**Tarandeep Kaur****Secondary Outcome**

Disability- WOMAC scale = The 24-components were asked in WOMAC scale. It was used to evaluate the extent of pain, Muscle stiffness, and Level of physical function. It is very reliable and valid tool to assess the people with knee and hip Osteoarthritis. High score of WOMAC indicates worse pain and functional status. KOOS outcome measure evaluates five elements - Pain, signs & Symptoms, Functional Independence, Sport and restoration function and Knee related quality of life. It is alternative part of WOMAC.

Muscle strength – Dynamometry and Manual Muscle Testing are used to assess the muscle strength. Isokinetic dynamometry is used to assess maximum strength of Quadriceps and Hamstrings at 30 degree/s, 60degree/s, 90degree/s is done.

Balance – Static Balance – Romberg test – Evaluated in four situations - (i) Eyes Open/Firm surface [EO] (ii) Eyes closed/Firm surface [EC] (c) Eyes Open / shaky surface [EOSS] (d) Eyes Closed/Shaky surface [ECSS]. To avoid differences in patient outcome all individuals who have participated have to prior run before balance tests. Dynamic Balance – Balance error scoring system and step test

Physical function - Time up and time go test (TUG Test)

Gait parameters – 6 minute walk test /3D gait analysis

Quality of life : - SF-36, SF-36 scale used to assess the capabilities of the client in context of life performance tasks.

RESULTS

The results of the 7weeks studying trail infer that an average trail of confirmation in regards to the use of strengthening exercises along with therapeutic aquatic exercises was effective than control interventions as seeing the outcome measures had improved. The participants had a reduction in pain during movement (VAS), their physical function significantly improved as well as their strength and gait capacity as compared to when they hadn't taken the intervention the whole point of conducting strengthening exercises with aquatic is because the water has low impact on the body thus causing a reduction in joint stiffness too, thereis body conditioning due to its cooling effect and is good for cardiovascular health conditions. The strengthening of both the major knee muscles quadriceps and hamstring significantly enhanced joint stability. Before performing these exercises, a 10-15minutes session of warm up and cool down is required, such as walking in the pool front ways and backwards, sideways and high stepping the temperature of the water is also checked. This intervention is to be given for a ,maximum of seven weeks reports following these exercises proved to have had an effect on the reduction of pain during move, movement. The whole point of conducting strengthening exercises with aquatic is that water has low impact on the body there is body conditioning due to its cooling effects, and good for the overall cardiovascular health and usually effective on overweight patients, the strengthening of the quadriceps and hamstring may enhance joint stability.

In case of OA affecting the medial side of the knee with the use of these water exercises, It is advised to strengthen the knee major muscles, opposite to the affected knee side, thus lowering the stress on the medial knee side which in this case is the affected, and vise-versa. Other doable exercises in water can be done too such as aquatic stationary cycle. A study conducted in 2007 by the APTA using a set of different exercise's in water had shown that the combination of strengthening exercises along with TAE demonstrated a reduction in pain and an improved physical function. There was reduced joint stiffness, improvement on the quality of life. As compared to land based exercises, performing them in water is advantageous because there are less chances of injury. The out turn of this study demonstrates, participants in each experimental group notably improved, in that; pain and physical dysfunction were reduced, thereby enhancing the speed of walking, all this was observed following intervention. A post treatment check up was done few weeks after intervention and the outcome showed that the functional status of the therapeutic group was better than their inceptive status. Although a number of patients could not go all the way through the intervention, due to the unbearable pain that came with exercises, it was seen that, administration of isotonic based exercises gave a considerable amount of outcome on decreasing pain. On the other hand isokinetic exercises proved to have had improved the physical disability as well as enhancing the speed at which the patients



**Tarandeep Kaur**

walked, with that said, a 60 degrees/ second angular speed peak torques lied in both isokinetic and isotonic exercise groups thereby producing a substantial muscle strength procure. Nonetheless remarkable muscle strength procures in 180 degrees/second angular speed top force was only established in the isokinetic set following intervention. Survey of the tests which counted for self assessment dysfunction revealed a close decline in the disorder. In general this study depicts, that water based exercises do hold, yet temporary medically applicable results on dysfunction, self assessed pain and the well being of patients suffering from osteoarthritis of both knee and hip succeeding a water based treatment. Still there is no clarity in regards to the results being centered on the contemporary proof. The prompt effects of water based exercises demonstrate an exact with sustained results, even after having varying partaking set of patients with either knee or hip osteoarthritis. In contrast to the people who did not partake in the water based exercise interventions, the experimental category that had performed these exercises had statistically significant values in context to the results. Control group have lesser positive results as compared to experimental group. There was a reduction in pain, improved performance and well being, as a result of the treatment. With a sum of seventy two percent to seventy five percent patients showing reduction in pain and advanced performance in context to seventeen percent of the non experimental group. There was a continued satisfaction ½ months post fulfilling the intervention, meanwhile a large percentage of the survey partakers continued performing the therapeutic aquatic exercises on their own.

DISCUSSION

This review describes about the efficacy of strengthening exercises along with aquatic therapy on patients with Knee OA. Our findings and data revealed that 7 week treatment, 4 sessions /week protocol showed reduced intensity of pain and stiffness around knee joint along with improvement in functional independency in people with knee OA, Hip/Knee muscle strength and quality of life in people with OA. Our treatment protocol mainly targets the positions in which patient performs actively as much as possible with increase in the resistance progressively with the help of turbulence of water (17). Especially, Participants were mainly focus on the exercises to be done in group therapy instead of orthopedic surgery. It has been stated that Hip abductors are prime muscles to provide stabilization to the opposite side pelvis during the phase of walking and it will leads to reduction of compressive forces around knee joint complex. (16, 17). The Primary result of this review suggested that Hip and Knee OA is very common and can be cure and prevented by Physical Therapy. An exercise programme has beneficial results in reducing the intensity Of pain and muscle stiffness around knee joint along with improvement in functional independency in people with knee OA. Our treatment Protocol mainly targets the positions in which patient performs actively as much as possible with increase in resistance progressively with the help of turbulence of water (15).

There is a significant enhancement in functional tests, such as "sit-and-reach", "knee-push-up", "timed-up-and-go", knee strength test, Half and full squats 60 seconds. Same type of positive results which are coming with the aerobic and muscle strength training also will be achieved with the help of aquatic therapy treatment (17,18). In addition to this, our findings revealed experimental group has more positive results in relation to balance and walking. Balance on different types of surfaces and increase of walking speed are the main components. They showed significant result in improvement of static and dynamic balance with increase of step and stride length. In Cochrane review, researchers advised that therapeutic aquatic exercise may have more pros for the cure of patients/clients with osteoarthritis. They conducted many clinical experiments upto 28 April,2015 and suggested that TAE have greater impact on muscle strength and compared to control group whereas no significant positive results came.[18] Functional independence, Activity limitation, participation restrictions, pain intensity, QoL are assessed before, during and after the treatment have been completed. The outcome measures used in the study showed favourism in context to outcome of severity of pain and physical function (21). Our narrative review of evidence exposed the effect of strengthening along with TAE in reduction of pain and improvement of physical function. Intervention protocol which is planned for the Knee OA patients may not be beneficial for the Hip OA or mixed OA patients. There is possibility that results could vary according to type and location of OA. As a whole evidence revealed that strength training with aquatic therapy for extrimities of lower limb for pain reduction and improvement in physical





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function. Strengthening of group of muscles depend on each compartment of knee joint which involved in OA. However, strengthening of quadriceps and hamstring is beneficial for knee OA (13,14). Clinical Trials assessed different outcomes measures relating to Physical function and mobility. Water provide the surface and platform for doing exercise in comfortable manner (20). In acute stage OA Isotonic exercises play important role in strengthening of muscles around knee joint complex and to provide mobility and stability isokinetic helps the people with OA (19). There are some clinical guidelines and recommendations to follow strengthening exercises along with aquatic therapy. This can be given to all individuals with OA. There should be clinical guidelines have to be follow to implement the intervention (13). Our review suggested that strengthening along with aquatic therapy exercises is needed in reducing the pain severity and improving independence level in patients with Knee OA. Thus clinical guidelines, recommendations and audit tool have been created in our study with evidence to implement aquatic therapy in clinics (1, 6). This is a well-organized narrative review focused on the topic 'To study the effect of strengthening exercises along with therapeutic aquatic exercises on patients with knee osteoarthritis' and we have efficiently concluded with evidence that strengthening exercises along with therapeutic aquatic exercise show major health wise upgrade in osteoarthritic patients through acquiring increased physical performance and decreased pain and joint stiffness. The exercise protocol has helped to enhance major muscle strength of both hip and knee and refined quality of life in people with osteoarthritis. The strengthening exercises consistently helped to enhance muscle mass, density of bone, and joint flexibility. Therapeutic Aquatic exercises has made better progress in muscle tone, improved motor control and posture on walking, also better mobility under water helped to increase range of motion. Overall exercise protocol and outcome measures accommodating both the approaches has shown better result and together they have brought a positive health impact on patients suffering from osteoarthritis.

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Table 1. - Various search methods and databases

PubMed (2003-2018)	Keywords- osteoarthritis, hydrotherapy, physical function, aquacycling, and land based exercise, pain, quality of life, and aged meta-analysis.
Science direct (2016-2018)	Keywords- osteoarthritis, exercise, strength training, Rehabilitation, muscle strength, water based exercise, evidenceBased medicine.
Research gate (2018-2019)	Keywords- osteoarthritis, aquatic therapy, activities of dailyliving, function, occupational therapy, pain, gait, balance.
Cochrane Library (2015)	Keywords- aquatic exercise, hip and knee osteoarthritis.





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Table 2. Type of intervention planned for control group

Type	Duration
Medication/social attention	This is done along with the experimental group for over 7weeks.
Nutrition/usual care	
Disease Education	
Not starting any new exercise intervention for the affected knee.	

Table 3. - Guidelines and treatment protocol for Knee OA patients (12, 13, 18).

Name of Intervention	Name of exercises	Duration	Time	Frequency	Intensity	Water Temp.
Strengthening exercises along with therapeutic aquatic exercise.	<ul style="list-style-type: none"> • Squats • Lunges • Calf raises • ROM exercises • Functionalweight bearing exercises • Isotonic, isokinetic and isometric exercises • Progressive exercises 	7weeks	45-60 min	4 sessions /week	10 repetition/ Exercise. Progressive intensity.	32-43°C

Table 4. - Aquatic exercise treatment protocol (16,23). GUIDELINES OF AQUATIC EXERCISES

Phase	Water depth (at the level of)	Exercises	Sets and repetitions/time
Seven days	Xiphisternum	<ul style="list-style-type: none"> • Bilateral led squats • Dynamic lunges • Bilateral leg calf raises 	2*10 each 5 minutes
Two weeks	ASIS	<ul style="list-style-type: none"> • Continue phase 1 	2*10 10mins
Three weeks	ASIS	<ul style="list-style-type: none"> • Continuation of phase 1 • Unilateral leg stance opposite hip hitching. • Unilateral leg bearing / contralateral knee flexion and extension. • Unilateral body position counterpart hip abduction and adduction 	2*15 each 15mins
Four weeks	ASIS	<ul style="list-style-type: none"> • Unilateral leg squats • Unilateral calf raises 	2*20 15mins





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		<ul style="list-style-type: none"> • Exercise from phase one and three. 	
five weeks	ASIS	<ul style="list-style-type: none"> • 8 Step ups, fast and slow Continue exercise from phase four. 	2*20 15mins
Six weeks	ASIS	<ul style="list-style-type: none"> • 8 step downs • Modified exercises fromPhase five 	2*20 15mins
Seven weeks	ASIS	<ul style="list-style-type: none"> • Continued exercisesfrom phase six. • Leg’s Resistance andSpeed is increased 	3*10 15mins





Screening of Region Specific - Native Isolates from Rice Rhizospheric Soils of Cauvery Delta Zone in Tamil Nadu for its PGPR Activity

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 16 Jun 2024

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ABSTRACT

Rice is the staple food for human life for their daily calorie requirements. The production constrains are due to pest, diseases and nutritional deficiencies. The rhizosphere soil that contains vitamins, amino acids and nutrients harbors a niche for the plant growth promoting rhizobacteria, a group of beneficial bacteria that enhance the growth and yield of crop plants. In the present study plant growth promoting rhizobacteria were isolated from the rice rhizosphere soils from Cauvery delta region of Tamil Nadu. The isolated ten bacterial strains were analyzed for their physico-chemical properties and characterized biochemically for tentative species identification. Microscopic observation of bacterial strains were rod shaped, ring and curved rod, gram reaction was gram positive and gram negative and it was also observed for the motility and endospore formation. IAA, GA₃ and Siderophore were analyzed for the phytohormone production (IAA, GA₃ and Siderophore) results showed that IAA production ranged from (22.19±0.84 to 17.10±0.34 µg/ml), GA₃ production ranged from (6.80±0.05 to 1.08±0.03 µg/ml) and the siderophore production ranged from (10.17 to 4.20 µg/ml). The isolated region specific PGPR strains could be recommended as an effective PGPR bioinoculant for the rice crop in the Cauvery Delta zones of Tamil Nadu

Keywords: Cauvery Delta zone, Native PGPR isolates, IAA, GA₃ and Siderophore production.





INTRODUCTION

Half of the world's population relies on rice (*Oryza sativa* L.) to meet their daily calorie needs, making it the second most important staple crop for humans (Ahmad *et al.*, 2019; FAO 2020). Its contribution in global caloric intake is 23 per cent (Joshi *et al.*, 2020). The region of soil known as the rhizosphere surrounds the root and is impacted by root chemical excretion. Rhizospheric bacteria can obtain vitamins and amino acids from root exudates in addition to other nutrients, increasing their populations of bacteria that are best suited to consume them (Berendsen *et al.*, 2012). The group of helpful bacteria known as Plant Growth Promoting Rhizobacteria (PGPR) supports plant growth and biocontrol through a wide range of ways Kloepper and Schroth (1978). It has been common practice for many years to use rhizobacteria that promote plant development to enhance soil and plant health. Nearly all plants engage in interactions with the microorganisms in their surroundings at every stage of growth. Plant-microbe interactions may be advantageous, detrimental or neutral. In soil, a sizable number of microorganism populations engage in interactions with plant roots (Meena *et al.*, 2012). These microbes, which can colonize plant roots to promote plant growth and mitigate various biotic and abiotic stresses, include bacteria that fix nitrogen, solubilize nutrients, produce phytohormones, antibiotics, and enzymes (Glick 2012; Azcon *et al.*, 2013). Rice-microbe interactions are most successfully mediated by a variety of soil bacteria, including *Azospirillum*, *Pseudomonas*, *Bacillus*, *Exiguobacterium*, *Chryso bacterium*, *Ralstonia*, *Kecuria*, *Serratia*, *Pantoea*, *Enterobacter*, *Burkholderia*, and *Cyanobacteria* (Lucas *et al.*, 2014; Pittol *et al.*, 2016). To improve growth, seed emergence, crop yield and output, PGPR have been isolated and screened from the rhizospheric soil of a variety of crops (Farah *et al.*, 2006). Hence, the present work was aimed to isolate the native PGPR bacteria of rice rhizosphere soils from the cauvery delta zone of Tamil Nadu and to biochemically characterize and to evaluate the efficacy of their PGP activity.

MATERIALS AND METHODS

Collection of soil sample

Rhizosphere soil sample were collected from 5 different districts of Cauvery delta zone from Tamil Nadu such as Nagapattinam, Mayiladuthurai, Thiruvavur, Thanjavur and Cuddalore. Two soil samples were collected from each district. Samples were aseptically kept in sterile poly bags in the targeted sites and carefully transferred to laboratory for further analysis.

Isolation of Native PGPR from rice rhizosphere

The native bacterial colonies were isolated from the rhizospheric soil of rice fields from Cauvery delta zone of Tamil Nadu. One gram of soil was diluted with sterile distilled water and dilution is carried out up to 10^{-6} dilution and the extraction was taken to spread on the Luria Bertani (LB) agar medium. Then, LB agar medium was incubated for 48 hrs at a temperature of 28°C (room temperature). After the incubation the isolates were purified and maintained in LB slants at 4°C for further studies.

Designation of the Native bacterial isolates from Cauvery Delta Zone in Tamil Nadu

All the bacterial isolates isolated from the rice rhizosphere soils were designated as Cauvery Delta Zone (CDZ) – Native Isolate (NI) from 1 to 10 Viz., CDZ – NI – 1 to CDZ – NZ -10.

Morphological characterization of Native PGPR isolates

To report tentatively identified PGPR isolates, the following morphological test were performed to assess the cell shape, gram reaction, endospore and motility.

Cell Shape

The purified cultures, at log phase were observed microscopically for the cell morphological characteristics.



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Gram staining was carried out as per the Hucker's modification (Rangaswami, 1975). In compound microscope under oil-immersion the culture which showed Violet colour that denotes gram positive bacteria and pinkish red colour which denotes gram negative.

Motility

Bacterial isolates were stabbed into the semisolid agar medium and inoculated. These inoculated stabs were incubated at 30°C for 72 hrs and motility was observed. The distance between the place of stab and the point of growth indicated motility.

Biochemical Characterization of Native PGPR bacterial isolates**Oxidase test**

The Native PGPR isolates were streaked on Trypticase soy agar medium and incubated at 30°C in an inverted position for 48 hrs. After the incubation period, 2-3 drops of para-aminodimethyl aniline oxalate solution were added on the streaked area and the plates were observed for the colour change from pink to maroon and finally to purple within 30 seconds indicated a positive reaction.

Nitrate reduction test

The Native PGPR bacterial isolates were inoculated into the nitrate broth and the culture were incubated at 30°C for 14 days. After the incubation period, 2ml of broth was tested by adding equal amount of sulfanilic acid and alpha naphthylamine development of red colour indicated that nitrate had been reduced to nitrite.

Hydrogen Sulphide Production

Sulfide indole motility (SIM) agar medium were prepared inoculated with the tested Native PGPR isolates and incubated at 30°C for 48 hrs. After incubation black coloration along the line of stab inoculation indicated H₂S production.

Catalase activity

A loopful of Native PGPR bacterial isolates maintained at nutrient agar slants for 24 hrs, after incubation period this is transferred to 0.5 ml of 3 per cent H₂O₂ solution and the presence of effervescence was detected.

Indole Production

The isolated native PGPR colonies were inoculated into glucose tryptone broth in test tubes and the tubes were incubated at 30°C for 2 days. After incubation period, 0.3 ml of Kovacs reagent was added and mixed well. The reddening of the alcohol layer within few minutes indicated indole production.

Methyl red and Voges Proskauer test

The MRVP broth prepared in two sets were inoculated with the Native PGPR isolates and incubated for 48 hrs at 30°C. To the first set of tubes 5 drops of methyl red indicator was added. The development of distinct red colour was indicated as positive reaction for MR test. Another set of tubes were added with 2-3 drops of barrit reagent and shaken gently for 15 minutes. The positive reaction of acetyl methyl carbinol production was indicated by the development of red colour this indicates positive result for the VP test.

Citrate Utilization

The Native PGPR isolates were inoculated into simmons citrate agar medium and incubated for 48 hrs at 30°C. Simmons citrate agar contained citrates as it is the only carbon source. The presence of growth and change of colour from green to blue due to pH change indicated positive reaction.





Phytohormone production by the Native PGPR bacterial isolates

Production of indole -3-acetic acid (IAA)

The production of indole-3-acetic acid (IAA) was measured in Luria- Bertani (LB) broth supplemented with 5mM L-tryptophan (Gordon and Weber (1951). Bacterial cultures (10^7 CFU ml⁻¹) were inoculated in LB broth and the maintained at 30°C in a shaking condition for 36 hours at 120 rpm. The culture was centrifuged at 10000 rpm for 15 minutes at room temperature after the incubation period. 2 ml Salkowski reagent (2 per cent 0.5 M FeCl₃ in 35 per cent perchloric acid) was added to one milliliter of supernatant. Two drops of orthophosphoric acid was also added, and the mixture was maintained in the dark for colour development. After 2 hours, the optical density was measured at 530 nm.

Siderophore production

The siderophore production was determined on Blue agar Chrome Azurol S (CAS) medium-containing CAS and Hexadecyl Trimethyl Ammonium Bromide (HDTMT) as indicators by incubating at 28°C for 24 hrs. Siderophore production (µg/ml) was quantitatively estimated spectrophotometrically employing the procedure suggested by Adhikari, *et al.*,(2013).

Estimation of Gibberellic acid (GA₃)

Gibberellic acid production by the Native PGPR isolates was determined by following the method of Borrow *et al* (1955). 100 ml medium was prepared and sterilized. One ml of broth of each of the isolates were added separately in the respective broth and incubated at 37°C for 7 days. After the incubation, the culture was centrifuged at 8000 rpm for 10 mins to remove the bacterial cells. Fifteen ml of the culture was pipette out separately into the test tubes and two ml of zinc acetate solution was added. After 2 mins two ml of potassium ferrocyanide solution was added and centrifuged at 8000 rpm for 10 mins. Five ml of supernatant was added to five ml of 30 per cent hydrochloric acid and the mixture was incubated at 27°C for 75 mins. The blank was prepared with five per cent hydrochloric acid. Absorbance was measured at 254 nm in a UV-VIS spectrophotometer.

RESULTS

In the present study, Native PGPR were isolated from rice rhizosphere soil and characterized for various plant growth promoting activity. A total of ten bacterial colonies were successfully isolated from different locations of Cauvery delta zone of Tamil Nadu, such as Nagapattinam, Thiruvavur, Thanjavur, Mayiladuthurai and Cuddalore district and the rhizosphere soil of rice were designated as CDZ – NI – 1, CDZ – NI – 2, CDZ – NI – 3, CDZ – NI – 4, CDZ – NI – 5, CDZ – NI – 6, CDZ – NI – 7, CDZ – NI – 8, CDZ – NI – 9 and CDZ – NI – 10 showed in (Table - 1). Native PGPR bacterial isolates were characterized morphologically. The results were tabulated in (Table - 2) and the morphological characterization with different shapes *viz.*, rod, curved rod and ring shaped colonies were identified and the gram staining was carried out the results were positive for CDZ – NI – 2, CDZ – NI – 6 and CDZ – NI – 9 and gram negative staining for CDZ – NI – 1, CDZ – NI – 3, CDZ – NI – 4, CDZ – NI – 5, CDZ – NI – 7, CDZ – NI – 8 and CDZ – NI – 10 and motility test and endospore test were also observed.

Biochemical test for isolated Rhizosphere PGPR isolates

The result for the biochemical test performed for the identification of the isolates showed in (Table - 3). Oxidase test was positive for the isolates CDZ – NI – 3, CDZ – NI – 4, CDZ – NI – 6, CDZ – NI – 7 and CDZ – NI – 10 and the negative for the isolates CDZ – NI – 1, CDZ – NI – 2, CDZ – NI – 5, CDZ – NI – 7 and CDZ – NI – 9. Nitrate reduction test were positive in all the isolates except CDZ – NI – 6. H₂S production were negative in CDZ – NI – 1, CDZ – NI – 2, CDZ – NI – 4, CDZ – NI – 5, CDZ – NI – 7, CDZ – NI – 8 and CDZ – NI – 9 and was found positive for CDZ – NI – 3, CDZ – NI – 5 and CDZ – NI – 6. In catalase test positive results was noticed in all the isolates except CDZ – NI – 1 and CDZ – NI – 5. In indole test was negative for all the isolated native PGPR strains. The positive result of Methyl Red test was noted in CDZ – NI – 1, CDZ – NI – 6 and CDZ – NI – 8 and the negative result was noted in CDZ – NI – 2, CDZ – NI – 3, CDZ – NI – 4, CDZ – NI – 6, CDZ – NI – 8, CDZ – NI – 9 and CDZ – NI – 10 and also Vogas





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Proskauer's test was negative for all the isolates except CDZ – NI – 3, CDZ – NI – 6 and CDZ – NI – 9. In citrate utilization test positive results were observed in CDZ – NI – 1, CDZ – NI – 3, CDZ – NI – 5, CDZ – NI – 6, CDZ – NI – 7 and CDZ – NI – 10, and the negative citrate utilization was observed in CDZ – NI – 2, CDZ – NI – 4, CDZ – NI – 5 and CDZ – NI – 9. Based on the biochemical test the PGPR bacterial isolates were tentatively identified as *Azospirillum lipoferum*, *Bacillus subtilis*, *Azotobacter*, *Pseudomonas fluorescens*, *Azospirillum brasilense*, *Bacillus megaterium*, *Fraturia aurentia*, *Pseudomonas putida*, *Bacillus polymyxa* and *Pseudomonas aueruginosa*.

In vitro Phytohormone producing activity

In vitro Plant Growth Promoting activity of different bacterial rice rhizospheric native PGPR isolates were shown in Table - 4 and Figure - 1. Rhizosphere Native PGPR isolates were analyzed for its efficacy to produce IAA, GA₃ and Siderophore production. Based on the efficacy of the rhizospheric bacterial isolates, the maximum IAA production was recorded in CDZ – NI -1 (22.19±0.84) (µg/ml), which was followed by CDZ – NI -4 (22.19±0.05) (µg/ml), and the least was recorded in the CDZ – NI -2 (17.10±0.34) (µg/ml). In GA₃ production, maximum amount of GA₃ produced by the CDZ – NI -1 (6.80±0.05) (µg/ml) and the least was produced by CDZ – NI -10 (1.08±0.03). The siderophore production was maximum on CDZ – NI -1 (10.17) (µg/ml), which was followed by 9.10(µg/ml) on CDZ – NI -6 and the least siderophore production was found in CDZ – NI -2 (4.20) (µg/ml). The best and effective strains which performed better in maximum IAA, GA₃ and Siderophore production were selected and used in further studies.

DISCUSSION

Henry *et al.*, (2014) had studied the characterization of PGPR from potato plant Rhizosphere which showed its potential plant growth promotion that indicated the highest quantity of IAA (5.816µg/ml), GA₃, phosphate solubilization and siderophore. Krunal *et al.*, (2017) reported the characterization of PGPR from rice rhizosphere, such as IAA, phosphate solubilization, siderophore production etc. Similar results were also reported by Safiullah *et al.*, (2019), Yasin *et al.*, (2022) in coffee plantation soils. Our findings of utilizing the Native PGPR strains as an effective bioinoculant in increasing the growth and yield was in line with the findings of the above listed scientists.

CONCLUSION

The native PGPR isolates *viz.*, *Azospirillum lipoferum*, *Bacillus megaterium*, *Fraturia aurentia*, and *Pseudomonas fluorescence* were isolated from rice rhizosphere of different locations of Cauvery delta region of Tamil Nadu and were assessed for IAA, GA₃ and Siderophore production. Hence these isolated native PGPR isolates could be recommended as an effective PGPR bioinoculants for rice crop cultivated in the Cauvery Delta Zone of Tamil Nadu.

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Table - 1. Description of Cauvery Delta Zone - Native bacterial isolates

Cauvery delta zone	Name of the location	Isolate code	Source (Rice)
Nagapattinam	South Poigai Nallur	CDZ - NI - 1	Rhizosphere soil
	Kilvelur	CDZ - NI - 2	Rhizosphere soil
Mayiladuthurai	Sirkazhi	CDZ - NI - 3	Rhizosphere soil
	Pandhanallur	CDZ - NI - 4	Rhizosphere soil
Thiruvarur	Nannilam	CDZ - NI - 5	Rhizosphere soil
	Thiruthurai poondi	CDZ - NI - 6	Rhizosphere soil
Thanjavur	Orathanadu	CDZ - NI - 7	Rhizosphere soil
	Papanasam	CDZ - NI - 8	Rhizosphere soil
Cuddalore	Kattumannar koil	CDZ - NI - 9	Rhizosphere soil
	Kumaratchi	CDZ - NI - 10	Rhizosphere soil





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Table - 2. Morphological characterization of Cauvery Delta Zone - Native bacterial isolates from rice Rhizosphere

Isolates	Colony characters	Gram staining	Cell shape	Motility	Endospore
CDZ - NI - 1	White flat slimy colonies	Gram –ve	Curved rods	+ ve	- ve
CDZ - NI - 2	White flat wrinkled colonies with irregular margins	Gram +ve	Rod	+ ve	+ ve
CDZ - NI - 3	White transparent, viscous colonies	Gram –ve	Rod	+ ve	- ve
CDZ - NI - 4	Slimy, white raised colonies	Gram –ve	Rod	+ ve	+ ve
CDZ - NI - 5	Slightly opaque colonies of non-sporulating rods occurring in pairs	Gram –ve	Curved rods	+ve	- ve
CDZ - NI - 6	White flat wrinkled colonies with irregular margins	Gram +ve	Rod	+ve	+ ve
CDZ - NI - 7	Typical brown water soluble pigment	Gram –ve	Ring	+ ve	- ve
CDZ - NI - 8	Pinkish white raised slimy colonies	Gram –ve	Rod	+ ve	- ve
CDZ - NI - 9	White flat colonies	Gram +ve	Rod	+ ve	+ ve
CDZ - NI - 10	Slimy white raised colonies	Gram –ve	Rod	- ve	+ ve

Table - 3. Biochemical Characteristics of the Cauvery Delta Zone - Native bacterial PGPR isolates from rice Rhizosphere

Isolates	Oxidase test	Nitrate reduction	H ₂ S production	Catalase test	Indole production	MR test	VP test	Citrate utilization	Tentative Species identification
CDZ - NI - 1	-	+	-	-	-	+	-	+	<i>Azospirillum lipoferum</i>
CDZ - NI - 2	-	+	-	+	-	-	-	-	<i>Bacillus subtilis</i>
CDZ - NI - 3	+	+	+	+	-	-	+	+	<i>Azotobacter</i> sp.
CDZ - NI - 4	+	+	-	+	-	-	-	-	<i>Pseudomonas fluorescens</i>
CDZ - NI - 5	-	+	-	-	-	+	-	+	<i>Azospirillum brasilense</i>
CDZ - NI - 6	+	+	+	+	-	-	+	-	<i>Bacillus megaterium</i>
CDZ - NI - 7	-	-	+	+	-	+	-	+	<i>Fraturia aurentia</i>
CDZ - NI - 8	+	+	-	+	-	-	-	+	<i>Pseudomonas putida</i>
CDZ - NI - 9	-	+	-	+	-	-	+	-	<i>Bacillus polymyxa</i>
CDZ - NI - 10	+	+	-	+	-	-	-	+	<i>Pseudomonas aeruginosa</i>



**Table - 4. *In – vitro* Phytohormone producing activity of Cauvery Delta Zone - Native bacterial isolates from rice Rhizosphere**

Isolate code	IAA ($\mu\text{g/ml}$)*	GA ₃ ($\mu\text{g/ml}$)*	Siderophore production ($\mu\text{g/ml}$)*
CDZ - NI - 1	22.19 \pm 0.84	6.80 \pm 0.05	10.17
CDZ - NI - 2	17.10 \pm 0.34	1.32 \pm 0.03	4.20
CDZ - NI - 3	17.21 \pm 0.12	1.41 \pm 0.02	8.03
CDZ - NI - 4	22.19 \pm 0.5	4.76 \pm 0.05	6.67
CDZ - NI - 5	21.11 \pm 0.1	4.74 \pm 0.03	6.82
CDZ - NI - 6	20.60 \pm 0.15	5.81 \pm 0.04	9.10
CDZ - NI - 7	19.70 \pm 0.13	4.86 \pm 0.01	8.13
CDZ - NI - 8	17.62 \pm 0.15	4.35 \pm 0.01	4.30
CDZ - NI - 9	18.13 \pm 0.4	4.05 \pm 0.02	4.99
CDZ - NI - 10	21.17 \pm 0.56	1.08 \pm 0.03	8.06

Values of mean of three replications \pm SD



Review on Aya Thanga Chenduram; Higher Order Siddha Medicine for Male Infertility

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 27 Jun 2024

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ABSTRACT

According to WHO, infertility is a disease of reproductive system defined by failure to achieve the clinical pregnancy after 12 months or more of regular unprotected sexual intercourse. WHO estimates 60–80 million couples worldwide currently suffer from infertility and is estimated to affect 8–12% of couples worldwide. Hence, there is an urgent need to develop a safe and effective higher order therapeutic drug from natural resources for male infertility. In *Siddha* medical system from ancient times, infertility has been treated successfully with higher order medicines like *Aya Thanga Chenduram* (ATC), *Aya Velli Chenduram*, *Thanga Linga Chenduram*, *Poorana Chandhrodayam*, *Sorna PushpaRasa Chenduram*, *Seena PaashanaParpam*, etc. This study is aimed to review the ingredients of ATC towards its therapeutic use in Male infertility. ATC is one among the Higher order *Siddha* medicine prepared from *Ayam*, *Thangam*, *Valairasam*, *Kandhagam* and *Sangu paashanam*, indicated for male infertility. ATC is practised by *vaidhyars* and *siddha* physicians to treat Male infertility from longer period. According to *Siddha* concept, ATC is a precise medicine for Male infertility because the major ingredients of ATC like *Ayam*, *Thangam*, *Rasam* and





Kandhagam have Sweet and Astringent taste. According taste theory, they enhance the quality of semen and a potent nervine tonic respectively. As per *Gunapadam* text, *Ayam* and *Thangam* are indicated for *Thathunattam* (Male infertility). Scientifically most of the ingredients of *ATC* have proved for its spermatogenic and aphrodisiac actions. This review study conducted that, the higher order *Siddha* preparation *Aya Thanga Chenduram* has suggested drug for Male infertility. Further scientific studies to be conducted to ensure its safety and efficacy on Male infertility.

Keywords: Male Infertility; *Aya Thanga Chenduram*; *Siddha* Medicine.

INTRODUCTION

Siddha system is one of the traditional medical system providing preventive, promotive, curative, rejuvenate and rehabilitative health care by adopting scientific and holistic approach.

WHAT IS INFERTILITY?

The term “infertility” came from Latin word *infertilis* which means “not fertile”(1) Infertility is a disease of the male and female reproductive system. According to the International Committee for Monitoring Assisted Reproductive Technology, World Health Organization (WHO), infertility is a disease of reproductive system defined by failure to achieve the clinical pregnancy after 12 months or more of regular unprotected sexual intercourse(2). According to *Siddha* literature, infertility in male is called as *Aan maladu*, *Veeriyanashtam*, *Thathunattam* and *Aanmaikuraipaadu*.

According to *Yugi muni* in *Siddha* literature (3), the following characters contribute to infertile man

- Lack of sweetness in semen
- Buoyancy of water
- Absence of virility
- Frothy micturition

GLOBAL INCIDENCE OF INFERTILITY (4)

As per the WHO estimates 60–80 million couples worldwide currently suffer from infertility. It varies across regions of the world and is estimated to affect 8–12% of couples worldwide. It tends to be the highest in countries with high fertility rates; an occurrence termed “barrenness amid plenty.”

INFERTILITY IN INDIA

In India 10-15% of couples were infertile(5). Of this, the male factor is responsible for 20-40%. In Indian couples seeking treatment, the male factor is the cause in approximately 23%(6).

CAUSES OF MALE INFERTILITY

Male infertility is caused by wide range of etiologies. Numerous factors are defined with unequivocal and harmful effect on male reproduction function, i.e.,

1. sedentary life style problems,
 2. nutritional deficiencies
 3. genetic causes
 4. hormonal issues
 5. physical problems likewise varicocele, damaged sperm ducts, torsion, Klinefelter’s syndrome, retrograde ejaculation,
 6. psychological issues comprised of erectile dysfunction, premature ejaculation and ejaculatory incompetence
- Oligospermia may be considered as a pathologic effect of the abovementioned causes and consequently oligospermia represents a cause of reduced male fertility (7).





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AVAILABLE TREATMENT MODALITIES AND IT'S DISADVANTAGES:

Broad range of strategies had been carried out to overcome the male infertility complications.

- Hormonal treatment using Gonadotropin releasing hormone(GnRH), Gonadotropins like Human Chorionic Gonadotropin (HCG),Follicle Stimulating Hormone (FSH) and Luteinizing hormone(LH).
- Selective Estrogen Receptor Modulators(SERMs)
- Aromatase Inhibitor (AI) therapy.
- Dopamine agonist.
- Surgical procedures.
- Assisted Reproduction Technology (ART)

However, shortcomings of the above stated treatments cannot be overlooked which may include acceptability, high expenditure and threat of diverse complications during surgical procedures. Approximately, half of the couples undergoing consultation for male infertility terminated ART treatment, mainly due to physical and emotional pain resulting from treatment. Additionally, there were some concerns for the offspring conceived by means of ART including in vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI) via microsurgical epididymal sperm aspiration (MESA) or percutaneous epididymal sperm aspiration (PESA) showed a higher risk of birth defects. (7) Hence, there is a need for a safe and effective higher order therapeutic drug from novel natural sources for male infertility. Many efficacious *siddha* medicines available for male infertility. *Aya Thanga Chenduram* (ATC)[®] is one among the Higher order *Siddha* preparation for male infertility.

OBJECTIVE

The main objective of this review is to prove that a Higher order *Siddha* medicine *Aya Thanga Chenduram* is an effective suggested drug for Male infertility (*Aan maladu*).

MATERIAL AND METHOD

- Classical text available in *Siddha* literature is reviewed.
- Database available after net surfing, modern literatures and various research articles were also reviewed.

AYA THANGA CHENDURAM[®]:**Ingredients of Aya Thanga Chenduram (ATC)**

- | | | |
|-------------------------------|---------------------------|----------------------|
| 1. <i>Aya thool</i> | (powdered form of Ferrum) | - 175grams |
| 2. <i>Thangam</i> | (Gold) | - 4.2 grams |
| 3. <i>Sangu paashanam</i> | (White Arsenic) | - 1.05 grams |
| 4. <i>Valairasam</i> | (Mercury) | - 25.2 grams |
| 5. <i>Kandhagam</i> | (Sulphur) | - 35 grams |
| 6. <i>Elumichampazhacharu</i> | (Lemon juice) | -Sufficient quantity |

PROCEDURE

The above ingredients purified by the standard procedures as per *siddha* literatures. After purification, *Valai Rasam* grinded with *Thangam* as a first step of this medicine preparation then add *Kandhagam* and grind it continuously until it becomes black in colour. Then add *Ayam* and *Sangu paashanam* and grind into fine powder and then add lemon juice, grind for about 6 to 9 hours per day for 4 days into waxy consistency and make it into pea sized pills and dry it. Then keep the dried pills in *Vaaluka enthiram* and incinerate for 12 hours, leave it for one night. The next day morning, open out the *Vaaluka enthiram*, the medicine will be red in colour. Then grind it and keep it in an air tight container.

DOSE: 65-130mg (Twice a day)

VEHICLE: Honey



**INDICATIONS**

Nalla thejasum, Aan thanmaiym Visheshikkum.

SIDDHA PHARMACOLOGICAL CHARACTERS OF ATC⁽⁹⁾**1. Ayam (Iron or Ferrum)**

- It has astringent taste.
- It has nutrient, alterative and hematinic actions.
- And it is indicated for *Thathunattam* (Male infertility) in the song of its general character.

2. Thangam (Gold)

- It has sweet taste.
- It has aphrodisiac, nervine tonic and alterative actions.
- And it is indicated for *Thathunattam* (Male infertility) in the song of its general character.

3. Sangu paashanam (White arsenic)

- It has nutrient, nervine tonic and antioxidant actions.
- It has the potency of stimulating genital organs.

4. Vaalairasam (Mercury)

- It has six tastes, predominantly sweet in taste.
- It has both heat and cold potency in equal proportion.
- It is considered as Chakaravathi (King of all drugs).

5. Kandhagam (Sulphur)

- It has astringent taste.
- It has alterative action.

6. Elumicham pazhacharu (Lemon juice)⁽¹⁰⁾

- Cold potency
- It has antioxidant property since it is a rejuvenating herb.

SCIENTIFIC EVIDENCES

According to modern literature review, Iron (which is the major ingredient of *Aya Thanga Chenduram*) has major role in male reproduction. Iron is one of the most abundant mineral nutrients in the organism and plays a critical role in the synthesis of nucleic acids and proteins, electron transport, cellular respiration, proliferation and differentiation(11) all of which are intimately related to spermatogenesis and spermatozoa metabolism(12) Three mammalian gene expressions are directly regulated by iron(11), two of which have an impact on male reproduction. The type 5 isozyme of acid phosphatase is an Fe-containing molecule found in semen in large quantities and of prostatic origin. It is believed that its presence may be associated with the liquefaction process of semen(13). Fe is involved in a variety of redox reactions catalysed by cytochromes, with a subsequent energy production, drug and hormonal metabolism, propagation and activation of the defence systems via the nicotinamide adenine dinucleotide phosphate (NADP) oxidase(11) The connection between iron and the Krebs cycle is further solidified by the mitochondrial aconitase enzyme(14). Under ROS overproduction or in a state of iron deficiency, cellular respiration is inhibited by the nitrosylation of heme in mitochondrial enzymes aconitase and glyceraldehyde-3-phosphate dehydrogenase(15), leading to a depletion of adenosine triphosphate (ATP) and a subsequent loss of spermatozoa motility(16). It is widely known that during spermatid development, mitochondria undergo dramatic events related to movement and shaping, including aggregation and fusion or elongation alongside the growing axoneme(17). Disruptions of mitochondrial function typically affects male fertility - a phenotype that is easily screened for and characterized at the subcellular level. The mitoferrin gene product and other proteins involved in iron metabolism





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show enriched expression in the testes suggesting that mitochondrial iron metabolism plays a role in spermatogenesis(17,18). In addition, Nikolaev et al(19) stated that Fe and non-hemic ferroproteins are involved in ejaculate thinning and viscosity, sperm pH, alongside with normal spermatogenesis. The importance of iron in male fertility has been shown in a variety of *in vivo* and *in vitro* studies. According to Kanwal et al(20), it was only iron from all the bulk elements evaluated in the seminal plasma of Niki-Rawi bulls, which was significantly and positively correlated with sperm motility. Tvrdá et al(21). showed that iron quantified in bovine seminal plasma was positively associated with sperm motility characteristics.

DISCUSSIONS

Major ingredients of ATC like *Ayam*, *Thangam*, *Rasam* and *Kandhagam* have Sweet and Astringent taste. According to the theory of taste in our Siddha literature(22), these tastes enhance the quality of semen and a potent nervine tonic respectively. *Ayam* and *Thangam* are indicated for *Thathunattam* (Male infertility) in the song of its general character. Many ingredients of ATC have nutritive, alterative, aphrodisiac, antioxidant and nervine tonic action which means it may favor in sperm production and sexual potency. Since Rasam has six tastes and two potencies, it can be used as best remedy for many diseases. Rasam and lemon extract have cool potency which may support spermatogenesis and sperm motility. According to Panchabootha theory,

- Earth + Water = helps in growth and proliferation
- Fire + Air = helps in viability and motility
- Space = Give space to all process

All the above mentioned characters are directly related to spermatogenesis and sperm motility.

The other preparations from various Siddha literatures possess the few ingredients of ATC and these also have spermatogenic and aphrodisiac actions.

Ayam which is also be a major ingredient of

Aya Velli Chenduram⁽⁸⁾

Aya chenduram⁽⁹⁾

Thangam which is also be a major ingredient of

1. *Thanga chenduram*⁽⁹⁾

2. *Thanga lingachenduram*⁽⁸⁾

Rasam and *Kandhagam* which are also be the major ingredients of

1. *Poorana chandhrodayam*⁽⁸⁾

2. *Sorna pushpa rasa chenduram*⁽⁸⁾

Sangu paashanam which is also be a major ingredient of

1. *Seena paashanaparpam*⁽⁸⁾

2. *Naaga rasa parpam*⁽⁸⁾ All the above mentioned preparations are indicated for *Thathunattam* (Male infertility)

CONCLUSION

As per the review of abovementioned literatures, all the ingredients of *Aya Thanga Chenduram* have potent spermatogenic and aphrodisiac action. According to basic *siddha* concept and scientific evidences, most of the ingredients of ATC have proved for its spermatogenic and aphrodisiac actions. This review study conducted that, the higher order *Siddha* preparation, *Aya Thanga Chenduram* has suggested effective drug for Male infertility. Further scientific studies to be conducted to ensure its safety and efficacy on Male infertility.





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Development and Evaluation of Sparfloxacin Formulation for the Management of Antibiotic Resistance

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Received: 20 Feb 2024

Revised: 09 Mar 2024

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ABSTRACT

Antibiotic resistance is a global health threat resulting from extreme exposure and misuse of antibiotics. One of the resistance mechanisms is bacterial expression of efflux pumps due to which antibiotic concentration inside the bacterial cell is reduced. Blocking this pathway is a potential strategy to reduce bacterial resistance. This study is focused on determining the effectiveness of various phytoconstituents as an inhibitor of various efflux pumps of *Escherichia coli* namely AcrAB-Tolc, AcrB, EmrE, EmrD, and MacA using *insilico* methods. Docking analysis using PyRx and Auto Dock Vina software showed Ursolic acid with the highest average affinity. In vitro studies have demonstrated better activity of Sparfloxacin in resistant *Escherichia coli* when used along with Piperine or Citric acid. Further, the capsule formulation containing Sparfloxacin in combination with Citric acid was developed and evaluated. In addition to overcoming the resistance of *Escherichia coli* to Sparfloxacin, Citric acid has also improved the in-vitro drug release of Sparfloxacin. Although Citric acid and piperine have low binding affinity with efflux pumps as compared to Ursolic acid, they were found to be more effective in-vitro indicating the probability of altered outer membrane permeability in addition to binding with efflux pumps rendering increased concentration of Sparfloxacin in the bacterial cell.

Keywords: Antibiotic resistance, *Escherichia coli*, Efflux pump, Citric acid, Piperine, Sparfloxacin





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INTRODUCTION

Antibiotic resistance is the main impediment to treat infectious disorders brought on by bacteria due to their acquisition of capacity to withstand antibiotics[1]. The resistance is developed due to alteration of drug target, drug inactivation, expression of efflux pumps and altered outer membrane permeability of the bacterial cell[2]. *Escherichia coli* (*E. coli*) is a gram-negative, rod-shaped bacterium commonly found in the lower intestine of warm-blooded organisms. While most strains of *E. coli* are harmless and even beneficial, certain pathogenic strains can cause infections[3]. *E. coli* has become a significant public health concern due to its ability to develop resistance to multiple antibiotics. *E. coli* can acquire and express resistance genes, which can be transferred between bacterial cells through plasmids or other mobile genetic elements. These resistance genes code for various enzymes, efflux pumps, or modifications that can inactivate or evade the action of antibiotics[4]. Efflux pumps are one of the critical mechanisms employed by *E. coli* to resist antibiotics. These pumps are membrane-bound proteins that actively pump antibiotics out of the bacterial cell. Efflux pumps in *E. coli* are part of the resistance-nodulation-division (RND) super family, such as AcrAB-TolC, which is highly associated with antibiotic resistance. One important and promising approach to battle bacterial resistance is the development of efflux pump inhibitors, which can boost the efficacy of the medicine and widen its spectrum of action by restoring the bacterium's susceptibility to the utilized antibiotic [5,6]. This paper entails a virtual screening-based evaluation of selected phytochemicals as efflux pump inhibitors. Also, the selected compounds should be bioavailable. Hence, the drug-likeness and ADMET study of selected phytochemicals is reported. Further, formulation and evaluation of Sparfloxacin capsule formulation along with selected phytochemicals is reported.

MATERIALS AND METHODS

Selection of Receptors, ligands and antibiotic

Relevant receptor proteins for *E. coli* were selected namely AcrAB- Tolc (PDB ID- 5O66), AcrB (PDB ID- 2W1B), EmrE (PDB ID- 3B5D), EmrD (PDB ID- 2GFP), MacA (PDB ID- 3FPP)[7]. Their three-dimensional (3D) structures were downloaded from protein data bank (<https://www.rcsb.org/>)[8]. The receptor structures were further prepared before docking[9]. Twenty phytoconstituents with reported antimicrobial activity were used for the study and are given in Table 1. Their 3D structures were downloaded from Pubchem in SDF formats [10]. Those formats were further converted into PDBQT format using AutoDock tools. According to the resistance map, *E. coli* was found to have resistance to fluoroquinolone in India (71%) followed by US (31%), South Africa (29%) and Australia (16%). Sparfloxacin, a fluoroquinolone was selected for this study^[11] and was purchased from Dhamtec Pharma, Navi Mumbai.

In silico Studies: Computational Virtual Screening and Molecular Docking

Molecular docking was performed using PyRx[12] and AutoDock Vina softwares. The investigation of docked complexes was performed using Biovia Discovery Studio[13].

In vitro Microsusceptibility testing study

An in vitro microsusceptibility test of *E. coli* to Sparfloxacin alone and with various phytochemicals was assessed by monitoring the zone of inhibition. About 5µg, 50µg, 100µg, 150µg, and 200µg of Sparfloxacin and selected Phytochemicals were added to wells punched on Agar plate spread with *E. coli*. The plates were incubated for 24 to 42 hr followed by measurement of zone of inhibition. The phytochemicals which increased the susceptibility of *E. coli* to Sparfloxacin were further selected for formulation development.

Formulation of capsule

A physical mixture of Sparfloxacin and citric acid in equal ratio was prepared after triturating it for 20 minutes in a mortar and pestle. The angle of repose of the resulting mixture was measured to determine flow properties. The mixture was filled in the capsule to contain 200mg each of Sparfloxacin and citric acid.





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Drug-excipient interactions

The drug-excipient interactions were evaluated using X-ray diffraction (XRD), Differential Scanning Calorimetry (DSC), and Fourier-Transform Infrared Spectroscopy (FTIR).

Assay of Sparfloxacin capsules using UV-Spectroscopy

Absorption correction method was used to simultaneously analyze Sparfloxacin and citric acid^[14]. Powder equivalent to about 100mg of Sparfloxacin was taken in a 100 ml volumetric flask and mixed in 0.1N HCl (1000µg/ml). The mixture was sonicated for about 15 to 20 minutes and then filtered. From this, 1ml of the solution was diluted to 10ml (100µg/ml) with 0.1N HCl. Further, 1ml of the resulting solution was diluted with 0.1 N HCl to 10ml (10µg/ml). The absorbance of resulting solution was measured at 295nm where citric acid do not show any absorbance.

Dissolution study of marketed tablet and developed capsule formulation

The comparison of the dissolution behaviour of marketed tablet and developed capsule formulation was performed using rotating basket apparatus in 0.1N HCl for 1 hr at 37°C.

RESULT AND DISCUSSION

In silico Studies

In silico molecular docking studies were performed to access the binding of phytochemicals with the efflux pump proteins. The binding affinities of selected 20 phytochemicals and Sparfloxacin with efflux pumps are given in Table 1. The binding interactions of Sparfloxacin with efflux pumps are shown in Fig. 1. The results indicate that the selected phytochemicals exhibited varying degrees of binding affinity to various proteins. Furthermore, a literature survey revealed that the AcrAB-TolC efflux pump in *E. coli* significantly contributes to the resistance to Fluoroquinolone antibiotics. Ursolic acid was found to have better affinity for this receptor as well as the highest average binding affinity. This implies that Ursolic acid might have a strong affinity to the active sites of efflux pump receptors of *E. coli* suggesting reducing the ability of bacteria to expel antibiotics from within the cell. However, *In-vitro* studies are required to validate these findings and evaluate the actual impact of Ursolic acid on efflux pump activity and Antibiotic resistance. *In-vitro* microsusceptibility testing was performed by studying the zone of inhibition to evaluate the effectiveness of different combinations of each of 5µg of Sparfloxacin with phytochemicals against *E. coli*. It displayed resistance to Sparfloxacin and individual phytochemicals at lower concentration. The zones of inhibition of Sparfloxacin were only slightly increased in the presence of selected phytochemicals indicating resistance. *E. coli* highlights the challenges in treating infections caused by this bacterial strain, emphasizing the need for alternative strategies to overcome its intrinsic resistance mechanism.

Further, a higher concentration of 50µg was chosen. Despite the higher concentration, no significant change was observed in the response of *E. coli*. Further experimentation with increased concentrations is warranted to determine the optimal concentration required to effectively target *E. coli*. The concentration of phytochemicals was also further increased to 100 µg, 150 µg, and 200 µg. The zones of inhibition for each concentration were observed for individual and combination. At these concentration, clear and larger zone of inhibition were observed around the wells containing piperine and citric acid. This indicates that the increased concentration was effective in inhibiting the growth of *E. coli*, overcoming its resistance to a certain extent. Notably, the combination of Sparfloxacin with phytochemicals could not be measured as the entire Petri plate was cleared due to strong inhibition. Sparfloxacin along with Citric acid or Piperine showed bigger zone compared to other phytochemicals (Table 2). Further experiment was aimed to determine the concentration ratio of drug and adjuvant required to achieve a minimum zone of inhibition of 23 mm, following the guidelines set by the European Committee on Antimicrobial Susceptibility Testing (EUCAST)^[15]. Different concentration ratios of Sparfloxacin and Piperine or Citric acid, were tested. Among the tested ratios, the (32:30) ratio of Sparfloxacin to Citric acid exhibited a zone of inhibition measuring a minimum of 23 mm, as required by EUCAST guidelines. The results are shown in Fig.1 and Table 3. Although citric acid is used as a preservative in formulations, when tested individually, it did not exhibit a significant zone of inhibition against



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resistant *E.coli*, suggesting limited antimicrobial activity of its own against selected resistant strain. But, it was found to significantly increase zone of inhibition of Sparfloxacin. *In silico* methods showed lower affinities of citric acid for efflux pumps in comparison to piperine suggesting different mode of action. Citric acid, being an organic acid, may act as a permeabilizer, disrupting the bacterial cell membrane, and thereby facilitating the entry of Sparfloxacin into bacterial cells and enhancing its antimicrobial activity. This combination strategy could lead to improved efficacy in combating *E.coli*. Piperine, on the other hand, demonstrated its own zone of inhibition against *E. coli*, indicating its inherent property and ability to inhibit bacterial growth. Similarly, when piperine was combined with Sparfloxacin, a larger zone of inhibition was observed compared to the individual zone of inhibition of Piperine. This indicates synergistic interaction between piperine and Sparfloxacin, resulting in enhanced antimicrobial activity against *E. coli*. Based on the results of the in vitro study and limited research available on citric acid, it was selected for development of Sparfloxacin formulation. Additionally, Citric acid is recognized as safe and widely used in pharmaceutical formulations. Also, Sparfloxacin belongs to BCS Class 2 (low solubility, high permeability), and Citric acid is a chelating agent having solubility enhancement properties, it was considered to be best-suited adjuvant for formulation development.

Formulation of Capsule

The formulation of the capsule involved the preparation of a physical mixture of Sparfloxacin (200 mg) and Citric acid (200 mg) followed by encapsulation. Angle of Repose was found to be 32° indicating good flow properties of the mixture.

Drug-Excipient interaction studies: XRD, DSC, and FTIR studies were performed to understand the drug-excipient compatibility. Fig.2. shows PXRD data. The results revealed a gradual decrease in peak intensity, indicating a transition of Sparfloxacin from crystalline to amorphous nature in the samples. This might improve the solubility of Sparfloxacin. DSC thermograms are shown in Fig.3. The melting behavior of Sparfloxacin (256°C) and citric acid (153 °C) in our study closely aligns with reported literature values indicating no drug-excipient interaction. FTIR spectra are shown in Fig.4. It was found that the peaks observed for formulation are identical with that of pure Sparfloxacin, at nearly the same characteristic peaks further confirming undesired chemical interaction between citric acid and Sparfloxacin. There was more broadening and increased intensity of peak due to hydroxyl group indicating extensive hydrogen bond formation. Also, peak due to carbonyl group was found to be enhanced and broadened.

Assay of Sparfloxacin capsules using UV spectroscopy

From the overlay UV spectrum of Sparfloxacin and citric acid in 0.1N HCl, the λ_{max} of Sparfloxacin was found to be 295nm wherein citric acid does not interfere. Hence, the concentration of Sparfloxacin was determined at 295nm. The % content of Sparfloxacin capsules was found to be 99.8 % w/w.

Dissolution study

A comparative dissolution study between the marketed tablet and formulated capsules is shown in Fig.5. The formulated capsule demonstrated a substantially higher drug release compared to the marketed tablets, indicating improved dissolution properties and enhanced release. These findings highlight the potential of formulated capsules as a more efficient dosage form for delivering the drug.

ACKNOWLEDGEMENT

The author expresses gratitude to the administration of PES Modern College of Pharmacy (for ladies), Moshi, Pune, for providing the necessary facilities.





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Table 1 - Binding of phytochemicals with selected receptors on *E.coli*

Sr.No	Ligand PubChem CID	Binding energy (Kcal/mol)					Average (Kcal/mol)
		AcrABTolc	AcrB	EmrE	EmrD	MacA	
1.	Citric acid 311	-5.9	-5.6	-2.2	-5.5	-5.6	-4.96
2.	Coumarin 323	-6.7	-6.4	-3.9	-7.1	-6.1	-6.04
3.	Salicylic acid 338	-5.8	-5.6	-2.7	-6.2	-5.7	-5.2
4.	Gallic acid 370	-6.6	-6.3	-4.7	-5.9	-6	-5.9
5.	Berberine 2353	-8.2	-7.6	-3.6	-6.9	-7.5	-6.76
6.	Eugenol 3314	-6.1	-5.9	-2.6	-6.5	-5.2	-5.26
7.	Theobromine 5429	-6.4	-6.5	-4.4	-6.3	-6.1	-5.94
8.	Reserpine 5770	-8.4	-8.8	-5.7	-7.0	-7.9	-7.56
9.	Oleanolic acid 10494	-8.8	-8.7	-5.4	-7.8	-7.6	-7.66
10.	Ursolic acid 64945	-9.0	-9.5	-5.1	-8.1	-7.4	-7.82
11.	Isoflavone 72304	-8.3	-8	-5.6	-9.4	-7.2	-7.7
12.	Carnosol 442009	-8.3	-7.8	-5.6	-7.3	-8.2	-7.44
13.	Resveratrol 445154	-7.6	-7.1	-4.5	-8.1	-7.2	-6.9





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14.	Piperine 638024	-8.2	-7.7	-5.0	-7.0	-7.1	-7.0
15.	Curcumin 969516	-8.4	-7.2	-4.7	-6.8	-6.8	-6.78
16.	Capsaicin 1548943	-6.2	-6.5	-4.6	-8.1	-6	-6.28
17.	Quercetin 5280343	-8.9	-8.0	-4.1	-8.9	-8	-7.58
18.	Rutin 5280805	-8.3	-9.1	-3.8	-7.1	-7.6	-7.18
19.	Ellagic acid 5281855	-8.7	-8.3	-4	-7.5	-7.5	-7.2
20.	Olympicin A 57380109	-3.6	-5.9	-4	-6.1	-6.0	-5.12
21.	Sparfloxacin 60464	-6.4	-8.1	-4.1	-6.7	-8.2	-6.7

In above table, the binding affinities of selected 20 phytochemicals and Sparfloxacin with efflux pumps are given.

Table 2 - Study of zone of inhibition of Sparfloxacin, citric acid and piperine

Combination (100µg/ml)	Zone of Inhibition (mm)
Sparfloxacin	40
Citric acid	10
Sparfloxacin +Citric acid	50
Sparfloxacin	40
Piperine	33
Sparfloxacin + Piperine	70

Sparfloxacin along with Citric acid or Piperine showed a bigger zone compared to other phytochemicals as given in above Table 2.

Table 3 – Effect of various ratios of Phytochemical and Sparfloxacin on zone of inhibition of E.coli

Quantity ratio (µg) Sparfloxacin: Citric acid	E.Coli[ATCC ®25922] Zone of Inhibition (mm)	Quantity ratio (µg) Sparfloxacin: Piperine	E.Coli[ATCC ®25922] Zone of Inhibition (mm)
16 + 40	20 mm	16+40	26 mm
32 + 30	23 mm	32+30	23 mm
48 + 20	27 mm	48+20	24 mm
64 + 10	32 mm	64+10	28 mm

In the above table, zone of inhibition of Sparfloxacin with Piperine or Citric acid is given.



Figure 1- Effect of various ratios of a) Citric acid b) Piperine along with Sparfloxacin on zone of inhibition of E.coli





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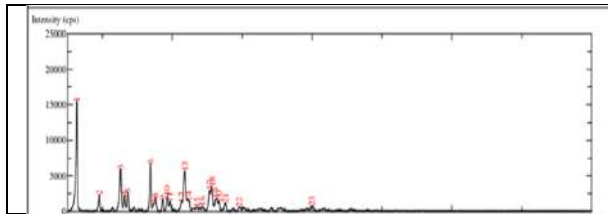


Figure 2 - PXRD of (a) Sparfloxacin

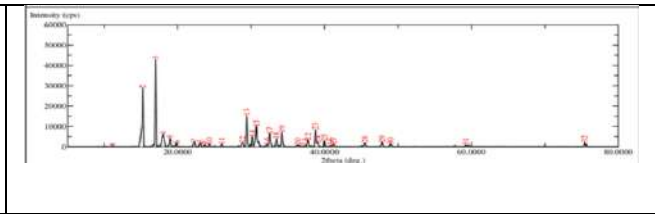


Figure 2- PXRD of (b) Citric acid

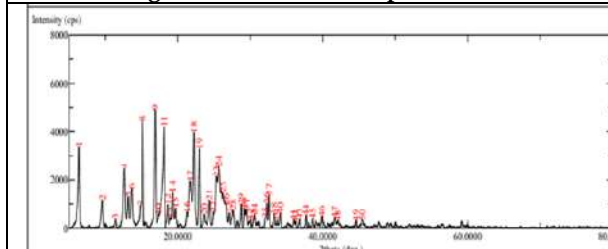


Figure 2 - PXRD of (c) Sparfloxacin: Citric acid

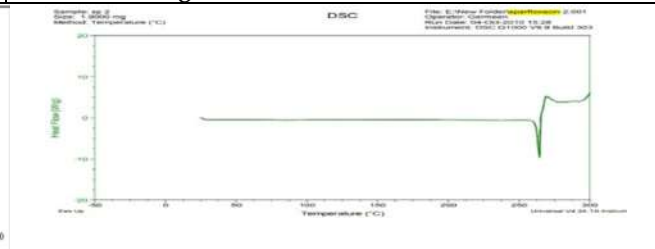


Figure 3- DSC of a) Sparfloxacin

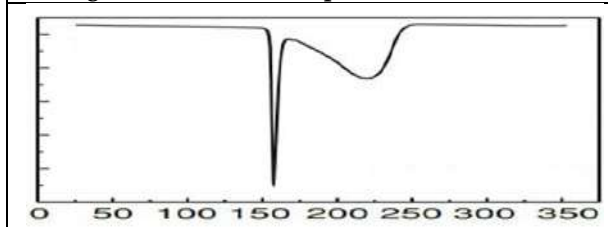


Figure 3- DSC of b) Citric acid

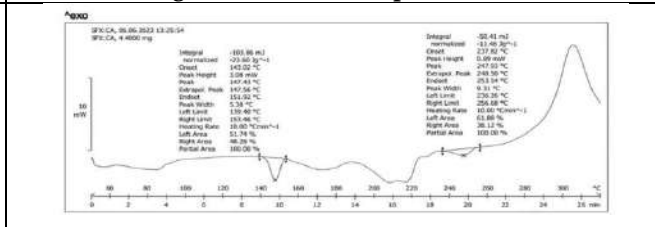


Figure 3- DSC of c) Sparfloxacin: Citric acid

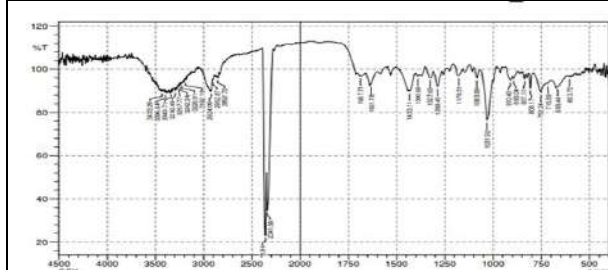


Figure 4 - FTIR of a) Sparfloxacin

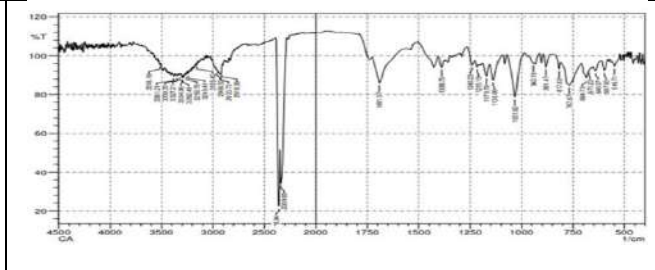


Figure 4 - FTIR of b) Citric acid

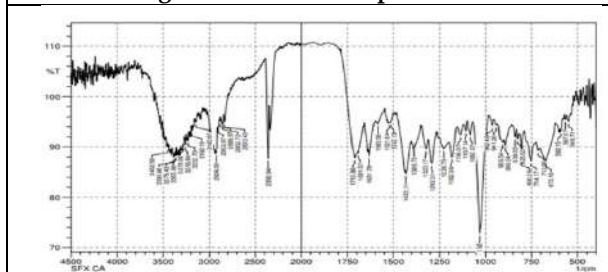


Figure 4 - FTIR of c) Sparfloxacin: Citric acid

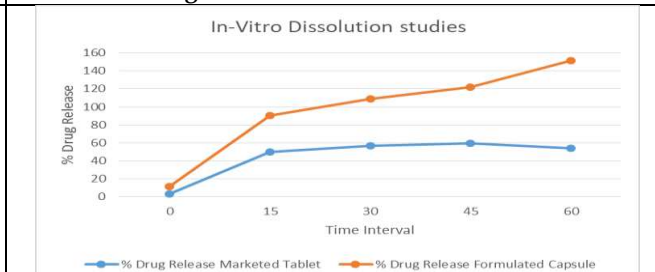


Figure 5 - Comparative study of in vitro dissolution drug release of marketed tablet and formulated Capsules.





Distimake dissectus (Convolvulaceae): An Addition to the Flora of Banaskantha District (North Gujarat)

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

Distimake dissectus (Jacq.) A.R.Simoes & Staples, a new species from the Banaskantha district of Gujarat state, India. Detailed descriptions along with colored photographs, distribution, ecological notes are provided for its easy identification.

Keywords: Banaskantha, North Gujarat, *Distimake dissectus*

INTRODUCTION

The genus *Distimake* (Convolvulaceae) is represented by 100 species, and distributed in the tropical regions of the world (Mabberley, 2008). In India, over 15 species are reported (Santapau & Henry, 1973). Therefore, *Distimake dissectus* we reported in the Gujarat state by Shah 1978, Patel 2013 and Jani 2014. During field work, the author collected unknown specimen from Ratanpur village of Dantiwada taluka, in Banaskantha district, throughout January 2024, on critical study of these specimens using relevant taxonomic literature (Shah, 1978; Cook, 1903), online e-floras (e-floraofindia) and illustrations. Exploration of floristic literature (Patel, 2000; Patel, 2008; Dabgar, 2008; Meena, 2011; Meena, 2012; Meena, 2012; Patel, 2013; and Patel, 2022) revealed that this species has not been recorded from whole Banaskantha till date. Therefore, *Distimake dissectus* (Jacq.) A.R.Simoes & Staples. We report here the additional report of the state of Gujarat. A detailed taxonomic description and photographs of diagnostic characters of the species is provided here to January 2024 this record for Banaskantha and facilitate its easy field identification.





MATERIAL AND METHODS

Morphological description and ecological information presented here are based on field observations and material collected during fieldwork of the Ratanpur village Banaskantha in species identify confirmed by comparison with the pertinent literature.

RESULT AND DISCUSSION

Taxonomic accounts *Distimake dissectus* (Jacq.) A.R. Simoes & Staples. Herbaceous twiner; stems slender, terete, striate, patently hirsute, glabrescent. Leaves alternate, palmately divided nearly to the base, with 5–7 lanceolate, mucronulate, sinuate, coarsely dentate to irregularly pinnately lobed segments, glabrous, the middle segment 4-7.5 cm long, 1–2.5 cm broad, the lateral ones and especially the basal ones smaller; petiole up to 7 cm long, patently hirsute. Inflorescence axillary, 1-to few-flowered, cymose; peduncles 5-10 cm long, patently hirsute, glabrescent in the upper portion hirsute; pedicels 1.5–2.5 cm long, thickened above, glabrous, minutely verrucose at the top. Flower-buds 1.5–2.5 cm long, narrow-ovoid, acute at apex. Sepals sub-equal, 2–2.5 cm long, ovate or oblong, mucronulate at apex, glabrous, herbaceous with narrow scarious margin, afterwards enlarged and coriaceous in fruit. Corolla 3–4 cm long, funnel shaped, white, with a rose or purple throat, the limb with 5 distinct bands. Stamens 5, unequal, included; filaments 5–7 mm long, filiform, villous at base, glabrous towards apex; anthers up to 5 mm long, spirally twisted above the half. Disk cup-shaped. Pistil 2 cm long; ovary 1.5 × 1.5 mm long glabrous, 2-celled; style c. 8 mm long; stigma bilobed, globose. Capsule globose, 1–2 cm in diameter, glabrous, 4-valved, 4-seeded; seeds 1.2 × 0.8 mm, black, glabrous.

Flowering & Fruiting: August-January.

Habitat: A Common twiner along hedges on the moist evergreen and mixed deciduous forests.

Locality: Banaskantha, North Gujarat, India.

ACKNOWLEDGMENTS

The authors are thankful to Dr. Sanjay A. Patel, I/c Head, Smt. G. B. Pavaya & Smt. P. S. Pavaya Science (M.Sc.) College, Palanpur, Dr. Mukesh S. Mali, Range Forest Officer of Gujarat Forest for their kind helps during the course of the present study.

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Figure: 1 *Distimake dissectus* (Jacq.) A.R. Simoes & Staples. A. Twing B. and C. Flower D. and E. Leaves F. Androecium G. Gynoecium H. and I. Fruit J. Seed I. and J. Fruit





Synergizing Coordination Skills with Forehand Jump Smash Techniques: A Quantitative Analysis of Badminton Performance

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Coordination is typically used to demonstrate how muscles work together when moving. This study was conducted to find out the relationship between selected coordination abilities and the performance of forehand Jump smash in Badminton players and the relationship among the independent variables. For this study, a total of twenty state-level badminton players, ages ranging from 18 to 24, were selected as subjects. As proposed by Peter Hirtz, the essential data for analyzing the relationships was acquired by administering several coordinative Ability tests. Orientation Ability, Differentiation Ability, Balance Ability, Reaction Ability, and Rhythm Ability are the five coordinative abilities used in this study as well as a Hicks smash test to measure the forehand jump smash for performance. For analyzing the results of the study, the Pearson Correlation Coefficient method was applied. For the testing of the hypothesis, the level of significance was set at 0.05.

Keywords: Coordination, Correlation, Performance, Smash, Sports.



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INTRODUCTION

The word "coordination" is used in badminton. It is frequently employed to illustrate how muscles cooperate to produce movement. To effectively execute skills like strokes and footwork, you'll need good coordination. The words "coordination" can also refer to the synchronization of time and location. This stage makes certain that a stroke is carried out precisely at the appropriate moment and location. To strike the shuttle, a technically sound, coordinated stroke must be executed on the court in the proper position at the proper time. As a result of strategy, coordination also involves taking the right position on the court at the right time. As a result, the shuttle will be able to move during a stroke more tactically. Coordination is the coordinated movement of all the muscular groups in the body. When doing any movement with a specified goal, it is essential. Inter-muscular coordination and intra-muscular coordination are the two types of muscle group coordination. It involves the synchronization of different muscle groups and the fibres of a single muscle. In order to do tasks requiring both speed and strength more effectively and with less energy use, coordination is required. This leads to higher performance over time. People lose coordination when they become fatigued, and vice versa; therefore, a person who is fatigued cannot acquire moves that call for a great deal of coordination. The tough ability of coordination requires a high level of other fitness traits including balance, strength, and agility. On a sports field, someone who appears well coordinated may also be displaying exceptional timing. It's also a difficult skill to teach; instead, it develops naturally over a person's formative years. There are five different coordination skills. For the long-term training process and for the ongoing improvement and adjustment of sports tactics, all coordination skills are crucial. The degree of coordinative Ability strongly influences the motor learning ability. The central nervous system's motor control and regulatory processes play a major role in the development of coordinated abilities. Because the execution of each coordinated ability's motor control and regulation process depends on the CNS's normal operating pattern, when a certain component of these functions is improved, the athlete is better able to perform a particular set of movements. Therefore, the concepts of motor coordination are the most useful for comprehending the nature of coordination.

METHODOLOGY

The study was conducted to find out the relationship between selected coordinative ability and the performance of forehand Jump smash in badminton players and the relationship among the independent variables. For this purpose of the study, a total of twenty State Level Badminton Players, ages ranging from 19-24 years were selected as subjects. As proposed by Peter Hirtz, the essential data for analyzing the relationships was acquired by administering several coordinative Ability tests. Orientation Ability, Differentiation Ability, Balance Ability, Reaction Ability, and Rhythm Ability are the five coordinative abilities used in this study. A performance test for jump smash (Hicks Smash Test) was also done in addition to the coordination Ability. To assess selected coordinative ability, the subjects were tested in a numbered medicine ball run test for orientation Ability, backward medicine ball throw test for differentiation Ability, ball reaction exercise test for reaction capacity, long nose test for balance ability, and sprint at given rhythm test, as well as a Hicks smash test to measure the forehand jump smash for performance. For analyzing the result of the study the Pearson Correlation Coefficient method was applied. For the testing of the hypothesis, the level of significance was set at 0.05.

RESULT

In Table-2 the correlation coefficient with one asterisk (*) of mark is significant at 5% level, whereas the one with two asterisk (**) mark shows the significance at 1% level. The following conclusions may be drawn from the results in Table-2:

- The Performance of forehand jump smash in the badminton players was significantly correlated to none of the coordinative abilities tested.
- Orientation Ability had a highly positive significant correlation with balance Ability at a 1% level of significance.



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- Balance Ability was significantly correlated to rhythm Ability at a 5% level of significance.
- Reaction Ability had a highly positive significant correlation with performance at a 1% level of significance.
- All those correlation coefficients having a p-value less than 0.05 are significant at the 5% level. This is shown by the asterisk (*) mark by the side of the correlation coefficient. Similarly, correlations having a p-value less than 0.01 are significant at a 1% level, and this is indicated by two asterisks (**) marks by the side of the correlation coefficient.

DISCUSSION OF FINDINGS

The correlation matrix reveals several significant relationships between coordinative abilities and badminton performance. Notably, orientation skills exhibit a strong positive correlation with performance, suggesting that players with better spatial awareness and ability to orient themselves in the court tend to perform better in badminton matches. This finding aligns with the nature of badminton, which requires quick changes in direction and precise positioning. Balance also shows a positive correlation with differentiation, indicating that players who maintain better balance during play may have an enhanced ability to distinguish subtle differences in shuttlecock trajectory, speed, and spin. This ability can be crucial for making split-second decisions and executing accurate shots. Furthermore, reaction time is strongly correlated with performance, underscoring the importance of quick reflexes in responding to opponents' shots. In a fast-paced sport like badminton, the ability to react swiftly can be the difference between winning and losing a point.

CONCLUSIONS

Coordinative talents are generally stable and generalized patterns of motor control and regulatory processes that allow athletes to perform a set of motions with greater quality and effect. Sports performance is directly related to coordination qualities. All the coordinative abilities are important for learning sports techniques and for their continuous refinement and modifications during the long-term training process. Overall, it can be concluded that the low coefficient of correlation displayed by the selected coordinative ability does not imply that these coordinative abilities do not contribute to the performance of subjects in badminton; however, the significant coefficient correlation of these coordinative abilities with performance may be due to the level of performance of badminton players, and some other coordinative ability whimsy may contribute to the performance of badminton players.

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Table 1 : Descriptive Statistics of the selected coordinative ability and badminton performance.

	Mean	Std. Deviation
Orientation	10.8993	.67538
Differentiation	3.4000	.50709
Balance	11.1233	1.17605
Reaction	67.4667	12.27580
Rhythm	.7820	.25838
Performance	50.1147	8.09996

Table 2: Correlation matrix for the data of the selected coordinative abilities and Badminton performance.

	Orientation	Differentiation	Balance	Reaction	Rhythm	Performance
Orientation Pearson correlationSig. (2-tailed) N	1	.189	.739**	.440	.505	.407
	20	.500	.002	.101	.055	.132
		20	20	20	20	20
Differentiation Pearson correlationSig. (2-tailed) N		1	-.308	-.353	.277	-.411
		20	.264	.196	.318	.128
			20	20	20	20



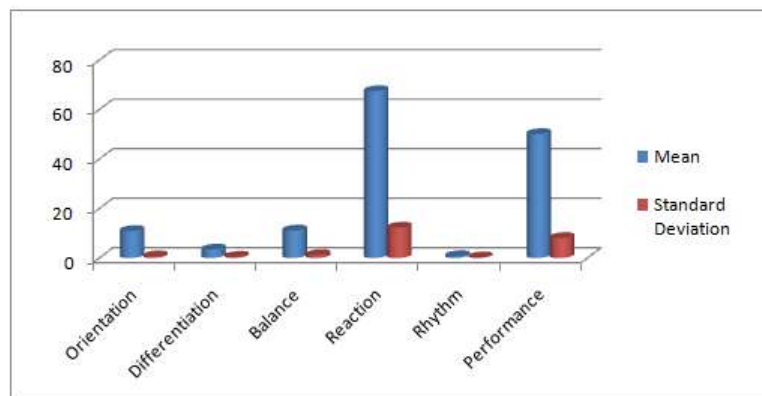


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Balance	Pearson		1	.422	.582*	.315
	correlation					
	Sig. (2-tailed)			.117	.023	.252
	N		20	20	20	20
Reaction	Pearson			1	.013	.692**
	correlation					
	Sig. (2-tailed)				.964	.004
	N			20	20	20
Rhythm	Pearson				1	-.019
	correlation					
	Sig. (2-tailed)					.948
	N				20	20
Performance						1
	Correlation					
	Sig. (2-tailed)					
	N					20

*. Correlation is significant at the 0.05 level (2-tailed).

** . Correlation is significant at the 0.01 level (2-tailed).



Graph 1: Graph shows selected coordinative ability and badminton performance





Unlocking Potential: The Significance of Early Diagnosis of Dysgraphia and the Detrimental Effects of Late Identification – A Case Study.

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Dysgraphia is a condition of neurodevelopmental origin that primarily affects the students' ability to convert their thoughts into written language. It is a learning disability that hinders a person's ability to write. Learners with dysgraphia also struggle with writing skills, spellings and organizing their thoughts on paper. This paper aims to stress the significance of timely and early diagnosis of this neurological condition based on a case study of 30 hours involving a 27-year-old learner with dysgraphia and cognitive disability. The researcher conducted a needs analysis to better understand the learner's challenges, as the difficulties faced by learners with dysgraphia are diverse. A pre-test was administered to assess the specific areas of difficulty. Questionnaires were distributed to the two special education teachers, involved with the student to gather additional insights. It is crucial to consider environmental factors, as they greatly influence a student's development. Teaching interventions were implemented through activities followed by a post-test to measure any kind of improvement. Unfortunately, the case study revealed no noticeable progress. This is because without early diagnosis it becomes more difficult for adults to make significant improvements through intervention. They may already have ingrained writing habits and methods that are challenging to rectify. Hence, it's essential to diagnose in time precisely.

Keywords : learning disability, dysgraphia, diagnosis, education, case study.



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INTRODUCTION

Learning Disability otherwise mentioned as LD is a common term that refers to a heterogenous set of disorders, one of which is dysgraphia. In India, the prevalence of this disability is not apprehended. A study conducted in a south Indian city reports the following, among the 15.17% of SLDs (Specific Learning disorders) reported, 12.5% are diagnosed with dysgraphia, 11.2% with dyslexia and 10.5% with dyscalculia. Dyslexia is another neurological condition, that commonly co-occurs with dysgraphia. This primarily affects the person's ability to read. They find it hard to recognize the letters and read the words with coherence. A key symptom of dyslexia is the difficulty they face in decoding words and the lack of phonemic awareness which is the ability to correlate the sounds and the letters or words. It is important to note that dyslexia or dysgraphia doesn't necessarily affect the learner's intelligence or their cognitive abilities. However, in some cases, these symptoms could be prominently seen. Dyscalculia on the other hand is a condition where the learners have difficulty in understanding the numbers. According to the British Dyslexia Association, about 6% of people have dyscalculia. The three conditions namely, dyslexia, dysgraphia and dyscalculia are three distinct neuro-developmental conditions. However, 30% of people with dyslexia are diagnosed with dysgraphia and 26% with dyscalculia. Also, around 36% of people with dysgraphia are said to have the symptoms of dyscalculia. Hence, it's evident that these conditions are likely to co-occur with each other. The cause of occurrence of the conditions could be varied. A child could be diagnosed with dysgraphia in an educational setup when they are initially learning to write, which can be termed as 'developmental dysgraphia'. It can also be caused due to any sudden trauma which can be termed as 'acquired dysgraphia'. Kids with ASD – Autism Spectrum Disorder and ADHD – Attention Deficit Hyperactivity Disorder are also said to be affected by dysgraphia.

LITERATURE REVIEW

The newsletter "The Importance of Early Detection of Specific Learning Disorders" discusses the importance of early detection and intervention for specific learning disorders (SLDs) such as dyslexia, dysgraphia, dyscalculia and dyspraxia. Early diagnosis has a huge impact on children's learning experiences. This is crucial to prevent the children from having problematic behaviour, poor self-esteem and mental health. Branding children as "slow" or "less intelligent" can block their process of learning. It will hinder the children from reaching their full academic and personal potential. They are also at risk of falling behind the years. The right techniques followed in the classroom also have key significance in enhancing the child's ability over the years. The accuracy of assessment methods used to identify learning disabilities determines the success of the detection.

The article "Comprehensive Assessment and Evaluation of Students with Learning Disabilities" by the National Joint Committee on Learning Disabilities" emphasized the importance of a comprehensive approach to assess and evaluate students with learning disabilities. It talked about using multiple sources to gather data which included not only tests but other informal measures. It differentiated between the evaluation and assessment. Assessment is the collection of data through multiple resources. Whereas Evaluation is the interpreting and summarizing of the comprehensive data and it is used to determine the strengths and weaknesses of the children. It emphasized on the impact of legislation in the assessment and evaluation of LD students and further how it helped to enhance the continued efforts in the future. It talked about the influence of research in this comprehensive assessment and evaluation. It gave a brief idea about the educational trends practiced. Additionally, the article produced guiding principles for comprehensive assessment and evaluation and also various instruments and procedures for the same. The characteristics that differentiate LD students and other types of behavioural problems were also discussed. It emphasized the importance of educational administrators who provide support for effective assessment and evaluation. To summarize, the articles emphasized on the significance of assessment and evaluation.

A report from the National Joint Committee on Learning Disabilities addresses that the identification and intervention of Learning Disability learners must be carried out within 4 years. The delay in the intervention can end up affecting the cognition, communication, sensory and motor abilities. The early identification is to determine the obstacles in the process



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of learning. These difficulties could be seen in all students, however, in neurotypical students it's temporary and wears off and in LD learners it persists. Hence the screening evaluation is important for diagnosing and enhancing the learning opportunities. The common mistake committed is to 'wait and see' and to assume the child will 'grow out of it'. So, the children have to be guarded against the premature identification of disability. It also talks about the identification process i) screening, ii) To check the presence of risk and protective answers, iii) systematic observations and iv) comprehensive evaluation. It also takes into account the biological, environmental and cultural factors. It went on to broadly explain the risk factors and protective factors. Various intervention strategies were customized which also included occupational and physical therapy. The professionals providing the services should be culturally and linguistically sensitive. The administrative and supervisory personnel development helps in promoting early identification and intervention. He concludes by talking about the systematic research needs in the areas of identification and learning opportunities.

The article "Disabilities in Written Expression" by Teresa J Gardner talked about the significance of writing in a mathematical class. Many mainstream teachers are unaware of the range of Learning disabilities and their effects on the language and cognitive abilities of a child. The teachers wouldn't have received adequate information to handle the learning disabilities also due to the limited or no training. The significance of writing in a math class to develop reasoning skills and to communicate their understanding was discussed. It also helped them to reflect on their understanding. It is said to help them calculate correct responses. The condition of dyscalculia is briefly explained. As maths is conceived as a difficult subject, many symptoms are overlooked and the students are considered not smart enough. Dyscalculia is often said to be accompanied with dysgraphia making it more difficult to understand the mathematical procedures. For these children, pictures, symbols and drawings are said to be used. It also reviewed a number of articles to determine teaching practices effective for the LD learners. Journal writing was also introduced to the students. Mathematical instructions, concepts etc helped to have a better understanding. It concluded by saying further problem-solving studies and instructional practices are required. The article exclaimed writing as an assistance to understand mathematics better.

NEEDS ANALYSIS

The first few classes were spent on observing the characteristics of the learner. The learner was a 27-year-old male who was diagnosed with dysgraphia and cognitive disabilities. The learner was studying at a different special school and was transferred to the same recently. The learner was fluent in talking Tamil comparatively to English which was his first language. Found it very hard to focus in any topic and was easily distracted. After repeating for even three to four times, was unable to grasp the concept. The learner found it difficult to understand the concept of sounds. Sight words were easy to remember for the learner due to the repetitive reinforcement. So, in the case of learners like them in the beginner level, it would be ideal to increase the number of sight words and aim to progress the ability of the learner from beginner level to intermediate level.

INSIGHTS FROM THE INTERVIEW

The one-on-one discussion with the director of the particular special school was very insightful. The director expressed that in his experience of 20 years in the field, it's seen that the acceptance of parents regarding their kid's condition is minimal and the denial of the parents delays the rightful intervention the student needs. Early intervention is highly important for any kind of improvement of the kid. The years 0 to 3 are known to be the golden age and once that's missed it would be hard to train or teach the kids a new concept and make them understand. Creating awareness is very important and various counselling programs were being held for that. He also went on to talk about the financial exploitation of the parents due to their lack of awareness. Talking about students with dyslexia he said, it's rare to find students with pure dyslexia and often it's accompanied with other disabilities. He went on to explain how treating students with dyslexia or any disability should be a teamwork of the parents, teachers and society. The needs of a particular student should be analyzed first and then the respective therapies have to be implemented with consistency until any improvement is seen. Special educators, occupational therapists, psychologists, and physiotherapists will also help the children if needed. Hence teamwork is important for overall recovery. He also mentioned how there have been students from the standard neuro-typical school education system, being admitted to their special schools. This might be because of the failure of diagnosis or if there was any gap in



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their education due to various reasons. On talking about diagnosis, it's usually through experience, certain characteristics and clinical symptoms. Students are checked for their age-appropriate development in the following areas such as language, motor functions, fine motor functions and cognition level. This has to be made sure before teaching them a concept. Secondly, the researcher had a brief one-on-one conversation with the teachers of the LD learners. When talking about the characteristics of the LD learners they mentioned how attention-seeking behaviour is seen in most of them. Some of the students are very keen on everything being perfect and clean and they find the need to correct it if something isn't proper. They also emphasized how the learning gap can be a factor in LD learners. Social interaction is very minimal for these children. On talking about the methods of teaching and the activities with which they could be taught the effective one was visual learning, where pictures could be used to teach and memory games to improve their cognitive level and concentration level. There is a smart class that is being used to teach the students. The practical method of teaching is more useful. They could be initially introduced with two-word phrases then gradually move on into three-word phrases and so on. For introducing a new concept group teaching is ideal as the students will interact with each other and learn, also the competitive spirit to answer first comes in, which keeps them concentrated and more attentive. Repetition has been very effective as in concentrating on a single topic until improvement, is ideal. Teaching anything through games has had a better reception among the students than traditional teaching. They also mentioned the adversities of COVID-19 and the impact it had on the students. Since the consistency of the teaching and also the therapies were lost, it was a difficult situation for the students. The positive of it was many learned to use mobile phones for the sake of attending online classes, though it was not very effective as they only had basic knowledge to operate a mobile and computer. On talking about the limitations, they mentioned that, at the end of the day even in special schools it comes down to syllabus completion and so they find it difficult to give individual attention to the students who need it. They also went on to mention how the acceptance and the effort of the parents are vital. Parents could be more helpful. The behavioural changes of the students can differ according to their environment so the role of parents is significant. The school apart from teaching also conducts extra-curricular activities such as craftwork, food making, jewellery making etc. This is also done as a means to identify the interests of the students and kindle them. Parents also must be aware of their child's interests and provide support by all means. This was a comprehensive analysis of the students which not only included the educational aspects of the children but also gave importance to all the factors that impact a child's growth and improvement.

CASE STUDY

This case study aims to shed light on the experiences and challenges faced by a dysgraphic student in an educational setting and the significance of an early and timely diagnosis. The case study was conducted with a 27-year-old learner, who was diagnosed with dysgraphia and cognitive disabilities. The learner was made to write an introduction page with personal details such as name, age and parents' names. It was noticed that the learner had knowledge about the letters or alphabet. However, when the writing style of the student was analyzed it indicated symptoms of dysgraphia. Learners with dysgraphia experience difficulties with fine motor skills, spatial awareness, and letter formation which makes it difficult for them to write. The words in the page were not aligned due to a lack of spatial awareness. The size of the letters were inconsistent. The line alignment was not followed while writing a sentence. Hence, it was a clear case of dysgraphia. A pre-test was conducted, where the learner was asked to write the alphabet. As mentioned earlier, the learner had knowledge of the letters. It was then followed by a passage writing. A passage was given and the learner had to copy the same in the given blank space.

With reference to FIG 1 passage writing, it is very much evident that the writing of the learner is very poor. There was no consistent spacing followed in the writing. There was space noticed even between the letters of the word, which makes it appear scattered and difficult to understand. The sense of differentiation between the capital letters and small letters of the alphabet was missing. Capital letters were being used in the middle of the sentences. The baseline alignment of the sentences were not straight and can be seen going diagonal. The tendency to miss out or skip the words was seen. Also, the tendency to repeat the same words again is noticed. It was noticed that the learner didn't understand the word completion. When there was no space, the learner continued the same word in the next line without a hyphen. For instance, from FIG 1, "Co-habiting", 'Co-habiti' was written in one line and 'ng' in the



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other. This indicates that the learner copied the passage letter by letter, without a complete understanding of the words or sentences. The learners seemed to not know the use of punctuation and did not understand the meaning of the same. The spellings of most of the words were also found to be wrong. The learner was confused between the letters that look alike. For instance,

i] 'n and h'ii] 'b and d' etc.

This particular pre-test showed how the learner finds it difficult to write even at the copy level.

After the assessment of the competency of the learner and areas of difficulty, a few classes were conducted to teach the learner. The teaching intervention was primarily through writing activities. The initial few classes were used to correct the mistakes of the pre-test. The distinction between the capital and small letters was taught. Following that, a class was spent teaching the difference between the letters that looked alike such as 'n and h', 'p and b', or letters that were mirror images of each other such as 'b and d'.

In FIG 2 Similar letters, a set of words were given and the learner had to group the words with the same first letter. The grouping had to be made between the following letters,

- i) 'b and p',
- ii) 'n and m',
- iii) 'n and h' and
- iv) 'n and u'.

This test was taken soon after the class. Hence it was noticed that the mistakes were comparatively less and the words were grouped correctly. However, the spellings of certain words were noticed to be wrong. In all of the given words the learner wrote 'h' instead of 'n' and also some words were incompletely written.

The activity in FIG 3 Puzzle words, was to test the cognitive ability of the learner. A puzzle box with arranged words and the words to be found was given below the grid. The learner had to find out the words from the grid. It was noticed that the learner did not understand the concept and kept circling the letters and words randomly. When instructed again, the learner attempted to find the words however couldn't identify more than two words out of the ten given words. Despite the words to be found was given below, the learner found it hard to find out. The learner couldn't focus on identifying the words and find out the words.

With reference to the activity in FIG 4, Image writing, images were given for the learner to identify and write the names of the given images. Again, it was noticed that 'h' was written as 'n'. The spelling of the word 'aeroplane' was wrong. This indicated that the word 'aeroplane' was not a sight word for the learner. Sight words are common words, where the students don't have to spell or pronounce the sounds but can recognize them due to their familiarity. These are words that are taught repeatedly to the learners and they recognize the words from the spellings without having to process the sounds of the letters. So, here the words 'book' and 'house' were sight words that the learner was familiar with hence it was written correctly. While 'aeroplane' was not a sight word that was taught priorly to the learner and hence the learner doesn't know the spelling of the same. This indicates the learner's inability to write a new word by using the concept of sound or phonics. Though the learner has the knowledge to write the letters or alphabet, the sounds of each letter were not understood by the learner. Hence the learner finds it difficult to correlate sounds to its respective letters and write a word and could only write sight words. After these activities, a post-test was conducted to assess any improvements after the teaching and the activities. The learner had to write the dictated words.

FIG 5 Post test indicates that the learner scored 5 out of the 12 dictated words. The words dictated were not sight words and that is why the learner could not write the words. It was noticed that the learner was also confused between the letters that are pronounced similarly such as 'p and b', 'y and u', and 't and d'. So, it was evident that at the end of the study, there was no significant improvement in the learner. The temporary improvements were seen, as the test was conducted soon after teaching. But in the long term, there was no improvement because being a 27-



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year-old, the learner was accustomed to certain writing habits and it was too late to rectify. For learners with dysgraphia or any learning disability, the intervention has to be early and consistent to notice any significant or prominent change and progress. Only then the learners can be trained to improve. It is very hard and almost impossible to improve the conditions of an adult learner.

CONCLUSION

The article aimed to emphasize the significance of early diagnosis and timely intervention through a case study. It proved how the delay in the diagnosis can have detrimental effects as to having difficulties even at the age of 27 and any intervention for adult learners are usually ineffective. Hence learners with learning disabilities are to be diagnosed and treated early and the intervention has to be consistent to enable their age-appropriate development that should allow them to survive independently in society.

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School is the place where we learn to read and write. It is the most crucial place for a student and it helps us to learn new things. The teachers are always helpful and teach us important things in life. We must always be regular to school as missing classes can lead to problems during exams. Schools teach us how to be consistent and punctual. School is a temple of knowledge. All great men have been taught to read and write at their schools. It is our school that educates us with the right values at an early age. We learn a lot of things around us that were not in our lives. School life is a period that makes up most of your childhood memories. We learn to laugh, cry alone and support by co-habiting with our classmates.

School is the place where we learn to read and write. It is the most crucial place for a student and it helps us to learn new things. The teachers are always helpful and teach us important things in life. We must always be regular to school as missing classes can lead to problems during exams. Schools teach us how to be consistent and punctual. School is a temple of knowledge. All great men have been taught to read and write at their schools. It is our school that educates us with the right values at an early age. We learn a lot of things around us that were not in our lives. School life is a period that makes up most of your childhood memories. We learn to laugh, cry alone and support by co-habiting with our classmates.

Fig 1 – Passage writing

II Arrange the words with the respective first letter

- bell, pen, pot, bun, bad, pond.

bell	pen
pot	bun
bad	pond
- net, man, mat, nose, milk, not.

net	man
nose	mat
not	milk
- hen, nest, hat, net, hand, no.

hen	nest
hat	net
hand	no
- neck, umbrella, under, name, ugly, nice.

neck	umbrella
under	name
ugly	nice

Fig 2 – Similar letters.

V FIND THE WORDS IN THE GRID

A	O	R	S	F	J
P	B	G	D	A	O
P	N	C	I	L	I
L	K	U	W	E	D
E	G	R	S	O	O
V	M	N	A	D	O
C	X	Z	T	Q	C

1. Apple 2. Pen 3. Pencil 4. Leg 5. Go 6. Egg 7. Nose 8. Rat 9. Cat 10. Book

Fig 3 – Puzzle words

IV Identify the pictures

- Book
- house
- A P I L O T

Fig 4 – Image writing

15/11/24

1) Gate ✓ 10) Boat ✓

2) cake ✓ 11) chair ✓

3) Box ✓ 12) Bird ✓

4) note ✓

5) school ✓

6) Bag ✓

7) Pencil ✓

8) phone ✓

9) Chalk ✓

Fig 5 – Post test





NRG β Closed Sets in Neutrosophic Topological Spaces

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

In this paper a new concept of Neutrosophic closed sets called Neutrosophic Regular Generalized β closed sets and their properties are studied and also discuss its relationship with other closed sets in Neutrosophic topological spaces is analyzed.

Keywords: The main aim of this paper is to analyze new concept of Neutrosophic closed sets called Neutrosophic Regular Generalized β closed sets and also specialized some of their basic properties with examples.

INTRODUCTION

Topological ideas are present in almost all areas of today's mathematics. The subject of topology itself consists of several different branches, such as a point set topology, algebraic topology and differential topology which have relatively little in common. Topologists are mathematicians who study qualitative questions about geometrical structures. Many concepts of topology have been generalized by considering the concept of semi - open sets due to Levine [1]. The notion of semi-pre open sets was defined by D.Andrijevic in 1986 [2] and also known as β open sets. In 1993, the concept of regular generalized closed sets [3] was introduced by N.Palaniappan and K. Chandrasekhara Rao. Neutrality the degree of indeterminacy, as an independent concept, was introduced by Smarandache [4] in 1998. He also defined the Neutrosophic set on three component Neutrosophic topological spaces (T- Truth, F -Falsehood, I-





Indeterminacy). Neutrosophic topological spaces (N-T-S) introduced by Salama [5] et al. R.Dhavaseelan and Saied Jafari [6] are introduced Neutrosophic generalized closed sets. In 2016, the concept of Neutrosophic Semi – Open sets [7] introduced by Iswarya P and Bageerathi K. I. Arokiarani [8] (2017) et al. introduced neutrosophic α closed sets in neutrosophic topological spaces. The notion of Neutrosophic β open sets and β closed sets [9] was defined by Renu Thomas and Anila.S in 2018. The main aim of this paper is to analyze new concept of Neutrosophic closed sets called Neutrosophic Regular Generalized β closed sets and also specialized some of their basic properties with examples.

PRELIMINARIES

In this section, we recall the basic definitions and operations of Neutrosophic sets and its fundamental results.

Definition 2.1[5]

Let X be a non- empty fixed set. A Neutrosophic set A is an object having the form

$A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle : x \in X \}$, where $\mu_A, \sigma_A, \gamma_A : A \rightarrow]0, 1^+ [$ and $0 \leq \mu_A(x) + \sigma_A(x) + \gamma_A(x) \leq 3^+$
 and $\mu_A(x)$ - represents the degree of membership function
 $\sigma_A(x)$ - represents the degree of indeterminacy function
 $\gamma_A(x)$ - represents the degree of non-membership function.

Set of all Neutrosophic set over X is denoted by $N(X)$.

Definition 2.2[5]

Let $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ be a Neutrosophic set on X , then the complement of A is

$A^c = \{ \langle x, \gamma_A(x), 1 - \sigma_A(x), \mu_A(x) \rangle : x \in X \}$.

Definition 2.3[5]

Let $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ and $B = \{ \langle x, \mu_B(x), \sigma_B(x), \gamma_B(x) \rangle \}$ be any two Neutrosophic sets, then

$A \subseteq B \Leftrightarrow \{ \mu_A(x) \leq \mu_B(x), \sigma_A(x) \leq \sigma_B(x), \gamma_A(x) \geq \gamma_B(x) \}$.

Definition 2.4[5]

Let X be a non- empty fixed set where $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ and $B = \{ \langle x, \mu_B(x), \sigma_B(x), \gamma_B(x) \rangle \}$ be two Neutrosophic sets, then

- $A \cup B = \{ \langle x, \max\{\mu_A(x), \mu_B(x)\}, \max\{\sigma_A(x), \sigma_B(x)\}, \min\{\gamma_A(x), \gamma_B(x)\} : x \in X \}$.
- $A \cap B = \{ \langle x, \min\{\mu_A(x), \mu_B(x)\}, \min\{\sigma_A(x), \sigma_B(x)\}, \max\{\gamma_A(x), \gamma_B(x)\} : x \in X \}$.

Definition 2.5[5]

Let X be a non-empty set and τ_N be the collection of Neutrosophic subsets of X satisfying the following properties:

- $0_N, 1_N \in \tau_N$
- $\cup T_i \in \tau_N$ for every $\{T_i : i \in J\} \subseteq \tau_N$
- $T_1 \cap T_2 \in \tau_N$ for any $T_1, T_2 \in \tau_N$

Then τ_N is a Neutrosophic topology and the space (X, τ_N) is called a Neutrosophic topological space (N-T-S). The element of τ_N is called a Neutrosophic open set and its complement is Neutrosophic closed set.

Definition 2.6 [5]

Let (X, τ_N) be a Neutrosophic topological space and $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ be a Neutrosophic set in X . Then Neutrosophic closure of A is $Ncl(A) = \cap \{H : H \text{ is a NCS in } X \text{ and } A \subseteq H\}$ and Neutrosophic interior of A is $Nint(A) = \cup \{M : M \text{ is a NCS in } X \text{ and } A \subseteq M\}$.

Definition 2.7

Let (X, τ_N) be a Neutrosophic topological space and $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ be a Neutrosophic set in X . Then A is said to be

- Neutrosophic semi closed set[7] (NSCS) if $Nint(Ncl(A)) \subseteq A$





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2. Neutrosophic pre-closed set[11] (NPCS) if $Ncl(Nint(A)) \subseteq A$
3. Neutrosophic α -closed set[8] ($N\alpha CS$) if $Ncl(Nint(Ncl(A))) \subseteq A$
4. Neutrosophic β -closed set[9] ($N\beta CS$) if $Nint(Ncl(Nint(A))) \subseteq A$
5. Neutrosophic regular closed set[12] (NRCS) if $Ncl(Nint(A)) = A$
6. Neutrosophic regular open set[12] (NROS) if $Nint(Ncl(A)) = A$
7. Neutrosophic b closed set[14] ($NbCS$) if $Ncl(Nint(A) \cap Nint(Ncl(A))) \subseteq A$.

Definition 2.8[9]

Let (X, τ_N) be a Neutrosophic topological space and $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ be a Neutrosophic set in X . Then Neutrosophic β closure of A is $N\beta cl(A) = \cap \{H: H \text{ is a } N\beta CS \text{ in } X \text{ and } A \subseteq H\}$ and Neutrosophic β interior of A is $N\beta int(A) = \cup \{M: M \text{ is a } N\beta OS \text{ in } X \text{ and } M \subseteq A\}$.

Definition 2.9

Let (X, τ_N) be a Neutrosophic topological space and $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ be a Neutrosophic set in X . Then A is said to be

1. Neutrosophic generalized closed set[6] (NGCS) if $Ncl(A \subseteq U)$ whenever $A \subseteq U$ and U is a NOS in X
2. Neutrosophic α generalized closed set[10] ($N\alpha GCS$) if $N\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is a NOS in X
3. Neutrosophic generalized pre-closed set[11] (NGPCS) if $NPcl(A) \subseteq U$ whenever $A \subseteq U$ and U is a NOS in X
4. Neutrosophic generalized semi closed set[13] (NGSCS) if $NScl(A) \subseteq U$ whenever $A \subseteq U$ and U is a NOS in X

Definition 2.10[9]

Let (X, τ_N) be a Neutrosophic topological space and $A = \{ \langle x, \mu_A(x), \sigma_A(x), \gamma_A(x) \rangle \}$ be a Neutrosophic set in X . Then Neutrosophic β closure of A is $N\beta cl(A) = \cap \{H: H \text{ is a } N\beta CS \text{ in } X \text{ and } A \subseteq H\}$ and Neutrosophic β interior of A is $N\beta int(A) = \cup \{M: M \text{ is a } N\beta OS \text{ in } X \text{ and } M \subseteq A\}$.

Theorem 2.11

Let A be a NS in a Neutrosophic topological space X . Then,

- (i) $(N\beta int(A))^c = N\beta cl(A^c)$
- (ii) $(N\beta cl(A))^c = N\beta int(A^c)$

Proof

- (i) Let A be a NS in Neutrosophic topological space. Now $N\beta int(A) = \cup \{M: M \text{ is a } N\beta OS \text{ in } X \text{ and } M \subseteq A\}$. Then $(N\beta int(A))^c = [\cup \{M: M \text{ is a } N\beta OS \text{ in } X \text{ and } M \subseteq A\}]^c = \cap \{M^c: M^c \text{ is a } N\beta CS \text{ in } X \text{ and } A^c \subseteq M^c\}$. Replacing (i) M^c by N , we get $(N\beta int(A))^c = \cap \{N: N \text{ is a } N\beta CS \text{ in } X \text{ and } N \supseteq A^c\} \Rightarrow (N\beta int(A))^c = N\beta cl(A^c)$. This proves (i). Analogously (ii) can be proved.

Neutrosophic Regular Generalized β closed sets

Definition 3.1

A Neutrosophic set \mathcal{D} in a Neutrosophic Topological Spaces $(\mathbb{R}, \mathfrak{N})$ is said to be a Neutrosophic Regular Generalized β closed set (in short $NRG\beta CS$) if $\beta cl(\mathcal{D}) \subseteq \mathbb{H}$ whenever $\mathcal{D} \subseteq \mathbb{H}$ and \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{N})$. The complement of Neutrosophic Regular Generalized β closed set is called as Neutrosophic Regular Generalized β open set ($NRG\beta OS$). The family of all $NRG\beta CS$ and $NRG\beta OS$ of a Neutrosophic Topological Spaces $(\mathbb{R}, \mathfrak{N})$ is denoted by $NRG\beta CS(\mathbb{R})$ and $NRG\beta OS(\mathbb{R})$ respectively.

Example 3.2

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{N} = \{0_N, L, 1_N\}$ be a Neutrosophic Topology on \mathbb{R} where $L = \{ \langle x, (0.3, 0.5, 0.9), (0.4, 0.5, 0.8) \rangle \}$. Then the Neutrosophic set $\mathcal{D} = \{ \langle x, (0.8, 0.5, 0.4), (0.6, 0.5, 0.5) \rangle \}$ is a $NRG\beta CS$ in \mathbb{R} .



**Theorem 3.3**

Every NCS is a NRG β CS but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NCS, $\text{Ncl}(\mathcal{D}) = \mathcal{D} \subseteq \mathbb{H}$. But every NCS set is $N\beta$ – closed which implies that $N\beta\text{cl}(\mathcal{D}) \subseteq \text{Ncl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a NRG β CS in \mathbb{R} .

Example 3.4

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a NT on \mathbb{R} where $L = \{\langle x, (0.4, 0.5, 0.7), (0.3, 0.5, 0.8) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.6, 0.5, 0.3), (0.7, 0.5, 0.4) \rangle\}$ is a NRG β CS but not a NCS in \mathbb{R} , since $\text{Ncl}(\mathcal{D}) = 1_{\mathbb{N}} \neq \mathcal{D}$.

Theorem 3.5

Every NaCS is a NRG β CS but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NaCS, $\text{Nacl}(\mathcal{D}) = \mathcal{D} \subseteq \mathbb{H}$. But every Na – closed set is $N\beta$ – closed which implies that $N\beta\text{cl}(\mathcal{D}) \subseteq \text{Nacl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a NRG β CS in \mathbb{R} .

Example 3.6

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} where $L = \{\langle x, (0.2, 0.5, 0.8), (0.4, 0.5, 0.9) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.6, 0.5, 0.4), (0.7, 0.5, 0.4) \rangle\}$ is a NRG β CS but not a NaCS in \mathbb{R} , since $\text{Nacl}(\mathcal{D}) = L^c \not\subseteq \mathcal{D}$.

Theorem 3.7

Every NPCS is a NRG β CS but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NPCS, $\text{NPcl}(\mathcal{D}) = \mathcal{D} \subseteq \mathbb{H}$. But every NPCS is NCS which implies that $\text{Ncl}(\mathcal{D}) \subseteq \text{NPcl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a NRG β CS in \mathbb{R} .

Example 3.8

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} where $L = \{\langle x, (0.1, 0.5, 0.9), (0.4, 0.5, 0.8) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.5, 0.5, 0.7), (0.6, 0.5, 0.6) \rangle\}$ is a NRG β CS but not a NPCS in \mathbb{R} , since $\text{Ncl}(\text{Nint}(\mathcal{D})) = L^c \not\subseteq \mathcal{D}$.

Theorem 3.9

Every NGCS is a NRG β CS but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NGCS and every NROS is NOS, $\text{Ncl}(\mathcal{D}) \subseteq \mathbb{H}$. But every NCS is $N\beta$ CS which implies that $N\beta\text{cl}(\mathcal{D}) \subseteq \text{Ncl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a NRG β CS in \mathbb{R} .

Example 3.10

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} where $L = \{\langle x, (0.3, 0.5, 0.9), (0.5, 0.5, 0.7) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.2, 0.5, 0.6), (0.4, 0.5, 0.8) \rangle\}$ is a NRG β CS but not a NGCS in \mathbb{R} , since $\text{Ncl}(\mathcal{D}) = L^c \not\subseteq \mathcal{D}$.

Theorem 3.11

Every NaGCS is a NRG β CS but not conversely.



**Proof**

Let $\mathcal{D} \subseteq \mathbb{H}$ where U is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a $\mathcal{N}\alpha\text{GCS}$ and every NROS is NOS, $\mathcal{N}\alpha\text{cl}(\mathcal{D}) \subseteq \mathbb{H}$. But every $\mathcal{N}\alpha\text{CS}$ is $\mathcal{N}\beta\text{CS}$ which implies that $\mathcal{N}\beta\text{cl}(\mathcal{D}) \subseteq \mathcal{N}\alpha\text{cl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $\text{NRG}\beta\text{CS}$ in \mathbb{R} .

Example 3.12

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} where $L = \{\langle x, (0.6, 0.5, 0.4), (0.6, 0.5, 0.2) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.7, 0.5, 0.3), (0.4, 0.5, 0.8) \rangle\}$ is a $\text{NRG}\beta\text{CS}$ but not a NGCS in \mathbb{R} , since $\mathcal{N}\alpha\text{cl}(\mathcal{D}) = 1_{\mathbb{N}} \notin \mathcal{D}$.

Theorem 3.13

Every NGPCS is a $\text{NRG}\beta\text{CS}$ but not conversely.

Proof:

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NGPCS and every NROS is NOS, $\text{NPcl}(\mathcal{D}) \subseteq \mathbb{H}$. But every NPCS is $\mathcal{N}\beta\text{CS}$ which implies that $\mathcal{N}\beta\text{cl}(\mathcal{D}) \subseteq \text{NPcl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $\text{NRG}\beta\text{CS}$ in \mathbb{R} .

Example 3.14

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L_1, L_2, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} , where $L_1 = \{\langle x, (0.3, 0.5, 0.7), (0.2, 0.5, 0.8) \rangle\}$, $L_2 = \{\langle x, (0.3, 0.5, 0.6), (0.6, 0.5, 0.4) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, 0.4, 0.5, 0.6 \rangle, (0.7, 0.5, 0.3) \rangle\}$ is a $\text{NRG}\beta\text{CS}$ but not a NGPCS in \mathbb{R} , since $\text{NPcl}(\mathcal{D}) = L_2 \notin \mathcal{D}$.

Theorem 3.15

Every NSCS is a $\text{NRG}\beta\text{CS}$ but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where U is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NSCS , $\text{NScl}(\mathcal{D}) = \mathcal{D} \subseteq \mathbb{H}$. But every NSCS is $\mathcal{N}\beta\text{CS}$ which implies that $\mathcal{N}\beta\text{cl}(\mathcal{D}) \subseteq \text{NScl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $\text{NRG}\beta\text{CS}$ in \mathbb{R} .

Example 3.16

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} , where $L = \{\langle x, (0.7, 0.5, 0.4), (0.6, 0.5, 0.3) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.9, 0.5, 0.2), (0.7, 0.5, 0.1) \rangle\}$ is a $\text{NRG}\beta\text{CS}$ but not a NSCS in \mathbb{R} , since $\text{Nint}(\text{Ncl}(\mathcal{D})) = 1_{\mathbb{N}} \notin \mathcal{D}$.

Theorem 3.17

Every NGSCS is a $\text{NRG}\beta\text{CS}$ but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NGSCS and every NROS is NOS, $\text{NScl}(\mathcal{D}) \subseteq \mathbb{H}$. But every NSCS is $\mathcal{N}\beta\text{CS}$ which implies that $\mathcal{N}\beta\text{cl}(\mathcal{D}) \subseteq \text{NScl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $\text{NRG}\beta\text{CS}$ in \mathbb{R} .

Example 3.18

Let $\mathbb{R} = \{k_1, k_2\}, \mathfrak{S}_{\mathbb{N}} = \{0_{\mathbb{N}}, L, 1_{\mathbb{N}}\}$ be a N.T. on \mathbb{R} , where $L = \{\langle x, (0.9, 0.5, 0.6), (0.0, 0.5, 0.1) \rangle\}$. Then the Neutrosophic set $\mathcal{D} = \{\langle x, (0.7, 0.5, 0.4), (0.3, 0.5, 0.6) \rangle\}$ is a $\text{NRG}\beta\text{CS}$ but not a NGSCS in \mathbb{R} , since $\text{NScl}(\mathcal{D}) = 1_{\mathbb{N}} \notin \mathcal{D}$.

Theorem 3.19

Every NbCS is a $\text{NRG}\beta\text{CS}$ but not conversely.

Proof

Let $\mathcal{D} \subseteq \mathbb{H}$ where U is a NROS in $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$. Since \mathcal{D} is a NbCS , $\text{Nbcl}(\mathcal{D}) = \mathcal{D} \subseteq \mathbb{H}$. But every NbCS is $\mathcal{N}\beta\text{CS}$ which implies that $\mathcal{N}\beta\text{cl}(\mathcal{D}) \subseteq \text{Nbcl}(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $\text{NRG}\beta\text{CS}$ in \mathbb{R} .





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Example 3.20

Let $\mathbb{R}=\{k_1,k_2\}$, $\mathfrak{S}_N=\{0_N,L,1_N\}$ is be a N.T. on \mathbb{R} where $L=\langle x,(0.7,0.5,0.4),(0.6,0.5,0.3) \rangle$. Then the Neutrosophic set $\mathcal{D}=\langle x,(0.9,0.5,0.3),(0.8,0.5,0.2) \rangle$ is a $NRG\beta CS$ but not a $N\beta CS$ in \mathbb{R} , since $Ncl(Nint(\mathcal{D})) \cap Nint(Ncl(\mathcal{D}))=1_N \notin \mathcal{D}$.

Theorem 3.21

Every $N\beta CS$ is a $NRG\beta CS$ but not conversely.

Proof:

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_N)$. Since \mathcal{D} is a $N\beta CS$, $N\beta cl(\mathcal{D}) = \mathcal{D} \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $NRG\beta CS$ in \mathbb{R} .

Example 3.22

Let $\mathbb{R}=\{k_1,k_2\}$, $\mathfrak{S}_N=\{0_N,L,1_N\}$ be a N.T. on \mathbb{R} where $L=\langle x,(0.2,0.5,0.8),(0.4,0.5,0.9) \rangle$. Then the Neutrosophic set $\mathcal{D}=\langle x,(0.6,0.5,0.4),(0.7,0.5,0.4) \rangle$ is a $NRG\beta CS$ but not a $N\beta CS$ in \mathbb{R} , since $N\beta cl(\mathcal{D})=L \notin \mathcal{D}$.

Theorem 3.23

Every $NG\beta CS$ is a $NRG\beta CS$ but not conversely.

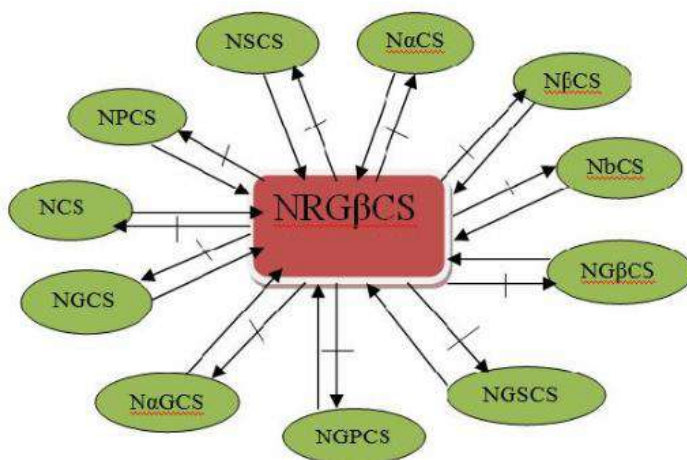
Proof:

Let $\mathcal{D} \subseteq \mathbb{H}$ where \mathbb{H} is a NROS in $(\mathbb{R}, \mathfrak{S}_N)$. Since \mathcal{D} is a $NG\beta CS$ and every NROS is NOS, $N\beta cl(\mathcal{D}) \subseteq \mathbb{H}$. Therefore \mathcal{D} is a $NRG\beta CS$ in \mathbb{R} .

Example 3.24

Let $\mathbb{R}=\{k_1,k_2\}$, $\mathfrak{S}_N=\{0_N,L,M,1_N\}$ be a N.T. on \mathbb{R} where $L=\langle x,(0.5,0.5,0.5),(0.3,0.7,0.7) \rangle$ and $M=\langle x,(0.6,0.4,0.4),(0.7,0.3,0.3) \rangle$. Clearly for the Neutrosophic set L , $L \subseteq L$ and $L \in \mathfrak{S}_N$. However $N\beta cl(L)=1_N \notin L$. Also $(\mathbb{R}, \mathfrak{S}_N)=\{0_N, 1_N\}$. Thus L is $NRG\beta CS$ but not $NG\beta CS$.

Thus from the above theorems and examples we have the following implications:



Theorem 3.25

If \mathcal{D} is NROS and $NRG\beta CS$ in $(\mathbb{R}, \mathfrak{S}_N)$ then \mathcal{D} is $N\beta$ – closed.

Proof

Suppose \mathcal{D} is NROS and $NRG\beta CS$ in $(\mathbb{R}, \mathfrak{S}_N)$. Then by definition $N\beta cl(\mathcal{D}) \subseteq \mathcal{D}$. But always $\mathcal{D} \subseteq N\beta cl(\mathcal{D})$. Thus $\mathcal{D} = N\beta cl(\mathcal{D})$ which implies that \mathcal{D} is $N\beta$ – closed.





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Theorem 3.26

Let $\mathcal{D} \subseteq (\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$ be NRG β CS. Then $N\beta cl(\mathcal{D}) \setminus \mathcal{D}$ does not contain non – empty NRCS.

Proof:

Let F be a NRC subset of $N\beta cl(\mathcal{D}) \setminus \mathcal{D}$. Then clearly $\mathcal{D} \subseteq \mathbb{R} \setminus F$ where \mathcal{D} is NRG β CS in \mathbb{R} and $\mathbb{R} \setminus F$ is NRO in \mathbb{R} . Thus $N\beta cl(\mathcal{D}) \subseteq \mathbb{R} \setminus F$ or equivalently $F \subseteq \mathbb{R} \setminus N\beta cl(\mathcal{D})$. By assumption $F \subseteq N\beta cl(\mathcal{D})$. Then $F \subseteq (\mathbb{R} \setminus N\beta cl(\mathcal{D})) \cap N\beta cl(\mathcal{D}) = \phi$.

Theorem 3.27

Suppose that \mathcal{D} is a NRG β CS. Then \mathcal{D} is N β CS if and only if $N\beta cl(\mathcal{D}) \setminus \mathcal{D}$ is NRCS.

Proof

Assume that \mathcal{D} is a N β CS. Then we have $N\beta cl(\mathcal{D}) \setminus \mathcal{D} = \phi$ which is NRCS. Conversely, assume that $N\beta cl(\mathcal{D}) \setminus \mathcal{D}$ is NRCS. Hence from Theorem 3.23, $N\beta cl(\mathcal{D}) \setminus \mathcal{D}$ does not contain non – empty NRCS and since $N\beta cl(\mathcal{D}) \setminus \mathcal{D}$ is NRCS and subset of itself, so $N\beta cl(\mathcal{D}) \setminus \mathcal{D} = \phi$. Therefore, $\mathcal{D} = N\beta cl(\mathcal{D})$ and so \mathcal{D} is N β CS.

Lemma 3.28

Suppose that $F \subseteq \mathcal{D} \subseteq (\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$, where \mathcal{D} is NROS in \mathbb{R} . Then the following two conditions are valid.

1. If \mathcal{D} is NRG β CS in \mathbb{R} and F is NRG β CS in \mathcal{D} , then F is NRG β CS in \mathbb{R} .
2. If F is NRG β CS in \mathbb{R} , then F is NRG β CS in \mathcal{D} .

Proof:

Assume that \mathbb{H} is NROS in \mathbb{R} and $F \subseteq \mathbb{H}$. Then $F \subseteq \mathbb{H} \cap \mathcal{D}$ and $\mathbb{H} \cap \mathcal{D}$ is NROS in \mathcal{D} . Since F is NRG β CS in \mathcal{D} , $N\beta cl_{\mathcal{D}}(F) \subseteq \mathbb{H} \cap \mathcal{D}$. Since \mathcal{D} is NROS and NRG β CS in \mathbb{R} then by Theorem 3.22, \mathcal{D} is N β – closed in \mathbb{R} . Thus $N\beta cl(\mathcal{D}) = \mathcal{D}$. Hence $N\beta cl(F) \subseteq N\beta cl(F) \cap N\beta cl(\mathcal{D}) = N\beta cl(F) \cap \mathcal{D} = N\beta cl_{\mathcal{D}}(F) \subseteq \mathbb{H} \cap \mathcal{D}$. So we have $N\beta cl(F) \subseteq \mathbb{H}$ whenever $F \subseteq \mathbb{H}$ and \mathbb{H} is NROS in \mathbb{R} which implies that F is NRG β CS in \mathbb{R} . Suppose V is a NRO subset of \mathcal{D} such that $F \subseteq V$. Since \mathcal{D} is NROS, then by transitivity V is NROS. And since F is NRG β CS in \mathbb{R} , we have $N\beta cl(F) \subseteq V$. Thus $N\beta cl_{\mathcal{D}}(F) = N\beta cl(F) \cap \mathcal{D} \subseteq V \cap \mathcal{D} = V$ which implies that F is NRG β CS in \mathcal{D} .

Corollary 3.29

Suppose that $F \subseteq \mathcal{D} \subseteq (\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$, where \mathcal{D} is NROS and NRG β CS in \mathbb{R} . Then F is NRG β CS in \mathcal{D} iff F is NRG β CS in \mathbb{R} .

Definition: 3.30

Let $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$ be a Neutrosophic topological space and \mathcal{D} be a Neutrosophic set in \mathbb{R} , then the NRG β interior of \mathcal{D} is defined as $NRG\beta \text{ int}(\mathcal{D}) = \cup \{M/M \text{ is a NRG}\beta\text{OS in } \mathbb{R} \text{ and } M \subseteq \mathcal{D}\}$. Clearly $NRG\beta \text{ int}(\mathcal{D})$ is the biggest NRG β open set over \mathbb{R} which is contained in \mathcal{D} .

Theorem: 3.31

Neutrosophic Regular Generalized β open subsets P and Q of a N-T-S \mathbb{R} we have

- (i) $NRG\beta \text{ Int}(P) \subseteq P$
- (ii) $P \text{ is NRG}\beta \text{ open set in } \mathbb{R} \Leftrightarrow NRG\beta \text{ Int}(P) = P$
- (iii) $NRG\beta \text{ Int}(NRG\beta \text{-Int}(P)) = NRG\beta \text{-Int}(P)$
- (iv) If $P \subseteq Q$ then $NRG\beta \text{ Int}(P) \subseteq NRG\beta \text{-Int}(Q)$

Proof

Proof of (i) is directly get the result through the Definition 3.30.

Let P be NRG β –open set in \mathbb{R} . Then $P \subseteq NRG\beta \text{ int}(P)$ and from 3.31(i) we obtain the result $P = NRG\beta \text{-Int}(P)$. Now Conversely we assume that $P = NRG\beta \text{-Int}(P)$. Then P is a NRG β –open set in N-T-S \mathbb{R} . From the result (ii), $NRG\beta \text{-Int}(NRG\beta \text{-Int}(P)) = NRG\beta \text{-Int}(P)$ we get the result(iii). Since $P \subseteq Q$, by using(i), $NRG\beta \text{-Int}(P) \subseteq P \subseteq Q$. i.e., $NRG\beta \text{-Int}(P) \subseteq Q$ from the result (iii), $NRG\beta \text{-Int}(NRG\beta \text{-Int}(P)) \subseteq NRG\beta \text{ Int}(Q)$. Thus $NRG\beta (P) \subseteq NRG\beta \text{-Int}(Q)$ we get the result (iv).

Theorem 3.32

Let P and Q are two Neutrosophic subsets of N- T-S $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$ then

- (i) $NRG\beta \text{-Int}(P \cap Q) = NRG\beta \text{-Int}(P) \cap NRG\beta \text{-Int}(Q)$





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(ii) $NRG\beta -Int(P \cup Q) \supseteq NRG\beta -Int(P) \cup NRG\beta -Int(Q)$.

Proof

Since $P \cap Q \subseteq P$ and $P \cap Q \subseteq Q$, follows from the theorem 3.31(iv), $NRG\beta -Int(P \cap Q) \subseteq NRG\beta -Int(P)$ and $NRG\beta -Int(P \cap Q) \subseteq NRG\beta -Int(Q)$. This implies that $NRG\beta -Int(P \cap Q) \subseteq NRG\beta -Int(P) \cap NRG\beta -Int(Q)$ (1) follows from the theorem 3.31 (i), $NRG\beta -Int(P) \subseteq P$ and $NRG\beta -Int(Q) \subseteq Q$. This implies that $NRG\beta -Int(P) \cap NRG\beta -Int(Q) \subseteq P \cap Q$. Now from theorem 3.31(iv), $NRG\beta -Int((NRG\beta -Int(P) \cap NRG\beta -Int(Q))) \subseteq NRG\beta -Int(P \cap Q)$. From theorem 4.2(iii), $NRG\beta -Int(P) \cap NRG\beta -Int(Q) \subseteq NRG\beta -Int(P \cap Q)$(2). From (1) and (2), $NRG\beta -Int(P \cap Q) = NRG\beta -Int(P) \cap NRG\beta -Int(Q)$. This implies (i). Since $P \subseteq P \cup Q$ and $Q \subseteq P \cup Q$, by from theorem 3.31(iv), $NRG\beta -Int(P) \subseteq NRG\beta -Int(P \cup Q)$ and $NRG\beta -Int(Q) \subseteq NRG\beta -Int(P \cup Q)$. This implies that $NRG\beta -Int(P) \cup NRG\beta -Int(Q) \subseteq NRG\beta -Int(P \cup Q)$. Hence (ii).

Definition: 3.33

Let $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$ be a Neutrosophic topological space and \mathcal{D} be a Neutrosophic set in \mathbb{R} , then the $NRG\beta$ closure of \mathcal{D} is defined as $NRG\beta cl(\mathcal{D}) = \cap \{M/M \text{ is a } NRG\beta CS \text{ in } \mathbb{R} \text{ and } \mathcal{D} \subseteq M\}$. Clearly $NRG\beta cl(\mathcal{D})$ is the smallest $NRG\beta$ closed set over \mathbb{R} which contains \mathcal{D} .

Theorem: 3.34

Neutrosophic Regular Generalized β closed subsets P and Q of a N-T-S \mathbb{R} we have

- (i) $P \subseteq NRG\beta cl(P)$
- (ii) P is $NRG\beta$ closed set in $\mathbb{R} \Leftrightarrow P = NRG\beta cl(P)$
- (iii) $NRG\beta cl(NRG\beta cl(P)) = NRG\beta cl(P)$
- (iv) If $P \subseteq Q$ then $NRG\beta cl(P) \subseteq NRG\beta cl(Q)$

Proof

Proof of (i) is directly get the result through the Definition 3.33.
 Let P be $NRG\beta$ -closed set in \mathbb{R} . Then $P \supseteq NRG\beta -cl(P)$ and from 3.34(i) we obtain the result $P = NRG\beta -cl(P)$. Now Conversely we assume that $P = NRG\beta -cl(P)$. Then P is a $NRG\beta$ -closed set in N-T-S \mathbb{R} . From the result (ii), $NRG\beta -cl(NRG\beta -cl(P)) = NRG\beta -cl(P)$ we get the result(iii). Since $P \subseteq Q$, by using(i), $NRG\beta -cl(P) \subseteq P \subseteq Q$. i.e., $NRG\beta -cl(P) \subseteq Q$ from the result (iii), $NRG\beta -cl(NRG\beta -cl(P)) \subseteq NRG\beta cl(Q)$. Thus $NRG\beta cl(P) \subseteq NRG\beta -cl(Q)$ we get the result (iv).

Theorem 3.35

Let \mathcal{D} be a NS in a Neutrosophic topological space \mathbb{R} . Then,

- (i) $(NRG\beta int(\mathcal{D}))^c = NRG\beta cl(\mathcal{D}^c)$
- (ii) $(NRG\beta cl(\mathcal{D}))^c = NRG\beta int(\mathcal{D}^c)$

Proof

(i) Let \mathcal{D} be a NS in a Neutrosophic topological space \mathbb{R} . Now $NRG\beta int(\mathcal{D}) = \cup \{M: M \text{ is a } NRG\beta OS \text{ in } \mathbb{R} \text{ and } M \subseteq \mathcal{D}\}$. Then $(NRG\beta int(\mathcal{D}))^c = [\cup \{M: M \text{ is a } NRG\beta OS \text{ in } \mathbb{R} \text{ and } M \subseteq \mathcal{D}\}]^c = \cap \{M^c: M^c \text{ is a } NRG\beta CS \text{ in } \mathbb{R} \text{ and } \mathcal{D}^c \subseteq M^c\}$. Replacing M^c by N , we get $(NRG\beta int(\mathcal{D}))^c = \cap \{N: N \text{ is a } NRG\beta CS \text{ in } \mathbb{R} \text{ and } N \supseteq \mathcal{D}^c\} \Rightarrow (NRG\beta int(\mathcal{D}))^c = NRG\beta cl(\mathcal{D}^c)$. This proves (i). Analogously (ii) can be proved.

Definition 3.36

Let $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$ be a Neutrosophic topological space over \mathbb{R} then the $NRG\beta$ exterior of a Neutrosophic set \mathcal{D} over \mathbb{R} is denoted by $NRG\beta ext(\mathcal{D})$ and is defined as $NRG\beta ext(\mathcal{D}) = NRG\beta int(\mathcal{D}^c)$.

Theorem 3.37

Let $(\mathbb{R}, \mathfrak{S}_{\mathbb{N}})$ be a Neutrosophic topological space over \mathbb{R} and $P, Q \in NRG\beta(\mathbb{R})$. Then

- (i) $NRG\beta ext(P \cup Q) = NRG\beta ext(P) \cap NRG\beta ext(Q)$





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(ii) $NRG\beta \text{ ext}(P) \cup NRG\beta \text{ ext}(Q) \subseteq NRG\beta \text{ ext}(P \cap Q)$

Proof

(i) By Definition 3.36, De Morgan’s law and Theorem 3.32(i),

$$\begin{aligned} NRG\beta \text{ ext}(P \cup Q) &= NRG\beta \text{ int}(P \cup Q)^c \\ &= NRG\beta \text{ int}(P^c \cap Q^c) \\ &= NRG\beta \text{ int}(P^c) \cap NRG\beta \text{ int}(Q^c) \\ &= NRG\beta \text{ ext}(P) \cap NRG\beta \text{ ext}(Q) \end{aligned}$$

(ii) It is similar to (i).

Definition 3.38

Let $(\mathbb{R}, \mathfrak{N})$ be a Neutrosophic topological space over \mathbb{R} and $P \in NRG\beta(\mathbb{R})$. Then the $NRG\beta$ boundary of a Neutrosophic set \mathcal{D} over \mathbb{R} denoted by $NRG\beta \text{ fr}(\mathcal{D})$ and is defined as $NRG\beta \text{ fr}(\mathcal{D}) = NRG\beta \text{ cl}(\mathcal{D}) \cap NRG\beta \text{ cl}(\mathcal{D}^c)$. It must be noted that $NRG\beta \text{ fr}(\mathcal{D}) = NRG\beta \text{ fr}(\mathcal{D}^c)$.

Theorem 3.39

Let \mathcal{D} be a NS in a Neutrosophic topological space \mathbb{R} . Then

- (i) $(NRG\beta \text{ fr}(\mathcal{D}))^c = NRG\beta \text{ ext}(\mathcal{D}) \cup NRG\beta \text{ int}(\mathcal{D})$
- (ii) $NRG\beta \text{ cl}(\mathcal{D}) = NRG\beta \text{ int}(\mathcal{D}) \cup NRG\beta \text{ fr}(\mathcal{D})$

Proof

Let \mathcal{D} be a NS in a Neutrosophic topological space \mathbb{R} . Then

(i) By Theorem 3.35 (i) & (ii), we have

$$\begin{aligned} (NRG\beta \text{ fr}(\mathcal{D}))^c &= [NRG\beta \text{ cl}(\mathcal{D}) \cap NRG\beta \text{ cl}(\mathcal{D}^c)]^c \\ &= [NRG\beta \text{ cl}(\mathcal{D})]^c \cup [NRG\beta \text{ cl}(\mathcal{D}^c)]^c \\ &= [NRG\beta \text{ cl}(\mathcal{D})]^c \cup [(NRG\beta \text{ int}(\mathcal{D}))^c]^c \\ &= NRG\beta \text{ int}(\mathcal{D}^c) \cup NRG\beta \text{ int}(\mathcal{D}) \\ &= NRG\beta \text{ ext}(\mathcal{D}) \cup NRG\beta \text{ int}(\mathcal{D}). \end{aligned}$$

(ii) By Theorem 3.35 (i) & (ii), we have

$$\begin{aligned} NRG\beta \text{ int}(\mathcal{D}) \cup NRG\beta \text{ fr}(\mathcal{D}) &= NRG\beta \text{ int}(\mathcal{D}) \cup [NRG\beta \text{ cl}(\mathcal{D}) \cap NRG\beta \text{ cl}(\mathcal{D}^c)] \\ &= [NRG\beta \text{ int}(\mathcal{D}) \cup NRG\beta \text{ cl}(\mathcal{D})] \cap [NRG\beta \text{ int}(\mathcal{D}) \cup NRG\beta \text{ cl}(\mathcal{D}^c)] \\ &= NRG\beta \text{ cl}(\mathcal{D}) \cap [NRG\beta \text{ int}(\mathcal{D}) \cup (NRG\beta \text{ int}(\mathcal{D}))^c] \\ &= NRG\beta \text{ cl}(\mathcal{D}) \cap \mathbb{R} = NRG\beta \text{ cl}(\mathcal{D}). \end{aligned}$$

Theorem 3.40

Let \mathcal{D} be a NS in a Neutrosophic topological space $(\mathbb{R}, \mathfrak{N})$. Then

- (i) \mathcal{D} is a $NRG\beta$ open set over \mathbb{R} if and only if $\mathcal{D} \cap NRG\beta \text{ fr}(\mathcal{D}) = \emptyset$.
- (ii) \mathcal{D} is a $NRG\beta$ closed set over \mathbb{R} if and only if $NRG\beta \text{ fr}(\mathcal{D}) \subseteq \mathcal{D}$.

Proof

Let \mathcal{D} be a NS in a Neutrosophic topological space $(\mathbb{R}, \mathfrak{N})$. Then

(i) Assume that \mathcal{D} is a $NRG\beta$ open set over \mathbb{R} . Thus $NRG\beta \text{ int}(\mathcal{D}) = \mathcal{D}$. By Theorem 3.35, $NRG\beta \text{ fr}(\mathcal{D}) = NRG\beta \text{ cl}(\mathcal{D}) \cap NRG\beta \text{ cl}(\mathcal{D}^c) = NRG\beta \text{ cl}(\mathcal{D}) \cap (NRG\beta \text{ int}(\mathcal{D}))^c$. So

$$\begin{aligned} NRG\beta \text{ fr}(\mathcal{D}) \cap NRG\beta \text{ int}(\mathcal{D}) &= NRG\beta \text{ cl}(\mathcal{D}) \cap (NRG\beta \text{ int}(\mathcal{D}))^c \cap NRG\beta \text{ int}(\mathcal{D}) \\ &= NRG\beta \text{ cl}(\mathcal{D}) \cap \mathcal{D}^c \cap \mathcal{D} \\ &= \emptyset. \end{aligned}$$

Conversely let $\mathcal{D} \cap NRG\beta \text{ fr}(\mathcal{D}) = \emptyset$. Then $\mathcal{D} \cap NRG\beta \text{ cl}(\mathcal{D}) \cap NRG\beta \text{ cl}(\mathcal{D}^c) = \emptyset$ or $\mathcal{D} \cap NRG\beta \text{ cl}(\mathcal{D}^c) = \emptyset$ or $NRG\beta \text{ cl}(\mathcal{D}) \subseteq \mathcal{D}^c$ which implies \mathcal{D}^c is a $NRG\beta$ closed set and so \mathcal{D} is a $NRG\beta$ open set.

(ii) Let \mathcal{D} be a $NRG\beta$ closed set. Then $NRG\beta \text{ cl}(\mathcal{D}) = \mathcal{D}$. By Definition 3.38, $NRG\beta \text{ fr}(\mathcal{D}) = NRG\beta \text{ cl}(\mathcal{D}) \cap NRG\beta \text{ cl}(\mathcal{D}^c) \subseteq NRG\beta \text{ cl}(\mathcal{D}) = \mathcal{D}$. Therefore, $NRG\beta \text{ fr}(\mathcal{D}) \subseteq \mathcal{D}$. Conversely, $NRG\beta \text{ fr}(\mathcal{D}) \subseteq \mathcal{D}$. Then $NRG\beta \text{ fr}(\mathcal{D}) \cap \mathcal{D}^c = \emptyset$. From $NRG\beta \text{ fr}(\mathcal{D}) = NRG\beta \text{ fr}(\mathcal{D}^c)$, $NRG\beta \text{ fr}(\mathcal{D}^c) \cap \mathcal{D}^c = \emptyset$. By (i), \mathcal{D}^c is a $NRG\beta$ open set and so \mathcal{D} is a $NRG\beta$ closed set.



**Theorem 3.41**

Let \mathcal{D} be a NS in a Neutrosophic topological space $(\mathbb{R}, \mathfrak{N})$. Then

(i) $\text{NRG}\beta \text{ fr}(\mathcal{D}) \cap \text{NRG}\beta \text{ int}(\mathcal{D}) = \phi$.

(ii) $\text{NRG}\beta \text{ fr}(\text{NRG}\beta \text{ int}(\mathcal{D})) \subseteq \text{NRG}\beta \text{ fr}(\mathcal{D})$.

Proof

(i) By Theorem 3.40(i), it is clear.

(ii) By Theorem 3.35(i),

$$\begin{aligned} \text{NRG}\beta \text{ fr}(\text{NRG}\beta \text{ int}(\mathcal{D})) &= \text{NRG}\beta \text{ cl}(\text{NRG}\beta \text{ int}(\mathcal{D})) \cap \text{NRG}\beta \text{ cl}(\text{NRG}\beta \text{ int}(\mathcal{D}))^c \\ &= \text{NRG}\beta \text{ cl}(\text{NRG}\beta \text{ int}(\mathcal{D})) \cap \text{NRG}\beta \text{ cl}(\mathcal{D}^c) \\ &\subseteq \text{NRG}\beta \text{ cl}(\mathcal{D}) \cap \text{NRG}\beta \text{ cl}(\mathcal{D}^c) \\ &= \text{NRG}\beta \text{ fr}(\mathcal{D}). \end{aligned}$$

CONCLUSION

Many different forms of closed sets have been introduced over the years. Various interesting problems arise when one considers openness. Its importance is significant in various areas of mathematics and related sciences, in this paper we have introduced Neutrosophic Regular Generalized β closed sets in Neutrosophic Topological Spaces and studied some of its properties. Also, we investigate the relationships between the other existing Neutrosophic sets. This shall be extended for future research with some more applications.

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A Comprehensive Review: Pharmacological Activities of Isolated Bioactive Compounds from Different Species of *Cucurbitaceae* Plants

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 24 Jun 2024

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ABSTRACT

This article reviews isolated bioactive compounds from Cucurbitaceae family plants with their pharmacological action. Bioactive components from medicinal plants have long been studied as therapeutic agents in biomedical and natural product research. Cucurbitaceae plants have been utilized in traditional medicine for ages, and herbal manuals that aid in understanding the therapeutic potential of plants may be found in ancient writings from a variety of civilizations. The efficacy of these plants has been attributed to their bioactive components, which have long been used to treat diabetes, cancer, oxidative stress, jaundice, hepatitis, urinary tract infections, and inflammation. This review article highlighted extracted bioactive compounds from various species along with their pharmacological activity to aid researchers in understanding the existing isolated phytochemicals and isolation of novel phytochemicals with good activity in future. This review examined the available reputable sources and reference papers, as well as scientific-research publications from various national, international journals and databases, with an emphasis on isolated bioactive compounds with pharmacological potential from Cucurbitaceae family plants. The various bioactive compounds like Momordicine I, II and III, Beta carotene, Taraxerol, ferulic acid, Charantin, 1-tert-butyl-5,6,7-trimethoxyisoquinolene, Cucurbitacin B and E have anticancer activity, Antidiabetic effect, hypolipidemic activity, antimicrobial activity. Cucurbitaceae plants possess extensive biological potential including antioxidants, antidiabetic, anti-inflammatory, hypolipidemic, anti-tubercular, and jaundice. Researchers may be able to find a new therapeutic lead by isolating bioactive molecules and pharmacologically screening those components.





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This information was analyzed to offer researchers with in-depth knowledge of the reported bioactive components from Cucurbitaceae plants, which can help with the isolation of novel leads and their pharmacological testing.

Keywords: Bioactive compounds Cucurbitaceae, gourds and cucurbits, Pharmacological activity, Secondary metabolites, Antidiabetic, Antioxidants.

INTRODUCTION

Several countries recognized the importance of discovering therapeutically improved medicines from native and endemic medicinal plants to diagnose a range of diseases, as well as providing a pool of potential drug lead[1]. In comparison to common synthetic small-molecule libraries, the natural products are generally richer with bioactive substances that occupy a greater range of chemical space. Discovery of scaffolds with structural diversity and bioactivities that can be helpful to create new medications or can be utilized for optimization of leads [2]. Many drugs are nothing but plant-based natural drugs or their derivatives such as taxol used as an anticancer agent since 1992 [3], Artemisinin is used as an antimalarial agent [4,5], Solamargine is used in cancer chemotherapy [6,7] and Masoprocol is used as lipooxygenase inhibitor. Natural products are widely used in the field of cosmetics, pharmaceuticals, agriculture, and nutraceuticals. Cucurbitaceae family contains more than 800 species with 120 genera. Some major species are beneficial for human being like Cucurbita (pumpkin, zucchini, squash), Lagenaria (calabash), Luffa, Momordica (bitter melon), Citrullus (water melon) (genomics of cucurbits) [8] to treat diseases like, cancer, diabetes mellitus, oxidative stress, bacterial infection, ulcer, urinary tract infection, jaundice hepatitis. These plants are grown as annual vines, shrubs, trees having tendrils on leaves; palmately lobed exstipulate leaves are present. Flowers are unisexual, pentamerous or pentagonal, white or yellow, monoecious, five stamens, free or connate anther. Fruits are soft. Roots are branched. Many researchers have been focused to many of the Cucurbitaceae family plants for study as they contain phytochemicals abundantly. Many disorders demand for long-term consumption of synthetic medications, however these medications come with adverse effects. Therefore, from the perspective of human health, the isolation of bioactive components is increasingly significant and desirable. In order to this aspect, this review investigated isolated bioactive compounds and their therapeutic properties as well as extracts from the Cucurbitaceae family plants.

METHODOLOGY

Search strategy

Web of science, Scopus, Google scholar online platforms had surfed to collect and analyze the data for this review. The search terms included "isolation of compounds from Cucurbitaceae", "bioactive compounds from Cucurbitaceae", "isolation from Cucurbita", "isolation from Momordica", "isolation from Coccinia", some other articles were also referred for additional information.

Inclusion and Exclusion criteria

Some inclusion and exclusion criteria were implemented on number of articles retrieved in order to include the papers that were most pertinent to this study. Only English-language articles were taken into consideration. Publications that in-depth analyzed isolation of bioactive compounds and their pharmacological effects from Cucurbitaceae plants were included.





RESULT AND DISCUSSION

Ethanomedical studies of Cucurbitaceae plants

According to history, *M. charantia* has antibacterial, anti-inflammatory, anti-parasitic, antifungal properties, purgative, vermifuge, menstruation stimulant, febrifuge, lactagogue, digestive stimulant, and wound treatment activity [9]. *M. charantia* fruit acts as an anthelmintic, stomachic, antibilious and laxative and also used in rheumatism, gout and diabetes [10]. Pumpkin, or *Cucurbita pepo*, is exploited in ethnomedicine due to its astringent effect, In leprosy, in purification of blood, in bronchitis, fever, hemoptysis, and painful chests [11]. Presently, the fruits of the leaf gourd, *Cucurbita ficifolia*, are used to treat type 2-diabetes [12], Hemorrhoids, wound and fever. *Cucumis sativus* (Cucumber) fruit is used to relief inflammation of alimentary mucous membrane; seeds contain calming properties and consumed as a booster, with diuretic and anthelmintic properties, whole plant has ability to acts UV protectant, gastroprotective, wound healing, anti-helminthic, hepatoprotective, antimicrobial, and anticancer agents [13]. as Karounidiol and its 3-O-benzoate derivative (multiflorane triterpenoids), identified from the seed extract having anti-tumor promoters properties [8]. *Telfairia occidentalis* fruit pericarp acts as a good DPPH radical scavenger. *Telfairia occidentalis* has been found to contain α - and β -amyrins, and its antioxidant activity in the pericarp has been documented for the first time [53].

Pharmacological activities

Antidiabetic activity of isolated compounds from Cucurbitaceae family plants

14 Cucurbitanes triterpenoids, kuguacin, octanorcucurbitacin, trinorcucurbitacins, polypeptide p and vicine were reported in *M. charantia* [18]. Liva et al. extracted 5 beta,19-epoxy-3-beta,25-dihydroxycucurbita-6,23(E)-diene and 3-beta,7-beta,25-trihydroxycucurbita-5,23(E)-dien-19-al from *M. charantia* and found anti-hyperglycemic at 400 mg/kg in diabetes-induced mice [19]. *M. charantia* saponin Momordicine II and 3-hydroxycucurbita-5, 24-dien-19-al-7, 23-di-O-glucopyranoside IV identified and demonstrated considerable insulin secretion action in MIN6-cells at 10 and 25 g/mL concentrations [18]. Polypeptide K isolated from *Momordica charantia* shown antidiabetic activity in 142 retrospective study cases [20]. Isolation of betulinic acid from *M. balsamina* was proved as antidiabetic compound. Quercetin helps to lower sugar in type 2 diabetic rats reported in *C. indica* effectively [21]. β -sitosterol and lupeol two major compounds isolated from *Coccinia grandis* were possessed insulinotropic potential in RINm5F rat cells [22]. From investigation of insulin secretion activity, Momordicoside U increases glucose absorption. Conjugated linolenic acid isolated from *Momordica charantia* found to release intestinal GLP-1 and acts as antidiabetic agent. Additionally, Momordin and 9c, 11t, and 13t conjugated linolenic acid, which were also isolated from *Momordica charantia*, had PPAR activation properties and hence function as antidiabetic agents [23].

Trihydroxy-octadecadienoic acids isolated from an ethanolic extract of *Bryonia alba* have the potential to restore lipid metabolism dysfunction in alloxan-induced diabetic mice and demonstrated hypoglycemic action. Glucose tolerance test revealed considerable anti-hyperglycemic effect of globulins, found in *Citrullus Lanatus* seeds in male Wistar rats. *Cucumis prophetarum* identified N-Trisaccharide as anti-hyperglycemic compound in streptozotocin (STZ)-nicotinamide (NA) produced type 2 diabetic rats and shown effective antidiabetic activity in -amylase and -glucosidase assays [10]. By restoring pancreatic beta cell mass, colocynthis oil, which was isolated from *C. colocynthis* had beneficial antidiabetic activity [24]. Tocopherol isolated from *Cucurbita pepo* shown interaction with various enzymes such as protein-tyrosine phosphatase 1B (PTP-1B), peroxisome proliferator-activated receptor gamma (PPAR- γ), and dipeptidyl peptidase IV (DPP-IV) confirmed diabetic potential [25]. Being potential bioactive anti-diabetic components, betulinic acid and 5'-methylgenistein detected and isolated from *M. balsamina* [26]. P-hydroxybenzoic acid, protocatechuic acid, isovanillin, 5-hydroxymethylfurfural, vitexin-2''-O-rhamnoside and vitexin-4''-O-glucoside were isolated from *Benincaseae Exocarpium*, in which vitexin-2''-O-rhamnoside exhibited strongest inhibitory efficacy against A-glucosidase (IC₅₀ values of $12.82 \pm 1.18 \mu\text{M}$). Compounds isovitexin, vitexin, orientin and vitexin-4''-O-glucoside (IC₅₀: 48.19 ± 0.70 , 52.28 ± 7.81 , 36.14 ± 4.21 , 65.38 ± 4.22 , and $48.69 \pm 5.94 \mu\text{M}$, respectively) shown similar A-glucosidase inhibitory activity as that of acarbose [27]. Cephalandrine A and Cephalandrine B were isolated from *Coccinia grandis* root part and aerial parts shown glucose lowering effect and





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act as antidiabetic compounds[21,28,29]. Table I showing pharmacological activities, species and structures of isolated compounds of Cucurbitaceae plants.

Antibacterial activity of isolated compounds from Cucurbitaceae family plants

Quercetin-3, 4'-O-D-di-glucopyranoside, 3,4-dihydroxy methyl benzoate, isorhamnetin-4-O-D glucopyranoside, 3, 4-dihydroxybenzoic acid, quercetin, myricetine, quercetin-4'-O-D-glucopyran have antidiabetic activity isolated from *Cucurbita pepo* [30]. Gallic acid, ferulic acid, lutein, beta carotene, retinol, tocopherols, rutin, and Kaempferol are all found in *Cucurbita moschata* [31]. From *Cucurbita pepo* plants, stigmaterol, stigmastadienol, five multiflorane-type triterpenoids, lutein, flavoxanthin, luteoxanthin, chrysanthemaxanthin, and cryptoxanthin were isolated and shown antibacterial potential [32]. *Momordica charantia* was the source of ribosome inactivating proteins (RIPs), Momordica charantia lectin (MCL), Momordica anti-HIV protein of 30 kD (MAP30), -momorcharin (-MMC), -momorcharin, -momorcharin, and -momorcharin were effective against bacterial infection[9]. Plumericin (Iridoid lactone), an antibacterial compound found in *M. Charanta*, had good action against enterococci and bacilli by minimum inhibitory concentration near to standard drug [33]. Momordica monadelpha (Tilkor) stigmaterol and tritriacontane have been discovered to exhibit antibacterial action [34]. Additionally, antibacterial activity has been reported for ferulic acid, methyl caffeate, ligstroside, trans-p-coumaric acid, and kaempferol-3-O-D-glucoside, isolated from methanolic extract of *Coccinia grandis* [35]. Novel alkaloid 1-tert-Butyl-5,6,7-trimethoxyisoquinolene, isolated from *Coccinia grandis* shown good antimicrobial activity [36]. Taraxerol isolated from *Coccinia grandis* had shown antimicrobial activity. Isolation and Structure Elucidation of Compounds from *Coccinia grandis* Leaves Extract*

Anticancer activity of isolated compounds from Cucurbitaceae family plants

Several compounds from *Trichosanthes kirilowii*, including tri-chobenzolignan, ligballinol, pinoresinol, chrysoeriol 7-O-D-glucopyranoside, luteolin 7-O-D-glucopyranoside, 10-cucurbita-5, 24-dien-3-ol, and ehletianol C exhibit anticancer potential. [37]. Fruit and leaves of *L. echinata* possess abundant phenolic components such as coumaric acid, chlorogenic acid, catechin, gallic acid, and vanillic acid could have powerful anticancer potential [38]. The anticancer agent 1, 8 dihydroxy-4-methyl-anthracene 9, 10-dione present in fraction LA/FII of the *Luffa acutangula* plant strongly inhibited NCI-H460 cells [39]. Tetra cyclic triterpenes-Cucurbitacin I was reported in *Lagenaria siceraria* as an anticancer agent [40]. The peptides extracted from *Momordica dioica*, according to Selvam et al., suppressed cell proliferation and led to cell death, suggesting that it has a potential to treat colon cancer [41]. α , β Momorcharin, extracted substance from *Momordica charantia*, was effective at killing cancer cell lines by apoptosis induction and calcium overload approach in cells[42]. In pre-initiated/initiated tumors cells, kuguacin J reported in *Momordica charantia* has demonstrated their significant anticancer properties to trigger apoptosis/cell cycle arrest as well as could inhibit resistance to anticancer medicines in progressed cancer growth [43]. Various Cucurbitacin and dihydro-Cucurbitacin compounds were isolated from the root of *Bryonia aspera*, At 50 $\mu\text{g/ml}$, dihydro-Cucurbitacin D and iso dihydro-Cucurbitacin D inhibited HepG2 and MDBK cells by more than 50%, Cucurbitacin L and Neocucurbitacin C shown high inhibitory activity on MCF7 cells (IC₅₀ = 12.2, 13.05 $\mu\text{g/ml}$)[44]. 3, 7-di-O-rhamnoside kaempferol found in *B. dioica* root proven antitumor and apoptogenic effect in cell lines, including the promyelocytic human leukemia U937 and myelogenous leukemia cell line K562. Myricetin (2, 5, 7, 3, 4, 5-penta hydroxyl flavonol) was isolated as chief component from *B. dioica* aqueous extract. Myricetin also shown anticancer and apoptogenic effects against malignancies like colorectal cancer, ovarian cancer, leukemia, and lung cancer. Additionally, it has been shown that Myricetin can kill cancer cells at various stages in different cancer cell lines especially through activating CDKs and cyclins [45]. Cucurbita glycosides A and B (*C. pepo*) are potent antitumor bioactive compounds, had IC₅₀ values of 17.2 g/mL and 28.5 g/mL, respectively. Cucurbitacin B and E have ability to acts as an anti-proliferative compound by inhibiting various cell lines extracted from *C. pepo* cv. Dayangua. Activation of the Epstein-Barr infection caused due to cancer promoter 12-O-tetradecanoyl-phorbol-13-acetic acid derivation is inhibited by 23,24-dihydrocucurbitacin F[46]. *Citrullus colocynthis* leaf extract contains glucocucurbitacin derivatives. 25-p-coumaroyl-3'-acetyl-1-2-O- β -d-glucocucurbitacin I displayed interesting specific antitumor activity to Caco-2 cells (1 and 10 $\mu\text{g/mL}$), for IEC6 cells(-24%) and for both HT29 (-32%) and Caco-2 (-19%) toxic [47]. Trichobenzolignan isolated from *Trichosanthes kirilowii* also proved to be cytotoxic compounds. It had shown moderate activities in human lung cancer, colon





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cancer, ovarian cancer and breast cancer cell lines[37]. Cucumol B reported in methanolic extract of *Cucumis melo* also act as potent cytotoxic agent against SKOV-3 and MCF-7 cell lines and moderate agent toward HCT-116 cell line[32]. 3-O-beta-D-glucuronopyranosyl gypsogenin (III), 3-O-beta-D-glucopyranosyl gypsogenin (IV)[48] and 3-O-beta-D-glucopyranosyl hederagenin (V)[14] had reported in *Momordica dioica* root extract possessed anticancer activity against cancer cell (L1210). Two cell lines NB4 and K562 were potently suppressed from proliferating by plumericin isolated from *Momordica charantia* vine at effective doses.

Anti-inflammatory activity of isolated compounds from Cucurbitaceae family plants:

Quillaic acid an anti-inflammatory compound against RAW 264.7 cells was found in *Momordica cochinchinensis* Sprenger seeds [49]. Two active components were discovered in the roots of *Cayaponia tayuya*, 23, 24-dihydrocucurbitacin B and Cucurbitacin R shown anti-inflammatory activity in various mouse oedema models such as phospholipase A2, serotonin, carrageenan and 12- O-tetradecanoylphorbol 13-acetate (TPA) models [50]. Anti-inflammatory properties of cucurbitacins reported in *C. sativus* seeds and were attributed for cyclooxygenase (COX) suppression[51]. RAW 264.7 cells which are activated due to macrophage are suppressed by 3 β , 7 β , 25-trihydroxycucurbita-5, 23(E)-dien-19-al, and 25-isopropenylchole-5, 6-ene-3-O-d-glucopyranoside extracted from *Momordica charantia* L., and demonstrated considerable anti-inflammatory action in NF-B, iNOS, IL-6[52].

CONCLUSIONS

This review highlighted medicinal potential of Cucurbitaceae plants used as dietary, medicinal, ethno veterinary causes. Different pharmacological potentials of various extracts and fractions of Cucurbitaceae plants are highlighted in this article. The fractions Isoviteixin, Vitexin, Orientin, and Vitexin-2''-O-Rhamnoside isolated in *Benincasa Exocarpium* plant had shown stronger inhibitory activity compared to positive control (Amino guanidine hydrochloride) as well as antidiabetic activity similar to standard (Acarbose). Gallic acid and Caffeic acid shown significant inhibitory activity of AGE formation in BSA glucose system. Protocatechuic Acid had high α - glucosidase inhibition activity. 1-tert-Butyl-5, 6, 7-trimethoxyisoquinoline (*Coccinia grandis*) possesses better analgesic and anti-inflammatory activity. *L. echinata* can be used for diabetes, neurological and cancer treatment. It is still necessary to identify several phytochemicals from these plants that may have more medicinal effect. These plant exhibits notable antidiabetic properties in addition to other potential therapeutic uses, as demonstrated by preclinical research and clinical trials. The purpose of this in-depth review is to observe the chemical elements contained in plants belonging to the Cucurbitaceae family that have already been documented and have a large extent of space for further investigation of chemical components with therapeutic value from these plants. The study can be expanded to examine the molecular effects of these distinct phytochemicals with respect to mechanism in severe illnesses and development of leads to treat these ailments in future prospects. Also the advent of newer multi drug resistance bacteria poses a risk to health worldwide and keeps the scientific community on its toes. Scientists working on drug development countenance a significant problem in comprehending the fundamental chemical processes involved in the screening of bioactive small molecules. This led scientists to turn towards herbal medicines for a remedy because it is now widely recognised that they are crucial in the development of effective treatments.

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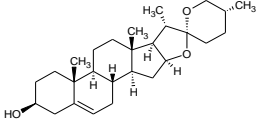
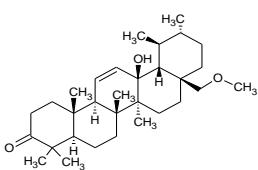
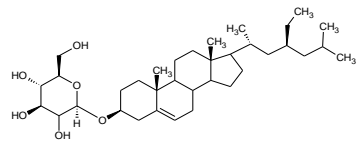
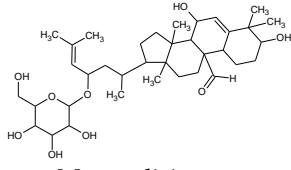




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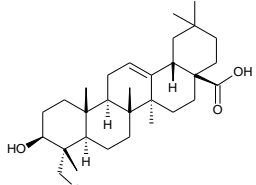
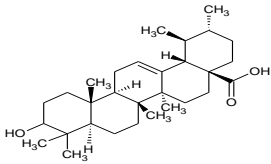
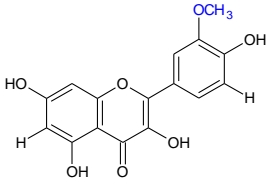
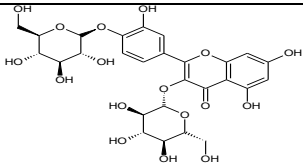
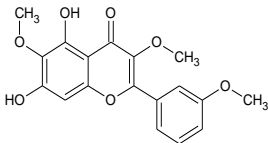
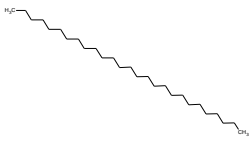
Table I Showing pharmacological activities, species and structures of isolated compounds of Cucurbitaceae plants.

Sr. No.	Bioactive Compounds	Species	Pharmacological actions	References
1	 Diosgenin	Momordica Charantia L	Hypocholesterolamic effect, Anticancer Activity, Anti-Inflammatory and Immunological Activity, Anti-Infectious Activity, Anticoagulant and Antithrombotic Effects	[54,55]
2	 Momordicine I	Momordica charantia	Anticancer activity through M-I inhibition of c-Met and downstream signaling of c-Myc, survivin, and cyclin D1 through the inactivation of STAT3 in HNC cells.	[56]
3	 Charantin (β -Sitosteryl glucoside)	Momordica charantia	Hypoglycemic activity, Promote insulin sensitivity in type 2 diabetic mice, increase the expression of GLUT4 and of IRS-1 in type 2 diabetic mice	[57,58]
4	 Momordicine	Momordica charantia	Antidiabetic effect significant insulin releasing activity in MIN6 β -cells	[59]





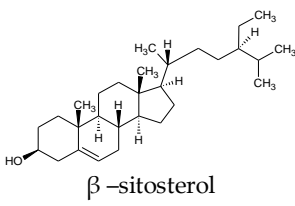
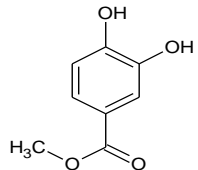
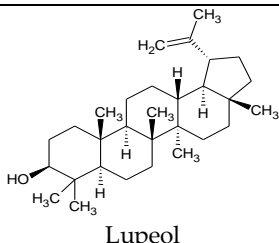
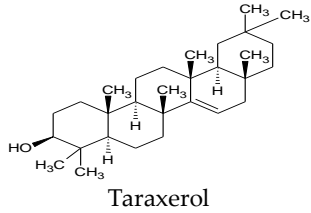
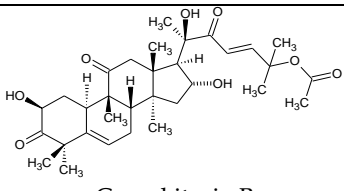
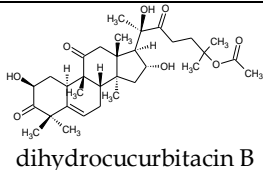
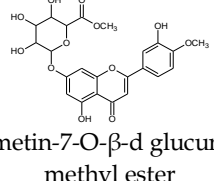
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5	 <p>Hederagenin</p>	Momordica dioica Luffa cylindrica	Anti-tumor, anti-inflammatory, anti-depressant, anti-neurodegenerative, anti-hyperlipidemia, anti-diabetic, anti-leishmanial, and anti-viral activity	[60]
6	 <p>Ursolic acid</p>	Citrullus colocyntis	Antimicrobial activity, anti-inflammatory, anticancer, antidiabetic, antioxidant effects	[16,61–63]
7	 <p>Isorhamnetin</p>	Cucurbita pepo	Antibacterial activity	[30]
8	 <p>Quercetin-3, 4'-O-di-β-glucopyranoside</p>	Cucurbita pepo	Antibacterial activity	[30]
9	 <p>5,7 dihydroxy, 3, 6, 3' trimethoxyflavone</p>	Cucurbita pepo	Antibacterial activity	[30]
10	 <p>Heptacosane</p>	Coccinia grandis root part	Antibacterial activity	[16,28,64]





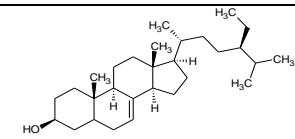
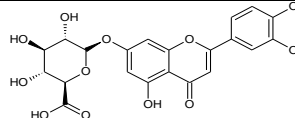
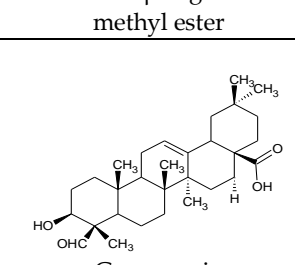
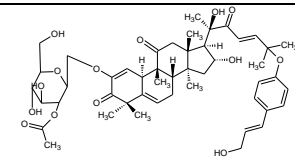
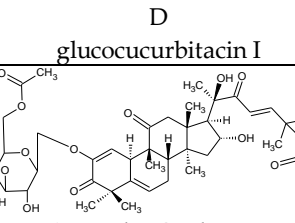
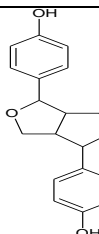
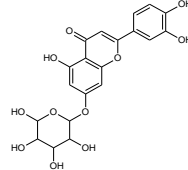
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11	 <p>β-sitosterol</p>	Coccinia grandis	Insulinotrophic properties in rat RINm5F cells in vitro. In silico immunostimulants, antioxidant and inhibitory potential against Receptor Binding Domain (RBD) of SARS-CoV-2 Spike Glycoprotein	[13,22,65]
12	 <p>3,4-dihydroxy methyl benzoate</p>	flowers of Cucurbita pepo L.	Antibacterial activity	[30,66]
13	 <p>Lupeol</p>	Fruits and roots of Coccinia indica Benincasa hispida seeds	Immense anti-inflammatory potential, anti-microbial, anti-proliferative, anti-invasive, anti-angiogenic, anti-protozoal, and cholesterol-lowering agent, Effective on lung cancer such as A427 cancer cells and normal MRC-5 cells	[67]
14	 <p>Taraxerol</p>	Coccinia grandis (L). Voigt, Momordica charantia	Anti-tumor actions against sarcoma 180 cell line in mice, anti-inflammatory activity in albino rats, Alzheimer's and Parkinsonism potential, COX inhibitor, anti-microbial potential, anti-allergic, used in diabetes	[68,69]
15	 <p>Cucurbitacin B</p>	Cucumis prophetarum	Potent anticancer activity against NIH3T3 and KA31T	--
16	 <p>dihydrocucurbitacin B</p>	Cucumis prophetarum	Potent anticancer activity against NIH3T3 and KA31T	--
17	 <p>Diosmetin-7-O-β-d glucuronide methyl ester</p>	Luffa cylindrica fruits	Antioxidant, anti-inflammatory, and antimicrobial activities	[70]





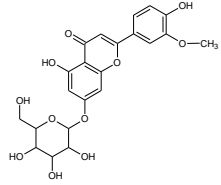
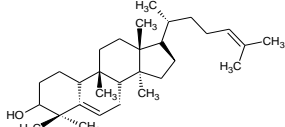
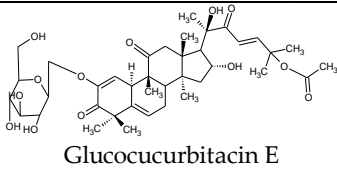
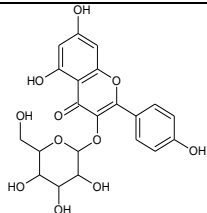
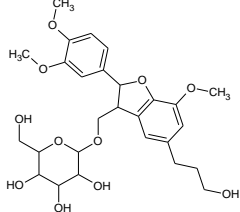
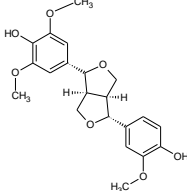
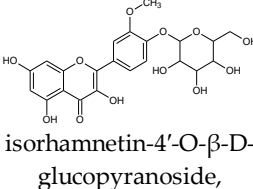
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18	 <p>22, 23-dihydroxy spinasterol</p>	Citrullus colocynthis leaves	Prominent antioxidant activity, moderate fungicidal activity against R. solani and M. grisea, insecticidal activity	--
19	 <p>Luteolin-7-O-β-d-glucuronide methyl ester</p>	Luffa cylindrica fruits	Antioxidant activity	[70]
20	 <p>Gypsoenin</p>	Luffa cylindrica Roem seeds Momordica cochinchinensis Sprenger seeds Momordica dioica methanolic extract of root	Anti-inflammatory activities in RAW 264.7 cells	--
21	 <p>25-p-coumaroyl-3'-acetyl-2-O-β-D glucocucurbitacin I</p>	Ethyl acetate extract of Citrullus Colocynthis Leaves	cytotoxic (-24%) for IEC6 cells	[47]
22	 <p>6'-acetyl-2-O-β-D- glucocucurbitacin E</p>	Ethyl acetate extract of Citrullus Colocynthis Leaves	cytotoxicity (-45%) for Caco-2 cells	[47]
23	 <p>ligballinol</p>	Trichosanthes kirilowii	Cytotoxic activity	--
24	 <p>luteolin 7-O-β-D-glucopyranoside</p>	Trichosanthes kirilowii	moderate activities in all cancer cell lines SUCH AS A-549 (human lung cancer), HT-29 (human colon adenocarcinoma), OVCAR (human ovarian carcinoma), and MCF-7 (human breast cancer)	--





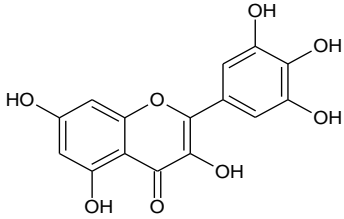
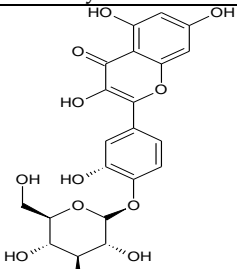
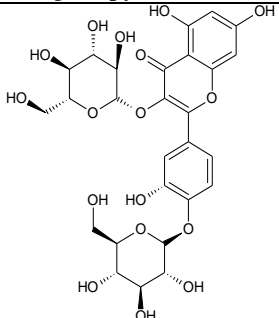
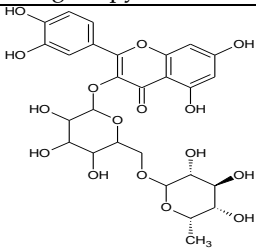
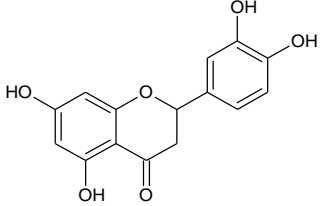
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25	 <p>chrysoeriol-7-O-β-D-glucopyranoside,</p>	Trichosanthes kirilowii	moderate activities in all cancer cell lines SUCH AS A-549 (human lung cancer), HT-29 (human colon adenocarcinoma), OVCAR (human ovarian carcinoma), and MCF-7 (human breast cancer)	--
26	 <p>10α-cucurbita-5,24-dien-3β-ol</p>	Trichosanthes kirilowii	significant activity on HT-29 and OVCAR cancer cell lines	--
27	 <p>Glucocucurbitacin E</p>	Citrullus colocynthis leaf ethyl acetate extract	antibacterial activity against both Bacillus cereus and Enterococcus faecali	[47]
28	 <p>kaempferol-3-O-β-D-glucoside</p>	methanol extract of Coccinia grandis leaves	Inhibition of Echinochloa colonum at 15 μ g/mL Intervention Effect on Estradiol Metabolism	[35]
29	 <p>3,4'-O-dimethylcedrusin 9''-O-glucopyranoside</p>	ethyl acetate extract of the stem of Coccinia grandis	---	--
30	 <p>(+)-medioresinol</p>	ethyl acetate extract of the stem of Coccinia grandis	Leishmanicidal activity and cardiovascular disease risk reduction Antifungal mechanisms.	--
31	 <p>isorhamnetin-4'-O-β-D-glucopyranoside,</p>	flowers of Cucurbita pepo L.	Antibacterial activity	[30,66]





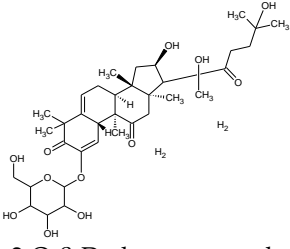
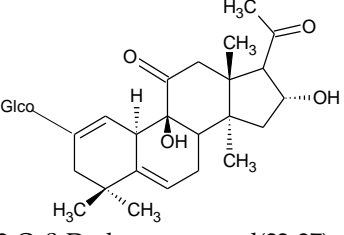
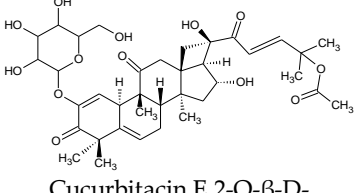
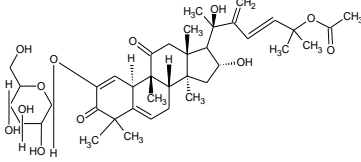
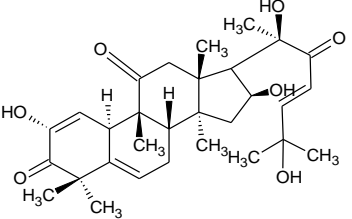
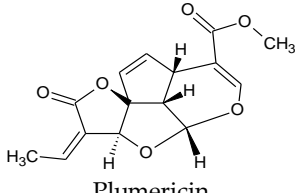
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32	 <p style="text-align: center;">Myricetin</p>	flowers of Cucurbita pepo L.	Antibacterial activity	[30,66]
33	 <p style="text-align: center;">quercetin-4'-O-β-D-glucopyranoside</p>	flowers of Cucurbita pepo L.	Antibacterial activity	[30,66]
34	 <p style="text-align: center;">quercetin-3,4'-O-β-D-diglucopyranoside</p>	flowers of Cucurbita pepo L.	Antibacterial activity	[30,66]
35	 <p style="text-align: center;">quercetin-3-O-β-D-glucopyranosyl-(1→6)-α-L-rhamnopyranoside</p>	Methanolic extract of Cucumis melo	--	[71]
36	 <p style="text-align: center;">luteolin</p>	methanolic extract of Cucumis melo	anti-inflammation, anti-allergy and anticancer potential	[71]





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37	 <p>2-O-β-D-glucopyranosyl-cucurbitacin L</p>	Citrullus colocynthis leaf ethyl acetate extract	Antibacterial activity against Gram-positive bacteria such as B. cereus, S. aureus, E. faecalis	[47,61]
38	 <p>2-O-β-D-glucopyranosyl(22-27)-hexanorcucurbitacin I</p>	Citrullus colocynthis leaf ethyl acetate extract	Antibacterial activity against Gram-positive bacteria such as B. cereus, S. aureus, E. faecalis	[47,61]
39	 <p>Cucurbitacin E 2-O-β-D-glucopyranoside</p>	Citrullus colocynthis	antimicrobial activity, in vitro cytotoxic action against hepatoma cell line (HepG2) and mice-bearing tumor of Ehrlich's ascites carcinoma (EAC)	[61]
40	 <p>Colocynthin</p>	Citrullus colocynthis	hepatoprotective against carbon tetra chloride induced toxicity in experimental animals	[61]
41	 <p>Cucurbitacin I glycosides</p>	Citrullus colocynthis	in vitro cytotoxic action against hepatoma cell line (HepG2) and mice-bearing tumor of Ehrlich's ascites carcinoma (EAC)	[61]
42	 <p>Plumericin</p>	Momordica charantia vine	Suppression of cancer cell such as NB4 and K562at effective doses (ED50) of 4.35 0.21 and 5.58 0.35 g/mL, respectively.	[33]





Biochemical Studies on the Effects of L-Glutamine in Copper (CuSO₄) Exposed Fresh Water Zebra Fish (*Brachydanio rerio* (Ham))

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

The purpose of the study is to investigate the effect of L-glutamine supplementation on the metabolism of proteins in freshwater fish exposed to copper sulphate. In aquatic ecosystems, heavy metal pollution frequently has a negative impact on the aquatic biota. One of the most harmful heavy metals to fish is copper, and eating fish that has had its water treated with copper can be extremely dangerous for human health. Fish are typically employed in water quality management as indications of pollution. Reduced growth, a shorter lifespan, issues with reproduction, lower fertility, and behavioural changes are examples of chronic impacts. Fish residing in close proximity to the sediment have the potential to collect copper sulphate. In the current study, the toxic effects of copper sulphate (LC₅₀ 0.308µg/l; CuSO₄) were assessed throughout exposure periods of 5, 10, and 15 days on (0.20ppm) one sublethal quantity of total protein in the gill, gut, and muscle tissues of freshwater fish, *Brachydanio rerio*. In contrast to control, it is all decreasing. The findings demonstrated the heavy metal copper sulphate's hazardous properties. When 0.10 ppm of L-glutamine is administered to the remaining copper-treated fish, the protein content is increased more frequently than in copper-treated fish, suggesting that L-glutamine alleviates the negative effects of copper sulphate.

Keywords: Zebra fish, Toxic effects, Copper sulphate, L-glutamine, Biochemical studies.





INTRODUCTION

Environmental pollution not only causes a decrease in water quality, but it subsequently affects all living organisms in that system. Therefore, it is necessary to not only identify and manage these pollution sources, but also to maintain their effects on the health of aquatic environment. Heavy metal pollution is a major environmental problem facing the modern world. The global heavy metal pollution is increasing in the environment due to increasing of human activities. Moreover, it is gaining in importance day by day due to its obvious impact on human health through the food chain (Mohanambal. R and Saravanan. K, 2019). In commercial and recreational fish ponds, copper sulphate is commonly used as an algicide to suppress the growth of filamentous algae and phytoplankton, as well as to manage some fish infections (Tucker and Robinson, 1990). On the other hand, fish, especially farmed species like catfish, cyprinids, and salmonids, are poisonous to copper at a certain concentration (Wurts and Perschbache, 1994). Consequently, fish should be treated when bioaccumulation reaches a hazardous stage. According to Lopes et al. (2001), the ability of copper to catalyse oxidative processes that results in the generation of reactive oxygen species is connected with its harmful effect. Fish are excellent models for studying aquatic systems because they occupy the highest positions in the food pyramid and may mimic the effects of heavy metals on other living things, such as humans, as well as exert direct stress on themselves (Vander et al., 2003). Heavy metal pollution of the environment is a global issue due to the indestructibility of these metals and the poisonous effects most of them have on living things when they reach a specific concentration (Alam et al., 2002). Many fish species are employed to biologically track changes in ambient anthropogenic pollution levels (Vinodhini and Narayanan, 2008; Palaniappan and Karthikeyan, 2009). According to Ebrahimpour and Mushrifah (2010), heavy metals can reach the aquatic environment by atmospheric deposition, weathering from the geological matrix, or anthropogenic sources such as sewage, mining wastes, industrial discharge, and agricultural waste. Both natural and man-made causes of copper contamination, including mine washing, agricultural leaching, and direct application as molluscicide and algicide, can be found in the aquatic environment. The first tissue to come into contact with waterborne pollutants is the gill. The gills are mostly impacted by impurities like metals because of their huge surface area and the short diffusion distance between the blood and water. According to Demir et al. (2016), chemicals may negatively impact fish gill function overall, increasing fish susceptibility to toxic compounds and possibly resulting in fish mortality. In generally speaking, the gill cells respond quickly for various chemicals to overcome physiological impairment or tissue damage. According to Atabati et al. (2015), the gill serves as the primary site for copper uptake due to its continuous and direct interaction with the external surroundings. In aquaculture and agriculture, copper sulphate is used globally as a fungicide and algicide (Lasiene et al., 2016). For a variety of bacterial and ectoparasitic illnesses, copper sulphate is used as a medicinal chemical in the aquaculture sector. Fish parasites, including trematodes, protozoa, and external fungi and bacteria, are becoming less common. Additionally, it stops germs from growing (Nouh and Selim, 2013; Lasiene et al., 2016). The only free amino acid that is involved in the immune system's response to muscle damage is glutamine; lymphocytes and macrophages use it as an energy source and to enhance protein synthesis.

EXPERIMENTAL TEST

The goal of the current investigation is to assess the toxicity of copper in tissues and determine whether fresh water l-glutamine may mitigate the effects of copper toxicity in *B. danio rerio*. The freshwater fish, known as *Branchydanio rerio*, were procured from commercial aquariums and transported to the laboratory in huge plastic troughs, where they underwent a week of acclimation. For the experiments, healthy fish with equal body weights (4 to 4.5 g) and lengths (3 to 3.5 cm) were utilised. $\text{CuSO}_4 + 5 \text{H}_2\text{O}$, the stock solution of copper sulphate, was made by dissolving the proper amount of salt in distilled water. During the test periods, the physio-chemical characteristics of the test water were routinely evaluated using the slanted method as outlined by APHA (1998). Using the probite analysis Finney technique (1971), batches of twenty healthy fish were subjected to varying concentrations of the pesticide copper sulphate in order to determine the median lethal concentration (LC_{50} value: $0.308 \mu\text{g/l}$). The fish were subjected to one sublethal dose of copper sulphate (0.20 ppm) for 5, 10, and 15 days, in that order. As a control, another group was kept. When each exposure period came to an end, the fish were slaughtered, and their gills,





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intestines, and muscles were collected for protein analysis. After that, the fish were reared, and they were exposed to a concentration of 0.10 ppm L-glutamine for 96 hours. For protein analysis, fish tissue samples from the gills, intestine, and muscle should once again be obtained. Using Lowry et al.'s (1951) approach, the total protein content of the tissues was estimated. Following tissue isolation from the test animals, a 10% TCA solution that was cold was homogenised. A 3000-rpm centrifuge was used to homogenise the tissue. After discarding the supernatant, 1.0 millilitres of 0.1N NaOH were used to dissolve the precipitate. This is followed by the mixing of 4.0 ml of alkaline copper reagent with 0.5 ml of supernatant (or 0.5 ml of serum if serum was isolated from blood). This is left to mingle for 10 minutes at room temperature. After that, thoroughly mix with 0.5 ml of folin-ciocalteau reagent. Using a Bausch and Lomb UV Spectrophotometer, the blue coloured absorption was measured at 620 nm. The same protocol was applied to standards in the concentration range of 20–100µg and to a blank that contained 1.0 millilitres of distilled water. For serum, the protein concentration was represented as mg/dl, and for tissue, it was represented as mg/g wet weight. The amount of protein in the fish treated with copper sulphate and L-glutamine was measured in the gill, intestine, and body muscle. Biochemical data from copper sulphate and L-glutamine treated fish were compared with those from control groups.

RESULTS

Protein content of the gill tissue

Table 1 shows the tissue protein content of *Branchydanio rerio* freshwater fish treated with L-glutamine, copper sulphate and also the control. The protein content of the fish treated with metal had sublethal concentrations of 76.19, 71.30, and 79.12 mg/g of wet weight of tissue, compared to 80.12 mg/g in the control group's gill tissue. The percentages that decreased were -4.90, -11.00, and -13.28 after 5, 10, and 15 days of exposure, in that order. The fish treated with L-glutamine had a protein content of 79.12, with a percentage of -1.24. At the $P < 0.05$ level, the mean difference was statistically significant. (Fig. 1; Table 1).

Protein that is present in intestinal tissue

The amount of protein in the control fish's intestinal tissue were 119.35 mg/g of wet weight tissue. Fish treated with copper sulphate had sublethal concentrations of 114.21, 110.66, and 108.34 mg/g of wet weight tissue. The amount of protein in the zebrafish gut tissue treated with copper was reduced. The decreasing percentages for the 5, 10, and 15-day exposure periods were -4.30, -7.28, and -9.22, respectively. Fish protein treated with glutamine had a content of 118.41 mg/g and a percentage of -0.78. Table 1 and Figure 1 show that the mean difference was statistically significant at the $P < 0.05$ level.

Protein content of the muscle tissue

Table 1 shows that the tissue protein content of *Branchydanio rerio* freshwater fish treated with L-glutamine, copper sulphate and also the control. The sublethal concentrations of copper sulphate treatment were 128.20, 123.18, and 120.22 wet weight of tissue, respectively, while the amount of protein in the control muscle tissue was 130.18 mg/g. Muscle tissue treated with copper exhibits declining patterns in its protein content. The corresponding lowered percentages for 5, 10, and 15 days of exposure was -1.52, -5.37, and -7.65. protein content of the L-glutamine treated fish were 131.22 wet weight of tissue, its increased percentage was 1.0079. The mean differences between the control, copper treated and L-glutamine groups were statistically significant at the $P < 0.005$ level (Table 1; Fig. 1). These lines are correct but these lines should be placed under table 1.

DISCUSSION

The widespread use of fungicides, algaecides, and insecticides in agricultural fields, followed by the release of the waste products into water bodies, is the cause of copper contamination in freshwater ecosystems. In addition, various industries such as mining, sewage sludge, plastics, electroplating, metal refining, atmospheric deposition, and others



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can cause copper toxicity (Mendil D.; Demirci Z., and Panagos P.; Ballabio C., 2018). The micronutrient and trace element copper is crucial for the development and metabolism of living things. Copper is an essential component of numerous metabolic enzymes and glycoproteins found in fish and other animals. Moreover, it is necessary for the nervous system to operate and for the production of haemoglobin (Nordberg GF; Fowler BA., 2018; and Sorensen EMB., 1948). However, living things are toxically affected by copper at higher concentrations (Richard Bull., 2000). Freshwater fish are poisonous to copper at concentrations between 10 and 20 parts per billion (ppb) (Carol Ann Woody B; Louise SO,2012). A number of variables, including pH, dissolved organic carbon (DOC), anions, and water hardness, affect how toxic copper is to aquatic life. Fish mostly absorb copper through their feed or environmental exposure (Dang F, Zhong H, Wang WX., 2009). Freshwater fish experienced an oxidative stress response when exposed to waterborne copper (Eyckmans M.; Celis N.,2011). Fish with chronic copper toxicity have poor growth, shortened life spans, weakened immune systems, and issues with reproduction (Yacoub AM; Gad NS. 2012). When teleost fish (*Oreochromis niloticus*) were exposed to copper toxicity in their gills, apoptosis was induced (Monteiro SM;dos Santos NMS.,2009). Exposure to copper sulphate in *Cyprinus carpio* resulted in morphological and biochemical alterations in the liver tissue (Varanka Z.; Rojik I., 2001). Fish livers have the largest concentration of copper accumulation, but fish gills and body tissue have lower concentrations (Bawuro AA; Voegborlo RB.,2018).

The oxidative metabolism, lipid peroxidation, and protein content in carp tissue were all impacted by the bioaccumulation of this trace element (Radi AAR; Matkovics B., 1988). Apoptosis was induced in response to copper toxicity in the gills of teleost fish (*Oreochromis niloticus*) (56 Bawuro AA; Voegborlo RB, 2018). Exposure to copper sulphate in *Cyprinus carpio* resulted in morphological and biochemical alterations in the liver tissue (Sepe A; Ciaralli L; Ciprotti M, 2003). An organism's altered activity can be inferred from alterations in an organ's biochemical composition brought on by heavy metal stress. It sheds information on how their biological energy is used to combat the harmful stress. The metabolism of the freshwater fish, *Danio rerio* is impacted by heavy metal salts. Stress has always been determined by observing changes in metabolic processes after being exposed to heavy metal stress. However, the pattern of metal-induced physiological changes varies greatly between metals and between animals. Animal tissue has a significant amount of protein, a key organic component that is crucial to cellular metabolism. Since all enzymes are proteins, they regulate intracellular processes and quicken the rate of metabolism within an organism. Glutamine serves as an energy source for lymphocytes and macrophages and is a conditionally necessary amino acid that is implicated in the immunological response to muscle damage (Walsh et al., 1998). Long-term or vigorous exercise-induced immune responses have been shown to lower intramuscular and plasma glutamine concentrations (Castell & Newsholme, 1997; Gleeson, 2008), which may then result in compromised immune system function (Rohde et al., 1998). The advantages of L-glutamine supplementation may influence athletic performance and training, which could account for the rise in popularity of oral L-glutamine supplements among endurance and strength athletes in recent years (Antonio & Street, 1999; Candow et al., 2001). Few studies support the efficacy of L-glutamine supplementation on improving muscle function and reducing muscle soreness, despite the fact that it has been well-documented to restore plasma glutamine concentrations and improve systemic immune system function (Castell, 2003; Kuhn et al., 2010). (Rahmani et al., 2013; Street et al., 2011). Supplementing *Oreochromis niloticus* with glutamine alters the intestine's relative weight and length, as well as the length and villus of the villus.

Feed efficiency in fish fed a diet supplemented with Gln was observed. Dietary Gln supplementation also had a favourable impact on final body weight and weight increase (Pedro L.P.F. Carvalho, 2023). In the current investigation, fish branchydanio rerio protein levels in the chosen tissues were found to be lower in chronic copper sulphate concentrations when compared to control and protein contents exposed to L-glutamine. The current study's findings on the decreased levels of protein in the gills, intestine, and muscle are consistent with those of Mastan (2008), Kumar, and Gopal (2001), who noted that the stress of copper and distillery effluents caused protein levels to drop in several fish organs, including the *C. punctatus*. Dinodia et al. (2002) also studied the effects of cadmium toxicity on fish species found in freshwater environments, specifically *Labeo rohita*, *Cirrhinus mrigala*, and *Cyprinus carpio*. The findings showed that all fish species experienced a decrease in body tissue and residual protein after 45 days of exposure, which could be attributed to the malfunction of multiple physiological and biochemical processes within the body. According to Abel (1974), changes in membrane permeability could be the cause of the protein drop.





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Barytelephusa cunicularis's differences in protein metabolism were investigated by Nagabhushanm and Kulkarni in 1979. The freshwater bivalve Corbicula striatella showed a decrease in protein levels most of the time following heavy metal exposure, according to Mahajan and Zambare (2001). According to Kumar et al. (2012), sodium arsenide reduced the amount of protein in Clarius batractus catfish. *Branchydanio rerio* had lower total protein content in the gill, intestinal, and muscular tissues of freshwater fish in the current study as compared to the control group. When fish exposed to L-glutamine had higher protein contents than fish treated with copper, this suggests that L-glutamine acts as an analgesic against the effects of copper sulphate.

CONCLUSION

The present study indicates that the presence of a concentration of heavy metal copper sulphate in the water is toxic to fish and alters the protein of the fish tissues, and the L-glutamine was used to gain the copper toxic effect. The results indicate that the use of copper sulphate in agriculture fields may pose a threat to aquatic fauna and flora as well as humans. Therefore, the information obtained may be useful for the management and monitoring of agricultural insecticide concentrations in aquatic ecosystems. The L-glutamine are indicating its contribution to protein metabolism and immune function in copper sulphate affected fish species.

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Table 1. The amount of total protein content in the selected tissues of *Branchydaniorerio* exposed to copper sulphate and L-glutamine.

Parameter	Exposure period in days					p-value
	Control	5days	10days	15days	96 hours L-glutamine	
Gill% COC	80.12±1.8592	76.19±1.4556 -4.90	71.30±1.2373 -11.00	69.48±3.1044 -13.28	79.12±1.5176 -1.24	6.9407*
intestine % COC	119.35±1.9539	114.21±2.0181 -4.30	110.66±1.6243 -7.28	108.34±1.3852 -9.22	118.4±2.1374 -0.78	1.5429*
Muscle % COC	130.18±1.9850	128.20±3.3410 -1.52	123.18±1.5690 -5.37	120.22±2.0852 -7.65	131.22±1.7289 1.0079	9.8746*

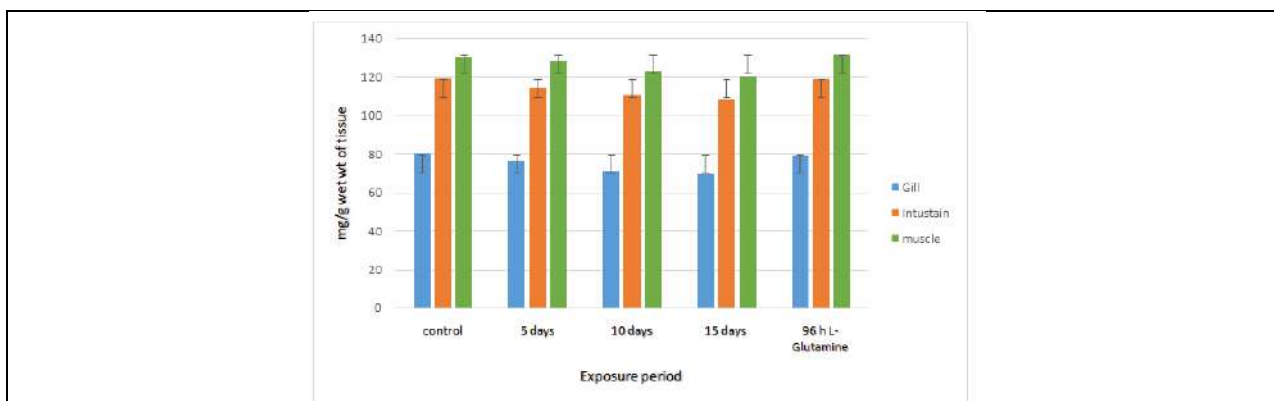


Fig. 1. The amount of total protein in the selected tissue of *Branchydanio rerio* exposed to sublethal concentration of copper sulphate and L-glutamine exposure





Some Properties on Lukasiewicz Type (1&2) Operators Over Neutrosophic Fuzzy Matrices

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

In this paper, we defined Lukasiewicz type (1 &2) conjunction and disjunction operators in the independent component of Neutrosophic fuzzy set and Neutrosophic fuzzy Matrix. Some properties of union, intersection and complement of Lukasiewicz type (1 &2) conjunction and disjunction operators have been examined.

Keywords: Neutrosophic Fuzzy Set (NFS), Neutrosophic Fuzzy Matrices (NFM), Lukasiewicz, Conjunction, Disjunction

AMS Subject Classification: 03E72

INTRODUCTION

The idea of the fuzzy set (FS), a class of items with a range of membership grades, was first suggested by Zadeh [21]. The function allocates a membership grade for each element among zero and one in FS. Atanassov [1,2] generalized the concept of fuzzy sets and introduced the notion of intuitionistic fuzzy sets (IFS). He established some of its fundamental attributes in detail. A neutrosophic set (NS) initially emerged by Smarandache [13]. NS is moreover adaptable and efficient since, in comparison to IFS, it can handle partially independent and dependent components, which is essential in today's uncertain ecological situation. Smarandache [14] extended the concept of NS into four fields: logic, set, probability, and statistics. Kim and Roush created the fuzzy matrix (FM) theory idea. FM is frequently utilized in the field of real-world applications and addresses a variety of uncertain challenges. Pal [11] developed the outlook of intuitionistic fuzzy matrices (IFM) and explored numerous results-based IFMs. Wang et al.





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[22] developed a novel viewpoint to construct an intuitionistic fuzzy similarity matrix based on IFM. A novel approach to creating neutrosophic fuzzy matrices (NFM) based on neutrosophic fuzzy was developed by Dhar et al. in [6]. Neutrosophic fuzzy matrices were introduced by Smarandach [12, 13, 14,15,16], Murugadas [18], Uma [19], and Vidhya [20] also created new theories and established some of its properties. Atanassov [3,5] presented some operators on the Lukasiwicz intuitionistic fuzzy conjunction and disjunction in IFSs. In [9,10], Muthuraji introduced the Lukasiwicz operators in intuitionistic fuzzy matrices and proved algebraic structure in IFM. We deliberate in operations over NFM with some Lukasiewicz-type algebraic features (1 & 2). In Section 2 we introduce the basic idea of NFM characteristics. The operator propositions of the Lukasiwicz conjunction and disjunction types (1& 2) over NFM are covered in Section 3. We develop the features based on union, intersection, and complement over NFM.

PRELIMINARIES

In this chapter, give some basic preliminaries about Neutrosophic Fuzzy set, Neutrosophic Fuzzy Matrix with operator.

Definition 2.1[12,13, 14]: A universe of X defined in a Neutrosophic set ' Ω ' as $\Omega = \{ \{x, T_{\Omega}^{\square}(x), I_{\Omega}^{\square}(x), F_{\Omega}^{\square}(x)\}, x \in X \}$, where $T_{\Omega}^{\square}, I_{\Omega}^{\square}, F_{\Omega}^{\square} : X \rightarrow]0, 1^+[$ and the condition $0^- \leq T_{\Omega}^{\square}(x) + I_{\Omega}^{\square}(x) + F_{\Omega}^{\square}(x) \leq 3^+$ and where T_{Ω}^{\square} is degree of truth membership, I_{Ω}^{\square} is the degree of indeterminacy and F_{Ω}^{\square} is the degree of false non-membership.

Definition 2.2[12]: Let Ω and Ψ are two neutrosophic fuzzy set and let $x_{\Omega} = (T_{x_{\Omega}}^{\square}, I_{x_{\Omega}}^{\square}, F_{x_{\Omega}}^{\square}) \in \Omega, y_{\Psi} = (T_{y_{\Psi}}^{\square}, I_{y_{\Psi}}^{\square}, F_{y_{\Psi}}^{\square}) \in \Psi$, define as type-1 operation of union and intersection over NFS is

$$\Omega \cup_1 \Psi = \left(\max(T_{x_{\Omega}}^{\square}, T_{y_{\Psi}}^{\square}), \min(I_{x_{\Omega}}^{\square}, I_{y_{\Psi}}^{\square}), \min(F_{x_{\Omega}}^{\square}, F_{y_{\Psi}}^{\square}) \right)$$

$$\Omega \cap_1 \Psi = \left(\min(T_{x_{\Omega}}^{\square}, T_{y_{\Psi}}^{\square}), \max(I_{x_{\Omega}}^{\square}, I_{y_{\Psi}}^{\square}), \max(F_{x_{\Omega}}^{\square}, F_{y_{\Psi}}^{\square}) \right)$$

Definition 2.3[12]: Let Ω and Ψ are two neutrosophic fuzzy set and let $x_{\Omega} = (T_{x_{\Omega}}^{\square}, I_{x_{\Omega}}^{\square}, F_{x_{\Omega}}^{\square}) \in \Omega, y_{\Psi} = (T_{y_{\Psi}}^{\square}, I_{y_{\Psi}}^{\square}, F_{y_{\Psi}}^{\square}) \in \Psi$, define as type-2 operation of union and intersection over NFS is

$$\Omega \cup_2 \Psi = \left(\max(T_{x_{\Omega}}^{\square}, T_{y_{\Psi}}^{\square}), \max(I_{x_{\Omega}}^{\square}, I_{y_{\Psi}}^{\square}), \min(F_{x_{\Omega}}^{\square}, F_{y_{\Psi}}^{\square}) \right)$$

$$\Omega \cap_2 \Psi = \left(\min(T_{x_{\Omega}}^{\square}, T_{y_{\Psi}}^{\square}), \min(I_{x_{\Omega}}^{\square}, I_{y_{\Psi}}^{\square}), \max(F_{x_{\Omega}}^{\square}, F_{y_{\Psi}}^{\square}) \right)$$

Definition 2.4 [12,15]: Let $\langle x_T^{\square}, x_I^{\square}, x_F^{\square} \rangle, \langle y_T^{\square}, y_I^{\square}, y_F^{\square} \rangle \in NFS$ then define as

$$\langle x_T^{\square}, x_I^{\square}, x_F^{\square} \rangle \leftarrow \langle y_T^{\square}, y_I^{\square}, y_F^{\square} \rangle = \begin{cases} \langle 1, 1, 0 \rangle, & \text{if } \langle x_T^{\square}, x_I^{\square}, x_F^{\square} \rangle \geq \langle y_T^{\square}, y_I^{\square}, y_F^{\square} \rangle \\ \langle x_T^{\square}, x_I^{\square}, x_F^{\square} \rangle, & \text{if } \langle x_T^{\square}, x_I^{\square}, x_F^{\square} \rangle \leq \langle y_T^{\square}, y_I^{\square}, y_F^{\square} \rangle \end{cases}$$

Here $\langle x_T^{\square}, x_I^{\square}, x_F^{\square} \rangle \geq \langle y_T^{\square}, y_I^{\square}, y_F^{\square} \rangle$ means $x_T^{\square} \geq y_T^{\square}, x_I^{\square} \geq y_I^{\square}$, and $x_F^{\square} \leq y_F^{\square}$





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Definition 2.5 [4]: Let $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right)$ is said to be Neutrosophic Fuzzy Matrix, if the all elements are belongs to Neutrosophic Fuzzy Set.

Definition 2.6[5, 19]: Let P and Q in NFM then $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right), Q = \left(\left\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \right\rangle \right) \in F_{m \times n}$, define as type-1 operation of union and intersection over NFM as

$$P \cup_1 Q = \left(\left\langle \max \left(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square} \right), \min \left(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square} \right), \min \left(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square} \right) \right\rangle \right)$$

$$P \cap_1 Q = \left(\left\langle \min \left(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square} \right), \max \left(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square} \right), \max \left(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square} \right) \right\rangle \right)$$

Definition 2.7 [19]: Let $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right), Q = \left(\left\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \right\rangle \right) \in F_{m \times n}$ are NFM, define as type-2 operation of union and intersection over NFM as

$$P \cup_2 Q = \left(\left\langle \max \left(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square} \right), \max \left(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square} \right), \min \left(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square} \right) \right\rangle \right)$$

$$P \cap_2 Q = \left(\left\langle \min \left(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square} \right), \min \left(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square} \right), \max \left(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square} \right) \right\rangle \right)$$

Definition 2.8 [19]: Let $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right), Q = \left(\left\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \right\rangle \right) \in F_{m \times n}$, P and Q be two NFM of same dimension. If $P \leq Q$, If $p_{T_{ij}}^{\square} \leq q_{T_{ij}}^{\square}, p_{I_{ij}}^{\square} \leq q_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \geq q_{F_{ij}}^{\square}$, for i, j then P is dominated by Q or Q dominated P. P and Q is called comparable. If either $P \leq Q$ (or) $Q \leq P, P < Q$ or $p_{T_{ij}}^{\square} < q_{T_{ij}}^{\square}, p_{I_{ij}}^{\square} < q_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} > q_{F_{ij}}^{\square}$

Definition 2.9 [12, 13, 15]: Let $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right) \in F_{m \times n}$, the complement of P with type 1 and type 2 in NFM is

$$P^{c_1} = \left(\left\langle p_{F_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{T_{ij}}^{\square} \right\rangle \right)$$

$$P^{c_2} = \left(\left\langle p_{F_{ij}}^{\square}, 1 - p_{I_{ij}}^{\square}, p_{T_{ij}}^{\square} \right\rangle \right)$$

Definition 2.10[8]: Consider that the two elements in $\langle T_{x_{\Omega}}^{\square}, I_{x_{\Omega}}^{\square}, F_{x_{\Omega}}^{\square} \rangle, \langle T_{y_{\Omega}}^{\square}, I_{y_{\Omega}}^{\square}, F_{y_{\Omega}}^{\square} \rangle \in \Omega$ such that $0 \leq T_{x_{\Omega}}^{\square} + I_{x_{\Omega}}^{\square} + F_{x_{\Omega}}^{\square} \leq 3$ and $0 \leq T_{y_{\Omega}}^{\square} + I_{y_{\Omega}}^{\square} + F_{y_{\Omega}}^{\square} \leq 3$, when all three components are independent. Now define

the conjunction and disjunction operators \oplus_{L_1} and \square_{L_1} of Lukasiewicz type -lis

$$\langle T_{x_{\Omega}}^{\square}, I_{x_{\Omega}}^{\square}, F_{x_{\Omega}}^{\square} \rangle \square_{L_1} \langle T_{y_{\Omega}}^{\square}, I_{y_{\Omega}}^{\square}, F_{y_{\Omega}}^{\square} \rangle = \left[\left\langle \max \left(T_{x_{\Omega}}^{\square} + T_{y_{\Omega}}^{\square} - 1, 0 \right), \min \left(I_{x_{\Omega}}^{\square} + I_{y_{\Omega}}^{\square}, 1 \right), \min \left(F_{x_{\Omega}}^{\square} + F_{y_{\Omega}}^{\square}, 1 \right) \right\rangle \right]$$

$$\langle T_{x_{\Omega}}^{\square}, I_{x_{\Omega}}^{\square}, F_{x_{\Omega}}^{\square} \rangle \oplus_{L_1} \langle T_{y_{\Omega}}^{\square}, I_{y_{\Omega}}^{\square}, F_{y_{\Omega}}^{\square} \rangle = \left[\left\langle \min \left(T_{x_{\Omega}}^{\square} + T_{y_{\Omega}}^{\square}, 1 \right), \max \left(I_{x_{\Omega}}^{\square} + I_{y_{\Omega}}^{\square} - 1, 0 \right), \max \left(F_{x_{\Omega}}^{\square} + F_{y_{\Omega}}^{\square} - 1, 0 \right) \right\rangle \right]$$




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RESULTS

Definition 3.1 :Consider that the two elements in $\langle T_{x_\Omega}^\square, I_{x_\Omega}^\square, F_{x_\Omega}^\square \rangle, \langle T_{y_\Omega}^\square, I_{y_\Omega}^\square, F_{y_\Omega}^\square \rangle \in \Omega$ such that $0 \leq T_{x_\Omega}^\square + I_{x_\Omega}^\square + F_{x_\Omega}^\square \leq 3$ and $0 \leq T_{y_\Omega}^\square + I_{y_\Omega}^\square + F_{y_\Omega}^\square \leq 3$, when all three components are independent. Now define the conjunction and disjunction operators \oplus_{L_2} and \square_{L_2} of Lukasiewicz type -2is

$$\langle T_{x_\Omega}^\square, I_{x_\Omega}^\square, F_{x_\Omega}^\square \rangle \square_{L_2} \langle T_{y_\Omega}^\square, I_{y_\Omega}^\square, F_{y_\Omega}^\square \rangle = \left[\left\langle \max(T_{x_\Omega}^\square + T_{y_\Omega}^\square - 1, 0), \max(I_{x_\Omega}^\square + I_{y_\Omega}^\square - 1, 0), \min(F_{x_\Omega}^\square + F_{y_\Omega}^\square, 1) \right\rangle \right]$$

$$\langle T_{x_\Omega}^\square, I_{x_\Omega}^\square, F_{x_\Omega}^\square \rangle \oplus_{L_2} \langle T_{y_\Omega}^\square, I_{y_\Omega}^\square, F_{y_\Omega}^\square \rangle = \left[\left\langle \min(T_{x_\Omega}^\square + T_{y_\Omega}^\square, 1), \min(I_{x_\Omega}^\square + I_{y_\Omega}^\square, 1), \max(F_{x_\Omega}^\square + F_{y_\Omega}^\square - 1, 0) \right\rangle \right]$$

Definition 3.2: A Neutrosophic fuzzy matrix P is $P = \left(\left\langle p_{T_{ij}}^\square, p_{I_{ij}}^\square, p_{F_{ij}}^\square \right\rangle \right)$ where $0 \leq p_{T_{ij}}^\square + p_{I_{ij}}^\square + p_{F_{ij}}^\square \leq 3$ for i, j, when all three components are independent. Now the conjunction and disjunction operators \oplus_{L_1} and \square_{L_1} of Lukasiewicz type -1 on NFM. Let $P = \left(\left\langle p_{T_{ij}}^\square, p_{I_{ij}}^\square, p_{F_{ij}}^\square \right\rangle \right)$ and $Q = \left(\left\langle q_{T_{ij}}^\square, q_{I_{ij}}^\square, q_{F_{ij}}^\square \right\rangle \right)$ be two NFMs of order m×n. then

$$P \square_{L_1} Q = \left(\left\langle \max(p_{T_{ij}}^\square + q_{T_{ij}}^\square - 1, 0), \min(p_{I_{ij}}^\square + q_{I_{ij}}^\square, 1), \min(p_{F_{ij}}^\square + q_{F_{ij}}^\square, 1) \right\rangle \right)$$

$$P \oplus_{L_1} Q = \left(\left\langle \min(p_{T_{ij}}^\square + q_{T_{ij}}^\square, 1), \max(p_{I_{ij}}^\square + q_{I_{ij}}^\square - 1, 0), \max(p_{F_{ij}}^\square + q_{F_{ij}}^\square - 1, 0) \right\rangle \right)$$

Definition 3.3: A Neutrosophic fuzzy matrix P is $P = \left(\left\langle p_{T_{ij}}^\square, p_{I_{ij}}^\square, p_{F_{ij}}^\square \right\rangle \right)$ where $0 \leq p_{T_{ij}}^\square + p_{I_{ij}}^\square + p_{F_{ij}}^\square \leq 3$ for i, j, when all three components are independent. Now the conjunction and disjunction operators \oplus_{L_2} and \square_{L_2} of Lukasiewicz type -2 on NFMs. Let $P = \left(\left\langle p_{T_{ij}}^\square, p_{I_{ij}}^\square, p_{F_{ij}}^\square \right\rangle \right)$ and $Q = \left(\left\langle q_{T_{ij}}^\square, q_{I_{ij}}^\square, q_{F_{ij}}^\square \right\rangle \right)$ be two NFMs of order m×n. then

$$P \square_{L_2} Q = \left(\left\langle \max(p_{T_{ij}}^\square + q_{T_{ij}}^\square - 1, 0), \max(p_{I_{ij}}^\square + q_{I_{ij}}^\square - 1, 0), \min(p_{F_{ij}}^\square + q_{F_{ij}}^\square, 1) \right\rangle \right)$$

$$P \oplus_{L_2} Q = \left(\left\langle \min(p_{T_{ij}}^\square + q_{T_{ij}}^\square, 1), \min(p_{I_{ij}}^\square + q_{I_{ij}}^\square, 1), \max(p_{F_{ij}}^\square + q_{F_{ij}}^\square - 1, 0) \right\rangle \right)$$

Proposition 3.1

For any Two NFM's P and Q then

- i) $\overline{(P \oplus_{L_1} Q)} = P \square_{L_1} Q,$
- ii) $\overline{(P \square_{L_1} Q)} = P \oplus_{L_1} Q.$

Proof





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Let $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right)$ and $Q = \left(\left\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \right\rangle \right)$ be two NFM's of order $m \times n$.

$$\overline{P \oplus_{L_1} Q} = \left(\left\langle \min(p_{F_{ij}}^{\square} + q_{F_{ij}}^{\square}, 1), \max(p_{I_{ij}}^{\square} + q_{I_{ij}}^{\square} - 1, 0), \max(p_{T_{ij}}^{\square} + q_{T_{ij}}^{\square} - 1, 0) \right\rangle \right)$$

$$= \left(\left\langle \max(p_{T_{ij}}^{\square} + q_{T_{ij}}^{\square} - 1, 0), \min(p_{I_{ij}}^{\square} + q_{I_{ij}}^{\square}, 1), \min(p_{F_{ij}}^{\square} + q_{F_{ij}}^{\square}, 1) \right\rangle \right)$$

$$\overline{\overline{P \oplus_{L_1} Q}} = P \square_{L_1} Q$$

Similarly $\overline{P \square_{L_1} Q} = P \oplus_{L_1} Q$

Proposition 3.2

For any Two NFM's P and Q then

i) $\overline{\overline{P \oplus_{L_2} Q}} = P \square_{L_2} Q$

ii) $\overline{P \square_{L_2} Q} = P \oplus_{L_2} Q$

Proof

By Proposition 3.1 it true.

Proposition 3.3

For any three NFM's P, Q and R then

i) $D \oplus_{L_1} R = H \cap_1 J$

ii) $D \oplus_{L_2} R = K \cap_1 L$,

Where $D = P \cap_1 Q, H = P \oplus_{L_1} R, J = Q \oplus_{L_1} R, K = P \oplus_{L_2} R, L = Q \oplus_{L_2} R$, D, H, K, L are all NFM

Proof

Let $P = \left(\left\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \right\rangle \right)$, $Q = \left(\left\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \right\rangle \right)$ $R = \left(\left\langle r_{T_{ij}}^{\square}, r_{I_{ij}}^{\square}, r_{F_{ij}}^{\square} \right\rangle \right)$ and be three NFM's of order $m \times n$

$$(P \cap_1 Q) \oplus_{L_1} R = \left(\left\langle \min(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}), \max(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}), \max(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) \right\rangle \right) \oplus_{L_1} R$$

$$= \left(\left\langle \min(1, \min(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square}), \max(0, \max(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}) + r_{I_{ij}}^{\square} - 1), \max(0, \max(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) + r_{F_{ij}}^{\square} - 1) \right\rangle \right)$$

$$= \left(\left\langle \min(1, p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}), \max(0, p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1), \max(0, p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1) \right\rangle \right)$$

$$= \left(\left\langle \min(1, p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}), \max(0, p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1), \max(0, p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1) \right\rangle \right)$$

$$\cap_1 \left(\left\langle \min(1, q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}), \max(0, q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1), \max(0, q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1) \right\rangle \right)$$

$$D \oplus_{L_1} R = H \cap_1 J$$

Similarly $D \oplus_{L_2} R = K \cap_1 L$





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Proposition 3.4

For any three NFM's P, Q and R then

- i) $(P \cap_1 Q) \square_{L_1} R = (P \square_{L_1} R) \cap_1 (Q \square_{L_1} R)$
- ii) $(P \cap_2 Q) \square_{L_2} R = (P \square_{L_2} R) \cap_2 (Q \square_{L_2} R)$

Proof

Let $P = \left(\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \rangle \right)$, $Q = \left(\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \rangle \right)$ and $R = \left(\langle r_{T_{ij}}^{\square}, r_{I_{ij}}^{\square}, r_{F_{ij}}^{\square} \rangle \right)$ be three NFMs of order $m \times n$

$$\begin{aligned} (P \cap_1 Q) \square_{L_1} R &= \left(\langle \min(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}), \max(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}), \max(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) \rangle \right) \square_{L_1} R \\ &= \left(\langle \max(\min(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square} - 1, 0), \min(\max(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}) + r_{I_{ij}}^{\square}, 1), \min(\max(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) + r_{F_{ij}}^{\square}, 1) \rangle \right) \\ &= \left(\langle \max(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} - 1, q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} - 1, 0), \min(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square}, q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square}, 1), \min(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square}, q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square}, 1) \rangle \right) \\ &= \left(\langle \max(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} - 1, 0), \min(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square}, 1), \min(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square}, 1) \rangle \right) \cap_1 \\ &\quad \left(\langle \max(q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} - 1, 0), \min(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square}, 1), \min(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square}, 1) \rangle \right) \end{aligned}$$

$$(P \cap_1 Q) \square_{L_1} R = (P \square_{L_1} R) \cap_1 (Q \square_{L_1} R)$$

Similarly $(P \cap_2 Q) \square_{L_2} R = (P \square_{L_2} R) \cap_2 (Q \square_{L_2} R)$

Proposition 3.5

For any three NFM's P, Q and R then

- i) $(P \cup_1 Q) \oplus_{L_1} R = (P \oplus_{L_1} R) \cup_1 (Q \oplus_{L_1} R)$
- ii) $(P \cup_2 Q) \oplus_{L_2} R = (P \oplus_{L_2} R) \cup_2 (Q \oplus_{L_2} R)$

Proof

Let $P = \left(\langle p_{T_{ij}}^{\square}, p_{I_{ij}}^{\square}, p_{F_{ij}}^{\square} \rangle \right)$, $Q = \left(\langle q_{T_{ij}}^{\square}, q_{I_{ij}}^{\square}, q_{F_{ij}}^{\square} \rangle \right)$ and $R = \left(\langle r_{T_{ij}}^{\square}, r_{I_{ij}}^{\square}, r_{F_{ij}}^{\square} \rangle \right)$ be three NFMs of order $m \times n$

Here $P \cup_1 Q = \left(\langle \max(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}), \min(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}), \min(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) \rangle \right)$

$$(P \cup_1 Q) \oplus_{L_1} R = \left(\langle \min(\max(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square}, 1), \max(\min(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}) + r_{I_{ij}}^{\square} - 1, 0), \max(\min(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) + r_{F_{ij}}^{\square} - 1, 0) \rangle \right) \dots(*)$$

W.k.t $P \oplus_{L_1} R = \left(\langle \min(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1), \max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), \max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) \rangle \right)$

$$Q \oplus_{L_1} R = \left(\langle \min(q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1), \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), \max(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) \rangle \right)$$





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$$(P \oplus_{L_1} R) \cup_1 (Q \oplus_{L_1} R) = \left(\left\langle \begin{array}{l} \max(\min(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1), \min(q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1)), \\ \min(\max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0)), \\ \min(\max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0), \max(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0)) \end{array} \right\rangle \right) \dots(**)$$

Let $U = \min(\max(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square}, 1) - \max(\min(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1), \min(q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1))$

If $p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} \geq 1$ then $\max(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square} \geq 1$

$U = 1 - \max(1, \min(q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1)) = 1 - 1 = 0$

If $p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} < 1$ then

$U = \min(\max(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square}, 1) - \max(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, \min(q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1)) = 0$

If $q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} \geq 1$ then $(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square} \geq 1$

$U = 1 - \max(1, \min(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1)) = 1 - 1 = 0$

If $q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square} < 1$ then

$U = \min(\max(p_{T_{ij}}^{\square}, q_{T_{ij}}^{\square}) + r_{T_{ij}}^{\square}, 1) - \max(\min(p_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}, 1), q_{T_{ij}}^{\square} + r_{T_{ij}}^{\square}) = 0$

Let $V = \max(\min(p_{I_{ij}}^{\square}, q_{I_{ij}}^{\square}) + r_{I_{ij}}^{\square} - 1, 0) - \min(\max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0))$

$V = \max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0) - \min(\max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0))$

If $p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} \geq 1$ then

$V = \max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0) - \min(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0))$

If $p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} < 1$ then

$V = \max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0) - \min(0, \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0)) = 0 - 0 = 0$

If $q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} \geq 1$ then

$V = \max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0) - \min(\max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1)$

If $q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} < 1$ then

$V = \max(q_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0) - \min(\max(p_{I_{ij}}^{\square} + r_{I_{ij}}^{\square} - 1, 0), 0) = 0 - 0 = 0$

Let $W = \max(\min(p_{F_{ij}}^{\square}, q_{F_{ij}}^{\square}) + r_{F_{ij}}^{\square} - 1, 0) - \min(\max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0), \max(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0))$

$W = \max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) - \min(\max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0), \max(b_{F_{ij}}^N + r_{F_{ij}}^{\square} - 1, 0))$





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If $p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} \geq 1$ then

$$W = \max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) - \min(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, \max(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0))$$

If $p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} < 1$ then

$$W = \max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) - \min(0, \max(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0)) = 0 - 0 = 0$$

If $q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} \geq 1$ then

$$W = \max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) - \min(\max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0), q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1)$$

If $q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} < 1$ then

$$W = \max(q_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0) - \min(\max(p_{F_{ij}}^{\square} + r_{F_{ij}}^{\square} - 1, 0), 0) = 0 - 0 = 0$$

Therefore $(P \cup_1 Q) \oplus_{L_1} R = (P \oplus_{L_1} R) \cup_1 (Q \oplus_{L_1} R)$

Similarly $(P \cup_1 Q) \oplus_{L_2} R = (P \oplus_{L_2} R) \cup_1 (Q \oplus_{L_2} R)$

Proposition 3.6

For any three NFM's P,Q and R then

i) $(P \cup_2 Q) \oplus_{L_1} R = (P \oplus_{L_1} R) \cup_2 (Q \oplus_{L_1} R)$

ii) $(P \cup_2 Q) \oplus_{L_2} R = (P \oplus_{L_2} R) \cup_2 (Q \oplus_{L_2} R)$

Proof

From Proposition 3.5

The (i) and (ii) is true.

Proposition 3.7

For any two NFM's P, and Q then

i) $(P^{C_1} \oplus_{L_1} Q^{C_1}) = (P \square_{L_2} Q)^{C_1}$

ii) $(P^{C_1} \square_{L_1} Q^{C_1}) = (P \oplus_{L_2} Q)^{C_1}$

iii) $(P^{C_2} \oplus_{L_1} Q^{C_2}) = (P \square_{L_2} Q)^{C_2}$

iv) $(P^{C_2} \square_{L_2} Q^{C_2}) = (P \square_{L_1} Q)^{C_2}$

Proof

i)

$$(P^{C_1} \oplus_{L_1} Q^{C_1}) = \left(\left\langle \min(p_{F_{ij}}^{\square} + q_{F_{ij}}^{\square}, 1), \max(p_{T_{ij}}^{\square} + q_{T_{ij}}^{\square} - 1, 0), \min(p_{T_{ij}}^{\square} + q_{T_{ij}}^{\square}, 1) \right\rangle \right)$$

$$= \left(\left\langle \max(p_{T_{ij}}^{\square} + q_{T_{ij}}^{\square} - 1, 0), \max(p_{F_{ij}}^{\square} + q_{F_{ij}}^{\square} - 1, 0), \min(p_{F_{ij}}^{\square} + q_{F_{ij}}^{\square}, 1) \right\rangle \right)$$

$$(P^{C_1} \oplus_{L_1} Q^{C_1}) = (P \square_{L_2} Q)^{C_1}$$





Similarly Proved ii),iii)and iv)

CONCLUSION

The Lukasiwicz conjunction and disjunction operatorstype(1&2) over Neutrosophic fuzzy matrices were investigated in this study. Here, we explored how to use Lukasiwicz conjunction and disjunction operators of type (1&2) to combine, intersect, and complement Neutrosophic fuzzy matrices. With Lukasiwicz conjunction and disjunction operators of type (1&2), several features of the complement, intersection, and union of neurosophic fuzzy matrices were also demonstrated.

ACKNOWLEDGMENT

The authors are highly thankful for the valuable comments which helped to improve the quality of the paper. Sincere grateful thanks to the editors, publishers of the article.

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Anti-Cataract Activity of *Mitragyna parvifolia* Root Extracts - An *In-silico* and *Ex vivo* Study

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 21 Jun 2024

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ABSTRACT

Mitragyna parvifolia popularly known as Kaim is a medium to large deciduous tree found in India, Pakistan and Srilanka. *M. parvifolia* is a substitute for the Ayurvedic drug *Kadamba* for which the accepted source is *Neolamarckia cadamba* and is used in the treatment of eye diseases, wounds, cough, and oedema. The present study deals with phytochemical studies, molecular docking and *in-vitro* anti-cataract activity of *Mitragyna parvifolia* root extracts against glucose induced cataract in isolated goat lenses. Phytochemical studies of alcohol extract showed the presence of carbohydrates, glycosides, alkaloids, tannins and flavonoids. Molecular docking studies of isorhynchophylline, rhynchophylline, corynoxine and Hirsutine against Aldose Reductase inhibitors showed that corynoxine and Hirsutine showed strongest binding affinity with binding energy of -12.3. In *ex vivo* study, the induction of cataract by glucose showed a significant decrease in catalase, reduced glutathione and increased malondialdehyde level. The result showed that alcohol extract at 1000 µg/ml dose exhibited significant anti-cataract activity thereby substantiating the traditional use of the plant in the treatment of eye diseases.

Keywords: Diabetic cataract, *Mitragyna parvifolia*, Aldose reductase, *insilico*





INTRODUCTION

Medicinal plants and their products have become a symbol of safety in contrast with synthetic drugs which are likely toxic and with more side effects. Each medicinal plant or herb has a specific quality and are used to treat multitude of ailments, causes and diseases. They are rich source of nutrients having different properties, non-toxic in nature and recommended for their high therapeutic value having no side effects. Most cultures from ancient times to the present day have used plants as a source of medicine [1]. As per WHO statistics, nearly 2.2 billion people worldwide have a vision impairment out of which at least 1 billion cases could have been prevented or treated [2]. Cataract is caused due to the loss in transparency of lens by either scattering or absorbing light such that visual acuity is compromised. Cataract can result from several causes like ageing, diabetes, obesity, high blood pressure etc. Although the condition is very common, the detailed molecular mechanism behind its development is not very well understood. As ageing takes place, oxidative stress occurs and cause damage to the normal cell structure due to the production of free radicals. Since these defective cells are not extruded, they either undergo necrosis or move to the capsule posterior area and forms capsular cataract. Thus, oxidative stress is a basic cataractogenesis mechanism. The enzyme aldose reductase catalyzes the reduction of glucose to sorbitol through polyol pathway. The intracellular accumulation of sorbitol leads to osmotic changes and results in diabetic cataract leading to the degeneration of lens fibers [3].

Mitragyna parvifolia (Roxb.) Korth. a medium to large sized deciduous tree belonging to the family Rubiaceae, is found distributed throughout the drier parts of India, Pakistan and Srilanka. *Mitragyna parvifolia* is a substitute for the Ayurvedic drug Kadamba for which the accepted botanical source is *Neolamarckia cadamba*[1]. *M. parvifolia* roots and barks are recommended in Ayurvedic texts for prevention and treatment of eye diseases, gastropathy, colic and fever. The leaves are used as stomachic, anti-inflammatory, anodyne, depurative and febrifuge [4]. Traditionally the roots are used for the treatment of eye diseases, since no work has been reported on the anti-cataract activity, the present study was undertaken.

MATERIALS AND METHODS

Plant material

The roots of *Mitragyna parvifolia* was collected from Tirunelveli region of Tamil Nadu in 2018. The collected material was identified and authenticated by Dr. V. Chelladurai, Taxonomist. Botanical identification was carried out by using various floras[5].

Preparation of extracts and preliminary phytochemical screening

Dried roots were pulverized using a mechanical grinder. Alcohol extract was prepared by Soxhlet extraction using 95% v/v ethanol. The extract was concentrated separately and the percentage yield was calculated. Preliminary phytochemical screening was performed following standard procedures to identify the presence of primary and secondary metabolites in the selected plant material [6,7,8].

Molecular docking and ADMET studies

Ligand and protein preparation

Isorhynchophylline, rhynchophylline and corynoxine, Hirsutine are the active constituents reported in the roots of *Mitragyna Parvifolia*[9]. The chemical structure of these compounds was obtained using the Pub chem database (<http://www.ncbi.nlm.nih.gov/pccompound>). The target protein Aldose reductase inhibitor was retrieved from Protein Data Bank (PDB) with PDB ID 5LIY.

Docking Studies

Docking studies were further carried out using Auto Dock Vina whereas the ligand and protein preparatory steps were done using Auto Dock Tools which is a part of MGL Tools 1.5.6. All the ligands were prepared, minimized, and optimized using AutoDock Vina. Preparation of the protein is an important step for performing the docking studies. The protein preparation was carried out for target protein Aldose reductase inhibitor retrieved from Protein Data



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Bank (PDB) with PDB ID 5LIY. The X-ray crystallographic structure of target protein Aldose reductase was deposited in PDB website with resolution of 2.05 Å. In the protein preparation, hetero groups, water molecules, and unwanted ligands were deleted. The grid generation forms an important step in docking as it defines the region to which the ligands will be interacting with the protein. Grid is defined using the co-crystallized ligand available with the protein structure from the Protein Data Base. The docked output of all the ligands were screened to identify the compounds with the highest docking score.

Ex Vivo Anti-cataract activity

Fresh goat eyeballs were obtained from the locals laughter house and the lenses were removed by extra-capsular lens extraction method. 36goat lenses were divided into 6 groups of 6 lenses each. The lenses were incubated in artificial aqueous humor of pH 7.8 at room temperature for 72 hrs. To prevent the microbial contamination, penicillin 32mg% and streptomycin 250mg% were added to the culture. Cataract was induced by using 55mM concentration of glucose. After 72 hours of incubation, lenses were removed for homogenate preparation using buffer solutions [10].

Experimental Protocol

Group 1 served as Normal control (vehicle treated non-cataract lenses)

Group 2 served as positive control (Lens treated with glucose 55mM to induce cataract)

Group 3 served as standard drug treated (Lens treated with glucose 55mM + ascorbic acid 20 µg/ml)

Group 4 consist of goat lenses treated with alcohol extract (250 µg/ml)

Group 5 consist of goat lenses treated with alcohol extract (500 µg/ml)

Group 6 consist of goat lenses treated with alcohol extract (1000 µg/ml)

Lens Morphology

Morphology of the lenses was studied by placing them on a graph sheet and the number of squares visible through the lenses is noted down as a measure of lens opacity. Changes in the morphology like haziness, swelling are noted, and the grading was done as per the criteria mentioned in Table 1.

Preparation of lens homogenate

For Malondialdehyde (MDA) estimation, 10% w/v of potassium chloride buffer was used to prepare the homogenate. For estimation of reduced glutathione (GSH) and catalase, 0.1M potassium phosphate buffer was used. The homogenates were centrifuged at 4000 rpm for 15 minutes. The supernatant obtained was used for further biochemical studies.

Estimation of Malondialdehyde

1 ml of homogenate was mixed with 2 ml of TCA-TBA-HCl reagent (15% Trichloro acetic acid (TCA) and 0.375% Thiobarbituric acid (TBA) in 0.25N HCl) and boiled for 15 mins. The mixture was cooled and the precipitate was removed by centrifugation at 1000 rpm for 10 mins. The absorbance was measured at 535 nm against a blank. The values were expressed as nmoles of MDA/min/mg [11].

Estimation of Reduced glutathione

1 ml of 5 % TCA (w/v) was mixed with 1 ml of 10 % homogenate and was allowed to stand for 30 mins. The mixture was then centrifuged at 2500 rpm for 15 mins. 0.5 ml of supernatant was mixed with 2.5 ml of 5'-DiThioNitroBenzoic acid (DTNB) and the absorbance was recorded at 412 nm. The values are expressed as µmoles/g [11].

Estimation of Catalase

To 0.1 ml of supernatant, 1 ml of phosphate buffer and 0.4 ml of distilled water was added. Reaction was initiated by adding 0.5 ml of hydrogen peroxide and the mixture was incubated at 37°C for 1 minute. Reaction was stopped by adding 2 ml of dichromate: acetic acid reagent and kept in boiling water bath for 15 mins. The mixture was allowed





to cool, and absorbance was read at 570 nm before and after reaction. Catalase activity was calculated in terms of $\mu\text{mol}/\text{min}/\text{g}$ [11].

Statistical analysis

The data was expressed as mean \pm S.E.M values and tested with One-Way Analysis of Variance (ANOVA) followed by Tukey-Kramer multiple comparison test.

RESULTS

The percentage yield of total alcohol extract was found to be 3.815% and preliminary phytochemical screening showed the presence of alkaloids, flavonoids, tannins, glycosides, and carbohydrates. The docking score, 2d, 3d interactions of isorhynchophylline, rhynchophylline, corynoxene and Hirsutine with target protein aldose reductase inhibitor are shown in Table 2, fig 1-4.

Photographic study of lenses

Normal lens incubated with artificial aqueous humour showed complete transparency. The lenses which are treated with glucose 55 mM showed complete opacification of the lens fibers as compared to normal lenses (normal control). Lenses incubated with glucose 55 mM and ascorbic acid (20 $\mu\text{g}/\text{ml}$) showed almost normal transparency when compared to cataractous lenses. The lenses incubated with alcohol extract 250 $\mu\text{g}/\text{ml}$ and 500 $\mu\text{g}/\text{ml}$ also showed comparatively less opacity when compared to cataractous lenses (disease control). The lenses incubated with alcohol extract 1000 $\mu\text{g}/\text{ml}$ showed almost normal transparency and the transparency was found to be comparable to the ascorbic acid treated lenses (Fig 5).

Effect of alcohol root extracts of *M. parvifolia* on lens antioxidant level

There was a statistically significant increase in MDA level in cataractous lenses (disease control) when compared to the normal lenses (normal control). Treatment with ethanol extract in various test doses and ascorbic acid (20 $\mu\text{g}/\text{ml}$) showed significant reduction ($p < 0.001$) in malondialdehyde level when compared to cataractous lenses (disease control). A statistically significant reduction in GSH and catalase level was observed in glucose 55 mM treated cataractous lenses (disease control). Treatment with alcohol extract at 250 $\mu\text{g}/\text{ml}$, 500 $\mu\text{g}/\text{ml}$, 1000 $\mu\text{g}/\text{ml}$ dose level showed significant increase ($p < 0.001$) in GSH and catalase level when compared to disease control. (Table. 3)

DISCUSSION

Phytochemical screening helps in the identification of various primary and secondary metabolites present in the plant material responsible for pharmacological activity. Cataract is caused when the transparency of lens is lost by either scattering or absorbing light such that visual acuity is compromised. This can result from several causes. Although the condition is very common, the detailed molecular mechanism behind its development is not very well understood. Osmotic stress caused by sorbitol accumulation in the lens has long been suggested to be the major cause of this since sorbitol was found to be accumulated to a substantially high level in cataractous lenses. Under hyperglycaemic conditions, sorbitol is formed from the reduction of glucose by the enzyme aldose reductase (AR) of the polyol pathway. Evidence is on the rise showing the contribution of oxidative stress to the development of diabetic cataract. These findings have led to the conclusion that the major cause of diabetic cataract is sorbitol accumulation. Thus, oxidative stress is a common basic cataractogenesis mechanism. Reduced glutathione (GSH) was found to be depleted in cataractous lenses which was accompanied by an increase in the level of lipid peroxidation products (LPO) like malondialdehyde (MDA). Oxidative stress may also be implicated in the cataract induced by glucose, due to the formation of superoxide (O_2^-) radical and H_2O_2 . Catalase and reduced glutathione are the key components of the lens innate enzyme defenses. Main role of catalase is to de-fix significant amounts of hydrogen peroxide, thus preventing damage to the membrane and biological structures. By inhibiting lipid peroxidation, reduced glutathione is reported to preserve the integrity of the membrane of phospholipid bilayers [12]. It is well



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known that polyol pathway has an important role to play in diabetic cataract. Aldose reductase enzyme catalyzes the higher concentration of glucose in the aqueous humour to their respective polyols. The accumulation of these polyols within the cells renders the cell hypertonic. To neutralize this hypertonicity extracellular water moves into the cell and as a result the lens swells, leading to series of physicochemical changes leading to cataract formation. This cataract formation can be inhibited by aldose reductase inhibitors. These inhibitors block the conversion of sugar to their respective polyols and inhibits the hydration of diabetic lenses [13].

In this study, it was observed that cataract lenses are highly opaque compared to normal lenses. The lenses treated with ethanol extract, ascorbic acid restored the level of reduced glutathione and catalase and reduced the level of MDA thus substantiating the traditional use of the drug chosen. Alcohol extract 1000 µg/ml showed better activity, which is almost comparable to ascorbic acid treated lenses.

CONCLUSION

Preliminary phytochemical screening of alcohol extract showed the presence of flavonoids and lot of studies have supported the presence of flavonoids and their antioxidant activity[14]. Hence the antioxidant activity of *Mitragyna parvifolia* may be attributed to the presence of flavonoids and further research related to the isolation can be studied.

ACKNOWLEDGMENT

The authors are thankful to Faculty of Pharmacy, M. S. Ramaiah University of Applied Sciences, Bangalore, for providing the facilities to perform the study.

CONFLICT OF INTEREST

None

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Table 1: Grades for cataract changes

Grade	Description	Details
0	No changes	Visible grid lines, lens outline and shape preserved
1	Mild	Visible grid lines, minimal lens swelling, lens outline and shape preserved
2	Moderate	Faintly visible grid lines, lens swelling present
3	Moderate to severe	Almost obstructed grid lines, lens outline and shape damaged
4	Severe	Invisible grid lines, distorted lens shape and outline, mature cataract about to rupture

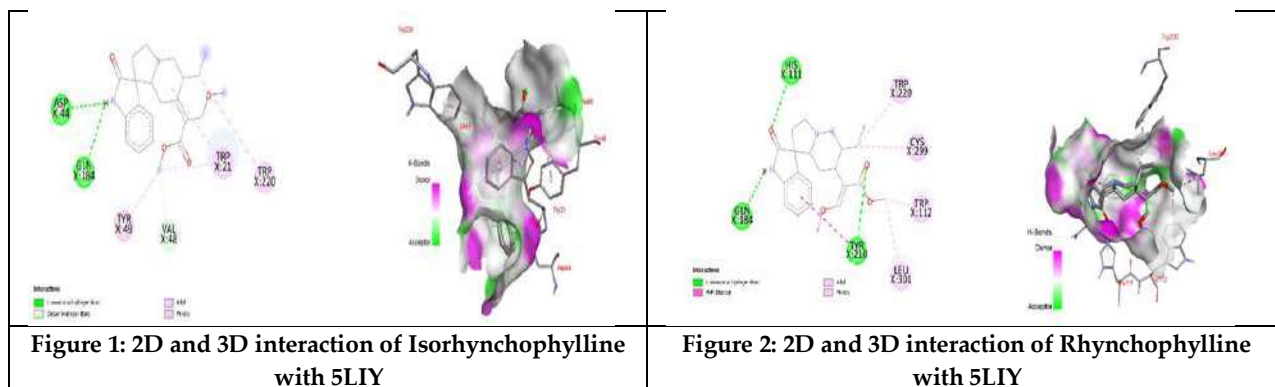
Table 2: Docking score of phytoconstituents of *Mitragyna parvifolia* against Aldose reductase inhibitors

Ligand	Binding energy (-Kcal/mol)	Interacting Residues
Isorhynchophylline	-8.5	ASP44, GLN184, TYR49, VAL48, TRP21, TRP220
Rhynchophylline	-8.6	CYS299, LEU301, TRP80, ASN161, TRP21, GLN184, TYR210, HIS111
Corynoxine	-9.2	ASN300, LEU301, TRP112, CYS299, TYR210
Hirsutine	-12.3	LEU301, TRP21, CYS299, TYR210

Table 3: Effect of *Mitragyna parvifolia* root extracts on lens antioxidant levels

Groups	Description	Malonaldehyde (nmoles/100 mg tissue)	GSH (nmoles/100mg tissue)	Catalase activity (nmoles/100mg tissue)
1	Normal control	1.74 ± 0.017***	57.42 ± 0.014***	2.04 ± 0.009***
2	Standard drug treated	0.90 ± 0.012***	53.58 ± 0.009***	0.887 ± 0.0008***
3	Disease control	3.33 ± 0.012 ^a	11.911 ± 0.0009 ^a	1.98 ± 0.008 ^a
4	Alcohol extract 250 µg/ml	1.91 ± 0.012***	21.69 ± 0.011***	0.571 ± 0.001***
5	Alcohol extract 500 µg/ml	1.37 ± 0.015 ***	36.39 ± 0.011***	0.546 ± 0.001***
6	Alcohol extract 1000 µg/ml	1.08 ± 0.099***	60.00 ± 0.009***	0.588 ± 0.0009***

Values are expressed as mean ± SEM and statistical analysed by One-way ANOVA followed by Turkey Kramer multiple comparison test. *** p < 0.001 in comparison with disease control^a p < 0.001 in comparison with control





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<p>Figure 3: 2D and 3D interaction of Corynoxetine with 5LIY</p>	<p>Figure 4: 2D and 3D interaction of Hirsutine with 5LIY</p>
<p>Fig.5a. Isolated goat eye lenses</p>	<p>Fig. 5b. Lens of Normal control</p>
<p>Fig. 5c. Lens of Positive control</p>	<p>Fig. 5d. Lens of standard</p>
<p>Fig. 5e. Lens of Alcohol extract (250µg/ml)</p>	<p>Fig. 5f. Lens of Alcohol extract (500µg/ml)</p>
<p>Fig. 5g. Lens of Alcohol extract (1000µg/ml)</p>	





Inverse Properties of Neutrosophic Fuzzy Matrices

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

In this paper, we discuss necessary and sufficient conditions for $\{1,2,3,4\}$ -inverses, Neutrosophic Fuzzy relation equations, and left (right) cancellable properties regarding Neutrosophic Fuzzy Matrices (NFM). Additionally, we study the equivalence relation between Moore-Penrose inverses (MPI) and minus ordering. The generalized inverse of an idempotent matrix exhibits marvelous algebraic characterizations in NFM. We provide some properties to preserve idempotency in NFM, and we also discuss the equivalence relation between Idempotent Intuitionistic Fuzzy Matrices, Pseudo-Similar, and Group inverses (GI). Finally, we present some results based on the MPI and GI of NFM, along with numerical examples.

Keywords: Moore – Penrose inverse of Neutrosophic Fuzzy Matrices

INTRODUCTION

Matrices are crucial in many fields of research in science and engineering. They are a fundamental component of fuzzy set theory, which revolutionized how we handle vague or imprecise data. Fuzzy matrices assign each element a value between 0 and 1, representing the degree of membership of an element in specific set. Fuzzy matrices are instrumental in handling imprecise data. They allow us to represent membership with varying degrees of certainty, making them valuable in fields like artificial intelligence, where uncertainty is prevalent. Fuzzy matrices find extensive applications in various domains, including control systems, decision-making, pattern recognition, and artificial intelligence, where they are employed to manage fuzzy logic and reasoning. The traditional matrix theory is unable to address problems involving numerous kinds of uncertainties. To overcome this situation, Zadeh [1] has





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studied fuzzy set. Many researchers have since completed numerous works. Only membership values are addressed by fuzzy matrices. These matrices cannot handle values that are not members. For such a case, Atanassov's [2] intuitionistic fuzzy set is adequate. In addition to capturing membership degrees, they also account for non-membership degrees and hesitancy, providing a more comprehensive framework for handling uncertainty. Each element in an intuitionistic fuzzy matrix has three values: μ (membership), ν (non-membership), and λ (hesitancy). Intuitionistic fuzzy matrices are particularly valuable when decision-makers need to express their doubts or conflicts in a more detailed manner. They excel in multi-criteria decision-making and expert systems. Intuitionistic fuzzy matrices find applications in multi-criteria decision-making, expert systems, and situations where decision-makers need to express their uncertainty in a more granular manner. The indeterminate information is not handled by intuitionistic fuzzy matrices. To overcome this situation, Smarandache [3] defined the neutrosophic set as a mathematical tool for dealing with situations involving imprecise, indeterminate, and inconsistent data. They offer a unique approach for dealing with elements that can be true, indeterminate, or false. Each element in a neutrosophic matrix can take one of three values: T, I, and F, representing the truth, neutrality, or falsity of an element's membership to a set. Neutrosophic matrices are indispensable in situations where information is incomplete or inconsistent. They provide a more versatile tool for decision-making in uncertain environments. Neutrosophic matrices are applied in areas such as decision-making in uncertain environments, information fusion in sensor networks, and situations where information is inconsistent or incomplete. Meenakshi [4] has discussed Fuzzy Matrix Theory and Applications. Anandhkumar et.al [5] have studied Secondary k-column symmetric Neutrosophic Fuzzy Matrices. Bhowmik and Pal [6] have discussed Generalized Intuitionistic Fuzzy Matrices. Meenakshi and Inbam [7] have characterized the minus Partial Order in Fuzzy Matrices. Anandhkumar et.al [13] have studied on Pseudo Similarity of Neutrosophic Fuzzy matrices. Anandhkumar et al.[9] have focused on Reverse Sharp and Left-T Right-T Partial Ordering on Neutrosophic Fuzzy Matrices. Shymal and Pal [10] have discussed Interval – valued fuzzy matrices. Thomson [11] has studied Convergence of powers of a fuzzy matrix. Anandhkumar, et al.[12] have focused On various Inverse of Neutrosophic Fuzzy Matrices. Anandhkumar, et al.[13] Pseudo Similarity of Neutrosophic Fuzzy matrices. Uma and Murugadas, et.al.[14] have studied Generalized Inverse of Fuzzy Neutrosophic Soft Matrices, Neutrosophic set \tilde{L} defined on universal \tilde{U} . $\tilde{G} = \tilde{G}(t, i, f) \in \tilde{L}$ with t –the truth membership, i the degree of indeterminacy and f the falsity membership are independent. we define some results regarding group inverse in Neutrosophic Fuzzy Matrices. The Generalized inverse of an Idempotent matrix holds marvelous algebraic characterizations in Neutrosophic Fuzzy Matrices. Also, we give some properties to preserve Idempotency in Neutrosophic Fuzzy Matrices. Finally, we give some results based on the Moore – Penrose inverse of Neutrosophic Fuzzy Matrices with numerical examples are given.

Notations and Preliminaries

NFM – Neutrosophic Fuzzy Matrices

NFR – Neutrosophic Fuzzy relation

P^+ – Moore-Penrose inverse of P

P^T – transpose of P,

$\tilde{L}^{(\#)}$, – Group inverse of L

Definition 2.1 [3] Let \tilde{L} be the NFM of order $o \times p$ is defined as $\tilde{L} = \{l^t_{i \times j}, l^i_{i \times j}, l^f_{i \times j}\}$, is characterized by $l^t_{i \times j}$ - truth, $l^i_{i \times j}$ indeterminacy and $l^f_{i \times j}$ falsity it can be defined as $0 \leq l^t_{i \times j} + l^i_{i \times j} + l^f_{i \times j} \leq 3$ for all $(o \times p)$.

Definition 2.2 [15] Let \tilde{L} and \tilde{M} be two NFM where $\tilde{L} = \{l^t_{i \times j}, l^i_{i \times j}, l^f_{i \times j}\}$, $\tilde{M} = \tilde{L} = \{m^t_{i \times j}, m^i_{i \times j}, m^f_{i \times j}\}$. Then





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$$\begin{aligned} \check{L} \oplus \check{M} &= (\max\{l^t_{ixj}, m^t_{ixj}\}, \max\{l^i_{ixj}, m^i_{ixj}\}, \min\{l^f_{ixj}, m^f_{ixj}\}) \\ \check{L} \otimes \check{M} &= (\min\{l^t_{ixj}, m^t_{ixj}\}, \min\{l^i_{ixj}, m^i_{ixj}\}, \max\{l^f_{ixj}, m^f_{ixj}\}) \end{aligned}$$

Definition 2.3 [15] Let \check{L} and \check{M} be two NFM. Then the composition of \check{L} and \check{M} is defined as $\check{L} \odot \check{M} = ((\sum_{p=1}^n (l^t_{ixj})^p \wedge (m^t_{ixj})^p), (\sum_{p=1}^n (l^i_{ixj})^p \wedge (m^i_{ixj})^p), (\prod_{p=1}^n (l^f_{ixj})^p \vee (m^f_{ixj})^p))$

Definition 2.4 [15] Let \check{L} and \check{M} be two NFM product $\check{L}\check{M}$ is well-defined by

$$\check{L}\check{M} = [\max(\min\{l^t_{ixj}, m^t_{ixj}\}), \max(\min\{l^i_{ixj}, m^i_{ixj}\}), \min(\max\{l^f_{ixj}, m^f_{ixj}\})]$$

The NFM product $\check{L}\check{M}$ is defined iff is equal to the number of columns \check{L} is the number of rows in \check{M} . Then \check{L} and \check{M} are comfortable for multiplication.

Definition 2.5 [11] Let \check{L} be the NFM of order $o \times p$. If all the entries are (0,0,1), then \check{L} is called for Zero NFM and it's denoted by 0. If all the entries are (1,1,0), then \check{L} is called for Unit NFM and it's denoted by Ψ . $\omega^t_{o \times p} = 1, \omega^i_{o \times p} = 1, \omega^f_{o \times p} = 0$, if $O = P$ and $\omega^t_{o \times p} = 0, \omega^i_{o \times p} = 0, \omega^f_{o \times p} = 1$, if $O \neq P$.

Remarks 1: Let $P, Q \in F_{s \times t}$ the given are equal significance",

- i) $P \leq^- Q$
- ii) $P = PP^-Q = QPQ^-$

Properties of minus ordering

This section covers our discussion of Necessary and Sufficient conditions for {1,2,3,4}-inverses, Neutrosophic Fuzzy relation equations, and the Left (Right) cancellable properties in Neutrosophic Fuzzy Matrices (NFM).

Definition3.1[6] For an $P \in N_{s \times t}$, P is called left (right) cancelable if $P^T P Y_1 = P^T P Y_2 (Y_1 P P^T = Y_2 P P^T) \Rightarrow P Y_1 = P Y_2 (Y_1 P = Y_2 P)$ for any $Y_1, Y_2 \in N_{s \times t}$.

P is termed cancelable when it exhibits both left and right cancelable properties.

Theorem3.1 For any NFM Q with dimensions $s \times t$ the below statements are of equal significance.

- i) $Q \{1, 3\} \neq \emptyset$.
- ii) Solutions exist for the NFR equation $YQ^T Q = Q$
- iii) Q is left cancelable and $Q^T Q \{1\} \neq \emptyset$.

Proof

(i) implies (ii)

For $R \in Q\{1,3\}$, then

$$Q = QRQ = (QR)^T Q = R^T Q^T Q$$

Therefore, R^T , is a solution of $Q = YQ^T Q$

(ii) implies (iii)

Assume that, R be a solution of $YQ^T Q = Q$

Then, $RQ^T Q = Q$

For $Y_1, Y_2 \in F_{s \times t}$

If $Q^T Q Y_1 = Q^T Q Y_2$, then

$$Q Y_1 = RQ^T Q Y_1 = RQ^T Q Y_2 = Q Y_2$$

Here, Q is left cancelable and

$$Q^T Q = (RQ^T Q)^T RQ^T Q = Q^T Q R^T RQ^T Q$$

$$\Rightarrow R^T R \in Q^T Q \{1\}$$

$$Q^T Q \{1\} \neq \emptyset$$

(iii) \Rightarrow (ii) Let $Y_1 \in Q^T Q \{1\}$

$$\Rightarrow Q^T Q Y_1 Q^T Q = Q^T Q$$





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$$\Rightarrow QY_1Q^TQ = Q$$

(Since by definition 2.3)

$$QY_1 \text{ is a solution of } YQ^TQ = Q$$

(ii) implies (i)

$$\text{Assume that, } R^T \text{ be a solution of } RQ^TQ = Q$$

$$\Rightarrow R^TQ^TQ = Q$$

$$Q = R^TQ^TQ = (QR)^TQ = QRQ$$

$$(QR)^T = (R^TQ^TQR)^T = R^TQ^TQR = QR$$

Thus, $(QR)^T = QR$ and $Q = QRQ$

$$\Rightarrow R \in Q\{1,3\} \text{ and } Q\{1,3\} \neq \emptyset.$$

Example 3.1 Let us consider NFM

$$\text{Let } Q = \begin{bmatrix} (1,0,0) & (0,0,0) \\ (0,0,0) & (0,0,0) \end{bmatrix} \text{ then, } T = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (1,0,0) & (0,0,0) \end{bmatrix}$$

$$QT = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,0) & (0,0,0) \end{bmatrix}, QTQ = \begin{bmatrix} (1,0,0) & (0,0,0) \\ (0,0,0) & (0,0,0) \end{bmatrix}$$

Satisfies $QTQ = Q$, $(QT)^T = QT$ and $TQ^TQ = Q$.

Therefore, $Q\{1,3\} \neq \emptyset \Rightarrow$ there exists a solution $TQ^TQ = Q$.

Theorem 3.2 For any $Q \in F_{s \times t}$ the below statements are of equal significance.

- (i) $Q\{1,4\} \neq \emptyset$
- (ii) The NFR equation $QQ^TZ = Q$ has solutions.
- (iii) Q is right cancellable and $Q^TQ\{1\} \neq \emptyset$.

Proof This solution closely resembles the solution presented in Theorem 2.5, Therefore $Q\{1,3\} \neq \emptyset$ iff $Q^T\{1,4\} \neq \emptyset$.

Example 3.2 Let us consider NFM $Q = \begin{bmatrix} (1,0,0) & (0,1,1) \\ (0,1,1) & (1,0,0) \end{bmatrix}$

Therefore $Q = Y$ itself is a $\{1\}$ – inverse sufficient $QTQ = Q$, $(YQ)^T = YQ$.

Theorem 3.3 Let $Q, R \in F_{s \times t}$, $Q \leq^- R$. If R^\dagger exist, Q is cancelable and $Q \in R\{2\}$ show that Q^\dagger occurs and $Q^\dagger = (R^\dagger)^TQ(R^\dagger)^T$.

Proof Let $Q \leq^- R \Rightarrow Q^-Q = Q^-R$ and $QQ^- = RQ^-$

Similarly $Q = QQ^-R = RQ^-Q$.

$$= QQ^-(RR^\dagger R)Q^-Q = Q$$

This claim that $R^\dagger \in Q_{s \times t}$

Since, $y_1, y_2 \in F_{s \times t}$

$$Q^-Qy_1 = Q^-Qy_2$$

$$Qy_1 = QQ^-Ry_1 = QQ^-Qy_1 = QQ^-Qy_2 = Qy_2$$

Implies that, $Q^-Qy_1 = Q^-Qy_2 \Rightarrow Qy_1 = Qy_2$

$$\text{Let } y_1 = QQ^-, y_2 = R^\dagger R$$

We require $QQ^- = Q^-R$

Likewise, $Q = R^\dagger RQ$

$$\text{Consider, } QR^\dagger = RR^\dagger QR^\dagger = R(R^\dagger QR^\dagger) = RR^\dagger$$

$$= (RR^\dagger)^T$$

$$= (RR^\dagger QR^\dagger)^T$$

$$= ((RR^\dagger Q)R^\dagger)^T = (QR^\dagger)^T$$

Also we can show $R^\dagger Q = (R^\dagger Q)^T$

Then, $R^\dagger \in Q\{1,2,3\}$

Therefore by theorem 3.1, 3.2 we complete that Q^\dagger occur and $Q^\dagger = (R^\dagger)^TQ(R^\dagger)^T$





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Theorem 3.4 Let $Q, R \in F_{s \times t}$ and Q^\dagger exist, and then the given are equal.

- (i) $Q \leq^- R$
- (ii) $Q^\dagger Q = Q^\dagger R$ and $QQ^\dagger = RQ^\dagger$
- (iii) $QQ^\dagger R = Q = RQ^\dagger Q$

Proof : This proof is similar by Theorem 3.3 replacing Q^- by Q^\dagger .

Corollary 3.1 If $Q \leq^- R$ and Q^\dagger occurs, then $R \in Q^\dagger\{1\}$

Proof: Q^\dagger Occur $\Rightarrow Q^\dagger = Q^\dagger Q = Q^\dagger R Q^\dagger \Rightarrow R \in Q^\dagger\{1\}$

Theorem 3.5 Let $Q, R \in F_{s \times t}$. If Q^\dagger and R^\dagger both occur and $Q \in R\{2\}$ then the given are equal.

- (i) $Q \leq^- R$
- (ii) $Q^\dagger Q = R^\dagger Q$ and $QQ^\dagger = QR^\dagger$
- (iii) $R^\dagger Q Q^\dagger = Q^\dagger = Q^\dagger Q R^\dagger$
- (iv) $Q^T Q R^\dagger = Q^T = Q^T R Q^\dagger$

Proof: This Proof is related to the Proof of theorem 3.4.

Theorem 3.6 If $Q \in F_{s \times t}$ and Q^\dagger exist, then

- (i) $(QQ^T)^\dagger, (Q^T Q)^\dagger$ are also occur and $(QQ^T)^\dagger = (Q^\dagger)^T Q^\dagger, (Q^T Q)^\dagger = Q^\dagger (Q^\dagger)^T$.
- (ii) $(QQ^\dagger)^\dagger, (Q^\dagger Q)^\dagger$ are also occur and $(QQ^\dagger)^\dagger = QQ^\dagger, (Q^\dagger Q)^\dagger = Q^\dagger Q$.

Proof (i) $QQ^T = QQ^\dagger QQ^T = (Q^\dagger)^T Q^T Q Q^\dagger$
 $= (Q^\dagger)^T (QQ^\dagger Q) Q^T = (Q^\dagger)^T Q^\dagger Q Q^T Q Q^\dagger$
 $\Rightarrow (Q^\dagger)^T Q^\dagger$ is result of $QQ^T = Y Q Q^\dagger Q Q^T$

Then, $(Q^\dagger)^T Q^\dagger \in QQ^T\{1,3\}$

Subsequently, QQ^T is symmetric

$(Q^\dagger)^T Q^\dagger \in QQ^T\{1,4\}$

By theorem 3.3. and 3.4

$(QQ^T)^\dagger$ Occur and

$$\begin{aligned} (QQ^T)^\dagger &= ((Q^\dagger)^T Q^\dagger)^T Q Q^T ((Q^\dagger)^T Q^\dagger)^T \\ &= (Q^\dagger)^T Q^\dagger Q Q^T (Q^\dagger)^T Q^\dagger \\ &= (Q^\dagger)^T Q^\dagger Q (Q^\dagger Q)^T Q^\dagger \\ &= (Q^\dagger)^T Q^\dagger Q Q^\dagger Q Q^\dagger \\ &= (Q^\dagger)^T Q^\dagger Q Q^\dagger = (Q^\dagger)^T Q^\dagger \end{aligned}$$

Equally, $(Q^T Q)^\dagger$ occur and $(Q^T Q)^\dagger = Q^\dagger (Q^\dagger)^T$

(i) $QQ^\dagger = QQ^\dagger QQ^\dagger QQ^\dagger$

QQ^\dagger is solution of $QQ^\dagger = Y Q Q^\dagger Q Q^\dagger$ and $(QQ^\dagger QQ^\dagger)^T = QQ^\dagger QQ^\dagger$

Therefore $QQ^\dagger \in QQ^\dagger\{1,3\} \cap QQ^\dagger\{1,4\}$

Hence, $(QQ^T)^\dagger$ exist

And $(QQ^\dagger)^\dagger = (QQ^\dagger)^T Q Q^\dagger (QQ^\dagger)^T = QQ^\dagger$

Similarly $(Q^\dagger Q)^\dagger = Q^\dagger Q$.

Moore – Penrose inverse of NFM

We discussed about equivalence relation between Idempotent intuitionistic Fuzzy Matrices and Pseudo – Similar Matrices.





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Definition 4.1 A \tilde{L} and \tilde{M} be two NFM of order $o \times p$ is said to be Pseudo – Similar and its indicated by $\tilde{L} \approx \tilde{M}$ if there exist $\tilde{L} = \tilde{G}\tilde{M}\tilde{H}$, $\tilde{M} = \tilde{H}\tilde{L}\tilde{G}$ and $\tilde{G} = \tilde{G}\tilde{M}\tilde{G}$.

The NFM, $\tilde{L} = \begin{bmatrix} (0,4,0,0) & (0,4,0,0) \\ (0,1,1) & (0,1,1) \end{bmatrix}$ and $\tilde{M} = \begin{bmatrix} (0,4,0,0) & (0,1,1) \\ (0,4,0,0) & (0,1,1) \end{bmatrix}$

Then idempotent NFM $\tilde{G} = \begin{bmatrix} (1,0,0) & (0,0,1) \\ (0,0,1) & (0,0,1) \end{bmatrix}$.

Definition 4.2 A \tilde{L} and \tilde{M} be two NFM of order $o \times p$ is said to be Pseudo – Similar and its indicated by $\tilde{L} \approx \tilde{M}$,if there exist $\tilde{L} = \tilde{G}\tilde{M}\tilde{H}$ and $\tilde{Y} = \tilde{H}\tilde{M}\tilde{G}$.

Remark:4.1 The $\tilde{L} = \tilde{M}$,the above definition redacts to Pseudo – Similarity and Semi – Similarity in the NFM semi group. It is clear that $\tilde{L} \approx \tilde{M}$ which is implies $\tilde{L} \approx \tilde{M}$.

Proposition 4.1 Let \tilde{L} and \tilde{M} be two NFM of order $o \times p$. Then the given are equal

- (i) $\tilde{L} \approx \tilde{M}$
- (ii) If \tilde{L} and \tilde{M} be two NFM. Such that $\tilde{L} = \tilde{G}\tilde{M}\tilde{H}, \tilde{M} = \tilde{H}\tilde{L}\tilde{G}$ and $(\tilde{G}\tilde{H})^\kappa \in F_p$ is idempotent for some odd $\kappa \in F$.
- (iii) If \tilde{L} and \tilde{M} be two NFM. Such that $\tilde{L} = \tilde{G}\tilde{M}\tilde{H}, \tilde{M} = \tilde{H}\tilde{L}\tilde{G}$ and $(\tilde{H}\tilde{G})^\kappa \in F_o$ is idempotent for some odd $\kappa \in F$.

Proof (i) implies (ii)

$\tilde{G} = \tilde{G}\tilde{M}\tilde{G}$ implies $\tilde{G}\tilde{H} \in F_o$ and $\tilde{H}\tilde{G} \in F_p$ are both idempotent NFMs.

(ii) implies (i)

Let $\kappa = 2\ell + 1$ with $\ell \in N_F$.

Since $\tilde{L} = \tilde{G}\tilde{M}\tilde{H}$ and $\tilde{M} = \tilde{H}\tilde{L}\tilde{G}$,

We have this $\tilde{L} = \tilde{G}(\tilde{H}\tilde{L}\tilde{G})\tilde{H} = (\tilde{G}\tilde{H})\tilde{G}\tilde{M}\tilde{H}(\tilde{G}\tilde{H}) = (\tilde{G}\tilde{H})^2\tilde{L}(\tilde{G}\tilde{H})^2 = (\tilde{G}\tilde{H})^2\tilde{G}\tilde{M}\tilde{H}(\tilde{G}\tilde{H})^2$.

Then procedure we get, $\tilde{L} = (\tilde{G}\tilde{H})^\ell \tilde{G}\tilde{M}\tilde{H}(\tilde{G}\tilde{H})^\ell$.

Similarly $\tilde{M} = \tilde{H}(\tilde{G}\tilde{H})^\ell \tilde{L}(\tilde{G}\tilde{H})^\ell \tilde{H}$.

Set $\tilde{G}' = (\tilde{G}\tilde{H})^\ell \tilde{G}\tilde{M}\tilde{H}(\tilde{G}\tilde{H})^\ell$.

Then $\tilde{L} = \tilde{G}'\tilde{M}\tilde{H}', \tilde{M} = \tilde{H}'\tilde{L}\tilde{G}'$ and $\tilde{G}'\tilde{H}' = (\tilde{G}\tilde{H})^\ell \tilde{G}\tilde{H}(\tilde{G}\tilde{H})^\ell = (\tilde{G}\tilde{H})^{2\ell+1} = (\tilde{G}\tilde{H})^\ell$ idempotent .

Hence by $\tilde{L} \approx \tilde{M}$

(i) implies (iii)

$\tilde{L} = \tilde{G}''\tilde{M}\tilde{H}''$ and $\tilde{M} = \tilde{H}''\tilde{L}\tilde{G}''$

By using $\tilde{G}'\tilde{M}\tilde{H}'$ is idempotent.

We get,

$\tilde{G}''\tilde{H}''\tilde{G}'' = (\tilde{G}'\tilde{H}'\tilde{G}')(\tilde{H}'\tilde{G}\tilde{H}')(\tilde{G}'\tilde{H}'\tilde{G}') = \tilde{G}'\tilde{H}'\tilde{G}' = \tilde{G}''$.

Therefore by $\tilde{L} \approx \tilde{M}$.

(iii) implies (i)

Let $\kappa = 2\ell + 1$ with $\ell \in N_F$.

Since $\tilde{L} = \tilde{G}\tilde{M}\tilde{H}$ and $\tilde{M} = \tilde{H}\tilde{L}\tilde{G}$,

We get, $\tilde{L} = \tilde{G}(\tilde{H}\tilde{G})^\ell \tilde{M}(\tilde{H}\tilde{G})^\ell \tilde{G}$ and $\tilde{M} = (\tilde{H}\tilde{G})^\ell \tilde{G}\tilde{M}\tilde{H}(\tilde{H}\tilde{G})^\ell$.

Set $\tilde{G}' = \tilde{G}(\tilde{H}\tilde{G})^\ell$ and $\tilde{M}' = (\tilde{H}\tilde{G})^\ell \tilde{H}$.

Then,

Similarly $\tilde{M} = \tilde{H}(\tilde{G}\tilde{H})^\ell \tilde{L}(\tilde{G}\tilde{H})^\ell \tilde{H}$.

Set $\tilde{G}' = (\tilde{G}\tilde{H})^\ell \tilde{G}\tilde{M}\tilde{H}(\tilde{G}\tilde{H})^\ell$.

Then, $\tilde{L} = \tilde{G}'\tilde{M}\tilde{H}', \tilde{M} = \tilde{H}'\tilde{L}\tilde{G}'$ and $\tilde{H}'\tilde{G}' = (\tilde{H}\tilde{G})^\ell \tilde{H}\tilde{G}(\tilde{H}\tilde{G})^\ell = (\tilde{H}\tilde{G})^{2\ell+1} = (\tilde{H}\tilde{G})^\ell \in F_o$ is idempotent.

Therefore by $\tilde{L} \approx \tilde{M}$. Then (i) is holds.

Example 4.1 Consider the NFM

$\tilde{L} = \begin{bmatrix} (0,4,0,0) & (0,4,0,0) \\ (0,1,1) & (0,1,1) \end{bmatrix}$ and $\tilde{M} = \begin{bmatrix} (0,4,0,0) & (0,1,1) \\ (0,4,0,0) & (0,1,1) \end{bmatrix}$.





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Then, $\check{G} = \begin{bmatrix} (1,0,0) & (0,0,1) \\ (0,0,1) & (0,0,1) \end{bmatrix}$ and $\check{H} = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix}$

$$LQM = \begin{bmatrix} (1,0,0) & (0,0,1) \\ (0,0,1) & (0,0,1) \\ (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix} \begin{bmatrix} (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \end{bmatrix} = \begin{bmatrix} (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \end{bmatrix}$$

$\check{G}\check{M}\check{H} = \check{L}$ and

$$MPL = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \\ (1,0,0) & (0,0,1) \\ (0,0,1) & (0,0,1) \end{bmatrix} \begin{bmatrix} (0.4,0,0) & (0.4,0,0) \\ (0,1,1) & (0,1,1) \\ (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix} = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \\ (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix}$$

$\check{H}\check{L}\check{G} = \check{M}$ holds.

Thus \check{L} and \check{M} are Pseudo – Similar , hence $\check{L} \approx \check{M}$.

$$LM = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix} \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix} = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix}$$

$$\text{Now, } (LM)^2 = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix} \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix} = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix} = LM.$$

and

$$ML = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix} \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix} = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix}$$

$$\text{Thus, } (\check{H}\check{G})^2 = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix} \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix} = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,1) & (0,0,1) \end{bmatrix} = \check{H}\check{G}.$$

Proposition 4.2 Let $\check{L} \in NF_o$ and $\check{M} \in NF_p$ be two NFM. Such that $\check{L} \approx \check{M}$. If $\check{G}\check{H} \in NF_{o \times p}$ is idempotent NFMs, \check{L} is regular iff \check{M} is regular.

Proof: If $\check{L} \approx \check{M}$, there exists idempotent NFMs $\check{G} \in NF_{o \times p}$ and $\check{H} \in NF_{p \times o}$. Such that $\check{M} = \check{H}\check{L}\check{G}$ $\check{L} = \check{G}\check{M}\check{H}$, and $\check{G} = \check{G}\check{M}\check{G}$.

Now, we have \check{H} is idempotent, i.e) $\check{H}^2 = \check{H}$ and \check{L} is regular, then here occurs $\check{K} \in NF_o$

Such that, $\check{L}\check{K}\check{L} = \check{L}$.

Let us describe $\check{V} = \check{H}\check{G}$, obviously $\check{V} \in NF_p$

$$\begin{aligned} \text{Then, } \check{M}\check{V}\check{M} &= (\check{H}\check{L}\check{G})\check{H}\check{G}(\check{H}\check{M}\check{G}) \\ &= \check{H}\check{L}(\check{G}\check{M}\check{G})\check{H}\check{L}\check{G} \\ &= \check{H}\check{L}(\check{G}\check{M}\check{G})\check{H} \\ &= \check{H}(\check{M}\check{V}\check{M})(\check{G}\check{M}\check{L})\check{G} \\ &= \check{H}\check{L}\check{H}\check{L}\check{G} \\ &= \check{H}\check{L}\check{H}\check{L}\check{G} \\ &= \check{H}\check{L}\check{G} \end{aligned}$$

$$\check{M}\check{V}\check{M} = \check{M}.$$

Hence, \check{M} is regular.

We can prove the converse Part in similar way.

Example 4.2 Consider the NFM

$$\check{L} = \begin{bmatrix} (0.4,0,0) & (0.4,0,0) \\ (0,1,1) & (0,1,1) \end{bmatrix} \text{ and } \check{M} = \begin{bmatrix} (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \end{bmatrix}.$$

Then, $\check{G} = \begin{bmatrix} (1,0,0) & (0,0,1) \\ (0,0,1) & (0,0,1) \end{bmatrix}$ and $\check{H} = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix}$, \check{L} and \check{M} are Pseudo – Similar, $\check{L} \approx \check{M}$.





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Again,

$$(\check{L})^2 = \begin{bmatrix} (0.4,0,0) & (0.4,0,0) \\ (0,1,1) & (0,1,1) \end{bmatrix} \begin{bmatrix} (0.4,0,0) & (0.4,0,0) \\ (0,1,1) & (0,1,1) \end{bmatrix} = \begin{bmatrix} (0.4,0,0) & (0.4,0,0) \\ (0,1,1) & (0,1,1) \end{bmatrix} = \check{L}.$$

$$(\check{M})^2 = \begin{bmatrix} (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \end{bmatrix} \begin{bmatrix} (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \end{bmatrix} = \begin{bmatrix} (0.4,0,0) & (0,1,1) \\ (0.4,0,0) & (0,1,1) \end{bmatrix} = \check{M}.$$

Therefore \check{L} and \check{M} are Idempotent.

$$\check{V} = \check{H}\check{G} = \begin{bmatrix} (1,1,0) & (1,1,0) \\ (1,1,0) & (0,1,1) \end{bmatrix}$$

$$\check{M}\check{V}\check{M} = \check{M}.$$

Thus \check{L} and \check{M} both are Regular.

Group Inverse of Neutrosophic fuzzy matrices.

We discussed about equivalence relation between Idempotent intuitionistic Fuzzy Matrices and Group inverses.

Definition 5.1 For \check{L} be a NFM. The Group inverse of \check{L} , is indicated by $\check{L}^{(\#)}$, is a commuting semi – inverse of \check{L} , that is the following conditions are satisfying, $\check{L}\check{L}^{(\#)}, \check{L} = \check{L}, \check{L}^{(\#)}\check{L}\check{L}^{(\#)} = \check{L}^{(\#)}$ and $\check{L}\check{L}^{(\#)} = \check{L}^{(\#)}\check{L}$.

Proposition 5.1 Let \check{L} and \check{M} are two NFM. If $\check{L}\check{M} = \check{M}\check{L}$ idempotent, then $(\check{L}\check{M})^{(\#)}$ exists and $(\check{L}\check{M})^{(\#)} = \check{L}^{(\#)}\check{M}^{(\#)} = \check{M}^{(\#)}\check{L}^{(\#)}$.

Proof: Let \check{L} is idempotent, Thus $\check{L}^{(\#)} = \check{L}$.

$$(\check{L}\check{M}(\check{L}^{(\#)}\check{M}^{(\#)}\check{L}\check{M})\check{M})\check{M} = \check{L}^2\check{L}^{(\#)}\check{M}^2\check{M}^{(\#)}\check{L}\check{M} = \check{L}\check{M}.$$

$$(\check{L}\check{M}(\check{L}^{(\#)}\check{M}^{(\#)}\check{L}\check{M})\check{M})\check{M} = \check{L}^{(\#)}\check{L}^2(\check{M}^{(\#)}\check{M}^2\check{M}^{(\#)})\check{L}^{(\#)} = \check{L}^{(\#)}\check{M}^{(\#)}.$$

$$\text{Finally, } \check{L}^2\check{M}^2(\check{L}^{(\#)}\check{M}^{(\#)}) = \check{L}^{(\#)}\check{L}\check{M}^{(\#)}\check{M} = \check{L}^2\check{M}^2(\check{L}^{(\#)}\check{M}^{(\#)})\check{L}\check{M}.$$

Proposition 5.2 Let $\check{L} \in NF_o$, the given equations are equivalent,

- (i) $\check{L}^{(\#)}$ is grp – inv.
- (ii) $\mathcal{R}(\check{L}) = \mathcal{R}(\check{L}^2)$ and $\mathcal{C}(\check{L}) = \mathcal{C}(\check{L}^2)$, then \check{L}^2 is regular.
- (iii) $\check{L}^2\check{G} = \check{L}$ and $\check{H}\check{L}^2 = \check{L}$ it can be solved by $\check{G} = \check{H}$.

Proof (i) implies (ii)

If $\check{L}^{(\#)}$ exists, use the definition (4.1) we have,

$$\check{L} = \check{L}^2\check{L}^{(\#)} = \check{L}^{(\#)}\check{L}^2$$

$$\check{L} = \check{L}^{(\#)}\check{L}^2 \text{ which implies that, } \mathcal{R}(\check{L}) = \mathcal{R}(\check{L}^{(\#)}\check{L}^2) \subseteq \mathcal{R}(\check{L}^2)$$

which implies that $\mathcal{R}(\check{L}) \subseteq \mathcal{R}(\check{L}^2)$

Since, $\mathcal{R}(\check{L}^2) \subseteq \mathcal{R}(\check{L})$, it follows that $\mathcal{R}(\check{L}) = \mathcal{R}(\check{L}^2)$.

Similarly, $\check{L} = \check{L}^2\check{L}^{(\#)}$

implies that $\mathcal{C}(\check{L}) = \mathcal{C}(\check{L}^2\check{L}^{(\#)}) \subseteq \mathcal{C}(\check{L}^2)$

which implies that $\mathcal{C}(\check{L}) \subseteq \mathcal{C}(\check{L}^2)$

Since, \check{L} is regular with $\mathcal{R}(\check{L}) = \mathcal{R}(\check{L}^2)$,

\check{L}^2 is also regular.

(i) implies (ii)

If \check{L}^2 is regular which is implies $\check{L}^2\{1\} \neq \text{empty set}$.

$$\mathcal{R}(\check{L}) \subseteq \mathcal{R}(\check{L}^2) \text{ implies } \check{L} = \check{L}(\check{L}^2)^- \check{L}^2 \text{ for all } (\check{L}^2)^- \in \check{L}^2\{1\}$$

$$\text{Then, } \mathcal{C}(\check{L}) = \mathcal{C}(\check{L}^2) \text{ implies } \check{L} = \check{L}^2(\check{L}^2)^- \check{L} \text{ for all } (\check{L}^2)^- \in \check{L}^2\{1\}.$$

Therefore any $(\check{L}^2)^-$ the matrix $(\check{L}^2)^- \check{L}$ is a way out for the matrix equality $\check{L}^2\check{G} = \check{L}$ and the matrix $\check{L}(\check{L}^2)^-$ is a way out for the matrix equality $\check{H}\check{L}^2 = \check{L}$.

(iii) implies (i)





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Let us think about \check{E} and \check{F} be way out of the equality $\check{L}^2\check{G} = \check{L}$ and $\check{H}\check{L}^2 = \check{L}$ respectively. Then, $\check{Y} = \check{E}\check{L}\check{F}$, we remark that

$$\begin{aligned} \check{L}\check{E}\check{L} &= (\check{F}\check{L}^2)\check{E}\check{L} = \check{F}(\check{L}^2\check{E})\check{L} = \check{F}\check{L}^2 = \check{L} \\ \check{L}\check{F}\check{L} &= \check{L}\check{F}(\check{L}^2\check{E}) = \check{L}(\check{F}\check{L}^2)\check{L} = \check{L}^2\check{E} = \check{L} \end{aligned}$$

We get, $\check{L}\check{Y} = \check{L}(\check{F}\check{L}\check{E}) = (\check{L}\check{F}\check{L})\check{E} = \check{L}\check{E} = \check{F}\check{L}^2\check{E} = \check{F}\check{L} = \check{F}(\check{L}\check{E}\check{L}) = (\check{F}\check{L}\check{E})\check{L} = \check{Y}\check{L}$.

$$\check{Y}\check{L}\check{Y} = (\check{F}\check{L}\check{E})\check{L}(\check{F}\check{L}\check{E}) = \check{F}(\check{L}\check{E}\check{L})(\check{F}\check{L}\check{E}) = \check{F}(\check{L}\check{E}\check{L})\check{E} = \check{F}\check{L}\check{E} = \check{Y}.$$

$$\check{L}\check{Y}\check{L} = \check{L}(\check{F}\check{L}\check{E})\check{L} = \check{L}\check{E}\check{L} = \check{L}$$

Hence $\check{Y} = \check{L}^{(\#)}$ is the grp – inv of \check{L} .

Example 3 Let us consider NFM $\check{L} = \begin{bmatrix} (0.9,0.6,0.2) & (0.7,0.4,0.2) \\ (0.7,0.4,0.2) & (0.8,0.4,0.2) \end{bmatrix}$ such that $\check{L}^2 = \check{L}$.

Let $\check{E} = \begin{bmatrix} (0.9,0.6,0.1) & (0.7,0.3,0.1) \\ (0.7,0.4,0.1) & (0.8,0.3,0.1) \end{bmatrix}$ be a out way of the relation $\check{L}\check{G} = \check{L}$.

and $\check{F} = \begin{bmatrix} (1,0.6,0.1) & (0.6,0.4,0.2) \\ (0.7,0.4,0.2) & (0.8,0.2,0.1) \end{bmatrix}$ be a out way of the relation $\check{H}\check{L} = \check{L}$.

Then

$$\check{Y} = \check{F}\check{L}\check{E} = \begin{bmatrix} (1,0.6,0.1) & (0.6,0.4,0.2) \\ (0.7,0.4,0.2) & (0.8,0.2,0.1) \end{bmatrix} \begin{bmatrix} (0.9,0.6,0.2) & (0.7,0.4,0.2) \\ (0.7,0.4,0.2) & (0.8,0.4,0.2) \end{bmatrix} \begin{bmatrix} (1,0.6,0.1) & (0.6,0.4,0.2) \\ (0.7,0.4,0.2) & (0.8,0.2,0.1) \end{bmatrix} \check{Y} = \check{L}$$

Again, $\check{L}\check{Y} = \check{Y}\check{L}$, $\check{L}\check{Y}\check{L} = \check{L}$ and $\check{Y}\check{L}\check{Y} = \check{Y}$ all holds. Thus \check{L} itself a grp – inv .

CONCLUSION

We define some results regarding the group inverse in Neutrosophic Fuzzy Matrices. The generalized inverse of an idempotent matrix holds marvelous algebraic characterizations in Neutrosophic Fuzzy Matrices. Additionally, we provide some properties to preserve idempotency in Neutrosophic Fuzzy Matrices. Finally, we present some results based on the Moore-Penrose inverse of Neutrosophic Fuzzy Matrices, along with numerical examples.

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Properties of the Adjacency Matrix of the Complement of Generalized Total Graph of Finite Field

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 27 Jun 2024

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ABSTRACT

Let R to be a commutative ring with identity and H to be a nonempty proper multiplicative prime subset of R . The generalized total graph of R is the graph (simple graph) $GT_H(R)$ with vertex set R , and x and y are two different vertices are said to be adjacent if and only if $x + y \in H$. The complement of the generalized total graph of R is the graph (simple graph) $\overline{GT_H(R)}$ with vertex set R , and x and y are two different vertices are said to be adjacent if and only if $x + y \notin H$. we consider R as the finite field F and the multiplicative prime subset $H = \{0\}$, designate the graph as the generalized total of finite field F , and denote $GT(F)$. In this article, We study the properties of the adjacency matrix of the complement of the generalized total graph $\overline{GT(F)}$, such as the Eigen values, rank, index, characteristic polynomial, minimal polynomial, Quadratic form, Spectrum and energy of the adjacency matrix of $\overline{GT(F)}$.

Keywords: Adjacency matrix, eigenvalues, Spectrum, Generalized total graph, Complement of Generalized total graph.

MSC 2010 Classifications: Primary 05C25, 05C75,; Secondary: 13A15, 13M05





INTRODUCTION

Consider R to be a commutative ring with identity, and $Z(R)$ is its zero-divisor sets of the Ring. In 2013, Anderson and Badawi[3] introduced the generalized total graph of a commutative ring R . Let H of R be a nonempty proper subset of R ; this R is said to be a multiplicative prime subset of R if it satisfies the following two conditions: (i) $ab \in H$ for all $a \in H$ and $b \in R$; (ii) if $ab \in H$ for $a, b \in R$, then either $a \in H$ or $b \in H$. For a multiplicative prime subset H of R , the *generalized total graph* $GT_H(R)$ is the simple undirected graph with vertex set R and x, y are two different vertices are adjacent if and only if $x + y \in H$. The entire literature regarding graphs from rings can be found in the monograph [2]. If there exists a path between any two different vertices of G , it is called a connected graph. For any vertex $v_i \in V(G)$, $\deg(v_i)$ denotes the degree of v_i . For any graph G , maximum degree of vertices is denoted as $\delta(G)$ and minimum degree of vertices is denoted as $\Delta(G)$. In this article, F denotes a finite field. $|F|$ is its cardinality, and $\{0\}$ and field itself is the only prime ideal in this field. When R is the field F and $H = \{0\}$, the generalized total graph of the field F is denoted as $GT(F)$. This paper investigates several properties of the adjacency matrix of the complement of generalized total graph $\overline{GT(F)}$. In particular, we study the characteristic equation and eigenvalues of the adjacency matrix of $GT(F)$. Next, we provide some properties of the adjacency matrix for $\overline{GT(F)}$. More specifically, we determine the Spectrum, rank, index, nature, quadratic form and energy of the adjacency matrix of $\overline{GT(F)}$. Let $G = (V, E)$ be the simple graph. The complement \bar{G} be a graph with the same vertex set V of the graph G is the simple graph with vertex set $V(G)$ and two different vertices x and y are adjacent in \bar{G} if and only if they are not adjacent in G .

ADJACENCY MATRIX OF $\overline{GT(F)}$

Recall that the adjacency matrix of a graph G is the $n \times n$ matrix $A(G)$, over complex field, whose entries are given by

$$a_{ij} = \begin{cases} 1 & \text{if } v_i \text{ and } v_j \text{ are adjacent} \\ 0 & \text{otherwise} \end{cases}$$

Lemma 2.1. Let $\overline{GT(F)}$ be the complement of the generalized total graph of F and $A'(F)$ be its adjacency matrix. Then the $(i, j)^{th}$ element of (F) is a_{ij} which is defined as $a_{ij} = \begin{cases} 0 & \text{if } v_i + v_j = 0 \\ 1 & \text{otherwise} \end{cases}$.

For simplicity, let us consider a matrix $J_n = \begin{pmatrix} 1 & 1 & 1 & \dots & 1 \\ 1 & 1 & 1 & \dots & 1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & 1 & \dots & 1 \\ 1 & 1 & 1 & \dots & 1 \end{pmatrix}_{n \times n}$, $I_n = \begin{pmatrix} 1 & 0 & 0 & \dots & 0 \\ 0 & 1 & 0 & \dots & 0 \\ 0 & 0 & 1 & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \dots & 1 \end{pmatrix}_{n \times n}$ is an identity matrix. Hence

$J_n - I_n = \begin{pmatrix} 0 & 1 & 1 & \dots & 1 \\ 1 & 0 & 1 & \dots & 1 \\ 1 & 1 & 0 & \dots & 1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & 1 & \dots & 0 \\ 1 & 1 & 1 & \dots & 1 \end{pmatrix}$. we can easily observe that $J_n - I_n = A(K_n)$ = adjacency matrix of a complete graph of order n .

We have some observations on these matrices

	J_n	I_n	$J_n - I_n = K_n$
characteristic polynomial	$\lambda^{n-1}(\lambda - n)$	$(\lambda - 1)^n$	$(\lambda + 1)^{n-1}(\lambda - (n - 1))$.
Minimal polynomials	$\lambda(\lambda - n)$	$\lambda - 1$	$(\lambda - (n - 1))(\lambda + 1)$.
Distinct Eigen Values	$0, n$	1	$n-1, -1$.
Spectrum	$\begin{pmatrix} n & 0 \\ 1 & n-1 \end{pmatrix}$	$\begin{pmatrix} 1 \\ n \end{pmatrix}$	$\begin{pmatrix} n-1 & -1 \\ 1 & n-1 \end{pmatrix}$.

PROPERTIES

Lemma 3.1. Let $A'(F)$ be the Adjacency matrix of $\overline{GT(F)}$, we can observe





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- (i) If Characteristic (F) = 2, then (F) is a $J - I$ matrix of order $|F| \times |F|$ with all diagonal entries are zero others one.
- (ii) If Characteristic (F) > 2, then each (i,j)th entry of (F) is defined by

$$a_{ij} = \begin{cases} 0 & \text{if either } j = i + 1, i \in \{2, 4 \dots |F| - 1\} \text{ or} \\ & j = i - 1, i \in \{3, 5 \dots |F|\} \\ 1 & \text{otherwise} \end{cases}$$

Proof.

(i) If Characteristic (F) = 2, then $y + y = 2y = 0$ for all elements $y \in F$. Therefore, each element of F is self-inverse. Hence, all the vertices of $GT(F)$ are isolated, so all the vertices adjacent in $\overline{GT(F)}$ so the entries of $A'(F)$ all are 1 except its diagonal (self - loop position).

(ii) When Characteristic (F) > 2, List all the member of F as $\{0, x_1, -x_1, x_2, -x_2, \dots, x_k, -x_k, \dots, x_{\frac{|F|-1}{2}}, -x_{\frac{|F|-1}{2}}\}$ each $-x_k$ is the inverse of x_k for $1 \leq k \leq \frac{|F|-1}{2}$, which implies

$GT(F) = \langle 0 \rangle \cup \bigcup_{k=1}^{\frac{|F|-1}{2}} \langle x_k, -x_k \rangle$. To find the adjacency matrix of $GT(F)$, relabel the elements F as $\{v_1, v_2, \dots, v_{|F|}\}$ in such a way that $v_1 = 0, v_2 = x_1, v_3 = -x_1, \dots, v_{|F|-1} = x_{\frac{|F|-1}{2}}, v_{|F|} = -x_{\frac{|F|-1}{2}}$. Consider that the relabeled elements of F head each row and column of $A(F)$. For $1 \leq i \leq |F|$ & $1 \leq j \leq |F|$, the (i, j) th entries of $A(F)$ is defined from $GT(F)$ as follows

$$a_{ij} = \begin{cases} 1 & \text{if } v_i + v_j = 0 \in F \\ 0 & \text{otherwise} \end{cases}$$

This implies that $a_{ij} = \begin{cases} 1 & \text{if } v_i + v_{i+1} = 0 \in F \text{ and } i \in \{2, 4, 6 \dots |F| - 1\} \\ 1 & \text{if } v_i + v_{i-1} = 0 \in F \text{ and } i \in \{3, 5, 7 \dots |F|\} \\ 0 & \text{otherwise} \end{cases}$

From this, we observe that

$$a_{ij} = \begin{cases} 1 & \text{if either } j = i + 1, i \in \{2, 4 \dots |F| - 1\} \text{ or } j = i - 1, i \in \{3, 5 \dots |F|\} \\ 0 & \text{otherwise} \end{cases}$$

So $a'_{ij} = \begin{cases} 0 & \text{if either } j = i + 1, i \in \{2, 4 \dots |F| - 1\} \text{ or } j = i - 1, i \in \{3, 5 \dots |F|\} \\ 1 & \text{otherwise} \end{cases}$

Corollary 3.2.

Let $A(F)$ be the Adjacency matrix of $GT(F)$, we can observe that

(i) Minimum degree = minimum row sum of (F) = $\delta((F)) = \begin{cases} |F| - 1, & \text{if characteristic (F) = 2} \\ |F| - 2, & \text{if characteristic (F) > 2} \end{cases}$

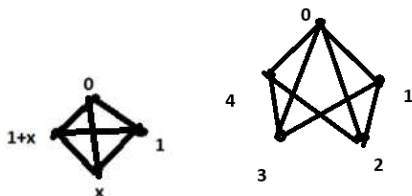
Maximum degree = maximum row sum of (F) = $\Delta((F)) = |F| - 1$

(ii) There is no isolated vertex.

Example 3.3.

Consider the field $F_4 = \frac{\mathbb{Z}_2[x]}{\langle x^2+x+1 \rangle} = \{0, 1, x, 1+x\}$; then the corresponding generalized total graph and its adjacency matrix are given by

$$A'(F_4) = \begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix}$$





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Suppose $F = Z_5$, then $\overline{GT_H(Z_5)}$ are given by $A'(Z_5) = \begin{pmatrix} 0 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 \end{pmatrix}$

Theorem 3.4. Let $A'(F)$ be the adjacency matrix of the $\overline{GT(F)}$, then the following properties hold

(i) $A'(F)$ is always a real symmetric matrix. (ii) $\text{Trace}(A'(F))$ is 0.

(iii) $\text{Determinant}(A'(F)) = \begin{cases} 1 - |F|, & \text{if characteristic}(F) = 2 \\ 0, & \text{if characteristic}(F) > 2 \end{cases}$

Proof.

(i) It is obvious

(ii) It is a simple undirected graph, so self-loops are not allowed and so a'_{ii} for all $1 \leq i \leq |F|$ in (F) . Hence all the diagonal elements are 0. Therefore $\text{Trace}(A'(F)) = 0$.

(iii) 2nd and 3rd rows are same. So determinant becomes 0. Similarly we can prove using i^{th} and $(i+1)^{\text{th}}$ rows where $1 < i < |F|$.

Theorem 3.5. Let $A'(F)$ be the Adjacency matrix of $\overline{GT(F)}$, then

(i) If $\text{Characteristic}(F) = 2$, then $A'(F)$ can be considered as a block matrix $\begin{pmatrix} J-I & J \\ J & J-I \end{pmatrix}$ where all its blocks having order $\frac{|F|}{2} \times \frac{|F|}{2}$ or we can say $A'(F) = J_{|F|} - I_{|F|}$.

(ii) If $\text{Characteristic}(F) > 2$, then $A'(F) = J_{|F|} - I_{|F|} - A(F)$, Where $A(F)$ be the adjacency matrix of $GT(F)$.

Proof: When $\text{characteristic}(F) = 2$, By lemma 2.2(i) we have $A'(F) = \begin{pmatrix} 0 & 1 & 1 \dots 1 & | & 1 & 1 & 1 \dots 1 \\ 1 & 0 & 1 \dots 1 & | & 1 & 1 & 1 \dots 1 \\ & & & \dots & & & \\ 1 & 1 & 1 \dots 0 & | & 1 & 1 & 1 \dots 1 \\ \hline 1 & 1 & 1 \dots 1 & | & 0 & 1 & 1 \dots 1 \\ 1 & 1 & 1 \dots 1 & | & 1 & 0 & 1 \dots 1 \\ 1 & 1 & 1 \dots 1 & | & 1 & 1 & 0 \dots 1 \\ & & & \dots & & & \\ 1 & 1 & 1 \dots 1 & | & 1 & 1 & 1 \dots 0 \end{pmatrix} = \begin{pmatrix} J-I & J \\ J & J-I \end{pmatrix}$.

where all its blocks

having order $\frac{|F|}{2} \times \frac{|F|}{2}$ or we can say $A'(F) = J_{|F|} - I_{|F|}$.

When $\text{characteristic}(F) > 2$, By lemma 2.2(ii) we have

$$A'(F) = \begin{pmatrix} 0 & 1 & 1 \dots 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 \dots 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 \dots 1 & 1 & 1 & 1 & 1 \\ & & & \dots & & & \\ 1 & 1 & 1 \dots 1 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 \dots 1 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 \dots 1 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 \dots 1 & 1 & 1 & 1 & 0 \end{pmatrix} = J_{|F|} - I_{|F|} - A(F).$$

Lemma 3.6. Let $A'(F)$ be the Adjacency matrix of $\overline{GT(F)}$. Let $f(\lambda)$ be the characteristic polynomial and $p(\lambda)$ be the minimal polynomial of $A(F)$, then

(i) The Characteristic equation of

$$A'(F) \text{ is } f(\lambda) = \begin{cases} (\lambda - (|F| - 1))(\lambda + 1)^{|F|-1} = 0, & \text{if Characteristic}(F) = 2 \\ \lambda^{\frac{|F|-1}{2}}(\lambda + 2)^{\frac{|F|-3}{2}}(\lambda^2 - (|F| - 3)\lambda - (|F| - 1)) = 0, & \text{if Characteristic}(F) > 2 \end{cases}$$





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(ii) The minimal polynomial of $A'(F)$ is $p(\lambda) = \begin{cases} (\lambda + 1)(\lambda - (|F| - 1)), & \text{if Characteristic (F) = 2} \\ \lambda(\lambda + 2)(\lambda^2 - (|F| - 3)\lambda - (|F| - 1)), & \text{if Characteristic (F) > 2} \end{cases}$

We recall that the root of the characteristic equation $|\lambda I - A| = 0$ is called the Eigenvalue of A. From this definition, one can easily determine all the Eigenvalues of $A'(F)$.

Theorem 3.7. Let λ_i be the Eigenvalues of $A'(F)$, then the distinct Eigen Values of $A'(F)$

- (i) whenever Characteristic (F) = 2, then $\lambda = -1, (|F| - 1)$
- (ii) Whenever Characteristic (F) > 2, then $\lambda = 0, -2, \frac{|F|-3 \pm \sqrt{(|F|-1)^2+4}}{2}$.

Proof. By solving the characteristic polynomials in previous theorem we can get this results.

Next, We recall that the definition of the Spectrum of a graph G is the set of Eigenvalues of Adjacency matrix, together with the multiplicities of the Eigenvalues of the adjacency matrix. If the distinct Eigenvalues of $A(G)$ are $\lambda_0 > \lambda_1 > \dots > \lambda_k$, and its corresponding multiplicities are $m(\lambda_0), m(\lambda_1), \dots, m(\lambda_k)$, then the Spectrum of the graph G by

Spectrum (G) = $\left(\begin{matrix} \lambda_0 \lambda_1 & \dots & \lambda_k \\ m(\lambda_0) & m(\lambda_1) & \dots & m(\lambda_k) \end{matrix} \right)$. With the help of this definition, we can derive the spectrum $\overline{GT(F)}$ as follows.

Theorem 3.8. If $A'(F)$ be its adjacency matrix of $\overline{GT(F)}$, then

$$\text{Spectrum}(\overline{GT(F)}) = \begin{cases} \left(\begin{matrix} (|F|-1) & -1 \\ 1 & |F|-1 \end{matrix} \right), & \text{if characteristic (F) = 2} \\ \left(\begin{matrix} (|F|-3 + \sqrt{(|F|-1)^2+4}) & 0 & (|F|-3 - \sqrt{(|F|-1)^2+4}) & -2 \\ \frac{2}{2} & |F|-1 & \frac{2}{2} & |F|-3 \end{matrix} \right), & \text{if characteristic (F) > 2} \end{cases}$$

Proof. The proof is trivial from the definition of Spectrum and solving the characteristics equation of $A'(F)$.

Note that The characteristic polynomial of $A(F)$ is defined as $|\lambda I - A(F)|$ and the characteristic equation of $A(F)$ to be $|\lambda I - A(F)| = 0$. Which yields the following

Recall the Binomial Expansion $(a + b)^n = \binom{n}{0}a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{n}b^n$.

Theorem 3.9. Let $f(\lambda)$ be the characteristic polynomial of $A'(F)$. If Characteristic (F) > 2, then we have the following observation in $f(\lambda)$.

The coefficient of $\lambda^{|F|}$ and $\lambda^{|F|-1}$ are 1 and 0 respectively for all cases and , and

The remaining coefficients of $\lambda^{|F|-k}$ equals to

$$\begin{cases} \left(\binom{|F|-1}{k} - (|F| - 1) \binom{|F|-1}{k-1} \right) \text{ for } k = 2, 3, \dots, |F| - 1 \text{ and } -(|F| - 1) \text{ for } k = |F|, & \text{if characteristic (F) = 2} \\ \left(\binom{|F|-3}{k} \right) 2^k - (|F| - 3) \binom{|F|-3}{k-1} 2^{k-1} - (|F| - 1) \binom{|F|-3}{k-2} 2^{k-2} \text{ for } k = 2, 3, \dots, \frac{|F|-3}{2}, & \text{if Characteristic > 2} \end{cases}$$

Proof. When characteristic (F) = 2, By the Binomial expansion, we have

$$\begin{aligned} (\lambda - (|F| - 1))(\lambda + 1)^{|F|-1} &= (\lambda - (|F| - 1)) \left(\binom{|F|-1}{0}(\lambda)^{|F|-1} + \binom{|F|-1}{1}(\lambda)^{|F|-2} + \binom{|F|-1}{2}(\lambda)^{|F|-3} + \dots + \binom{|F|-1}{|F|-1} \right) \\ &= \binom{|F|-1}{0}(\lambda)^{|F|} + \left\{ \binom{|F|-1}{1} - (|F| - 1) \binom{|F|-1}{0} \right\} (\lambda)^{|F|-1} + \left\{ \binom{|F|-1}{2} - (|F| - 1) \binom{|F|-1}{1} \right\} (\lambda)^{|F|-2} + \dots + \left\{ \binom{|F|-1}{|F|-1} - (|F| - 1) \binom{|F|-1}{|F|-2} \right\} \lambda - (|F| - 1) \end{aligned}$$

Clearly the coefficient of $\lambda^{|F|}$ and $\lambda^{|F|-1}$ are 1 & 0 respectively, From the above, coefficients of $\lambda^0 = \text{constant}$ equals $-(|F| - 1)$

The remaining coefficients of $\lambda^{|F|-k}$ equals to $\binom{|F|-1}{k} - (|F| - 1) \binom{|F|-1}{k-1}$.

When characteristic (F) > 2, By the Binomial expansion, we have

$$(\lambda + 2)^{\frac{|F|-3}{2}} = \binom{|F|-3}{0} (\lambda)^{\frac{|F|-3}{2}} (2)^0 + \binom{|F|-3}{1} (\lambda)^{\frac{|F|-5}{2}} (2) + \binom{|F|-3}{2} (\lambda)^{\frac{|F|-7}{2}} (2)^2 + \dots + \binom{|F|-3}{\frac{|F|-5}{2}} \lambda^1 (2)^{\frac{|F|-5}{2}} + \binom{|F|-3}{\frac{|F|-3}{2}} (2)^{\frac{|F|-3}{2}}$$





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Now, $(\lambda^{\frac{|F|+3}{2}} - (|F| - 3)(\lambda)^{\frac{|F|+1}{2}} - (|F| - 1)(\lambda)^{\frac{|F|-1}{2}})(\lambda + 2)^{\frac{|F|-3}{2}} =$
 $\binom{|F|-3}{\frac{2}{0}}(\lambda)^{|F|} + (\lambda)^{|F|-1} \left\{ \binom{|F|-3}{\frac{2}{1}} 2 - (|F| - 3) \binom{|F|-3}{\frac{2}{0}} \right\} + (\lambda)^{|F|-2} \left\{ \binom{|F|-3}{\frac{2}{2}} 2^2 - (|F| - 3) \binom{|F|-3}{\frac{2}{1}} (2) - (|F| - 1) \binom{|F|-3}{\frac{2}{0}} \right\}$
 $+ \dots + (\lambda)^{|F|-k} \left\{ \binom{|F|-3}{\frac{2}{k}} 2^k - (|F| - 3) \binom{|F|-3}{\frac{2}{k-1}} (2)^{k-1} - (|F| - 1) \binom{|F|-3}{\frac{2}{k-2}} 2^{k-2} \right\} + \dots$
 $+ - (|F| - 1)(\lambda)^{\frac{|F|-1}{2}} 2^{\frac{|F|-3}{2}}$

The coefficient of $\lambda^{|F|}$ and $\lambda^{|F|-1}$ are $\binom{|F|-1}{0} = 1$ and 0 respectively. The remaining coefficients of λ^{n-k} equals to $\binom{|F|-3}{\frac{2}{k}} 2^k - (|F| - 3) \binom{|F|-3}{\frac{2}{k-1}} 2^{k-1} - (|F| - 1) \binom{|F|-3}{\frac{2}{k-2}} 2^{k-2}$. Where $k = 2, 3, \dots, \frac{|F|-3}{2}$.

Proposition 3.10. ([8], proposition 2.3) Let a simple graph $\Gamma = (V, E)$, $A(\Gamma)$ be its adjacency matrix. Let us suppose that $\chi(\Gamma, \lambda) = \lambda^n + c_1\lambda^{n-1} + c_2\lambda^{n-2} + \dots + c_n$, where the coefficients c_i denote the sums of principal minors of A . Then (i) $c_1 = 0$ (ii) $-c_2$ is equals to $|E|$ (iii) $-c_3 = 2 \times$ (number of triangles in the graph).

This proposition gives the following lemma.

Theorem 3.11. Consider $f(\lambda) = \lambda^{|F|} + c_1\lambda^{|F|-1} + c_2\lambda^{|F|-2} + \dots + c_n$ is the characteristic polynomial for $A'(F)$. Then,

- (i) $c_1 = 0$ (ii) the number of edges of $\overline{GT(F)}$ is $-c_2 = \begin{cases} \binom{|F| \times (|F|-1)}{2} & \text{if characteristic } (F) = 2 \\ \frac{(|F|-1)^2}{2} & \text{if characteristic } (F) > 2 \end{cases}$
- (iii) twice the number of triangles in the graph $\overline{GT(F)}$ is $-c_3 = \begin{cases} \frac{(|F| \times (|F|-1) \times (|F|-2))}{3} & \text{if characteristic } (F) = 2 \\ \frac{(|F|-1) \times (|F|-2) \times (|F|-3)}{3} & \text{if characteristic } (F) > 2 \end{cases}$

Proof. (i) Consider Characteristic $(F) = 2$, then by Lemma 3.9(i), coefficient of $\lambda^{n-1} = 0$

Therefore $c_1 = 0$. Also the coefficient of $\lambda^{|F|-2}$ is $c_2 = \binom{|F|-1}{2} - \binom{|F|-1}{1} \times (|F| - 1) = -\frac{|F| \times (|F|-1)}{2}$. The coefficient of $\lambda^{|F|-3}$ is $c_3 = \binom{|F|-1}{3} - \binom{|F|-1}{2} \times (|F| - 1) = -\frac{|F| \times (|F|-1) \times (|F|-2)}{3}$

Suppose Characteristic $(F) > 2$, then by Lemma 3.9(ii)

Also the coefficient of $\lambda^{|F|-2}$ is $c_2 = \binom{|F|-3}{2} 2^2 - (|F| - 3) \times \binom{|F|-3}{1} (2) - (|F| - 1) \times \binom{|F|-3}{0} = -\frac{(|F|-1)^2}{2}$. The coefficient of $\lambda^{|F|-3}$ is $c_3 = \binom{|F|-3}{3} 2^3 - (|F| - 3) \times \binom{|F|-3}{2} (2)^2 - (|F| - 1) \times \binom{|F|-3}{1} 2 = -\frac{(|F|-1) \times (|F|-2) \times (|F|-3)}{3}$.

Note that the rank of a matrix is the number of non-zero Eigenvalues. The rank of A is denoted by r . The index of a matrix is the number of positive Eigenvalues of the matrix A , and it is denoted by p .

Theorem 3.12. Let $A'(F)$ be its adjacency matrix of the $\overline{GT(F)}$, then

- (i) The rank of $A'(F)$ is given by $r = \begin{cases} |F| & \text{if characteristic } (F) = 2 \\ \frac{|F|-1}{2} & \text{if characteristic } (F) > 2 \end{cases}$
- (ii) The index of $A'(F)$ is given by $p = \begin{cases} |F| - 1, & \text{if characteristic } (F) = 2 \\ 1, & \text{if characteristic } (F) > 2 \end{cases}$.

Proof.

From the spectrum of $A'(F)$ we can easily prove this result.

Note that, a quadratic form, It is a homogeneous polynomial of the second degree in any number of variables of a

matrix A . For example, $A = \begin{pmatrix} a & f & g \\ f & b & h \\ g & h & c \end{pmatrix}$, $X = (x \ y \ z)$ and $X^T = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$, then $XAX^T = ax^2 + by^2 + cz^2 + 2fxy + 2gzx +$

$2hzy$ which is a corresponding Quadratic form of A , λ_i are Eigenvalues. Here $i=1,2,3$.





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The real quadratic form XAX^T is called Positive definite if $\forall \lambda_i > 0$, Negative definite if $\lambda_i < 0$. Positive semi-definite if all $\lambda_i \geq 0$ and atleast one $\lambda = 0$, Negative semi definite if all $\lambda_i \leq 0$ and atleast one $\lambda = 0$. It is indefinite if some of the λ_i are positive and others negative. From this definition we can observe the lemma given below.

Lemma 3.13. Let $A'(F)$ be its adjacency matrix of $\overline{GT(F)}$. Let q be the quadratic form of $A'(F)$. Then

$$q = \begin{cases} 2\left(\sum_{i=1}^{|F|-1} (x_i \sum_{j>i}^{|F|} x_j)\right), & \text{if characteristic } (F) = 2 \\ 2\left[x_1 \sum_{i=2}^{|F|} (x_i + \sum_{j=1}^{\frac{|F|-1}{2}} (x_{2j} + x_{2j+1}) \times \sum_{k>2i+1}^{|F|} x_k)\right], & \text{if Characteristic } (F) > 2 \end{cases}$$

Proof. If Characteristic $(F) = 2$, then $q = (x_1 x_2 x_3 \dots x_{|F|})$ $\begin{pmatrix} 0 & 1 & 1 & \dots & 1 & 1 & 1 & \dots & 1 \\ 1 & 0 & 1 & \dots & 1 & 1 & 1 & \dots & 1 \\ & & & \dots & & & & & \\ 1 & 1 & 1 & \dots & 0 & 1 & 1 & 1 & \dots & 1 \\ \hline 1 & 1 & 1 & \dots & 1 & 0 & 1 & 1 & \dots & 1 \\ 1 & 1 & 1 & \dots & 1 & 1 & 0 & 1 & \dots & 1 \\ 1 & 1 & 1 & \dots & 1 & 1 & 1 & 0 & \dots & 1 \\ & & & \dots & & & & & & \\ 1 & 1 & 1 & \dots & 1 & 1 & 1 & 1 & \dots & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_{|F|-1} \\ x_{|F|} \end{pmatrix} = 0$, we get

$$2\left(\sum_{i=1}^{|F|-1} (x_i \sum_{j>i}^{|F|} x_j)\right)$$

If Characteristic $(F) > 2$, then $q = (x_1 x_2 x_3 \dots x_{|F|-1} x_{|F|})$ $\begin{pmatrix} 0 & 1 & 1 & \dots & 1 & 1 \\ 1 & 0 & 0 & \dots & 1 & 1 \\ 1 & 0 & 0 & \dots & 1 & 1 \\ & & & \dots & & \\ & & & & & \\ & & & & & \\ 1 & 1 & 1 & \dots & 0 & 0 \\ 1 & 1 & 1 & \dots & 0 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_{|F|-1} \\ x_{|F|} \end{pmatrix}$

$$= 2\left[x_1 \sum_{i=2}^{|F|} (x_i + \sum_{j=1}^{\frac{|F|-1}{2}} (x_{2j} + x_{2j+1}) \times \sum_{k>2i+1}^{|F|} x_k)\right].$$

Theorem 3.14. Let $A'(F)$ be its adjacency matrix of $\overline{GT(F)}$. Let q be the quadratic form of $A'(F)$, we can observe q is indefinite

Proof. By the result of spec of $A'(F)$, this adjacency matrix has both positive and negative Eigen values. Hence q is indefinite. In this view of the following definition, one can determine the energy of a simple graph G from its adjacency matrix A . consider $A(G)$ as the adjacency matrix of a graph G and let $\lambda_1, \lambda_2, \dots, \lambda_n$ Eigenvalue of A . Then, the Energy of the graph G is $En(G) = \sum_{i=1}^n |\lambda_i|$.

Theorem 3.15. Let $\overline{GT(F)}$ be the complement of the generalized total graph F , and $A'(F)$ be its adjacency matrix. Then the energy of the graph $\overline{GT(F)}$ is given by

$$En(A'(F)) = \begin{cases} 2(|F| - 1), & \text{if characteristic } (F) = 2 \\ (|F| - 3 + \sqrt{(|F| - 1)^2 + 4}), & \text{if characteristic } (F) > 2 \end{cases}$$

Proof.

have $Spec(\overline{GT(F)}) =$

$$\begin{cases} \begin{pmatrix} (|F|-1) & -1 \\ 1 & |F|-1 \end{pmatrix} & \text{if characteristic } (F) = 2 \\ \begin{pmatrix} \frac{|F|-3 + \sqrt{(|F|-1)^2 + 4}}{2} & 0 & \frac{|F|-3 - \sqrt{(|F|-1)^2 + 4}}{2} & -2 \\ \frac{|F|-1}{2} & \frac{|F|-3}{2} & \frac{|F|-3}{2} & \frac{|F|-3}{2} \end{pmatrix} & \text{if characteristic } (F) > 2 \end{cases} \quad En(\overline{GT(F)}) =$$

$$\begin{cases} (|F| - 1) + (1 \times |F| - 1) & \text{if characteristic } (F) = 2 \\ \frac{2+2+\dots+2}{\frac{|F|-3}{2} \text{ times}} + 0 + \frac{|F|-3 + \sqrt{(|F|-1)^2 + 4}}{2} + \left| -\left(\frac{|F|-3}{2} + \frac{\sqrt{(|F|-1)^2 + 4}}{2}\right) \right| & \text{if characteristic } (F) > 2 \end{cases}$$

Hence $En(\overline{GT(F)}) = \begin{cases} 2 \times (|F| - 1), & \text{if characteristic } (F) = 2 \\ |F| - 3 + \sqrt{(|F| - 1)^2 + 4}, & \text{if characteristic } (F) > 2 \end{cases}$





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CONCLUSIONS

In this article we discussed some theoretical properties of adjacency matrix of the complement of the generalized total graph of finite fields $\overline{GT(F)}$ such as Eigenvalues, rank, index, characteristic polynomial, minimal polynomial, Quadratic form, Spectrum, energy of the adjacency matrix of $\overline{GT(F)}$ and some related properties. This view will help us another approach to seeing the properties of graphs using an adjacency matrix.

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Comparison of Raunkier's Life Forms of Plants of Artificial Ecosystem with Different Natural Ecosystem

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

Raunkier's life forms of plant describe the classification of plants based on position of their renewal buds above or below the ground during unfavorable condition. The present study reports 212 plant species including 69 families, 176 genera with one family, one genus, and two species belonging to the Gymnosperm group. Further, the reported plant species were compared with Raunkier's normal biological spectrum and diverse types of vegetation seen in various natural plant communities through chi-square test by using Graphpad Prism 9.3.1(471). This comparison illustrates the difference between natural and artificial plant communities.

Keywords: Artificial ecosystem, Biological spectrum, Law garden, Plant community, Raunkier's life forms, Vegetation types.



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INTRODUCTION

The term 'Life form' was first coined by Warming in 1896 (Magdefrau, 1982). Plant life form can be defined as vegetative or morphological adaptation of the plant with respect to the environment. It can help in comparing vegetation types of different areas (Pavon *et al.*, 2000). Life form is different from growth form; life form is the physiognomy of vegetation whereas growth form is the actual structure of shoot apex (Adamson, 1939; Du Rietz, 1931). In other words, the growth form can be considered as the overall morphological characteristic of the plant that can be examined (Meusel, 1935). Several ecologists tried to classify the various life forms of the plants based on the physiognomy. For example- Theophrastus classified the plant community or vegetation into trees, shrubs and herbs. Different life forms of plants were first suggested by Humboldt in 1806 (Du Rietz, 1931), De Candolle and Kerner also classified Raunkier's life form but Kerner classified according to the taxonomic unit (Kerner, 1863; Du Rietz, 1931). Raunkier classified plants based on the height of renewal buds from the ground and also below the ground during resting or unfavorable conditions (Du Rietz, 1931; Adamson, 1939). Raunkier's classification of life forms of plants was acceptable for most the ecologists. Different ratio or percentage of life forms of plants in a plant community is known as the biological spectrum. This biological spectrum helps in revealing various climatic conditions and different vegetation types of distinct geographical regions (Rana *et al.*, 2002). With the help of the biological spectrum, dominant species of the natural ecosystem or plant community can be known and the impact of anthropogenic activities on these natural ecosystems can also be studied. Several works on life forms of plants have been done from India (Bharucha, 1941; Meher-Homji, 1964; Singh & Arora, 1994; Rana *et al.*, 2002) and from the world (Cromer & Pryor, 1942; Paulsen, 1912; Raunkier, 1934; Turrill, 1929). Most of the study on Raunkier's Life forms of plant and biological spectrum has been done on natural ecosystems, but not on artificial ecosystems like gardens. Several authors have done their phytochemical analysis on cultivated plants which were grown and maintained in artificial ecosystem like gardens, these may help society, researchers, scientists and industries for future references (Rutuba *et al.*, 2021; Shah *et al.*, 2021; Patel and Modi, 2018; Patel & Modi, 2019). Therefore, this present work focuses on the comparison of different vegetation physiognomy of natural ecosystems and artificial ecosystems. This study will also be helpful in addressing the stability of the artificial ecosystems like gardens.

RAUNKIER'S LIFE FORM

Raunkier classified plants into five categories based on the location of the renewal bud during adverse condition; Phanerophytes, Chamaephytes, Hemicryptophytes, Cryptophytes, and Therophytes viz. Plants with a renewal bud position more than 0.25m high from the ground are referred to be Phanerophytes. Chamaephytes are the plants having renewal buds that are less than 0.25m high from the ground. Hemicryptophytes are the plants that have renewal buds just above the earth's crust. Cryptophytes are the plants that have an underground renewal bud, such as a rhizome, bulb, or tuber. Therophytes are the plants that produce seed as a renewal bud in unfavorable conditions; they are essentially annual plants (Raunkier 1934; Cain, 1950; Adamson 1939).

MATERIAL AND METHODOLOGY

This study has been carried out during August- December, 2021 & carried out by using the transect (Eberhardt, 1978; Buckland *et al.*, 2007) and quadrat (Gleason, 1920; Shioda, 2008) (from 1×1 to 10×10 meters) methods for the collection of various plant specimens. Further, the identification of the plant species was carried out with the help of various literatures (Cooke, 1903; Shah, 1978). Following plants identification and field observations, all listed plants were classified according to Raunkier's life forms and compared to the normal biological spectrum of natural ecosystems as well as the biological spectrum of artificial ecosystems. Several authors applied R×C, G-test for comparing the vegetation of the different sites (Stalter *et al.*, 1991). The data of current study was analyzed through chi-square test using GraphPad Prism 9.3.1(471) software.

STUDY AREA Law Garden is approximately 50-year-old garden located at Ahmedabad district of Gujarat, India.

Location: 23°01'35"N 72°33'39"E (<https://earth.google.com/>).





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RESULT AND DISCUSSION

In the current study of Law Garden, Ahmedabad for the Raunkier's life form 212 plant species were listed. It comprises 69 families, 176 genera among them one family, one genus and two species belong to Gymnosperm group (Table 1). The survey of Raunkier's life forms of plants at Law Garden, Ahmedabad, an artificial ecosystem, revealed that (Table 1 and Graph 1) Phanerophytes are dominant species. The studied biological spectrum of Raunkier's life form of Law Garden Ahmedabad differs from the normal biological spectrum in that Phanerophytes (approximately double the normal spectrum) and Geophytes are more than the normal spectrum, Chamaephytes are close to the normal spectrum, Hemicryptophytes and Therophytes are much less than the normal spectrum, and Epiphytes are completely absent. Variations in the studied biological spectrum from the normal biological spectrum are may be due to the anthropogenic activity, because gardens are actually an artificial ecosystem where everything is grown and maintained by the human beings. Also, plants are planted as per human desire and for ornamental purposes. In gardens, several insecticides and pesticides are used to control insects and pests which may affect the soil fertility causing difficulty in the survival of herbaceous plants. This is the reason why hemicryptophytes and therophytes are very less. Here, the percentage of phanerophytes is more than normal, this may be because people like to grow more trees in the garden and epiphytes seem to be absent due to warm and non-moist climate.

While comparing different vegetation types with Law Garden floristic data using chi-square, it is observed that all the different types of vegetation are significantly different from Law Garden (Table 2). This study reveal (Graph 1) that Phanerophytes composition are in between Rainforest and Subtropical evergreen forest, Chamaephytes and Cryptophytes are nearly less or more than the normal biological spectrum and also near the desert and subtropical evergreen vegetation type. Hemicryptophytes are very less than normal biological spectrum but it is near to the Subtropical vegetation. Therophytes are very less than normal biological spectrum as well as not indicating any type of vegetation. The majority of life forms are Phanerophytes, which are intermediate between rainforest and Subtropical evergreen forest, but they are actually near subtropical vegetation, and other life forms such as Hemicryptophytes and Cryptophytes are also near Subtropical evergreen vegetation types, so the studied area may have Subtropical evergreen vegetation types. The present study of Law Garden, Ahmedabad for the different Raunkier's life forms of plant shows that the high percentage of Phanerophytes indicates Phanaerophyticphytoclimate. When Law Garden vegetation was compared to several forms of natural vegetation using chi-squared, it was discovered that Law Garden vegetation is considerably distinct from other natural vegetation. Subtropical evergreen type of vegetation shows similarities to Law garden as both vegetation share common climatic conditions. Absence of epiphytes indicates non-moisture environment throughout the year. Listing of 212 distinct species of Angiosperm with Phanerophytic climate of Law Garden, Ahmedabad, which indicates species rich region. According to ecologists, the more species rich area, the more it is stable. As a result, artificial ecosystems or plant communities, such as gardens that humans create and maintain, can be considered stable.

ACKNOWLEDGEMENT

Here we thankful to all the faculties of Department of Botany, Bioinformatics and Climate Change Impacts Management, School of Sciences, Gujarat University, Ahmedabad for directly and indirectly helping us. We also thankful our colleagues for continuously support.

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Table 1: Floristic diversity at Law Garden

Life form	Botanical name	Family	Common name	Habit
Chamaephytes	<i>Achyranthes aspera</i> L.	Amarantaceae	Aghedi	Herb
	<i>Adenium obesum</i> (Forssk.) Roem. &	Apocynaceae	Adenium	Herb





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	Schult.			
	<i>Bacopa monnieri</i> (L.) Wettst.	Scrophulariaceae	Brahmi	Herb
	<i>Bambusa vulgaris</i> Schrad.	Poaceae	Bamboo	Herbs
	<i>Catharanthus roseus</i> (L.) G. Don	Apocynaceae	Barmasi	Herb
	<i>Coleus amboinicus</i> Lour.	Lamiaceae	-	Herb
	<i>Croton bonplandianus</i> Baill.	Euphorbiaceae	-	Herb
	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Darbh	Grass
	<i>Mimosa pudica</i> L.	Mimosaceae	Lajamani	Herb
	<i>Ocimum sanctum</i> L.	Lamiaceae	Tulsi	Herb
	<i>Oldenlandia pumila</i> (L. f.) DC.	Rubiaceae	-	Herb
	<i>Pentas lanceolata</i> (Forssk) Deflers	Rubiaceae	-	Herb
	<i>Plumbago zeylanica</i> L.	Plumbaginaceae	Chitrak	Herb
	<i>Portulaca grandiflora</i> Hook.	Portulacaceae	Chinigulab	Herb
	<i>Rhapis excelsa</i> (Thunb.) Henry	Arecaceae	Raphnis palm	Shrub
	<i>Solanum diphyllum</i> L.	Solanaceae	-	Herb
	<i>Solanum villosum</i> Mill.	Solanaceae	Bhoypiudi	Herb
	<i>Turnera ulmifolia</i> L.	Turneraceae	-	Herb
Geophytes	<i>Asparagus gonocladus</i> Baker	Asparagaceae	Satavari	Herb
	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Satavari	Herb
	<i>Canna indica</i> L.	Cannaceae	-	Herb
	<i>Colocasia esculenta</i> (L.) Schott	Araceae	Adavi	Shrub
	<i>Cordyline fruticosa</i> (L.) A.Chev.	Asparagaceae	-	Shrub
	<i>Hymenocallis littoralis</i> (Jacq.) Salisb.	Amaryllidaceae	Spider lily	Herb
	<i>Mirabilis jalapa</i> L.	Nyctaginaceae	Gulbas	Herb
	<i>Ruellia tuberosa</i> L.	Acanthaceae	Fatakdi	Herb
	<i>Sensevieria hyacinthoides</i> (L.) Druce.	Asparagaceae	Snake plant	Herb
	<i>Sensevieria metallica</i> Gerome. & Labroy.	Asparagaceae	Snake plant	Herb
	<i>Sensevieria trifasciata</i> Prain.	Asparagaceae	Snake plant	Herb
<i>Zephyranthes rosea</i> Lindl.	Amaryllidaceae	Pink lily	Herb	
Hemicryptophytes	<i>Aloe vera</i> (L.) Burm.f.	Liliaceae	Kuvarpathu	Herb
	<i>Alternanthera brasiliana</i> (L.) Kuntze	Amarantaceae	Lal mehndi	Herb
	<i>Bryophyllum pinnatum</i> (Lamk.) Oken	Crassulaceae	Panfuti	Herb
	<i>Chlorophytum capense</i> (L.) Voss	Asparagaceae	Yellow kewda	Herb
	<i>Crinum asiaticum</i> L.	Amaryllidaceae	-	Herb
	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	-	Herb
	<i>Sphagneticola trilobata</i> (L.) Pruski	Asteraceae	Wadelia	Herb
<i>Tradescantia pallid</i> (Rose) D.R. Hunt	Commelinaceae	Rhoeo	Herb	
Hydrophytes	<i>Nymphaea pubescens</i> Willd.	Nymphaeaceae	Poyna	Herb
	<i>Typha angustata</i> Bory & Chaub.	Typhaceae	Gha bajarium	Herb
Phanarophytes	<i>Abutilon indicum</i> (L.) Sweet	Malvaceae	Kanksi	Undershrub
	<i>Acacia auriculiformis</i> Benth.	Mimosaceae	Australian baval	Tree
	<i>Acalypha hispida</i> Burm. f.	Euphorbiaceae	Acalypha	Undershrub
	<i>Acalypha wilkesiana</i> Muell. -Arg.	Euphorbiaceae	Acalypha	Shrub
	<i>Adansonia digitata</i> L.	Bombacaceae	Rukhdo	Tree
	<i>Adenanthera pavonina</i> L.	Mimosaceae	Ratanjali	Tree
	<i>Adhatoda vasica</i> (L.) Nees	Acanthaceae	Ardusi	Shrub
	<i>Haldina cordifolia</i> (Roxb.) Ridsdale	Rubiaceae	Haldu kalam	Tree
<i>Aegle marmelos</i> (L.) Corr.	Rutaceae	Bili	Tree	





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<i>Agave americana</i> L.	Asparagaceae	Agave	Shrub
<i>Agave vivipara</i> L.	Asparagaceae	Agave	Shrub
<i>Ailanthus excels</i> Roxb.	Simaroubaceae	Arduso	Tree
<i>Albizia lebeck</i> (L.) Benth.	Mimosaceae	Kalosiras	Tree
<i>Allamanda cathartical</i> L.	Apocynaceae	Allamanda	Shrub
<i>Alstonia scholaris</i> (L.) R. Br.	Apocynaceae	Saptarni	Tree
<i>Annona squamosa</i> L.	Annonaceae	Sitafal	Tree
<i>Antigonon leptopus</i> Hook. & Arn.	Polygonaceae	Icecream vel	Climber
<i>Azadirachta indica</i> A. Juss.	Meliaceae	Limdo	Tree
<i>Basella alba</i> L.	Basellaceae	Poi	Twinner
<i>Bauhinia tomentosa</i> L.	Caesalpinaceae	Piloasitro	Tree
<i>Bauhinia acuminata</i> L.	Caesalpinaceae	-	Shrub
<i>Bauhinia purpurea</i> L.	Caesalpinaceae	-	Tree
<i>Beaucarnea recurvata</i> Lem.	Asparagaceae	Pony tail palm	Shrub
<i>Bixa orellana</i> L.	Bixaceae	Sindur	Small tree
<i>Bougainvillea spectabilis</i> Willd.	Nyctaginaceae	Boganvel	Woody climber
<i>Caesalpinia pulcherrima</i> (L.) Sw.	Caesalpinaceae	Galtora	Shrub
<i>Calliandra haematocephala</i> Hassk.	Mimosaceae	-	Shrub
<i>Callistemon viminalis</i> (Sol. ex Gaertn.) G. Don	Myrtaceae	Bottle brush	Tree
<i>Carica papaya</i> L.	Caricaceae	Papalya	Tree
<i>Carissa spinarum</i> L.	Apocynaceae	Karamda	Shrub
<i>Caryotaurens</i> L.	Arecaceae	Shivjata	Tree
<i>Senna auriculata</i> (L.) Roxb.	Caesalpinaceae	Aval	Shrub
<i>Cassia fistula</i> L.	Caesalpinaceae	Garmalo	Tree
<i>Cassia javanica</i> L.	Caesalpinaceae	-	Tree
<i>Senna occidentalis</i> (L.) Link	Caesalpinaceae	Sundro	Tree
<i>Cassia roxburghii</i> DC.	Caesalpinaceae	-	Tree
<i>Senna siamea</i> (Lam.) H.S. Irwin & Barneby	Caesalpinaceae	-	Tree
<i>Casuarina equisetifolia</i> L.	Casuarinaceae	Sharu	Tree
<i>Cestrum nocturnum</i> L.	Solanaceae	Rat rani	Shrub
<i>Citrus limon</i> (L.) Osbeck	Rutaceae	Limbu	Shrub
<i>Coccinia grandis</i> (L.) Voigt.	Cucurbitaceae	Tindora	Climber
<i>Cocculus hirsutus</i> (L.) Theob.	Menispermaceae	Tanvel,	Climber
<i>Cocos nucifera</i> L.	Arecaceae	Nariyal	Tree
<i>Codiaeum variegatum</i> (L.) Rumph. ex A. Juss.	Euphorbiaceae	-	Shrub
<i>Conocarpus lancifolius</i> Engl	Combretaceae	Conocarpus	Tree
<i>Cordia dichotoma</i> Forst. F.	Boraginaceae	Gundo	Tree
<i>Cordia sebestena</i> L.	Boraginaceae	-	Small tree
<i>Couropita guianensis</i> Aubl.	Lecythidaceae	Shivling	Tree
<i>Crateva adansonii</i> DC.	Capparaceae	-	Tree
<i>Cycas circinalis</i> L.	Cycadaceae	Cycas	Small tree
<i>Cycas revoluta</i> Thunb.	Cycadaceae	Cycas	Small tree
<i>Dalbergia sissoo</i> DC.	Fabaceae	Sisam	Tree
<i>Delonix regia</i> (Hook.) Raf.	Caesalpinaceae	Gulmohor	Tree





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<i>Desmodium gangeticum</i> (L.) DC.	Fabaceae	Goto kado pandalio	Undershrub
<i>Dregea volubilis</i> (L.f.) Benth. ex Hook.f.	Apocynaceae	-	Climber
<i>Putranjiva roxburghii</i> Wall.	Euphorbiaceae	Putranjiva	Tree
<i>Duranta erecta</i> L.	Verbenaceae	-	Shrub
<i>Dypsis lutescens</i> (H.Wendl.) Beentje & J.Dransf.	Arecaceae	Areca palm	Tree
<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Amla	Tree
<i>Epipremnum pinnatum</i> (L.) Engl.	Araceae	-	Climber
<i>Erythrina variegata</i> L.	Fabaceae	Pangara	Tree
<i>Eucalyptus globulus</i> Labill.	Myrtaceae	Nilgiri	Tree
<i>Euphorbia milii</i> Des Moul.	Euphorbiaceae	-	Shrub
<i>Ficus benghalensis</i> L.	Moraceae	Vad	Tree
<i>Ficus religiosa</i> L.	Moraceae	Piplo	Tree
<i>Ficus virens</i> Aiton	Moraceae	Pipli	Tree
<i>Ficus benamina</i> L.	Moraceae	-	Tree
<i>Furcraea foetida</i> (L.) Haw.	Asparagaceae	-	Shrub
<i>Gliricidia sepium</i> (Jacq.) Walp.	Fabaceae	-	Tree
<i>Gmelina asiatica</i> L.	Verbenaceae	-	Woody climber
<i>Grevillea robusta</i> A.Cunn. ex R.Br.	Proteaceae	Silver oak	Small tree
<i>Guazuma ulmifolia</i> Lam.	Sterculaceae	Rudrakshi	Tree
<i>Hamelia patens</i> Jacq.	Rubiaceae	-	Shrub
<i>Hibiscus rosa-sinensis</i> var. rubro-plenus Sweet	Malvaceae	Jasud	Shrub
<i>Hibiscus rosa-sinensis</i> cv. sylvia Goodman.	Malvaceae	Jasud	Shrub
<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Jasud	Shrub
<i>Hibiscus schizopetalus</i> (Mast.) Hook. f.	Malvaceae	Jasud	Shrub
<i>Holoptelea integrifolia</i> (Roxb.) Planch	Ulmaceae	Kanjo	Tree
<i>Ixora chinensis</i> Lam.	Rubiaceae	Chines ixora	Shrub
<i>Ixora coccinea</i> L.	Rubiaceae	Red ixora	Shrub
<i>Ixora finlaysoniana</i> Wall. ex G.Don	Rubiaceae	-	Small tree
<i>Jasminum grandiflorum</i> L.	Oleaceae	Chameli	Shrub
<i>Jasminum sambac</i> (L.) W. Ait.	Oleaceae	-	Shrub
<i>Jatropha integerrima</i> Jacq.	Euphorbiaceae	-	Shrub
<i>Justicia gendarussa</i> Burm. f.	Acanthaceae	Kaloarduso	Undershrub
<i>Justicia spicigera</i> Schltdl.	Acanthaceae	-	Shrub
<i>Kigelia africana</i> (Lam.) Benth.	Bignoniaceae	-	Tree
<i>Phyllanthus reticulatus</i> Poir.	Euphorbiaceae	Kamboi	Shrub
<i>Lagerstroemia indica</i> L.	Lythraceae	Chinaimendhi	Tree
<i>Lantana camara</i> L.	Verbenaceae	Gandhari	Shrub
<i>Lawsonia inermis</i> L.	Lythraceae	Mendi	Shrub
<i>Leucaena leucocephala</i> (Lam.) De Wit	Mimosaceae	Su baval	Tree
<i>Leucophyllum frutescens</i> (Berland.) I.M. Johnst.	Scrophulariaceae	Nikadivya	Shrub
<i>Limonia acidissima</i> L.	Rutaceae	Kotha	Tree
<i>Livistona chinensis</i> (Jacq.) R.Br. ex Mart.	Arecaceae	Fan palm	Tree





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<i>Livistona speciosa</i> Kurz	Arecaceae	Fan palm	Tree
<i>Madhuca indica</i> J.F. Gmel.	Sapotaceae	Mahudo	Tree
<i>Mangifera indica</i> L.	Anacardiaceae	Ambo	Tree
<i>Manilkara hexandra</i> (Roxb.) Dub.	Sapotaceae	Rayan	Tree
<i>Melia azedarach</i> L.	Meliaceae	Bakanlimdo	Tree
<i>Millettia peguensis</i> Ali	Fabaceae	-	Tree
<i>Millingtonia hortensis</i> L. f.	Bignoniaceae	Akash neem	Tree
<i>Mimusops elengi</i> L.	Sapotaceae	Borsali	Tree
<i>Mitragyna parvifolia</i> (Roxb.) Koth.	Rubiaceae	Nanukadam	Tree
<i>Momordica balsamina</i> L.	Cucurbitaceae	Vadkarela	Climber
<i>Momordica charantia</i> L.	Cucurbitaceae	Karela	Climber
<i>Moringa concanensis</i> Nimmo	Moringaceae	Kadvosargavo	Tree
<i>Morus alba</i> L.	Moraceae	Shetur	Tree
<i>Mukia maderaspatana</i> (L.) M. Roem.	Cucurbitaceae	Chanak-chibhdi	Climber
<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae	Mitholimbado	Tree
<i>Murraya paniculata</i> (L.) Jack.	Rutaceae	Kamini	Tree
<i>Nerium oleander</i> L.	Apocynaceae	Lal Karen	Shrub
<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	Parijatak	Small tree
<i>Pandanus odorifer</i> (Forssk.) Kuntze	Pandanaceae	Kevro	Shrub
<i>Parkia biglandulosa</i> Whight & Arn.	Mimosaceae	Rambaval	Tree
<i>Euphorbia tithymaloides</i> L.	Euphorbiaceae	Vilayati kharsani	Undershrub
<i>Peltophorum pterocarpum</i> (DC.) K. Heyne	Caesalpinaceae	Tamrafali	Tree
<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Khajuri	Tree
<i>Pithecellobium dulce</i> (Roxb.) Benth.	Mimosaceae	Gorasambli	Tree
<i>Plumeria rubra</i> L.	Apocynaceae	Champo	Small tree
<i>Plumeria alba</i> L.	Apocynaceae	Champo	Small tree
<i>Polyalthia longifolia</i> (Sonn.) Thw.	Annonaceae	Asopalav	Tree
<i>Polyscias balfouriana</i> (Andre) L.H.Bailey	Araliaceae	Aralia	Shrub
<i>Polyscias guilfoylei</i> (W.Bull) L.H.Bailey	Araliaceae	Aralia	Shrub
<i>Polyscias scutellaria</i> (Burm.f.) Fosberg	Araliaceae	Aralia	Shrub
<i>Pongamia pinnata</i> (L.) Pierre	Fabaceae	Karanji	Tree
<i>Pritchardia martii</i> (Gaudich.) H.Wendl.	Arecaceae	Fan palm	Small tree
<i>Pseuderanthemum carruthersii</i> (Seem.) Guillaumin	Acanthaceae	Eranthemum	Shrub
<i>Psidium guajava</i> L.	Myrtaceae	Jamfal	Small tree
<i>Pterospermum acerifolium</i> (L.) Willd.	Sterculiaceae	-	Tree
<i>Punica granatum</i> L.	Lythraceae	-	Small tree
<i>Combretum indicum</i> (L.) DeFilipps	Combretaceae	Madhumalti	Climber
<i>Rosa indica</i> L.	Rosaceae	Gulab	Shrub
<i>Roystonea regia</i> (H.B. & K.) O. F. Cooke	Arecaceae	-	Tree
<i>Salvadora oleoides</i> Decne.	Salvadoraceae	Mithizar, piludi	Tree
<i>Salvadora persica</i> L.	Salvadoraceae	Khari zar, kharizar	Tree
<i>Spathodea campanulata</i> P.Beauv.	Bignoniaceae	-	Tree
<i>Sterculia foetida</i> L.	Sterculiaceae	Junglibadam	Tree
<i>Streblus asper</i> Lour.	Moraceae	Harero	Tree
<i>Syngonium podophyllum</i> Schott	Araceae	Arrowhead	Climber





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			plant	
	<i>Syzygiumcumini</i> (L.) Skeels	Myrtaceae	Jambu	Tree
	<i>Tabebuia rosea</i> (Bertol.) Bertero ex A.DC.	Bignoniaceae	-	Tree
	<i>Tabernemontana divaricate</i> (L.) R.Br.exRoem. &Schult.	Apocynaceae	-	Tree
	<i>Tabubea aurea</i> (Silva Manso) Benth. & Hook. f. ex S. Moore	Bignoniaceae	-	Tree
	<i>Tamarindus indica</i> L.	Caesalpinaceae	Ambli	Tree
	<i>Tecoma stans</i> (L.) Juss. ex Kunth	Bignoniaceae	-	Tree
	<i>Tecoma capensis</i> (Thunb.) Lindl.	Bignoniaceae	-	Shrub
	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight &Arn.	Combretaceae	Arjun sadad	Tree
	<i>Terminalia catappa</i> L.	Combretaceae	Deshibadam	Tree
	<i>Cascabela thevetia</i> (L.) Lippold	Apocynaceae	Pili Karen	Small tree
	<i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. &Thoms.	Menispermaceae	Galo	Climber
	<i>Trichodesma zeylanicum</i> (Burm.f.) R.Br.	Boraginaceae	-	Shrub
	<i>Trichosanthes cucumerina</i> L.	Cucurbitaceae	Jangliparval	Climber
	<i>Uraria picta</i> (Jacq.)DC.	Fabaceae	Pithvan	Shrub
	<i>Urena lobata</i> L.	Malvaceae	Vagadaubhindo	Undershrub
	<i>Vitex negundo</i> L.	Lamiaceae	Nagod	Shrub
	<i>Volkameria inermis</i> L.	Lamiaceae	Kadvi mehndi	Shrub
	<i>Withania somnifera</i> (L.) Dunal	Solanaceae	Ashvagandha,	Shrub
	<i>Yucca gloriosa</i> L.	Asparagaceae	Yucca	Shrub
Therophytes	<i>Acalypha indica</i> L.	Euphorbiaceae	Dadari	Herb
	<i>Alternanthera paronychioides</i> A.St.-Hil.	Amaranthaceae	-	Herb
	<i>Amaranthus viridis</i> L.	Amaranthaceae	-	Herb
	<i>Celosia argentea</i> L.	Amaranthaceae	-	Herb
	<i>Commelina benghalensis</i> L.	Commelinaceae	-	Herb
	<i>Digera muricata</i> (L.) Mart.	Amaranthaceae	Kanjro	Herb
	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	Bhangro	Herb
	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	-	Herb
	<i>Euphorbia hirta</i> L.	Euphorbiaceae	-	Herb
	<i>Euphorbia parviflora</i> L.	Euphorbiaceae	-	Herb
	<i>Oxalis corniculata</i> L.	Oxalidaceae	Changeri	Herb
	<i>Physalis minima</i> L.	Solanaceae	Popti, parpopti	Herb
<i>Cyanthillium cinereum</i> (L.) H.Rob.1	Asteraceae	Sahedevi	Herb	

Table 2: Statistical analysis of different vegetation

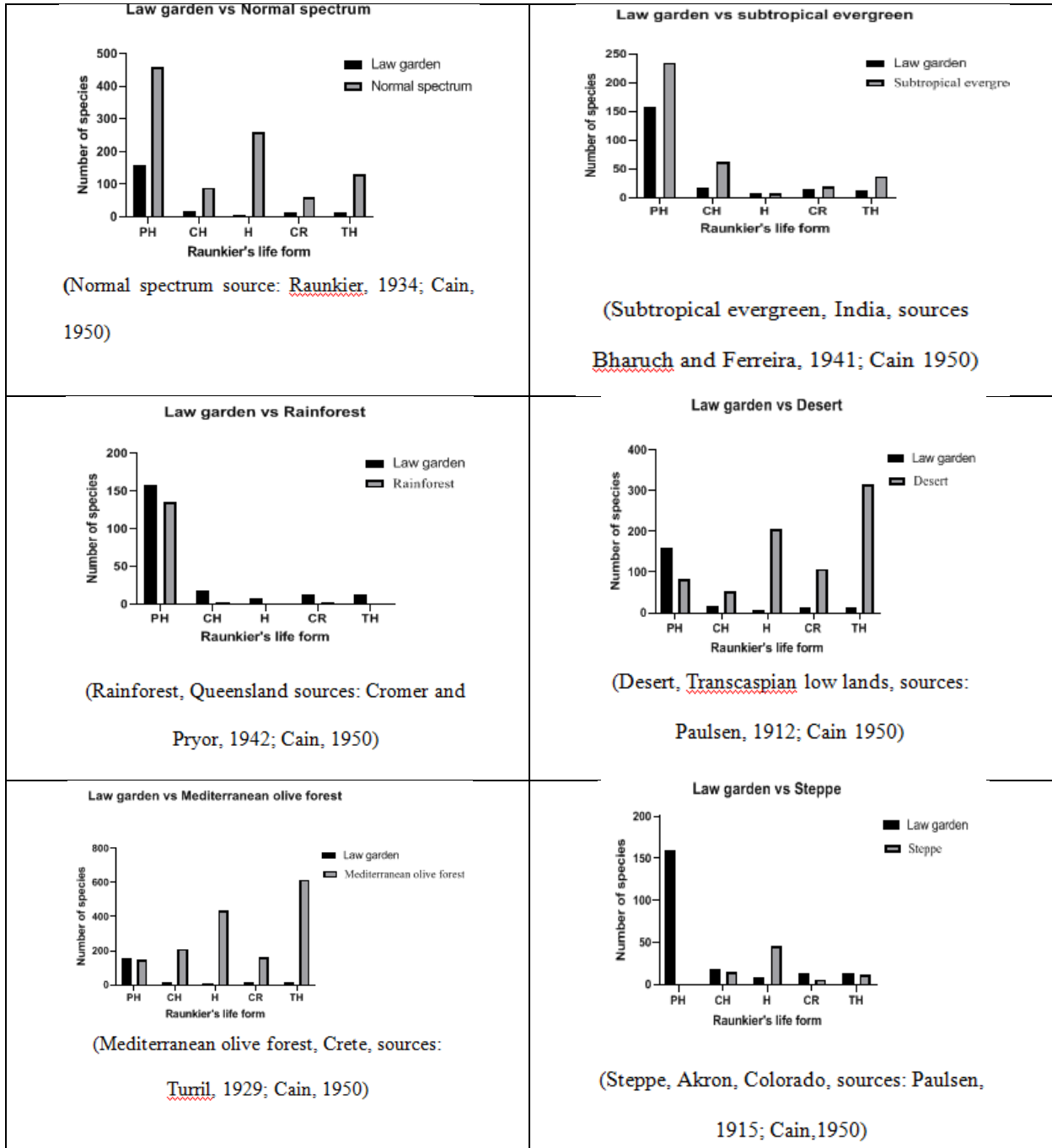
Sr.no.	Pair wise chi-square test	X ²	df	P value
1.	Law garden vs Normal spectrum	75.03	4	0.001
2.	Law garden vs Subtropical evergreen	13.29	4	0.010
3.	Law garden vs Rainforest	27.63	4	0.001
4.	Law Garden vs Desert	384	4	0.001
5.	Law garden vs Mediterranean olive forest	578.7	4	0.001
6.	Law garden vs steppe	162.4	4	0.001





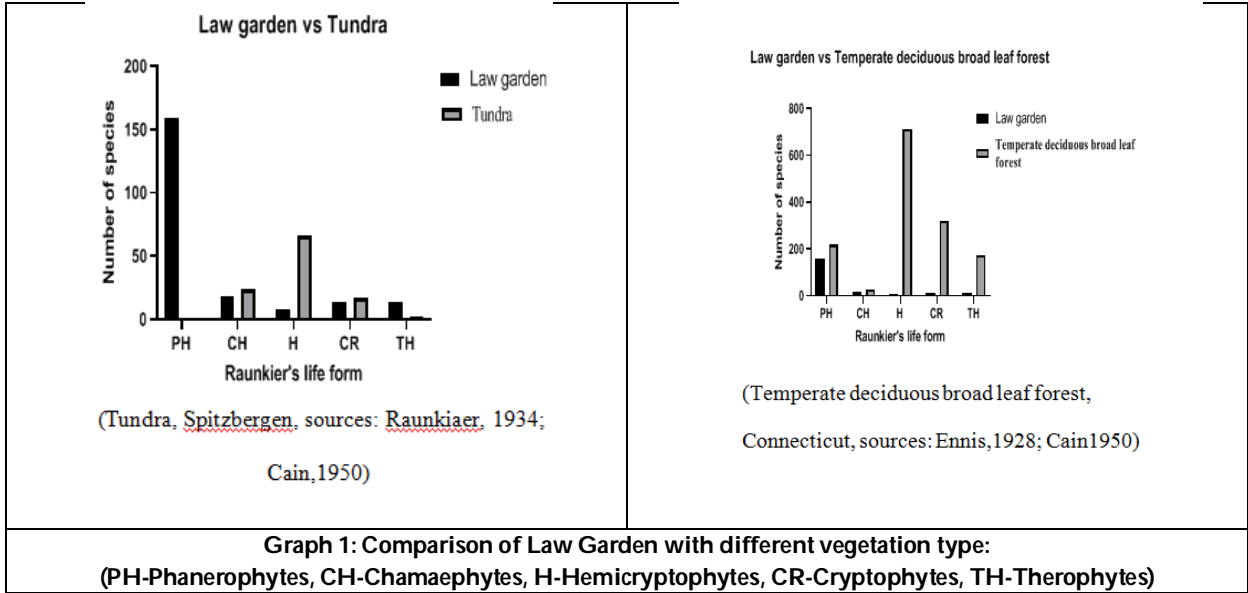
7.	Law garden vs Temperate deciduous broad leaf forest	436.8	4	0.001
8.	Law garden vs Tundra	198.3	4	0.001

p≤0.01





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Graph 1: Comparison of Law Garden with different vegetation type: (PH-Phanerophytes, CH-Chamaephytes, H-Hemicryptophytes, CR-Cryptophytes, TH-Therophytes)





On MIC- β -I-Open Sets and MIC- β -I-Continuous Function in Micro Ideal Topological Space

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 06 Jun 2024

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ABSTRACT

The main concept of this paper is to discuss the micro topology as an unadorned extension of nanotopology. Nano topology offers a wide variety of interesting results and applications. But for some time we have been looking for extended sets in micro topological space. Micro Topological Spaces introduced by S.Chandrasekar and introduces a new type of open sets. In this paper, we introduce and study MIC- β -I-open sets, MIC- β -I-continuous functions, MIC- β -I-irresolute, and MIC- β -I-irresolute in Micro ideal topological Spaces.

Keywords: MIC- β -I-open sets, MIC- β -I-continuous functions, MIC- β -I-irresolute, and MIC- β -I-irresolute

INTRODUCTION

Kuratowski [1] in 1933 and Vaidyanathaswamy [2] in 1944 proposed the concept of the ideal topological space (IDTS). R. Manoharan and P. Thangavelu [3] introduced Some New Sets and Topologies in Ideal Topological Spaces in 2013. In 1983, M.E.Abd El-Monsef, S.N.El-Deeb and R.A.Mahmoud [9] proposed β -open sets and β -continuous mapping. Hariwan Z.Ibrahim [7] initiated Micro β -open sets in Micro topology in 2020. E.Hatir and T.Noiri [10] introduced On β -I-open sets and a decomposition of almost-I-continuity. Glaisa T.Catalan, Roberto, N.Padua, Michael P.Baldado Jr [8] initiated On β -open sets and Ideals in Topological spaces in 2019. In this paper the Proposed Methodology is MIC- β -I-open sets, MIC- β -I-continuous functions, MIC- β -I-irresolute, and MIC- β -I-irresolute in Micro Ideal Topological Spaces and also some of their properties are investigated.





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PRELIMINARIES

Definition 1.2.1 [11]

Any ideal I on a topological space (X, τ) is a non empty collection of subsets of X which satisfies the following conditions

- i. $A \in I$, and $B \subset A$ implies $B \in I$.
- ii. $A \in I$ and $B \in I$ implies $A \cup B \in I$.

An Ideal topological space (X, τ) with an ideal I on X is denoted by (X, τ, I) .

Definition 1.2.2

A subset A of a topological space (X, τ) is said to be α -open (resp. pre-open, β -open) if $A \subseteq \text{Int}(\text{cl}(\text{Int}(A)))$ (resp. $A \subseteq \text{Int}(\text{cl}(A))$, $A \subseteq \text{cl}(\text{Int}(\text{cl}(A)))$).

Definition 1.2.3 [8,10]

A subset A of an ideal topological space (X, τ, ID) is said to be α -I-open (resp. pre-I-open, β -I-open) if $A \subseteq \text{Int}(C I \subseteq (\text{Int}(A)))$ (resp. $A \subseteq \text{Int}(C I \subseteq (A))$, $S \subseteq C I (\text{Int}(C I \subseteq (S)))$). The family of all α -I-open (resp. pre-I-open, β -I-open) sets in an ideal topological space (X, τ, I) is denoted by $\alpha IO(X)$ (resp. $PIO(X)$, $\beta IO(X)$).

- i) A subset A of an ideal topological space (X, τ, ID) is said to be semi-I-open if $2 A \subseteq \text{cl}^*(\text{int}(A))$.
- ii) A subset A of an ideal topological space (X, τ, ID) is said to be semi-I-closed if $\text{int}(\text{cl}^*(A)) \subseteq A$.
- iii) A subset A of an ideal topological space (X, τ, ID) is said to be β -I-open if $A \subseteq \text{cl}(\text{int}(\text{cl}^*(A)))$.

Definition 1.2.4

A function $f : (\Omega_1, \tau, ID) : (\Omega_2, \sigma)$ is said to be semi-I-continuous function (res. β -I-continuous) if $f^{-1}(V)$ is semi-I-open (resp. β -I-open) in Ω_1 for all open set V in Ω_2 .

Definition 1.2.5

A function $f : (\Omega_1, \tau, ID) : (\Omega_2, \sigma)$ is said to be

- i) β -irresolute if for each $V \in \beta O(\Omega_2, \sigma)$, $f^{-1}(V) \in \beta O(\Omega_1, \tau)$.
- ii) β -I-irresolute if for each $V \in \beta O(\Omega_2, \sigma)$, $f^{-1}(V) \in \beta IO(\Omega_1, \tau)$.

Definition 1.2.6 [5,6,12]

Let Ω be a set of infinite objects called Universe and R be an equal relationship to the Ω called the relationship of ignorance. This couple (U, R) is said to be a space for speculation.

Let $X \subseteq \Omega$.

- i) The minimum X in relation to R is a set of all items, which can be set for something divided as X in relation to R and it is denoted by $L_R(X)$. That is $L_R(X) = \bigcup_{x \in \theta} \{R(x) : R(x) \subseteq X\}$ where $R(x)$ denotes the equivalence class determined by X .
- ii) The upper approximation of X with respect to R is $U_R(X) = \bigcup_{x \in \theta} \{R(x) : R(x) \cap X \neq \emptyset\}$.
- iii) The boundary region of X with respect to R is the set of all objects, which can be neither in nor as not X with respect to R and it is denoted by $B_R(X)$.
That is, $B_R(X) = U_R(X) - L_R(X)$.

Definition 1.2.7 [11,12]

A space $(\Omega, \tau_R(X))$ is called a locally in discrete space if every Nano open set of Ω is Nano closed in Ω .





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Definition 1.2.8[5]

Let $(\Omega, \tau_R(X))$ be a Nano topological space here $\mu_R(X) = \{NU(N \cap \mu) : N, N' \in \tau_R(X)\}$ and called it Microtopology of $\tau_R(X)$ by μ where $\mu \in \tau_R(X)$.

Definition 1.2.9 [4,6] Micro Topology

The Microtopology $\mu_R(X)$ satisfies the following axioms

- (i) $\Omega, \varphi \in \mu_R(X)$
- (ii) The union of the elements of any sub-collection of $\mu_R(X)$ is in $\mu_R(X)$
- (iii) The inter section of the elements of any finite sub collection of $\mu_R(X)$ is in $\mu_R(X)$.

Then $\mu_R(X)$ is called the Microtopology on Ω with respect to X . The triplet

$(\Omega, \tau_R(X), \mu_R(X))$ is called Micro topological spaces and the elements of $\mu_R(X)$ are called Microopen sets and its complement is called Micro closed sets.

Definition 1.2.10[10]

Let $(\Omega, \tau_R(X), \mu_R(X))$ be an microtopological space with an ideal ID on K . The set operator $m-cl^*$ is called a micro*-closure and is defined a $sm-cl^*(A) = A \cup A_m^*$ for $A \subseteq \Omega$.

Definition 1.2.11 [5,11]

Let $(\Omega, \tau_R(X), \mu_R(X), I)$ be an Micro-topological space with an ideal Ion $\tau_R(X)$ and if $\wp(\Omega)$ is the set of all subsets of Ω and a set operator $(\cdot)^*, m^*: \wp(\Omega) \rightarrow \wp(\Omega)$, called a local function of A with respect to $\mu_R(X)$ and I , is defined as follows: for $A \subseteq \Omega, A_m^*(I, \mu_R(X)) = \{\Omega \in \Omega \setminus U \cap A \notin I \text{ for every } U \in \mu_R(X)\}$, where $\mu_R(X) = \{U \in \mu_R \setminus U \in U\}$. Furthermore, $Cl^*(A) = A \cup A^*(I, \mu_R(X))$ defines a Kuratowski closure operator for the Micro topology μ^* , finer than μ .

A Set operator $(\cdot)^{*S}: P(\Omega) \rightarrow P(\Omega)$ is called a semi local function and Cl^{*S} of A with respect to $\mu_R(X)$ and I are defined as follows: For $A \subseteq \Omega, A_m^*(I, \mu_R(X)) = \{\Omega \in \Omega \setminus U \cap A \notin I \text{ for each semi-open } U \text{ containing } \Omega\}$ and $Cl^{*S} = A \cup A^{*S}$.

MIC-β-I-Open sets

Definition 2.1

A subset A of an ideal topological space $(\Omega, \mu_R(X), ID)$ is said to be MIC-βI-open if $A \subseteq MIC-cl(MIC-int(MIC-cl^*(A)))$. The set consisting of all MIC-βI-open set in Ω_1 will be denoted by $MIC-\beta IO(\Omega)$.

Definition 2.2

A subset A of a Micro ideal topological space $(\Omega, \mu_R(X), ID)$ is said to be MIC-semi-I-open if $A \subseteq MIC-cl^*(MIC-int(A))$.

Example 2.3

Let $\Omega = \{p, q, r, s\}, \frac{\Omega}{R}(X) = \{\{p, s\}, \{q\}, \{r\}\}, X = \{q, r\}, \tau_R(X) = \{\emptyset, \Omega, \{q, r\}\}$ with $\mu = \{s\} \notin \tau_R(X)$, $\mu_R(X) = \{\emptyset, \Omega, \{s\}, \{q, r\}, \{q, r, s\}\}, \mu_R(X) = \{\emptyset, \Omega, \{p, q, r\}, \{p, s\}, \{p\}\}, I = \{\emptyset, \{q\}, \{r, s\}\}$, MIC-semi-I open sets = $\{\emptyset, \Omega, \{r\}, \{s\}, \{p, q\}, \{p, s\}, \{q, r\}, \{p, r, s\}, \{q, r, s\}\}$.

Theorem 2.4

Let $(\Omega, \mu_R(X), ID)$ be a Micro ideal topological space,
 i) Each MIC-semi-I-open set is MIC-βI-open.
 ii) Each MIC-βI-open set is MIC-β-open.





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Proof

(i) Let A be a subset of Ω_1 . If A is MIC-semi-I-open, then $A \subseteq \text{MIC-cl}^*(\text{MIC-Int}(A)) \subseteq \text{MIC-Int}(A) \cup (\text{MIC-Int}(A))^* \subseteq \text{MIC-Int}(A) \cup \text{MIC-cl}(\text{MIC-Int}(A)) \subseteq \text{MIC-cl}(\text{MIC-Int}(A)) \subseteq \text{MIC-cl}(\text{MIC-Int}(A \cup A^*)) \subseteq \text{MIC-cl}(\text{MIC-Int}(\text{MIC-cl}^*(A)))$. Therefore, A is a MIC- β I-open set .

(ii) Let A be a subset of Ω_1 . If A is MIC- β I-open set, then $A \subseteq \text{MIC-cl}(\text{MIC-Int}(\text{MIC-cl}^*(A))) \subseteq \text{MIC-cl}(\text{MIC-Int}(A^* \cup A)) \subseteq \text{MIC-cl}(\text{MIC-Int}(\text{MIC-cl}(A) \cup A)) \subseteq \text{MIC-cl}(\text{MIC-Int}(\text{MIC-cl}(A)))$. Therefore, A is a MIC- β I-open set. But generally the converse of this theorem is not true.

Example 2.5

Let $\Omega = \{n, o, p, q\}$, $\frac{\Omega}{R}(X) = \{\{n, q\}, \{o\}, \{p\}\}$, $X = \{o, p\}$, $\tau_R(X) = \{\emptyset, \Omega, \{o, p\}\}$ with $\mu = \{q\} \notin \tau_R(X)$, $\mu_R(X) = \{\emptyset, \Omega, \{q\}, \{o, p\}, \{o, p, q\}\}$, $\mu'_R(X) = \{\emptyset, \Omega, \{n, o, p\}, \{n, q\}, \{n\}\}$, $I = \{\emptyset, \{o\}\}$. Then we have $\{n, o\}$ and $\{n, q\}$ are MIC- β I-open sets but $\{n\}$ is not intersection of MIC- β I-open sets.

Definition 2.6

Let $(\Omega, \mu_R(X), ID)$ be a Micro ideal topological space, $A \subset \Omega$ and Ω be a point of Ω . Then

- (i) Ω is called an MIC- β I-interior point of A if there exists any $U \in \text{MIC-}\beta\text{-O}(\Omega)$ such that $\Omega \in U \subset A$.
- (ii) The set of all MIC- β I-interior point of A is called MIC- β I-interior point of A and is represented by MIC- β I-(MIC-Int(A)).

MIC- β I-Continuous Functions

Definition 3.1

A function $f: (\Omega_1, \mu_R(X), ID) \rightarrow (\Omega_2, \mu_R(Y))$ is called MIC-semi-I-continuous function (resp. MIC- β I-continuous function) if $f^{-1}(V)$ is MIC-semi-I-open (resp. MIC- β I-open) in Ω_1 for all MIC-open set V in Ω_2 .

Definition 3.2

A function $f: (\Omega_1, \mu_R(X), ID) \rightarrow (\Omega_2, \mu_R(Y))$ is called MIC- β I-continuous function (resp. MIC- β I-continuous function) if $f^{-1}(V)$ is MIC- β I-open (resp. MIC- β I-open) in Ω_1 for all MIC-open set V in Ω_2 . Generally each MIC-semi-I-continuous function is MIC- β I-continuous function, but the convers is not true as giving in next example.

Example 3.3

Let $\Omega_1 = \{e, g, h, i\}$, $\frac{\Omega_1}{R}(X) = \{\{e, i\}, \{g\}, \{h\}\}$, $X = \{g, h\}$, $\mu = \{i\}$, $\mu_R(X) = \{\emptyset, \Omega_1, \{i\}, \{g, h\}, \{g, h, i\}\}$, $\mu'_R(X) = \{\emptyset, \Omega_1, \{e, g, h\}, \{e, i\}, \{e\}\}$, $I = \{\emptyset, \{g\}\}$ and $\Omega_2 = \{j, k, l, m\}$, $\frac{\Omega_2}{R}(Y) = \{\emptyset, \Omega_2, \{j, k\}\}$, $Y = \{j\}$, $\mu = \{l\}$, $I = \{\emptyset, \{j\}, \{k\}, \{j, k\}\}$, $\mu_R(Y) = \{\emptyset, \Omega_2, \{l\}, \{j, k\}, \{j, k, l\}\}$, $\mu'_R(Y) = \{\emptyset, \Omega_2, \{l, j, m\}, \{l, m\}, \{m\}\}$. Define $f: (\Omega_1, \mu_R(X_1), ID) \rightarrow (\Omega_2, \mu_R(X_2))$ as $f(e) = j, f(g) = k, f(h) = l, f(i) = m$. Then f is MIC- β I-continuous but not MIC-semi-I-continuous because $\{j, k\}$ is MIC-open set in Ω_2 and $f^{-1}(\{j, k\}) = \{e, g\}$ which is MIC- β I-open set in Ω_1 but not MIC-semi-I-open in Ω_1 .

Theorem 3.4

For any function $f: (\Omega_1, (X), ID) \rightarrow (\Omega_2, (Y))$, the next properties are equivalent,

- 1) f is MIC- β I-continuous
- 2) For all $x \in X$ and every MIC-open set V in Y containing $f(x)$, there exists a MIC- I-open set U of Ω_1 containing x such that $f(U) \subset V$.

Proof

(1 \Rightarrow 2) Let V is MIC-open in Ω_2 such that $f(x) \in V$. Since f is MIC- β I-continuous, $f^{-1}(V)$ is MIC- β I-open set in Ω_1 . Let $U = f^{-1}(V)$. Then $f(x) \in f(U) \subset V$.





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(2 \Rightarrow 1) Let V be MIC-open set in Ω_2 and $x \in V$. Then V is MIC-open in Ω_2 and $f(x) \in V$. From the hypothesis, there exists an MIC- β -open set U in Ω_1 containing x such that $f(U) \subset V$. Then $x \in U \in \mathcal{U}(\Omega_1)$, i.e. $f^{-1}(V)$ is MIC- β -open set in Ω_1 . Therefore, f is MIC- β -continuous.

MICR- β -I-Irresolute

MIC- β -Irresolute

If for each $V \in \text{MIC-}\beta\text{-O}(\Omega_2, \mu_R(X_2)), f^{-1}(V) \in \text{MIC-}\beta\text{-O}(\Omega_1, \mu_R(X_1))$.

Theorem 4.1.2

Every MIC-irresolute is MIC- β -irresolute.

Proof

Let f be a MIC-irresolute function. Then $f^{-1}(V)$ is MIC-semi-closed in $(\Omega_1, \mu_R(X_1), \text{ID})$, for every MIC-semi-closed in $(\Omega_2, \mu_R(X_2))$, $f^{-1}(V)$ is MIC- β -closed in $(\Omega_1, \mu_R(X_1), \text{ID})$. Therefore, f is MIC- β -irresolute function.

Remark 4.1.3.

Every MIC- β -irresolute is not MIC-irresolute.

Example: 4.1.4

Let $\Omega_1 = \{l_1, m_1, n_1, o_1\}, \frac{\Omega_1}{R}(X_1) = \{\{n_1\}, \{l_1, m_1\}, \{o_1\}\}$ with $X_1 = \{m_1, o_1\}, \mu = \{n_1\}$, Micro open set $(X_1) = \{\emptyset, \Omega_1, \{n_1\}, \{o_1\}, \{l_1, m_1, o_1\}, \{n_1, o_1\}, \{l_1, m_1\}, \{l_1, m_1, n_1\}\}$, and Micro closed set $(X_1) = \{\emptyset, \Omega_1, \{n_1\}, \{o_1\}, \{l_1, m_1, o_1\}, \{n_1, o_1\}, \{l_1, m_1\}, \{l_1, m_1, n_1\}\}$, $I = \{\emptyset, \{m_1, n_1\}\}$, and $\Omega_2 = \{l_2, m_2, n_2, o_2\}, \frac{\Omega_2}{R}(X_2) = \{\{l_2, n_2\}, \{m_2\}, \{o_2\}\}, X_2 = \{l_2, o_2\}, \mu = \{m_2\}$, Micro open set $(X_2) = \{\emptyset, \Omega_2, \{m_2\}, \{o_2\}, \{l_2, n_2, o_2\}, \{m_2, o_2\}, \{l_2, n_2\}, \{l_2, m_2, n_2\}\}$, and Micro closed set $(X_2) = \{\emptyset, \Omega_2, \{m_2\}, \{o_2\}, \{l_2, n_2, o_2\}, \{m_2, o_2\}, \{l_2, n_2\}, \{l_2, m_2, n_2\}\}$, $I = \{\emptyset, \{l_2, m_2\}\}$. Define $f: (\Omega_1, \mu_R(X_1), I_1) \rightarrow (\Omega_2, \mu_R(X_2), I_2)$ as $f(l_1) = n_2, f(m_1) = o_2, f(n_1) = m_2, f(o_1) = l_2$. Then the inverse image of each MIC- β -closed set in Ω_2 is MIC- β -closed in Ω_1 . Therefore, f is MIC- β -irresolute. But f is not MIC-irresolute because, the subset $\{l_2, m_2, o_2\}$ is MIC- β -closed in $\Omega_2, f^{-1}(\{l_2, m_2, o_2\}) = \{m_1, n_1, o_1\}$ is not MIC-semi-closed in Ω_1 .

MIC- β -I-Irresolute

If for each $V \in \text{MIC-}\beta\text{-O}(\Omega_2, \mu_R(X_2)), f^{-1}(V) \in \text{MIC-}\beta\text{-I-O}(\Omega_1, \mu_R(X_1))$.

Theorem 4.2.1

Every MIC- β -I-irresolute is MIC- β -irresolute.

Proof Let f be a MIC- β -I-irresolute function. Then $f^{-1}(V)$ is MIC- β -I-closed in $(\Omega_1, \mu_R(X_1), \text{ID})$, for every MIC- β -closed in $(\Omega_2, \mu_R(X_2))$, $f^{-1}(V)$ is MIC- β -closed in $(\Omega_1, \mu_R(X_1), \text{ID})$. Therefore, f is MIC- β -irresolute function.

Remark 4.2.2.

Every MIC- β -I-irresolute is not MIC- β -I-irresolute.

Example 4.2.3

Let $\Omega_1 = \{i_1, j_1, k_1, l_1\}, \frac{\Omega_1}{R}(X_1) = \{\{k_1\}, \{i_1, j_1\}, \{l_1\}\}$ with $X_1 = \{i_1\}, \mu = \{k_1\}$, Micro open set $(X_1) = \{\emptyset, \Omega_1, \{k_1\}, \{o_1\}, \{i_1, j_1, k_1\}, \{i_1, j_1\}\}$, and Micro closed set $(X_1) = \{\emptyset, \Omega_1, \{n_1\}, \{o_1\}, \{l_1, m_1, o_1\}, \{n_1, o_1\}, \{l_1, m_1\}, \{l_1, m_1, n_1\}\}$, $I = \{\emptyset, \{i_1, j_1\}, \{i_1, j_1\}\}$, and $\Omega_2 = \{i_2, j_2, k_2, l_2\}, \frac{\Omega_2}{R}(X_2) = \{\{i_2, l_2\}, \{j_2\}, \{k_2\}\}, X_2 = \{j_2, k_2\}, \mu = \{l_2\}$, Micro open set $(X_2) = \{\emptyset, \Omega_2, \{l_2\}, \{j_2, k_2, l_2\}, \{j_2, k_2\}\}$, $I = \{\emptyset, \{j_2\}, \{k_2, l_2\}\}$. Define $f: (\Omega_1, \mu_R(X_1), I_1) \rightarrow (\Omega_2, \mu_R(X_2), I_2)$ as $f(i_1) = k_2, f(j_1) = l_2, f(k_1) = j_2$.



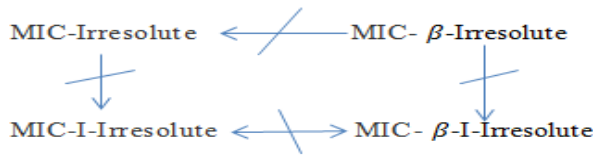


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$f(l_1)=i_2$. Then the inverse image of each MIC- β -closed set in Ω_2 is MIC- β -closed in Ω_1 . Therefore, f is MIC- β -irresolute. But f is not MIC- β -I-irresolute because, the subset $\{i_2, j_2, l_2\}$ is MIC- β -closed in Ω_2 . $f^{-1}(\{i_2, j_2, l_2\}) = \{j_1, k_1, l_1\}$ is not MIC- β -I-closed in Ω_1 .

Remark 4.2.4

We obtain the following diagram, where $A_1 \rightarrow A_2$ represents A_1 implies A_2 but not conversely.



CONCLUSION

Here's a look at some of Micro topological spaces , Let's consider something new type Micro- β -open sets in addition to describing the ongoing work of Micro- β -continuous function in MTS also discuss the properties and its use. This Paper was introduced Micro- β -I-open sets and Micro- β -I-continuity , Micro- β -I-Irresolute on MTS and investigated some of the basic structures in MTS. Various interesting problems set identified in the analysis . Future research will be considered about MTS applications.

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Evaluation of Anti Microbial Activity of the Siddha Formulation Tablet Linga Boopathy using Resazurin Microtitre Assay

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 10 Jun 2024

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ABSTRACT

Infectious diseases are observed to be the most important threat to human health. Majority of the presently available antibiotics have notable disadvantages in terms of antimicrobial spectrum and side effects. Over usage of such antibiotics is causing clinical resistance in microorganisms. *Siddha* system of medicines have the possibilities in combating drug-resistant pathogens. One such probable formulation in the *Siddha* system is Tablet *Linga Boopathy* which is indicated for fever, ulcer and worm infestations in *Siddha* literature. The objective of the study is to evaluate the anti-microbial efficacy of the formulation Tablet *Linga Boopathy* using Resazurin microtitre assay against the microbial strains of *Escherichia coli*, *Shigella Sonnei*, *Vibrio Cholerae* and *Candida albicans*. It was observed that the sample reveals significant action against the pathogen *Escherichia coli* with minimal inhibitory concentration value of 250 µg and *Shigella Sonnei* with the value of 500 µg with the lowest MIC values when compared to that of *Vibrio Cholerae* with minimal inhibitory concentration value of 1000 µg. Similarly, the sample demonstrate consistent anti-fungal action against *Candida albicans* with the MIC value of 500 µg. The study brings out the medical claims of the *Siddha* formulations possess dynamic antimicrobial actions and provide intense therapeutic advantages in infectious conditions.

Keywords: Antimicrobial, *Siddha* formulation, *Linga Boopathy*, Worm infestations, T.LB, *Invitro* study





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INTRODUCTION

Recent advancements in pharmaceuticals and development for unique chemical diverseness have reinforced the attempts for analysing leads from Siddha. Numerous plant extracts have been utilized to cure helminthic infections, gastrointestinal disorders, UTI, vaginitis, cervicitis, parasitic protozoan infections, respiratory diseases and inflammatory processes[1]. Antimicrobial resistance is a global challenge responsible for the high mortality and morbidity[2]. Finding therapeutic approaches against this resistance is a substantial worldwide challenge to the medical field[3]. In *Siddha* system of medicine Tablet. *Linga boopathyis* a herbomineral formulation consisting of *Syzygium aromaticum*. Linn (Ilavangam), *Tachyspermum ammi*. Linn (Omam), Red ochre (Poonkaavi), Mercuric sulphide (Lingam), artificially processed mercuric sulphide (Rasa chenduram), Hydragyrum subchloride (Rasa karpooram). It is used in *Siddha* medicine in treating fever, worm infestations, gastric ulcer[4]. The primary aim of the study is about to evaluate the anti-microbial efficacy of the formulation Tablet *Linga boopathy* using Resazurin microtitre assay.

MATERIALS AND METHODS

Procurement of the test drug

The test drug was purchased from GMP certified company IMPCOPS and used for analysis.

Ingredients of the test drug- Tablet *Linga boopathy*

1. *Syzygium aromaticum*. Linn (Ilavangam)
2. *Tachyspermum ammi*. Linn (Omam)
3. Red ochre (Poonkaavi)
4. Mercuric sulphide (Lingam)
5. artificially processed mercuric sulphide (Rasa chenduram)
6. Hydragyrum subchloride (Rasa karpooram)

Antimicrobial activity

The bacterial species of *Escherchia coli*, *Vibrio cholerae*, *Shigella sonnei* and the fungal species of *Candida albicans* were obtained from CLATR, Sathyabama university, Tamil Nadu.

Determination of MIC (Minimum inhibitory concentration) of the siddha formulation Tablet *Linga boopathy* using Resazurin Microtitre Assay

Test was performed in a 96 well Plates under sterile technique. An aseptic 96 well plate was marked. Volume of sample in DMSO comprises of 1000 µg was pipetted into the first well of the plate and transferred to subsequent wells by half of its weight until 8th Well. Then, 50 µl of nutrient broth was added to all other wells and serially diluted it. After that, 10 µl of resazurin indicator solution was added to each well. To each well 10 µl of bacterial/ fungal suspension was added. All the plates were wrapped loosely with cling film to make sure that bacteria did not turn into dehydrated. For 24-48 hours, the plate was incubated at 37 °C. The colour change was visualised. Any colour variations from purple to pink or colourless were documented as positive. MIC value was determined from the lowest concentration at which colour change occurred.

- Standard drug Chloramphenicol (10µg) was used as a positive control to determine the bacterial pathogens sensitivity.
- Standard drug Fluconazole (20µg) was used as a positive control to determine the x fungal pathogens sensitivity.

Color (+) Positive Value indicates the pale pink color in the well – Means there is no anti-microbial activity
Pale Pink for the sample in that particular well

Color Dark (-) Negative Value indicates the pale Dark purple Colour in the well – Means there is good anti-microbial activity for the sample in that particular well
purple





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RESULTS

It was observed from the results of the present investigation that the sample reveals convincing anti-microbial activity among all tested organisms. It was observed that the sample reveals significant activity against the pathogen *E-coli* (MIC 250 µg) and *Shigella Sonnei* -SS (MIC 500 µg) with the lowest MIC values when compared to that of *Vibrio Cholerae* – VC with MIC value of 1000 µg. Similarly, the sample demonstrate consistent anti-fungal activity against *Candida albicans* with the MIC value of 500 µg.(Table :1-3)

DISCUSSION

Antimicrobial activity of each ingredients of the *Siddha* formulation Tablet *Linga boopathy* has been considerably studied in preceding researches in current years. The ingredient *Syzygium aromaticum*. Linn (*Ilavangam*) exhibits antimicrobial activity due to the phenolic compounds mainly eugenol[5]. *Tachyspermum ammi*. Linn (*Omam*) encompasses thymol that has antifungal activity[6]. Red ochre (*Poonkaavi*) is a mineral depicted in *Siddha* literature under "*Uparasam*" class. It is used against herpes infection, bleeding disorders, vomiting, diarrhea, eye diseases and dental problems[7]. It is one of the sources of Iron. A fine powder of red ochre is prescribed for various skin conditions like leucoderma, scabies, psoriasis[8]. Mercuric sulphide (*Lingam*) is detailed in *Siddha* literature that comes under "*Pancha sootham*" and it influences on three humours, alleviates *kabam* and *pitham*. It is used in the treatment of fever, diarrhea, non healing ulcers, urticaria, eczema, scabies, leprosy, neurofibromatosis etc[7]. *Lingam* has anti-inflammatory, anti-pyretic and analgesic actions. *Linga chendooram* is the *Siddha* formulation in which *lingam* is a key ingredient, is used to treat fevers, venereal diseases and skin diseases and also has potent antibacterial actions against *E.coli*, *K.pneumoniae* and *S.aureus*. In *S.typhi* and *V.cholerae*, it shows moderate anti bacterial actions at 3mg and 4mg concentration[9]. Artificially processed mercuric sulphide (*Rasa chenduram*) has been used in traditional medicines for the treatment of pyrexia, pneumonia, neurological disorders, syphilis, paralysis of the tongue and insomnia[10]. Hydrargyrum subchloride (*Rasa karpooram*) has the therapeutic effect in venereal diseases, worm infestations, bacillary dysentery, scabies, pyrexia, syphilis, uterine cancer, chronic non healing ulcers etc[11]. *E.coli* is a gram negative, rod shaped, anaerobic coliform bacterium commonly present in humans gastrointestinal tract. This can cause food poisoning[12]. *Shigella sonnei* is a gram-negative, rod-shaped bacterium which is a causative agent of bacillary dysentery. It is transmitted through the fecal-oral route[13]. *Vibrio cholerae*, a Gram-negative bacteria which is responsible for fatal conditions like cholera and acute diarrhoea[14]. *Candida albicans* is a pathogenic yeast detected in the mouth and gastrointestinal tracts of human beings. *Candida* causes candidiasis which results in overgrowth of fungus, HIV infected patients[15]. It was observed that T.LB reveals significant anti bacterial activity against *E-coli* (MIC 250 µg), *Shigella Sonnei* (MIC 500 µg) and *Vibrio Cholerae* with MIC value of 1000 µg. Similarly, the sample demonstrate consistent anti-fungal activity against *Candida albicans* with the MIC value of 500 µg.

CONCLUSION

In this study, the *Siddha* formulation tablet *Lingaboopathy* was evaluated for its anti microbial activity. The study brings out the medical claims of the *Siddha* formulations possess dynamic antimicrobial actions and provide intense therapeutic advantages in infectious conditions like urinary tract infections, bacillary dysentery, diarrhea, cholera, candidiasis.

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Table 1. Anti-bacterial activity: T-LB (Growth of inhibition chart for the sample and standard drug)

S.No	Sample/ Microorganisms	Growth of inhibition										
		W-1 1000 µg	W-2 500 µg	W-3 250 µg	W-4 125 µg	W-5 62.5 µg	W-6 31.2 µg	W-7 15.6 µg	W-8 7.8 µg	STD Chloramphenicol (10µg)	DMSO	Culture
1	<i>E-coli - EC</i>	-	-	-	+	+	+	+	+	-	+	+
2	<i>Shigella Sonnei - SS</i>	-	-	+	+	+	+	+	+	-	+	+
3	<i>Vibrio Cholerae - VC</i>	-	+	+	+	+	+	+	+	-	+	+





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Table 2. Anti-fungal activity: T-LB (Growth of inhibition chart for the sample and standard drug)

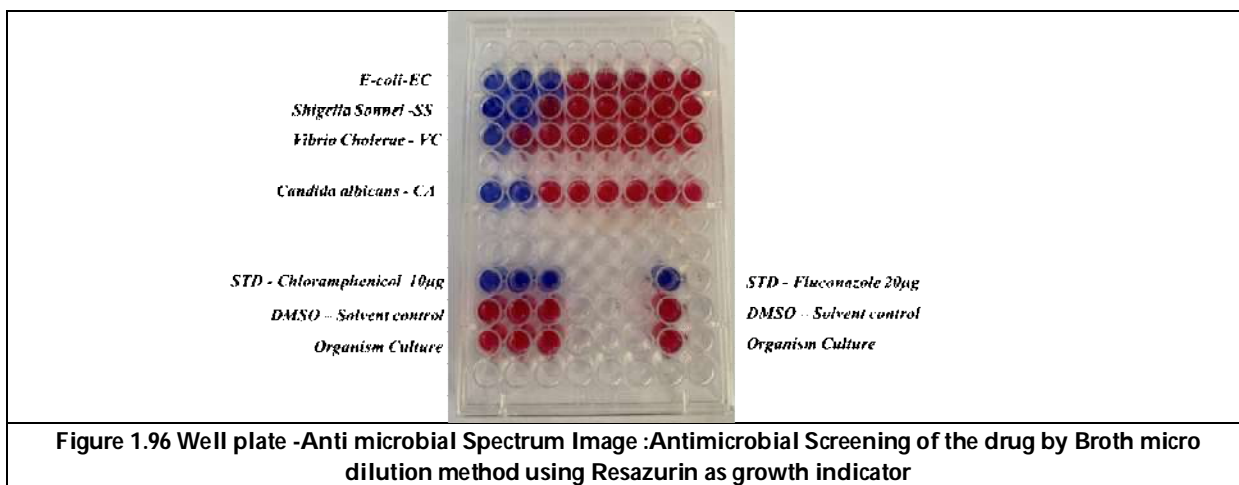
S.No	Sample/ Microorganisms	Growth of inhibition										
		W-1 1000 µg	W-2 500 µg	W-3 250 µg	W-4 125 µg	W-5 62.5 µg	W-6 31.2 µg	W-7 15.6 µg	W-8 7.8 µg	STD Fluconazole (20µg)	DMSO	Culture
1	Candida albicans - CA	-	-	+	+	+	+	+	+	-	+	+

The Symbol (+) indicates the growth of microorganism

The Symbol (-) indicates no growth of microorganism

Table 3. Report on MIC (Minimum inhibitory concentration) value of the Sample : T-LB

S.No	Name of the Organism	MIC Value (µg)
1	E-coli - EC	250 µg
2	Shigella Sonnei -SS	500 µg
3	Vibrio Cholerae - VC	1000 µg
4	Candida albicans - CA	500 µg





On Edge Pebbling Number and Cover Edge Pebbling Number of the Sunflower Graph (SF_n)

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Received: 21 Feb 2024

Revised: 10 Apr 2024

Accepted: 06 Jun 2024

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ABSTRACT

Let G be a connected graph. An edge pebbling move on a graph G is defined to be the removal of two pebbles from one edge and the addition of one pebble to an adjacent edge. An edge pebbling number $P_E(G)$ is defined to be the least number of pebbles such that any distribution of $P_E(G)$ pebbles on the edges of G allows one pebble to be moved to any specified, but arbitrary edge. A cover edge pebbling number $CP_E(G)$ of a graph G is defined as, however the pebbles are initially placed in the edges, the minimum number of pebbles required to place a pebble in all the edges. In this paper we find the edge pebbling number and cover edge pebbling number of the sunflower graph SF_n .

Keywords: Edge pebbling number, Cover edge pebbling number, Edge Demonic graph, Sunflower graph.

INTRODUCTION

Lagarias and Saks first suggested the game of pebbling. Later by Chung ^[1], it was introduced into the literature. Removal of two pebbles from one vertex and placement of one pebble on the adjacent vertex is called pebbling move. Given a connected graph G . The pebbling number $\pi(G)$ of G is the least number of pebbles needed in a graph G so that we can move a pebble to any arbitrary target vertex by a sequence of pebbling move whatever might be the initial configuration is. The concept of cover pebbling was first introduced by Crull ^[2]. The cover pebbling number is the least number of pebbles needed in a graph G so that we can move one pebble to all the vertices of the graph G .





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In [3] a new concept namely edge pebbling move, edge pebbling number and cover edge pebbling number has been introduced and cover edge pebbling number for certain standard graphs namely path, complete graph, friendship graph and star graph have been determined. In edge pebbling, pebbles will be distributed on the edges of the graph instead of the vertices. An edge pebbling move is the process of removing two pebbles from one edge and placing one pebble on its adjacent edge. Edge pebbling number $P_E(G)$ is the minimum number of pebbles needed in a graph G to reach any arbitrary target edge by a sequence of edge pebbling move regardless of initial configuration of pebbles. The cover edge pebbling number $CP_E(G)$ is the least number of pebbles needed in a graph G so that we can move one pebble to all the edges of the graph G . In this paper we establish the edge pebbling number and cover edge pebbling number for Sunflower Graph (SF_n).

EDGE PEBBLING NUMBER

Definition: 2.1[3] An edge pebbling move on a graph G is defined to be the removal of two pebbles from one edge and the addition of one pebble to an adjacent edge.

Definition : 2.2[3] An edge pebbling number $P_E(G)$ is defined to be the least number of pebbles such that any distribution of $P_E(G)$ pebbles on the edges of G allows one pebble to be moved to any specified, but an arbitrary edge.

Definition:2.3 [5] A graph G is said to be edge demonic if the edge pebbling number equals the number of edges. i.e., A graph G is said to be edge demonic if $P_E(G) = q$.

Definition : 2.4 [4]A Sunflower graph consists of a wheel with n - cycle $v_0, v_1, v_2, \dots, v_n$ (v_0 is a central vertex) and additional n - vertices w_1, w_2, \dots, w_n where w_i is joined with edges to (v_i, v_{i+1}) ; $i = 1, 2, \dots, n$; $i+1$ is taken as modulo n . It is represented by SF_n .

Theorem : 2.5 The edge pebbling number of the Sunflower graph is $4n$ (i.e) $P_E(G) = 4n$ ($n \geq 3$).

Proof : To prove : $P_E(SF_n) = 4n$

Claim : $P_E(SF_n) \geq 4n$

(i,e) atleast $4n$ pebbles are required to reach the target edge.

Suppose, $P_E(SF_n) < 4n$., then $4n-1$ pebbles are enough to reach any target edge regardless of the configuration of pebbles. But on considering the worst case (i,e) placing one pebble on each edge there will be edges without pebble since the number of edges in SF_n is $4n$.

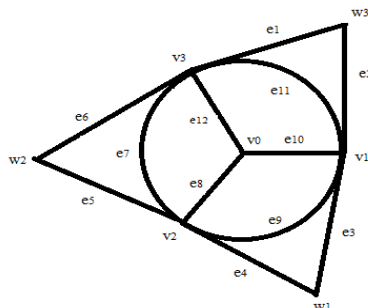
Hence $P_E(SF_n)$ cannot be less than $4n$.

Therefore, $P_E(SF_n) \geq 4n$.

Claim : $P_E(SF_n) = 4n$.

Consider the sunflower graph SF_3 ;

Let us consider the distribution of pebbles on the edges of the graph SF_3 in all possible ways.



SF₃

Distribution of pebbles for two edges by the above possible ways to reach the target edge (i,e) Placing pebbles on the edges $(e_1, e_2), (e_1, e_3), \dots, (e_1, e_{12}), (e_2, e_1), (e_2, e_3), \dots, (e_2, e_{12}), \dots, (e_{12}, e_1), (e_{12}, e_2), \dots, (e_{12}, e_{11})$ and vice versa. Distribution of





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Pebbles for three edges by the above possible ways to reach the target edge. (i,e)Placing pebbles on the edges $(e_1, e_2, e_3), (e_1, e_2, e_4), \dots, (e_1, e_2, e_{12}), (e_2, e_1, e_3), (e_2, e_1, e_4), \dots, (e_2, e_1, e_{12}), (e_3, e_2, e_1), (e_3, e_2, e_4), \dots, (e_3, e_2, e_{12}), \dots, (e_{12}, e_1, e_2), (e_{12}, e_1, e_3), \dots, (e_{12}, e_1, e_{11}), \dots, (e_{12}, e_{11}, e_{10})$ and vice versa. Distribution of pebbles for four edges by the above possible ways to reach the target edge. (i,e) Placing pebbles on the edge $(e_1, e_2, e_3, e_4), (e_1, e_2, e_3, e_5), \dots, (e_1, e_2, e_3, e_{12}), \dots, (e_{12}, e_2, e_3, e_4), \dots, (e_{12}, e_{11}, e_{10}, e_9)$ and vice versa.

Similarly for distribution of pebbles by the above possible ways for five edges, six edges, seven edges, eight edges, nine edges, ten edges, eleven edges, twelve edges, Therefore we can reach any of the target edge of SF_3 , with 12 pebbles.
 $P_E(e_1) = 12, P_E(e_2) = 12, P_E(e_3) = 12, P_E(e_4) = 12, P_E(e_5) = 12, P_E(e_6) = 12, P_E(e_7) = 12,$
 $P_E(e_8) = 12, P_E(e_9) = 12, P_E(e_{10}) = 12, P_E(e_{11}) = 12, P_E(e_{12}) = 12.$
 Now, by the definition of edge pebbling number,
 $P_E(SF_3) = \text{Max} \{P_E(e_i) / i = 1 \text{ to } 12\} = 12$

Hence $P_E(SF_3) = 12 = 4(3).$

Since the pattern of SF_3 is same for $SF_n, \forall n \geq 4$, we can conclude that $P_E(SF_n) = 4n.$

Therefore, the edge pebbling number of the sunflower graph SF_n is $4n.$

Theorem :2.6 The Sunflower graph is an edge demonic graph.

Proof: By the definition of edge demonic graph, a graph is said to be edge demonic if the edge pebbling number equals the number of edges. The number of edges of Sunflower graph is $4n$ and by the previous theorem, $P_E(SF_n)=4n.$ Hence the number of edges of Sunflower graph equals its edge pebbling number. Therefore, The Sunflower graph is an edge demonic graph.

COVER EDGE PEBBLING NUMBER

Definition 3.1 [3] A cover edge pebbling number $CP_E(G)$ of a graph is defined as, however the pebbles are initially placed in the edges, the minimum number of pebbles required to place a pebble in all the edges.

Definition : 3.2 [3] The distance $d(x)$ of an edge x in a graph G is the sum of the distances from each of the edges of $E(G)$, where $E(G)$ is the edge set of $G.$

i.e., $d(x) = \sum_{y \in E(G)} d(y, x) \quad \forall y \in E(G), x \neq y.$

Definition : 3.3[3] Let $x \in E(G).$ Then x is called a key edge if $d(x)$ is maximum.

Procedure to find the Cover Edge Pebbling Number of a Graph:

- Step 1:** Find the key edges of the given graph. Choose any one arbitrarily.
- Step 2:** Find all the distance zero edges of the given graph from the chosen key edge
- Step 3:** The number of pebbles to be placed in the chosen edge is 2 times of the edges obtained in step 2
- Step 4:** Find all the distance one edges of the given graph from the chosen key edge
- Step 5:** The number of pebbles to be placed in the chosen edge is 2^2 times of the edges obtained in step 4
- Step 6:** Find all the distance two edges of the given graph from the chosen key edge
- Step 7:** The number of pebbles to be placed in the chosen edge is 2^3 times of the edges obtained in step 6
- Step 8:** Continue the process until all the edges are taken into consideration except the chosen key edge
- Step 9:** Place one more pebble in the chosen key edge to cover itself
- Step 10:** Sum of all the pebbles placed in the chosen key edge during the above procedure is the cover edge pebbling number of the given graph

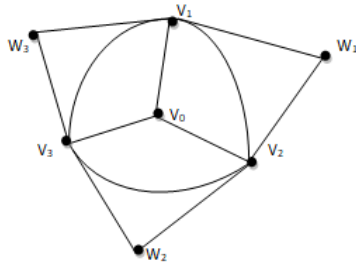
Theorem : 3.4 The cover edge pebbling number of a sunflower graph SF_3 is 35. i.e., $CP_E(SF_3) = 35.$





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Proof :

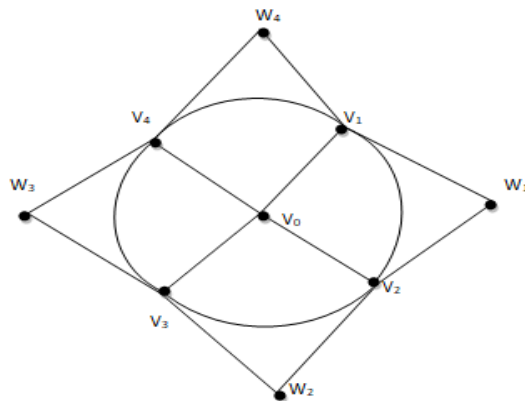


In Sunflower graph all the boundary edges are the key edges. Choose any one of the key edge from SF_3 . Let it be e^* . Each of the key edges are adjacent with 5 edges. To place one pebble on each of those 5 edges, $5(2) = 10$ pebbles are to be placed on e^* . Now, there are 6 remaining edges to be pebbled, which are not adjacent to e^* but adjacent with all other edges (on excluding the edge e^*). So, $6(4) = 24$ pebbles are to be on e^* to cover those 6 edges. Then one more pebble has to be placed on e^* to cover itself. Therefore, the cover edge pebbling number of a Sunflower graph SF_3 is 35.

(ie) $CP_E(SF_3) = 35$.

Theorem : 3.5 The cover edge pebbling number of a sunflower graph is 59. i.e., $CP_E(SF_4) = 59$.

Proof :



In Sunflower graph all the boundary edges are the key edges. Choose any one of the key edge from SF_4 . Let it be e^* . Each of the key edges are adjacent with 5 edges. To place one pebble on each of those 5 edges, $5(2) = 10$ pebbles are to be placed on e^* . On excluding the key edge e^* , now there are 8 edges to be pebbled. These 8 edges can be reached by crossing exactly one edge from e^* . So, $8(4) = 32$ pebbles has to be on e^* to cover those 8 edges. Now, there are 2 remaining edges to be pebbled (excluding the key edge e^*). Those 2 edges can be reached by crossing exactly two edges. Therefore, $2(8) = 16$ pebbles are to be on e^* to cover those 2 edges. Then one more pebble has to be on e^* to cover itself. Therefore, the cover edge pebbling number of sunflower graph SF_4 is 59. (ie) $CP_E(SF_4) = 59$.

Theorem : 3.6 The cover edge pebbling number of a sunflower graph SF_n is $28n-53$ ($n \geq 4$), i.e., $CP_E(SF_n) = 28n - 53$.

Proof : In sunflower graph all the boundary edges are the key edges. Choose any one of the key edge from SF_n . Let it be e^* . Each key edge is adjacent with 5 edges. Therefore, e^* is adjacent with 5 edges. Let e_1, e_2, e_3, e_4, e_5 be the 5 edges adjacent with e^* . To place one pebble on each of those 5 edges, $5(2) = 10$ pebbles are needed on e^* . On excluding the key edge e^* , now there are $4n-6$ edges to be placed. Among them $n+4$ edges are adjacent to those 5 edges e_1, e_2, e_3, e_4, e_5 . These $(n+4)$ edges can be reached by crossing exactly one edge. $\cdot 4(n+4)$ pebbles has to be on e^* to cover those





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$(n+4)$ edges. Now there are $(3n-10)$ remaining edges to be pebbled (On excluding the key edge e^*). Those $(3n-10)$ edges can be reached by crossing exactly two edges. So, $8(3n-10)$ pebbles has to be on e^* to cover those $(3n-10)$ edges. Finally, one more pebble has to be placed on e^* to cover itself. Hence, the cover edge pebbling number of Sunflower graph SF_n is $28n - 53$.

CONCLUSION

In this paper we find the edge pebbling number and the cover edge pebbling number of the Sunflower graph.

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Table 1.

Number of pebbles	Distribution	Possible ways to reach the target edge
12	One Edge	12-0
	Two Edges	11+1
		10+2
		9+3
		8+4
		7+5
		6+6
	Three Edges	10+1+1
		9+2+1
		8+3+1
		8+2+2
		7+4+1
		7+3+2
6+5+1		
6+4+2		
6+3+3		
5+4+3		
5+5+2		
4+4+4		





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	Four Edges	9+1+1+1 8+2+1+1 7+3+1+1 7+2+2+1 6+4+1+1 6+3+2+1 6+2+2+2 5+5+1+1 5+4+2+1 5+3+3+1 5+3+2+2 4+4+3+1 4+4+2+2 4+3+3+2 3+3+3+3
	Five Edges	8+1+1+1+1 7+2+1+1+1 6+3+1+1+1 6+2+2+1+1 5+4+1+1+1 5+4+1+1+1 5+2+2+2+1 4+4+2+1+1 4+3+3+1+1 4+3+2+2+1 4+2+2+2+2 3+3+3+2+1 3+3+2+2+2
	Six Edges	7+1+1+1+1+1 6+2+1+1+1+1 5+3+1+1+1+1 5+2+2+1+1+1 4+4+1+1+1+1 4+3+2+1+1+1 4+2+2+2+1+1 3+3+3+1+1+1 3+3+2+2+1+1 3+2+2+2+2+1 2+2+2+2+2+2
	Seven Edges	6+1+1+1+1+1+1 5+2+1+1+1+1+1 4+3+1+1+1+1+1 4+2+2+1+1+1+1 3+3+2+1+1+1+1 3+2+2+2+1+1+1 2+2+2+2+2+1+1
	Eight Edges	5+1+1+1+1+1+1+1 4+2+1+1+1+1+1+1 3+3+1+1+1+1+1+1





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		3+2+2+1+1+1+1+1 2+2+2+2+1+1+1+1
	Nine Edges	4+1+1+1+1+1+1+1+1 3+2+1+1+1+1+1+1+1 2+2+2+1+1+1+1+1+1
	Ten Edges	3+1+1+1+1+1+1+1+1+1 2+2+1+1+1+1+1+1+1+1
	Eleven Edges	2+1+1+1+1+1+1+1+1+1+1
	Twelve Edges	1+1+1+1+1+1+1+1+1+1+1+1





Assessment of Correlation Coefficient, Path Analysis and Genetic Divergence in Tomato (*Solanum lycopersicum* L.) Genotypes through Cluster Analysis

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 14 Jun 2024

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ABSTRACT

In the present study, fifty seven genotypes of tomato (*Solanum lycopersicum* L.) were examined for correlation and path coefficient analysis on yield and yield contributing characters and design used is RBD with three replications during summer season 2023. Observation was taken from five randomly selected plants for yield and yield characters. The results shows that the fruit weight, fruit length, fruit width, pericarp thickness and lycopene content shown positive significant correlation with yield per plant. However, fruit weight has the highest positive direct effect in the path coefficient analysis, followed by number of fruits per plant, lycopene content, plant height, number of primary branches, fruit length, pericarp thickness and titrable acidity. The maximum intra cluster distance were acquired for cluster VI followed by cluster VII. The highest inter cluster distance were detected between cluster VI and VII.

Keywords: Germplasm, Genetic diversity, Phenotypic coefficient, Path coefficient and Clusters





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INTRODUCTION

Tomato (*Solanumlycopersicum* L.) belongs to the family solanaceae. It is a self-pollinated annual crop and characterised by its $2n=2x=24$ chromosomes. It has greatest economical and nutritional value. It is commonly used as vegetable crop as both fresh fruit market and the processed food business around the world. Tomato has several used in human nutrition and consumes raw, cooked and processed into a different value added products (Kherwaet *al.*, 2023). It became more popular with consumers for their valuable properties, farmers for their high market value, and researchers for their genetic and genomic characteristics. About 90% of tomato is containing water, followed by soluble and insoluble solids (5-7%), citric acid and other organic acids. Though it is having good nutritional value, tomatoes are called as "Poor man's orange". Higher concentration of antioxidants like lycopene seen in ripened tomatoes which prevents cancers (Arya *et al.*, (2023). Scheduling of the breeding programme among the available genotypes would help from knowledge of the correlation among the characters. Valuation of genotypic and phenotypic coefficients of variation among the specific germplasm specifies the environmental effects upon the genotypes to be measured for the crop improvement. In breeding strategy, quality improvement of tomato fruits are equally important. Assessment of quality related attributes in tomato fruit shows wide genetic variation that could be used for crop improvement (Sahooet *al.*, 2022). Considerate of the genetic diversity originate in populations can be gained over correlation and path analysis. The purpose of correlation study is primarily to know about the suitability of various characters for indirect selection for one or more attributes which results in correlated response for several other attributes. Correlation coefficient helps to determine the nature and degree of relationship between any two measurable characters (Tsagayeet *al.*, 2022). Using path analysis, the correlation coefficient can be divided into direct and indirect effects on yield and yield components. The path coefficient analysis measures the separation of correlation coefficient into components of direct and indirect effects.

Crop genetic diversity should be considered a sustainable approach for a climate resilient and self-dependent production system. The higher the genetic diversity in farming land, the more chances of receiving multiple benefits in the agriculture system (Vermaet *al.*, (2023). Recent best cultivars are created by arduous selection and have been very successful in increasing phenotypic diversity as well as increased yield and productivity. Conversely, it has resulted in a perceptible loss of genetic diversity and a significant debility in landraces habit (Grozevaet *al.*, (2023). Knowledge of genetic divergence, its nature and degree is valuable for any heritable improvement programme (Spaldon and Kumar, 2017) and estimation of genetic distance is one of the suitable tools for parental selection in hybridization programme (Kumar *et al.*, (2017). Genetic divergence refers to the genetic distance between species or between populations within a species. Various observations are used to measure the genetic distance (Dar *et al.*, (2017). The significance of genetic diversity is manifest in relations of survival and adaptability of a species. For instance, a species with high genetic diversity will tend to produce a wider variety of offspring. In most of the vegetables like tomato, evaluation of genetic divergence have been proposed to provide diverse parents for getting high yielding hybrids (Sharma *et al.*, 2008). Mahalanobis D^2 statistics deals a reliable technique to estimate the genetic divergence available in the population (Mahalanobis, 1936). The present study was commenced to estimate correlation, path coefficient analysis and categorize the available germplasm into separate clusters on the basis of genetic diversity among their morphological and quality attributes using tocher method of clustering analysis of tomato germplasm.

MATERIALS AND METHODS

The experiment was conducted at Farmers field of Punganur, Chittoor district of Andhra Pradesh, India in summer season, 2023. The experimental material comprised of 57 genotypes. The experiment was laid out in Randomized Block Design (RBD) with three replications. A spacing of 60 x 30 cm and all the recommended agronomic package of practices were followed (staking, earthing up, irrigation, weeding, fertilizers applications) as recommended for commercial tomato production. The data were recorded on five randomly selected plants per replication for all the 13 characters *viz.*, plant height (cm), number of primary branches, days to 50% flowering, number of fruits per plant,

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fruit weight (g), fruit length (cm), fruit width (cm), pericarp thickness (mm), total soluble solids (°Brix), lycopene content (mg/100g), ascorbic acid (mg/100g), titrable acidity (%) and yield per plant (g).

STATISTICAL ANALYSIS

The analysis of variance was done by the method suggested by Panse and Sukhatme (1957). The GCV and PCV were calculated using the formulae of Al-Jibouriet *al.*, (1958). The direct and indirect effect were calculated through path coefficient analysis as suggested by Wright (1921) and Dewy and Lu (1959) at both phenotypic and genotypic levels. D^2 statistics was used for evaluating the genetic divergence between populations. The generalized distance between any two populations is given by formula,

$$D^2 = A = \sum \sum \lambda_{ij} \delta_{ai} \delta_{aj}$$

Where, D^2 = Square of generalized distance; λ_{ij} = Reciprocal of the common disposal matrix; $\delta_{ai} = (\mu_{i1} - \mu_{i2})$; $\delta_{aj} = (\mu_{j1} - \mu_{j2})$

μ = General mean

The germplasms of tomato were grouped on the basis of minimum generalized distance using Tocher's method as described by Rao (1952). The average inter and intra cluster distances were calculated by the formula given by Singh and Chaudhary (1979).

RESULTS AND DISCUSSIONS

Genotypic correlation coefficients for 13 characters in 57 tomato accessions

Assessment of correlation coefficient are advantageous in determining yield components which can be used for genetic enhancement of yield and it quantifies the degree of genetic and non-genetic association between two or more characters. It could be effectively exploited to formulate selection based strategies to improve the yield and yield attributing components. Genotypic correlation indicated the inherent association between genes controlling any two attributes, thus helps in effective selection scheme. Phenotypic correlation does not provide true estimates of relationship between two characters because of environment influence (Vijaylaxmi *et al.*, 2021). The research work was conducted to find out the correlation and direct and indirect effect of yield and yield attributing components of tomato through path coefficient analysis. The estimation of genotypic and phenotypic correlation coefficient presented in (Table 1). Genotypic correlation of plant height was shown positive and negative significant with number of primary branches (0.264), number of fruits per plant (0.376), fruit weight (-0.274), fruit length (-0.332), fruit width (-0.339) and total soluble solids (0.154). Number of primary branches were shown positive and negative significant with days to 50% flowering (0.303), number of fruits per plant (0.247), pericarp thickness (-0.208) and total soluble solids (0.227). Days to 50% flowering were shown positive and negative significant with fruit weight (0.225), lycopene content (0.309), ascorbic acid (0.204) and titrable acidity (0.132). Number of fruits per plant were shown only negative significant in association with fruit weight (-0.541), fruit length (-0.398), fruit width (-0.451), pericarp thickness (-0.387), ascorbic acid (0.228) and yield per plant (-0.325). Fruit weight was correlated positively with fruit length (0.781), fruit width (0.795), pericarp thickness (0.674), lycopene content (0.223) and yield per plant (0.964). Fruit length was associated positively with fruit width (0.821), pericarp thickness (0.702), lycopene content (0.311) and yield per plant (0.756). Fruit width was positively associated with pericarp thickness (0.502), lycopene content (0.188) and yield per plant (0.729). Pericarp thickness was positively associated with total soluble solids (0.197), lycopene content (0.263), ascorbic acid (0.190) and yield per plant (0.672). Total soluble solids was positively associated with lycopene content (0.490) and ascorbic acid (0.256). Lycopene content was associated with ascorbic acid (0.342), titrable acidity (0.155) and yield per plant (0.299). Similar results were observed by Kousaret *al.*, (2021), Nevani and Sridevi (2021), Dhyani *et al.*, (2022), Veera *et al.*, (2022), Singh *et al.*, (2023), Gonzalo and Nancy (2023) and Kherwa *et al.*, (2023).

Phenotypic correlation coefficients for 13 characters in 57 tomato accessions

The phenotypic correlation coefficient among various attributes shown that the most principal attribute *i.e.* plant height showed positive and negative significant correlation with number of primary branches (0.258), number of





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fruits per plant (0.316), fruit weight (-0.245), fruit length (-0.313) and fruit width (-0.298). Number of primary branches showed only positive and significant correlation with number of fruits per plant (0.166) and total soluble solids (0.181). Days to 50% flowering showed positive and significant correlation with fruit weight (0.180), lycopene content (0.215), ascorbic acid (0.160) and titrable acidity (0.273). Number of fruits per plant showed positive and negative significant correlation with fruit weight (-0.510), fruit length (-0.362), fruit width (-0.398), pericarp thickness (-0.346) and ascorbic acid (0.212). Fruit weight showed positive and significant correlation with fruit length (0.755), fruit width (0.753), pericarp thickness (0.649), lycopene content (0.212) and yield per plant (0.832). Fruit length showed positive and significant correlation with fruit width (0.802), pericarp thickness (0.664), lycopene content (0.294) and yield per plant (0.652). Fruit width showed positive and significant correlation with pericarp thickness (0.464), lycopene content (0.169) and yield per plant (0.625). Pericarp thickness showed positive and significant correlation with total soluble solids (0.184), lycopene content (0.253), ascorbic acid (0.184) and yield per plant (0.585). Total soluble solids showed positive and significant correlation with lycopene content (0.453) and ascorbic acid (0.251). Lycopene content showed positive and significant correlation with ascorbic acid (0.323) and yield per plant (0.243). Similar kind of studies were observed by Vijaylaxmiet al., (2021), Kumar et al., (2021), Kumar et al., (2021), Sahooet al.,(2022), Tsagayeeet al., (2022), Kumar et al., (2023), Arya et al., (2023) and Celiket al., (2023).

Path Coefficient Analysis

The genotypic path analysis estimates in (Table 2) specified that fruit weight (1.20283) has shown the highest positive effect on yield per plant followed by number of fruits per plant (0.24551), lycopene content (0.08596), plant height (0.08224), number of primary branches (0.06716), fruit length (0.03379), pericarp thickness (0.00881) and titrable acidity (0.00594). It was also observed that the high negative effect was applied by days to 50% flowering (-0.16383), fruit width (-0.11869), total soluble solids (-0.04146) and ascorbic acid (-0.04009). Similar results were observed by Alam and Paul (2019), Gillaniet al., (2019), Kumar et al., (2020), Limbaniet al., (2020), Sushmaet al., (2020), Dhyaniet al., (2022), Kerwaet al., (2023), Arya et al., (2023), Celiket al., (2023), Singh et al., (2023). The phenotypic path analysis. It specified that there was a significant positive direct effect for fruit weight (1.00345) followed by number of fruits per plant (0.41096), pericarp thickness (0.08842), total soluble solids (0.03179), plant height (0.02969), fruit width (0.01051) and number of primary branches (0.00141). It was also observed that the high negative effect on ascorbic acid (-0.07404), days to 50% flowering (-0.05735), titrable acidity (-0.02149), lycopene content (-0.01455) and fruit length (-0.00758). similar results were observed by Alam and Paul (2019), Reddy et al., (2019), Mauryaet al., (2020), Lekshmi and Celine (2020), Vijaylaxmiet al., (2021), Kumar et al., (2021), Kerwaet al., (2023), Arya et al., (2023).

Clustering Pattern of the Tomato Genotypes

The genetic diversity for 57 germplasms of tomato was evaluated for yield and yield attributing characters by using Mahalanobis D² statistics. The clustering patterns and grouping of 57 genotypes on the basis of the D² statistics analysis has been presented in (Table 3). The genotypes was grouped into seven clusters. The highest number of clusters were seemed in cluster □ which influenced 17 genotypes viz., EC-620.88, EC-638302, EC-620378, EC-692338, EC-631359, EC-615039, EC-631406, EC-620495, EC-620484, EC-620510, EC-631957, EC-620414, EC-692347, EC-620489, EC-631409, EC-631378 and EC-688516. PH: Plant height; NPH: Number of primary branches; DFF: Days to 50% flowering; NFPP: Number of fruits per plant; FW: Fruit weight; FL: Fruit length; FWD: Fruit width; PT: Pericarp thickness; TSS: Total soluble solids; LC: Lycopene content; AA: Ascorbic acid; TA: Titrable acidity; YPP: Yield per plant; G: Genotypic; P: Phenotypic; h²: Heritability; GA: Genetic advance; GAM%: Genetic advance as percent of mean PH: Plant height; NPH: Number of primary branches; DFF: Days to 50% flowering; NFPP: Number of fruits per plant; FW: Fruit weight; FL: Fruit length; FWD: Fruit width; PT: Pericarp thickness; TSS: Total soluble solids; LC: Lycopene content; AA: Ascorbic acid; TA: Titrable acidity; YPP: Yield per plant; GCV: Genotypic coefficient of variation; PCV: Phenotypic coefficient of variation; h²: Heritability; GA: Genetic advance; GAM%: Genetic advance as percent of mean. The second highest number of genotypes were seemed in cluster □ which influenced 16 genotypes viz., EC-620552, EC-632926, EC-617055, EC-620531, EC-620543, EC-631371, EC-631369, EC-632944, EC-631401, EC-631427, EC-620425, EC-690982, EC-620382, EC-631404, EC-635533 and EC-631412. The lowest clusters were shown in cluster □ which influenced 9 genotypes viz., EC-638522, EC-620508, EC-620404, EC-636877, EC-692388, EC-620498, EC-620361, Anagha, Miryalaguda, cluster □ which influenced 6 genotypes viz., EC-615040, EC-617060, EC-631438,



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EC-631415, EC-62516, PKM-1, cluster I which influenced 4 genotypes viz., Local Kerala, Kashi Tomato, Khorileikai, KasiAdarsh, cluster II which influenced 3 genotypes viz., EC-635526, EC-620376, EC-631351, cluster III which influenced 2 genotypes viz., EC-687604, EC-620385. Cluster I showed highest cluster mean for plant height (151.15), number of primary branches (8.16), number of fruits per plant (149.00) and ascorbic acid (26.99). Cluster VI showed highest cluster mean for pericarp thickness (5.71), total soluble solids (4.43) and lycopene content (3.72). Cluster VII showed highest cluster mean for days to 50% flowering (52.65), fruit weight (70.76), fruit length (4.86), fruit width (5.29), titrable acidity (0.56) and yield per plant (3107.30) have been given in (Table 4). Similar results were found by Thakur *et al.*, (2020), Doddamaniet *et al.*, (2022) and Vermaet *et al.*, (2023).

Intra and Inter clusters distance

The assessment of intra and inter cluster distance represented by D^2 values have been given in Table 5. The maximum intra cluster distance were acquired for cluster VI (240.37) followed by cluster VII (239.05), cluster II (227.89), cluster V (206.92) and cluster I (194.92). The minimum intra cluster D^2 values were acquired for cluster IV (83.58) and cluster III (21.55). The highest inter cluster D^2 values were detected between VI and VII (926.83) followed by cluster I and IV (696.60), cluster V and VI (690.97) and cluster I and III (645.06). The lowest inter cluster D^2 value was found between I and IV (170.68) and cluster IV and VII (202.35) (Fig. 1).

Contribution of characters towards divergence

The contribution of every character to divergence is shown in (Table 6). The character total soluble solids (21.929) contributes highest to divergence followed by yield per plant (19.422), fruit weight (14.285), titrable acidity (10.651), number of fruits per plant (10.025), pericarp thickness (9.461) and fruit length (7.393). However, days to 50% flowering (0.001), number of primary branches (0.313), fruit width (1.315), ascorbic acid (1.629) and plant height (1.879). Similar findings were observed by Kiranet *et al.*, (2017), Mishra *et al.*, (2018), Prakash *et al.*, (2019), Doddamaniet *et al.*, (2022).

CONCLUSION

Tomato is most popular vegetable cultivated by most of the farmers in India. Based on the overall results of present study, concluded that there is a significant positive correlation of yield per plant with fruit weight, fruit length, fruit width, pericarp thickness and lycopene content. The path coefficient analysis shown that the high positive direct effects towards fruit weight followed by number of fruits per plant, lycopene content, plant height, number of primary branches, fruit length, pericarp thickness and titrable acidity. Henceforth there is possibility of improvement in fruit yield by performing selection of correlated characters in tomato. Also this study reveals that significant diversity within and between the clusters were observed among the genotypes. The maximum intra cluster distance were acquired for cluster VI followed by cluster VII. The highest inter cluster D^2 values were detected between cluster VI and VII. Among the mean performance, cluster III was promising for plant height, number of primary branches, number of fruits per plant and ascorbic acid. Cluster VI was promising for pericarp thickness, total soluble solids and lycopene content. Cluster VII was promising for days to 50% flowering, fruit weight, fruit length, fruit width, titrable acidity and yield per plant.

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Table 1. Genotypic and phenotypic correlation coefficients for 13 traits in 57 accessions for 13 traits in 57 accessions

		PH	NPB	DFP	NFP P	FW	FL	FW D	PT	TSS	LC	AA	TA	YP P	
PH	G	1.000													
	P	1.000													
NP B	G	0.264 **	1.000												- 1.0 00
	P	0.258 **	1.000												- 0.9 00
DFP	G	0.075	0.303 **	1.000											- 0.8 00
	P	0.017	0.095	1.000											- 0.7 00
NF PP	G	0.376 **	0.247 **	- 0.001	1.000										- 0.6 00
	P	0.316 **	0.166 *	- 0.013	1.000										- 0.5 00
FW	G	- 0.274 **	0.001	0.225 **	- 0.541 **	1.000									- 0.4 00
	P	-	0.002	0.180	-	1.000									-





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		0.245 **		*	0.510 **															0.3 00
FL	G	- 0.332 **	- 0.056	0.099	- 0.398 **	0.781 **	1.000													- 0.2 00
	P	- 0.313 **	- 0.051	0.068	- 0.362 **	0.755 **	1.000													- 0.1 00
FW D	G	- 0.339 **	- 0.089	0.131	- 0.451 **	0.795 **	0.821 **	1.000												0.0 00
	P	- 0.298 **	- 0.068	0.081	- 0.398 **	0.753 **	0.802 **	1.000												0.1 00
PT	G	- 0.149	- 0.208 **	- 0.018	- 0.387 **	0.674 **	0.702 **	0.502 **	1.000											0.2 00
	P	- 0.124	- 0.139	- 0.021	- 0.346 **	0.649 **	0.664 **	0.464	1.000											0.3 00
TSS	G	0.154 *	0.227 **	0.010	0.119	0.063	0.136	- 0.092	0.197 **	1.000										0.4 00
	P	0.143	0.181 *	0.018	0.126	0.065	0.134	- 0.080	0.184 *	1.000										0.5 00
LC	G	0.098	0.019	0.309 **	0.119	0.223 **	0.311 **	0.188 *	0.263 **	0.490 **	1.000									0.6 00
	P	0.095	0.002	0.215 **	0.109	0.212 **	0.294 **	0.169 *	0.253 **	0.453 **	1.000									0.7 00
AA	G	0.080	0.065	0.204 **	0.228 **	0.030	0.034	- 0.113	0.190 *	0.256 **	0.342 **	1.0 00								0.8 00
	P	0.071	0.044	0.160 *	0.212 **	0.030	0.033	- 0.107	0.184 *	0.251 **	0.323 **	1.0 00								0.9 00
TA	G	- 0.096	0.132	0.384 **	- 0.014	0.039	0.020	0.097	- 0.082	0.070	0.155 *	0.0 28	1.0 00							1.0 00
	P	- 0.078	0.072	0.273 **	- 0.005	0.039	0.019	0.087	- 0.071	0.067	0.140	0.0 27	1.0 00							
YPP	G	- 0.123	0.099	0.141	- 0.325 **	0.964 **	0.756 **	0.729 **	0.672 **	0.140	0.299 **	0.0 65	- 0.0 14	1.0 00						
	P	- 0.098	0.062	0.097	- 0.135	0.832 **	0.652 **	0.625 **	0.585 **	0.140	0.243	0.0 54	- 0.0 10	1.0 00						

Table 2. Genotypic and phenotypic path coefficient analysis (direct and indirect effect) of yield and yield contributing characters of tomato

	PH	NPB	DFF	NFPP	FW	FL	FWD	PT	TSS	LC	AA	TA
PH	0.0822 4	0.0177 5	- 0.0122 5	0.0924 2	- 0.3290 1	- 0.0112 1	0.0402 9	- 0.0013 1	- 0.0064	0.0084	- 0.0032 2	- 0.0005 7





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	0.0296 9	0.0003 6	- 0.0009 7	0.1300 6	- 0.2453 6	0.0023 7	- 0.0031 3	- 0.0109 3	0.0045 5	- 0.0013 8	- 0.0052 4	0.0016 8
NPB	0.0217 4	0.0671 6	- 0.0496 8	0.0606 7	0.0013 7	- 0.0018 9	0.0105 8	- 0.0018 3	- 0.0093 9	0.0016 4	- 0.0025 9	0.0007 9
	0.0076 5	0.0014 1	- 0.0054 4	0.0684	0.0016 6	0.0003 9	- 0.0007 1	- 0.0122 9	0.0057 4	- 0.0000 4	- 0.0032 5	- 0.0015 5
DFP	0.0061 5	0.0203 7	- 0.1638 3	- 0.0003 5	0.2711 2	0.0033 5	- 0.0155 1	- 0.0001 6	- 0.0004 2	0.0265 7	- 0.0082	0.0022 8
	0.0005	0.0001 3	- 0.0573 5	- 0.0053 9	0.1808 5	- 0.0005 2	0.0008 6	- 0.0018 9	0.0005 7	- 0.0031 3	- 0.0118 6	- 0.0058 7
NFP P	0.0309 6	0.0166	0.0002 3	0.2455 1	- 0.6506 6	- 0.0134 5	0.0534 8	- 0.0034 1	- 0.0049 2	0.0102 2	- 0.0091 6	- 0.0000 9
	0.0094	0.0002 4	0.0007 5	0.4109 6	- 0.5115 9	0.0027 4	- 0.0041 9	- 0.0306	0.0040 1	- 0.0015 9	- 0.0157	0.0001
FW	- 0.0225	0.0000 8	- 0.0369 3	- 0.1328 1	1.2028 3	0.0263 8	- 0.0943 8	0.0059 4	- 0.0026 3	0.0191 6	- 0.0012 1	0.0002 3
	- 0.0072 6	0.0000 0	- 0.0103 4	- 0.2095 2	1.0034 5	- 0.0057 2	0.0079 2	0.0573 9	0.0020 7	- 0.0030 8	- 0.0022 4	- 0.0008 3
FL	- 0.0272 9	- 0.0037 5	- 0.0162 5	- 0.0977 6	0.9391 3	0.0337 9	- 0.0974 3	0.0061 9	- 0.0056 5	0.0267 5	- 0.0013 8	0.0001 2
	- 0.0092 9	- 0.0000 7	- 0.0039 2	- 0.1487	0.7572 4	- 0.0075 8	0.0084 3	0.0586 8	0.0042 6	- 0.0042 8	- 0.0024 6	- 0.0004 1
FWD	- 0.0279 2	- 0.0059 8	- 0.0214 1	- 0.1106 3	0.9564 3	0.0277 4	- 0.1186 9	0.0044 2	0.0038 2	0.0161 8	0.0045 3	0.0005 8
	- 0.0088 4	- 0.0001	- 0.0046 7	- 0.1636 3	0.7555 3	- 0.0060 8	0.0105 1	0.041	- 0.0025 6	- 0.0024 7	0.0079 3	- 0.0018 7
PT	- 0.0122 4	- 0.0139 8	0.003	- 0.0949 8	0.8107 5	0.0237 3	- 0.0595 8	0.0088 1	- 0.0081 6	0.0226 4	- 0.0076 3	- 0.0004 9
	- 0.0036 7	- 0.0002	0.0012 3	- 0.1422 1	0.6513 5	- 0.0050 3	0.0048 8	0.0884 2	0.0058 5	- 0.0036 9	- 0.0135 9	0.0015 3
TSS	0.0126 9	0.0152 1	- 0.0016 5	0.0291 2	0.0762 4	0.0046	0.0109 4	0.0017 3	- 0.0414 6	0.0421 2	- 0.0102 8	0.0004 2
	0.0042	0.0002	-	0.0518	0.0653	-	-	0.0162	0.0317	-	-	-





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	5	5	0.0010 3	5	7	0.0010 2	0.0008 5	7	9	0.0065 9	0.0185 8	0.0014 4
LC	0.0080 4	0.0012 8	- 0.0506 3	0.0291 9	0.2681 2	0.0105 1	- 0.0223 5	0.0023 2	- 0.0203 2	0.0859 6	- 0.0137 3	0.0009 2
	0.0028 1	0	- 0.0123 4	0.0448 6	0.2126 8	- 0.0022 3	0.0017 8	0.0224 1	0.0144	- 0.0145 5	- 0.0239	- 0.0030 1
AA	0.0066 1	0.0043 3	- 0.0334 9	0.0560 8	0.0363 9	0.0011 6	0.0134 2	0.0016 8	- 0.0106 3	0.0294 4	- 0.0400 9	0.0001 7
	0.0021	0.0000 6	- 0.0091 9	0.0871 5	0.0303 2	- 0.0002 5	- 0.0011 3	0.0162 3	0.0079 8	- 0.0047	- 0.0740 4	- 0.0005 9
TA	- 0.0078 5	0.0088 9	- 0.0628 7	- 0.0035 2	0.0474 5	0.0006 7	- 0.0115 5	- 0.0007 3	- 0.0029 2	0.0133	- 0.0011 2	0.0059 4
	- 0.0023 3	0.0001	- 0.0156 6	- 0.0018 6	0.0387 5	- 0.0001 5	0.0009 2	- 0.0063 1	0.0021 3	- 0.0020 4	- 0.0020 4	- 0.0214 9

Table 3. Genotypes included in various clusters based on D2 analysis in tomato

Cluster No.	No. of genotypes	Name of the genotypes
□	17	EC-620.88, EC-638302, EC-620378, EC-692338, EC-631359, EC-615039, EC-631406, EC-620495, EC-620484, EC-620510, EC-631957, EC-620414, EC-692347, EC-620489, EC-631409, EC-631378, EC-688516
□	16	EC-620552, EC-632926, EC-617055, EC-620531, EC-620543, EC-631371, EC-631369, EC-632944, EC-631401, EC-631427, EC-620425, EC-690982, EC-620382, EC-631404, EC-635533, EC-631412
□	2	EC-687604, EC-620385
□	3	EC-635526, EC-620376, EC-631351
□	6	EC-615040, EC-617060, EC-631438, EC-631415, EC-62516, PKM-1
□	9	EC-638522, EC-620508, EC-620404, EC-636877, EC-692388, EC-620498, EC-620361, Anagha, Miryalaguda
□	4	Local Kerala, Kashi Tomato, Khorileikai, KasiAdarsh

Table 4. Grouping of 57 genotypes and cluster means based on 13 characters

Cluster no	No. of Genotypes	Characters						
		PH	NPB	DFF	NFPP	FWG	FL	FWD
□	17	114.546	7.082	46.157	45.784	47.102	4.487	4.234
□	16	139.403	8.150	47.217	55.354	41.552	4.033	3.797
□	2	151.155	8.167	47.033	149.000	8.233	2.133	2.313
□	3	124.287	6.644	49.178	45.222	52.678	4.753	4.469
□	6	136.283	7.756	45.433	51.417	35.267	2.247	2.653





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□	9	129.064	7.867	48.541	48.963	47.400	4.500	4.131
□	4	127.617	7.733	52.650	46.583	70.767	4.860	5.291
Cluster no	No. of Genotypes	Characters						
		PT	TSS	LC	AA	TA	YPP	
□	17	5.137	3.853	3.318	20.608	0.397	2109.435	
□	16	4.567	4.158	3.383	22.154	0.420	2095.750	
□	2	2.800	4.017	3.563	26.993	0.493	1691.650	
□	3	5.589	3.133	3.371	25.587	0.514	1948.517	
□	6	4.411	4.139	3.282	23.889	0.486	1862.558	
□	9	5.715	4.437	3.712	23.328	0.560	2292.833	
□	4	4.875	3.942	3.695	25.178	0.569	3107.300	

Table 5. Average intra and inter cluster distance

	□	□	□	□	□	□	□
□	194.928	220.777	645.065	170.688	291.772	228.092	926.834
□		227.890	510.991	242.058	252.575	244.563	349.584
□			21.555	696.601	397.503	690.972	283.996
□				83.582	353.962	252.985	202.359
□					206.921	310.022	481.990
□						240.371	326.219
□							239.055

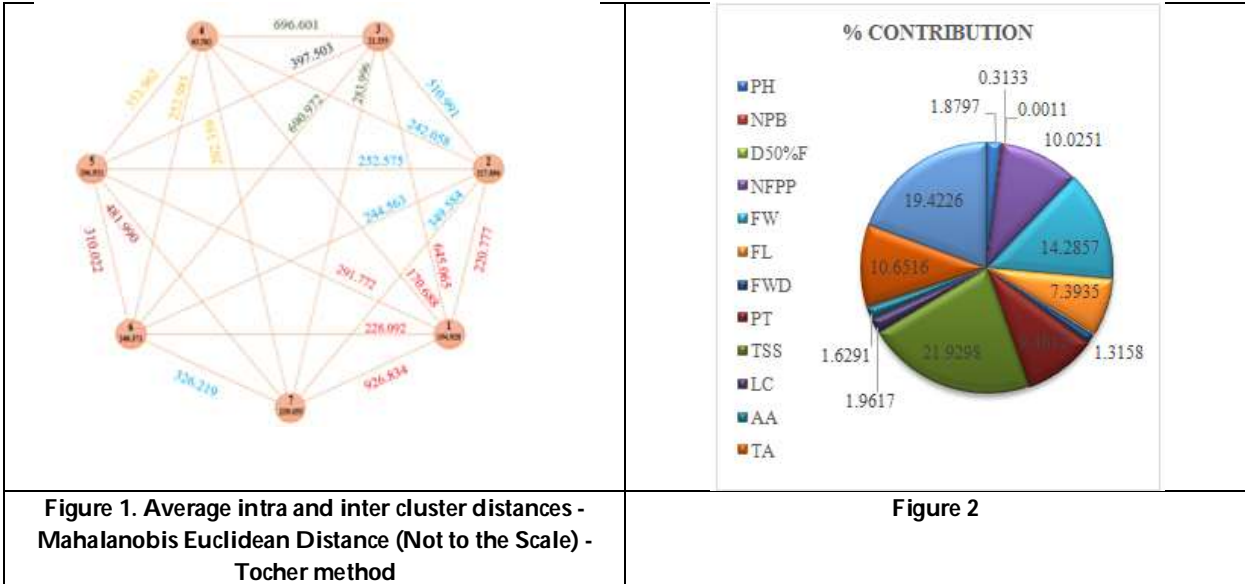
Table 6. Contribution of each characters to divergence

Character	No. of First Rank	% Contribution
PH	30	1.8797
NPB	5	0.3133
DFF	0	0.0011
NFPP	160	10.0251
FW	228	14.2857
FL	118	7.3935
FWD	21	1.3158
PT	151	9.4612
TSS	350	21.9298
LC	27	1.9617
AA	26	1.6291
TA	170	10.6516
YPP	310	19.4226
TOTAL	1596	100





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Strong Split Point Set Domination and Super Point Set Domination in Graphs

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Received: 21 Feb 2024

Revised: 10 Apr 2024

Accepted: 06 Jun 2024

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ABSTRACT

Let G be a simple graph with vertex set $V(G)$ and edge set $E(G)$. A subset D of $V(G)$ is called a dominating set if for any v in $V-D$, there exists a vertex u in D such that u and v are adjacent. D is called a point set dominating set of G if for every subset S of $V-D$, there exists a vertex u in D such that $S \cup \{u\}$ is connected. This concept was introduced by E. Sampathkumar and L. Pushpa Latha [4]. A point set dominating set is called a strong split point set dominating set of G if $\langle V - D \rangle$ is totally disconnected with at least two vertices. A point set dominating set D of G is called super point set dominating set of G if for every v in $V-D$ there exists a vertex u in D such that $N(u) \cap (V - D) = \{v\}$. In this paper the two concepts namely strong split point set dominating sets and super point set dominating sets are studied.

Keywords: point set domination, strong split point set domination, super point set domination





INTRODUCTION

In a simple graph G , the concept of point set domination was introduced in [4]. Here two new types of point set domination namely strong split point set domination and super point set domination are introduced.

Strong split point set domination in Graphs

A subset D of $V(G)$ is called a dominating set of G if for every v in $V-D$, there exists a u in D such that u and v are adjacent. V.R. Kulli and B. Janakiram [1] introduced the concept of strong split domination. A dominating set D of graph G is a strong split dominating set of G if the induced subgraph $\langle V - D \rangle$ is totally disconnected with atleast two vertices. Analogous to strong split domination, strong split point set domination is defined.

Definition 2.1

Let G be a simple graph. A point set dominating set D of G is called a strong split point set dominating set of G if $\langle V - D \rangle$ is totally disconnected with atleast two vertices. A minimum cardinality of a strong split point set dominating set of G is called the strong split point set domination number of G and is denoted by $\gamma_p^{ss}(G)$.

Remark 2.2: There is no strong split point set dominating set for a complete graph. $\gamma_p^{ss}(G)$ for some classes of graphs.

1. $\gamma_p^{ss}(K_{1,n}) = 1$
2. $\gamma_p^{ss}(K_{m,n}) = \min(m, n)$ where $m, n \geq 2$
3. $\gamma_p^{ss}(C_n) = n - 2$, if $n \geq 4$
4. $\gamma_p^{ss}(P_n) = n - 2$, if $n \geq 3$, When $n = 2, P_n$ is complete and hence has no strong split point set dominating set.
5. $\gamma_p^{ss}(W_n) = n - 2$, if $n \geq 5$
6. $\gamma_p^{ss}(D_{(r,s)}) = \min(r, s) + 1$ if atleast one of $r, s \geq 1$

Theorem 2.3: A point set dominating set D of G is a strong split point set dominating set of G iff the following conditions hold.

- (i) if $V-D$ has atleast two vertices.
- (ii) for any two vertices u, v in $V-D$, every $u-v$ path contains a vertex of D .

Remark 2.4: The property of strong split point set dominating set of G is super hereditary iff $V-D$ has atleast three vertices.

Theorem 2.5: A strong split point set dominating set of G is minimal iff for each vertex v in D , any of the following holds.

- (i) there exists a vertex u in $V-D$ such that u is adjacent with v .
- (ii) v is an isolate vertex of $\langle D \rangle$.

Theorem 2.6: A strong split point set domination D of G is minimal iff for any u in D , any of the following holds.

- (i) u is an isolate of $\langle D \rangle$ or there exists a v in $V-D$ such that v is dominated only by u in D .
- (ii) there exists a subset T of $V-D$ such that $T \cup \{u\}$ is connected and $T \cup \{v\}$ is not connected for any v in $D - \{u\}$.
- (iii) there exists a subset T of $V - (D - \{u\})$ containing u such that for any v in $D - \{u\}$, $T \cup \{v\}$ is disconnected.
- (iv) there is a vertex v in $V-D$ such that u is adjacent with v .

Proof: Let D be a strong split point set dominating set of G . Suppose D is a minimal. Then D is 1-minimal. Therefore, for any u in D , $D - \{u\}$ is not a strong split point set dominating set of G . Hence $D - \{u\}$ is either not a point set dominating set of G (or) $D - \{u\}$ is a point set dominating set of G but not a strong split point set dominating set of G . If $D - \{u\}$ is not a point set dominating set of G , then u satisfies any of the conditions (i), (ii) and (iii). If $D - \{u\}$ is a point set dominating set of G but not a strong split point set dominating set of G , then u satisfies condition (iv).





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Conversely if u satisfies any of the four conditions, then either $D - \{u\}$ is not a point set dominating set of G (or) $D - \{u\}$ is a point set dominating set of G but not a strong split point set dominating set of G . Therefore, D is 1-minimal and hence minimal strong split point set dominating set of G .

Theorem 2.7: Let G be a graph without isolated vertices. Then $n - \left\lfloor \frac{m}{\delta(G)} \right\rfloor \leq \gamma_p^{ss}(G)$, where n is the number of vertices of G . m is the number of edges in G .

Proof: Let D be a minimum strong split point set dominating set of G . Let $x \in V - D$. Then x is adjacent with atleast $\delta(G)$ vertices of D where $\delta(G) \geq 1$. Therefore $m \geq \delta(G) \cdot |V - D|$. Therefore $\frac{m}{\delta(G)} \geq |V - D|$. So $\left\lfloor \frac{m}{\delta(G)} \right\rfloor \geq |V - D| = n - \gamma_p^{ss}(G)$. Therefore $\gamma_p^{ss}(G) \geq n - \left\lfloor \frac{m}{\delta(G)} \right\rfloor$. Hence $n - \left\lfloor \frac{m}{\delta(G)} \right\rfloor \leq \gamma_p^{ss}(G)$.

Definition 2.8: A subset S of $V(G)$ is called a strong set independent of G if for any subset T of S with $|T| \geq 2$, T is disconnected.

Theorem 2.9: Let G be a graph with atleast 3 vertices without set-isolates. Then $\gamma_p^{ss}(G) = \alpha_0(G)$.

Proof: Let S be a maximum independent set of G . Since S is independent, T is independent. Therefore $T \cup \{u\}$ is independent for any u in S and hence $T \cup \{u\}$ is disconnected for any u in S . Since G has no set-isolates, there exists u in $V - S$ such that $T \cup \{u\}$ is connected. Therefore $V - S$ is a point set dominating set of G . Since S is totally disconnected, $V - S$ is a strong split point set dominating set of G . Therefore $\gamma_p^{ss}(G) \leq |V - S| = n - |S| = n - \beta_0(G) = \alpha_0(G)$. Therefore $\gamma_p^{ss}(G) \leq \alpha_0(G)$. Since by theorem 2.5, $V - S$ is a minimal strong split point set dominating set of G . Suppose D is a minimum strong split point set dominating set of G . Then $V - D$ is a totally disconnected set of G . Therefore $|V - D| \leq \beta_0(G)$. Therefore $n - \gamma_p^{ss}(G) \leq \beta_0(G)$. Therefore $n - \beta_0(G) \leq \gamma_p^{ss}(G)$. That is, $\alpha_0(G) \leq \gamma_p^{ss}(G)$. Hence $\gamma_p^{ss}(G) = \alpha_0(G)$.

Corollary 2.10: $\gamma_p^{ss}(G) = \alpha_0(G) = n - \beta_0(G)$. $\beta_0(G) \geq \gamma(G) \geq n - m$. Therefore $n - \beta_0(G) \leq m$. Hence $\gamma_p^{ss}(G) \leq m$.

Remark 2.11: $\gamma_p^{ss}(G) \geq \gamma_{ss}(G)$.

Theorem 2.12: Let G be a connected graph. Then $\lfloor \text{diam}(G) + 1 \rfloor \leq \gamma_p^{ss}(G)$.

Proof: From Theorem 9[1], $\lfloor \text{diam}(G) + 1 \rfloor \leq \gamma_{ss}(G)$. Hence $\lfloor \text{diam}(G) + 1 \rfloor \leq \gamma_{ss}(G) \leq \gamma_p^{ss}(G)$.

Theorem 2.13: Let H be any spanning subgraph of G without isolates. Then $\gamma_p^{ss}(H) \leq \gamma_p^{ss}(G)$.

Proof: Since H is a spanning subgraph of G without isolates, $\beta_0(H) \geq \beta_0(G)$. Therefore $\alpha_0(H) \leq \alpha_0(G)$. Since H has no isolates, G has no isolates. Therefore $\gamma_p^{ss}(H) = \alpha_0(H) \leq \alpha_0(G) = \gamma_p^{ss}(G)$.

Theorem 2.14: Let D be a strong split point set dominating set of G . If $\langle D \rangle$ is complete, then $\text{diam}(G) \leq 3$.

Proof: Let D be a strong split point set dominating set of G and $\langle D \rangle$ is complete. Then D is a strong split dominating set of G with $\langle D \rangle$ is complete. Therefore, by theorem 11[1], $\text{diam}(G) \leq 3$.

Theorem 2.15: Let G be a graph with $\Delta(G) \leq n - 2$. Then $\gamma_p^{ss}(\bar{G}) \geq \beta_0(G) - 1$.

Proof: Since $\Delta(G) \leq n - 2$, \bar{G} has no isolates. Therefore $\gamma_p^{ss}(\bar{G}) = \alpha_0(\bar{G}) = n - \beta_0(\bar{G}) = n - \omega(G)$. Since $\omega(G) \leq \alpha_0(G) + 1$, $\gamma_p^{ss}(\bar{G}) \geq n - (\alpha_0(G) + 1) = \beta_0(G) - 1$.

Theorem 2.16: Let G be a connected graph. Let S be a subset of $V(G)$ with atleast two vertices such that $\langle S \rangle$ is complete and for any vertex v in S , $\{v\} \cup T$ is not connected for any $T \subset V - S$, Then $V - S$ is a strong split point set dominating set of \bar{G} .

Proof: By hypothesis, $\langle S \rangle$ is totally disconnected in \bar{G} . Also for any $T \subset V - S$, there exists v in S such that $T \cup \{v\}$ is connected in \bar{G} . Therefore $V - S$ is a strong split point set dominating set of \bar{G} .

Theorem 2.17: Let G and \bar{G} have no isolates. Then $\gamma_p^{ss}(G) + \gamma_p^{ss}(\bar{G}) \leq n - 2 + \alpha_0(G)$.





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Proof: Since G and \bar{G} have no isolates, $\gamma_p^{ss}(G) = \alpha_0(G)$ and $\gamma_p^{ss}(\bar{G}) = \alpha_0(\bar{G})$. Therefore $\gamma_p^{ss}(G) + \gamma_p^{ss}(\bar{G}) = \alpha_0(G) + \alpha_0(\bar{G}) = \alpha_0(G) + n - \beta_0(\bar{G}) = \alpha_0(G) + n - \omega(G)$. Since G has no isolates, $\omega(G) \geq 2$. Therefore $\gamma_p^{ss}(G) + \gamma_p^{ss}(\bar{G}) \leq n - 2 + \alpha_0(G)$.

Super point set domination in Graphs

A subset D of $V(G)$ of a simple graph G is called a super dominating set if for every v in $V-D$, there exists a u in D such that $N(u) \cap (V - D) = \{v\}$. The minimum cardinality of a super dominating set of G is called super domination number of G [3]. Similar to this concept super point set domination is introduced.

Definition 3.1: A point set domination D of G is called a super point set dominating set of G if for every u in $V-D$, there exists a vertex v in D such that $N(v) \cap (V - D) = \{u\}$. The minimum cardinality of super point set dominating set of G is denoted by $\gamma_p^s(G)$.

Observation 3.2: Super point set dominating property is super hereditary. Hence a super point set dominating set of G is minimal iff it is 1-minimal.

$\gamma_p^s(G)$ of some classes of graphs:

1. $\gamma_p^s(G)(K_n) = n - 1$
2. $\gamma_p^s(G)(K_{1,n}) = n$
3. $\gamma_p^s(G)(K_{m,n}) = m + n - 2$
4. $\gamma_p^s(G)(P_n) = n - 2, \text{ if } n \geq 4 \text{ and } 2 \text{ if } n = 2$
5. $\gamma_p^s(G)(C_n) = n - 2, n \geq 4$
6. $\gamma_p^s(G)(W_n) = n - 1$

$$7. \gamma_p^s(D_{r,s}) = \begin{cases} 1 & \text{if } r = s = 0 \\ 2 & \text{if either of } r, s \text{ is } 1 \text{ and the other is } 0 \text{ (or) } r = s = 1 \\ 3 & \text{if } r \geq 1, s = 0 \\ r + s & \text{if } r, s \geq 1 \end{cases}$$

Observation 3.3: (i) $\gamma_p^s(G) \geq \gamma_p(G)$

(ii) $\gamma_p^s(G) \geq \frac{n}{2}$

Proof: If D is a $\gamma_p^s(G)$ of G , then $|D| \geq |V - D|$. That is $\gamma_p^s(G) \geq n - \gamma_p^s(G)$. Therefore $\gamma_p^s(G) \geq \frac{n}{2}$

(iii) $\gamma_p^s(G) \geq \gamma_{sp}(G)$.

Definition 3.4: A super point set dominating set D of G is perfect if $E(D, V-D)$ is a perfect matching.

Observation 3.5: $\gamma_p^s(G) = 1$, iff $G = K_1$ or K_2 . Also $\gamma_p^s(G) = n$ iff $G = \bar{K}_n$. Hence for a connected graph G , $\frac{n}{2} \leq \gamma_p^s(G) \leq n - 1$.

Theorem 3.6: For any connected graph G , $\gamma_p^s(G) = \frac{n}{2}$ iff every minimum super point set dominating set is a perfect set.

Proof: Let D be $\gamma_p^s(G)$ –set of G . If D is perfect then $|D| = |V - D|$. Therefore $\gamma_p^s(G) = \frac{n}{2}$. Conversely suppose $\gamma_p^s(G) = \frac{n}{2}$. Let D be a minimum super point set dominating set of G . Suppose there exists a vertex z in D such that $|N(z) \cap (V - D)| > 1$. Since for every vertex u in $V-D$, there exists a vertex v in D such that $|N(v) \cap (V - D)| = \{u\}$ and since $|N(z) \cap (V - D)| > 1$ we obtain $|D| > |V - D|$. Therefore $\gamma_p^s(G) > n - \gamma_p^s(G)$. So $2\gamma_p^s(G) > n$. Therefore





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$\gamma_p^s(G) > \frac{n}{2}$, a contradiction. Hence $|N(z) \cap (V - D)| \leq 1$, for every z in D . Suppose there exists a vertex z in D , such that $|N(z) \cap (V - D)| = 0$. Since $|D| = |V - D|$, there exists a vertex w in D such that $|N(w) \cap (V - D)| > 1$, a contradiction. Therefore, every vertex of D has a unique neighbour in $V-D$. Suppose there is a vertex u in $V-D$ such that $|N(u) \cap D| > 1$. Then either $|D| > \frac{n}{2}$ or there exists a vertex in D which has more than one neighbour in $V-D$, a contradiction. Therefore, every vertex in $V-D$ has a unique neighbour in D . Therefore, D is a perfect set.

Observation 3.7: Let G be a connected graph in which there exists two vertices x, y which have a common neighbour. Also there exist z_1, z_2 in $(V(G) - \{x, y\})$ such that $x \in N(z_1)$ and $y \notin N(z_1), x \notin N(z_2)$ and $y \in N(z_2)$. Then $\gamma_p^s(G) \leq n - 2$.

Proof: Let z be a common neighbour of x and y . Then $(V(G) - \{x, y\})$ is a point set dominating set of G . Since by hypothesis, there exist z_1, z_2 such that $x \in N(z_1)$ and $y \notin N(z_1), x \notin N(z_2)$ and $y \in N(z_2)$. Therefore $(V(G) - \{x, y\})$ is a super point set dominating set of G . Hence $\gamma_p^s(G) \leq |V(G) - \{x, y\}| = n - 2$.

Definition 3.8: u is a semiuniversal vertex in G if any vertex $v \neq u, v$ is either adjacent with u or have a common neighbour with u .

Observation 3.9: If G is a connected graph with the property that every vertex of G is either universal or semiuniversal, then it is not necessary that $\gamma_p^s(G) = n - 1$.

For example, Let G be a graph with $V(G) = \{x_1, x_2, \dots, x_k, y_1, y_2, \dots, y_k, u\}$ and $E(G) = \{x_i y_i, 1 \leq i \leq k\} \cup \{u x_i, u y_i, 1 \leq i \leq k\}$. G is connected, u is a universal vertex and all other vertices are semiuniversal. Let $D = \{x_1, x_2, \dots, x_{k-1}, y_2, y_3, \dots, y_k, u\}$. Then $V - D = \{x_k, y_1\}$. D is a point set dominating set of G . For x_k in $V-D$, there exists y_k in D such that $N(y_k) \cap (V - D) = \{x_k\}$ and for y_1 in $V-D$, there exists x_1 in D such that $N(x_1) \cap (V - D) = \{y_1\}$. Hence D is a super point set dominating set of G . Therefore $\gamma_p^s(G) \leq n - 2$.

Observation 3.10: If G is a connected graph with atleast two vertices, then $\gamma_p^s(G) \leq 2m - n + 1$. If $\gamma_p^s(G) = 2m - n + 1$, then G is a tree.

Proof: If G is a connected graph, then $m \geq n - 1$. Also $\gamma_p^s(G) \leq n - 1 = 2(n - 1) - n + 1 \leq 2m - n + 1$. Suppose $\gamma_p^s(G) = 2m - n + 1$. Therefore $2m - n + 1 \leq n - 1$. $2m \leq 2n - 2$. $m \leq n - 1$. Since G is connected, $m \geq n - 1$. Therefore $m = n - 1$. Therefore G is a tree.

Theorem 3.11: For any graph $G, \gamma_p^s(G) \geq n - \frac{1}{2} - \sqrt{\frac{2n^2 - 2n - 4m + 1}{4}}$ and the bound is sharp.

Proof: Let D be a $\gamma_p^s(G)$ -set of G . Since D is a super point set dominating set of G , for every u in $V-D$, there exists v in D such that $N(v) \cap (V - D) = \{u\}$. v is not adjacent with $n - |D| - 1$ vertices of $V-D$. Since there are $n - |D|$ vertices in $V-D$, there are $n - \gamma_p^s(G)$ vertices of D such that each of these vertices is not adjacent with $n - \gamma_p^s(G) - 1$ vertices of $V-D$. Therefore $m \leq n c_2 - (n - \gamma_p^s(G))(n - \gamma_p^s(G) - 1)$

$$= \frac{n(n - 1)}{2} - (n^2 - n\gamma_p^s(G) - n - n\gamma_p^s(G) + (\gamma_p^s(G))^2 + \gamma_p^s(G)).$$

$$(\gamma_p^s(G))^2 - 2n\gamma_p^s(G) + \gamma_p^s(G) \leq \frac{n(n - 1)}{2} - (n^2 - n) - m = \frac{n^2}{2} - \frac{n}{2} - n^2 + n - m = \frac{n}{2} - \frac{n^2}{2} - m.$$

$$(\gamma_p^s(G))^2 + (1 - 2n)\gamma_p^s(G) - \frac{n}{2} + \frac{n^2}{2} + m \leq 0.$$

Let $\gamma_p^s(G) = x$. Therefore $x^2 + (1 - 2n)x - \frac{n}{2} + \frac{n^2}{2} + m \leq 0$.





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Therefore
$$x = \frac{-(1-2n) \pm \sqrt{(-2n+1)^2 - 4(1)(-\frac{n}{2} + m + \frac{n^2}{2})}}{2} = \frac{(2n-1) \pm \sqrt{4n^2 + 1 - 4n + 2n - 4m - 2n^2}}{2} = n - \frac{1}{2} \pm \sqrt{\frac{2n^2 - 2n - 4m + 1}{4}}$$

Therefore $\gamma_p^s(G)$ lies between $n - \frac{1}{2} - \sqrt{\frac{2n^2 - 2n - 4m + 1}{4}}$ and $n - \frac{1}{2} + \sqrt{\frac{2n^2 - 2n - 4m + 1}{4}}$. Therefore $\gamma_p^s(G) \geq n - \frac{1}{2} - \sqrt{\frac{2n^2 - 2n - 4m + 1}{4}}$.

$\ln C_4, \gamma_p^s(G) = 2$. RHS = $n - \frac{1}{2} - \sqrt{\frac{2n^2 - 2n - 4m + 1}{4}} = 4 - \frac{1}{2} - \sqrt{\frac{[32 - 8 - 16 + 1]}{4}} = 4 - \frac{1}{2} - \frac{3}{2} = 2$.

Hence the bound is sharp.

Theorem 3.12: For any graph G, $n \leq \gamma_p^s(G) + \gamma_p^s(\bar{G}) \leq 2n - 1$.

Proof: $\gamma_p^s(G) \geq \frac{n}{2}$. Therefore $\gamma_p^s(G) + \gamma_p^s(\bar{G}) \geq n$. For a graph G, $\gamma_p^s(G) = n$ iff $G = (\bar{K}_n)$. If G or \bar{G} is \bar{K}_n , then \bar{G} or G has at least one edge. In that case $\gamma_p^s(\bar{G})$ or $\gamma_p^s(G) \leq n - 1$. Therefore $\gamma_p^s(G) + \gamma_p^s(\bar{G}) \leq n + n - 1 = 2n - 1$.

Remark 3.13: (i) If $G = K_n$, then $\gamma_p^s(G) = n - 1$ and $\gamma_p^s(\bar{G}) = n$. Therefore $\gamma_p^s(G) + \gamma_p^s(\bar{G}) = 2n - 1$.

(ii) When $G = P_4$, $\gamma_p^s(G) = 2 = \gamma_p^s(\bar{G})$ (since \bar{G} is P_4). Therefore $\gamma_p^s(G) + \gamma_p^s(\bar{G}) = 4 =$ number of vertices of P_4 . Hence the bounds above are sharp.

Theorem 3.14: Let T be a tree with atleast 3 vertices. Then $\frac{n}{2} \leq \gamma_p^s(T) \leq n - s_1$, where S is the set of supports of T such that any subset of S is connected and S is of maximum cardinality and $s_1 = |S|$.

Proof: Let D = V-S. Then D is a point set dominating set of G and it is also super. Therefore $\gamma_p^s(T) \leq |D| = n - |S| = n - s_1$. Clearly $\frac{n}{2} \leq \gamma_p^s(T)$.

Example: (i) Let $T = P_3, S = \{u\}$ where u is the centre of T. $\gamma_p^s(T) = 2 = 3 - 1 = 3 - |S| = 3 - s_1$.

(ii) Let $T = K_{1,n}, n \geq 2, S =$ The set contains the center vertex of T. $\gamma_p^s(T) = n, s_1 = 1, |V(T)| = n + 1$. Therefore $\gamma_p^s(T) = |V(T)| - s_1$.

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Effectiveness of Schroth Exercises in Adolescent Idiopathic Scoliosis: - A Review of Literature

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 16 Jun 2024

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ABSTRACT

Adolescent idiopathic scoliosis (AIS) is a deformity of the coronal plane of the spinal column that can be brought on by poor posture, carrying heavy backpacks, not exercising, and a host of other factors. It affects the entire spine's structure and shape, resulting in postural deformity, low back pain, decreased cardiopulmonary function, and a decreased quality of life (QOL). Isometrics and other exercises are used in the Schroth method, one of the most well-liked and effective scoliosis treatment techniques, to help patients maintain proper posture. An thorough literature evaluation was conducted to synthesize current information addressing the use of Schroth exercises in the management of adolescent idiopathic scoliosis.

Keywords: Adolescent idiopathic scoliosis, Scoliosis, Schroth exercises, Rehabilitation, AIS





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INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a most prevalent types of structural spinal column deformities and it affects the whole spine shape and condition of the thorax, trunk and posture.[1]The study reports that the incidence of AIS is approximately 2% every year, and the prevalence in the adolescent population has been reported as high as 5.2%.[2] Scoliosis is very common nowadays among adolescent may be due to faulty posture, heavy bag-packs, lack of exercises, using smartphones for a long period of time and many more reasons. Despite of unknown reasons, scoliosis is related to muscular imbalance, genetic factors, poor posture and insufficient exercise. The most common physical problems caused by these factors include deformation of spine and structure of the spinal column, altered characteristics of erector spinae muscle, lower back pain, decreased flexibility of spine, deformity of the thorax and thoracic spine and decreased cardiopulmonary function.[3]Prevention of adolescent idiopathic scoliosis is carried out through early screening, regular health checkups, posture education and awareness programs, sports activities and physical education classes and regular exercises.[4]The aim of exercise therapy is to correct posture, improve spine flexibility, correct muscular imbalance and improve cardiopulmonary function. However, without a proper medical and physical assessment and a detailed radiological diagnosis, excessive and inappropriate exercise may interfere with treatment and exacerbate the condition.[5]Study suggest that there are several physical therapies approaches which is designed to prevent and correction of scoliosis and Schroth method is one of the popular and most successful method in the treatment of scoliosis. Isometric exercises and other active and passive exercises are used in the Schroth exercises, a non-surgical physiotherapy strategy created by Katharina Schroth in 1920, to preserve proper posture.[6]The Schroth exercise program includes mirrors, isometric exercises, and other exercises to stretch or strengthen the asymmetrical muscles while maintaining a particular breathing pattern. It also includes posture correction with the aid of sensory, motor, and kinesthetic stimulation.[7]There are a lot of studies on adolescent idiopathic scoliosis and how well Schroth exercises work to correct it, but there aren't many that combined this information into a comprehensive evaluation of the literature.

MATERIALS AND METHODS

An extensive summary of the Schroth physiotherapeutic technique is given in this study for the treatment of AIS in adolescents. We conducted a thorough analysis of pertinent Schroth techniques, evaluated the body of research on their efficacy, and considered future directions for the study of Schroth physiotherapeutic approach in the management of adolescent idiopathic scoliosis.

Source

This study included earlier research, published from 2013 to August 2023, on the use of Schroth exercises in the treatment of scoliosis. This study is based on an extensive search for relevant literature conducted through PubMed, Google Scholar, PEDro, and COCHRANE. The search was conducted using a variety of keywords, including adolescent idiopathic scoliosis, AIS, scoliosis, and Schroth exercises, as well as word combinations.

Study Selection

These 20 literary works were chosen based on the subsequent inclusion criteria:

- Scoliosis and adolescent idiopathic scoliosis should be the focus of the study.
- The studies needed to look into how well Schroth exercises work in AIS.
- Systematic reviews, meta-analyses, and randomized control trials that examine how well Schroth exercises treat AIS or scoliosis.
- Articles published in English language.





DISCUSSION

Adolescent Idiopathic Scoliosis (AIS) and its management has remained a topic of continuous research and debate within the orthopedic and physiotherapy professionals. Adolescent Idiopathic Scoliosis and the recent interest in Schroth exercises, incorporated in their non-invasive nature and potential multifarious benefits, has added another layer of depth to the ongoing debate. Our review of literature on last decade's literature presents several key intuitions and also identifies different areas needing further investigation. According to Tugba Kuru Çolak et al.'s randomized trial, mild to moderate idiopathic scoliosis in adolescents can be effectively stopped and long-term improvement maintained with the right conservative physical therapy treatment. As a result, the results imply that the Schroth Best Practice Program improves idiopathic scoliosis [10]. According to a study by Pil-Neo Hwangbo and Kyoung-Don Kim, a patient with idiopathic scoliosis had notable effects on their vital capacity, Cobb's angle, and thoracic trunk inclination. The Schroth exercise's effects were what caused the improvement [11]. According to Jae-Man Yang et al., adults with idiopathic scoliosis may benefit from a reduction in Cobb's angle and the rib hump by the sequential administration of stretching, Schroth, and strengthening exercises [12]. According to Luis Ceballos-Laita et al.'s interpretation of the study, the Schroth method used alone can improve the quality of life (QoL) and reduce the Cobb angle and trunk rotation angle in adolescents with idiopathic scoliosis [13].

According to ArashKhaledi et al., AIS was found to be improved by both Schroth and SEAS exercises; this effect was more pronounced in the Schroth method trial [14]. According to Vanja Dimitrijevic et al.'s randomized controlled experiment, adding short-term Schroth physiotherapeutic exercises tailored to scoliosis-specific exercise regimen to standard therapy resulted in a significant improvement over standard care alone [15]. According to a research by Jae Yong Park et al., regardless of the degree of scoliosis, the Schroth Rehabilitation Exercise program caused distinct modifications in lumbar lordosis, calcaneal valgus angle, and scoliometer readings [16]. According to Min-Jae Kim and Dae-Sung Park, SERME may be a more successful technique for enhancing Cobb's angle and pulmonary function in scoliosis patients [17]. After examining publications, Joo-Hee Park et al. did a meta-analysis and found that the Schroth exercise had a large overall effect size. All things considered, schroth exercise is a suggested course of treatment for scoliosis sufferers [18]. According to ShkurtaRrecaj-Malaj et al., adolescents with mild to severe idiopathic scoliosis may improve from a 24-week regimen of combined Schroth and Pilates exercises in terms of their Cobb angle, ATR, chest expansion, trunk flexion, and quality of life [19]. After examining publications, Marlette Burger et al. did a systematic review and meta-analysis and found that the study indicates that Schroth exercises significantly lower the Cobb angle and enhance quality of life in teenagers with idiopathic scoliosis [20]. According to Ang Gao et al., Schroth exercises enhanced cervical spine alignment, shoulder balance, and health-related quality of life (HRQOL) in addition to stopping the progression of curves [21]. In contrast to the Schroth exercises, R.A. Mohamed and A.M. Yousef found that PNF patterns did not significantly enhance angle trunk rotation, which is a crucial component in curve correction.²²

CONCLUSION

The potential of Schroth exercises in the management of AIS is evident from the available literature, according to the literature review for the current study. For AIS sufferers, the treatment's non-invasiveness combined with its apparent psychological and physical advantages make it a fortunate choice. To optimize the results for AIS patients, more research is necessary, particularly large-scale trials, a clear procedure, and the combination of Schroth with other well-proven treatments.

Funding source: Not Applicable

Conflict of Interest: The authors declared no conflict of interest.





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ACKNOWLEDGMENT

I'm Simi Hazarika would like to express my gratitude to Dr. Abhijit Dutta, Dean, Faculty of Paramedical Sciences, Assam down town University for the continuous support and motivation of my research. I also like to thanks to Siva Sankar Kalita and Dr. B. C. Sarma sir for their contribution in my study.

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Table 1: Review of Literature

SL. NO	Author Name	Intervention	Title of the Study	Finding
1.	Tugba Kuru Çolaket al.(2023)	Cheneau-style brace and Schroth exercise program.	The Effectiveness of the Schroth Best Practice Program andChêneau-Type Brace Treatment in Adolescent Idiopathic Scoliosis: Long-Term Follow-Up Evaluation Results	This study shown that long-term recovery is largely sustained and that moderate idiopathic scoliosis in growing teenagers can be successfully stopped with adequate conservative treatment
2.	Luis Ceballos-Laitaet al. (2023)	Schroth method and conservative treatment.	The effectiveness of Schroth method in Cobb angle, quality of life and trunk rotation angle in adolescent idiopathic scoliosis: a systematic review and meta-analysis	In comparison to no intervention or other conservative therapy for AIS, this study demonstrated that the Schroth approach used alone is beneficial in reducing the Cobb angle





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				and the trunk rotation angle as well as increasing the quality of life in the near term.
3.	Doug Hill, Edmond Lou (2022)	Schroth exercises and brace	The effectiveness of Schroth exercises added to the brace on the postural control of adolescents with idiopathic scoliosis: Case series	According to this study, the brace and Schroth technique also markedly enhanced the postural control factors.
4.	Vanja Dimitrijevic et al. (2022)	Exercises for core stability and the Schroth technique	Effects of Schroth method and core stabilization exercises on idiopathic scoliosis: a systematic review and meta-analysis	This study demonstrates that for individuals with idiopathic scoliosis, both the Schroth technique and core stabilization exercises are beneficial.
5.	Joe H. Ghorayebetal. (2022)	Schroth Exercises	The Effect of Schroth Exercises on Cobb Angle, Quality of Life, and Functional Capacity in Adolescent Idiopathic Scoliosis: A Systematic Review of Randomised Controlled Trials	According to this study, Schroth exercises cause the Cobb angle in AIS patients to either regress or stop growing over time.
6.	ArashKhalediet al. (2022)	Schroth vs SEAS Exercise	The Effectiveness of Schroth vs SEAS Exercise Methods for Correcting Idiopathic Scoliosis in Adolescents: A Systematic Review	The results indicate that treating AIS with both Schroth and SEAS exercises was beneficial; the effects of the Schroth approach were more pronounced.
7.	Hikmet Kocaman, et al.(2021)	Schroth exercises and core stabilization exercises	The effectiveness of two different exercise approaches in adolescent idiopathic scoliosis: A single-blind, randomized-controlled trial	According to this study, Schroth exercises are superior to core stabilization exercises for the repair of scoliosis and related issues in cases of mild adolescent idiopathic scoliosis.
8.	Ang Gaoet al.(2021)	Schroth exercises	Schroth exercises improve health-related quality of life and radiographic parameters in adolescent idiopathic scoliosis patients	According to this study, Schroth exercises helped with shoulder balance, cervical spine alignment, and HRQOL while also stopping the growth of curves.
9.	R.A. Mohamed, A.M. Yousef (2021)	proprioceptive neuromuscular	Impact of Schroth three-dimensional vs.	In contrast to the Schroth exercises, the study





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		facilitation approaches with Schroth three-dimensional exercise	proprioceptive neuromuscular facilitation techniques in adolescent idiopathic scoliosis: a randomized controlled study	demonstrates that PNF patterns did not significantly enhance angle trunk rotation, which is a crucial component in curve correction.
10.	ShkurtaRrecaj-Malaj et. al (2020)	Schroth and Pilates Exercises	Outcome of 24 Weeks of Combined Schroth and Pilates Exercises on Cobb Angle, Angle of Trunk Rotation, Chest Expansion, Flexibility and Quality of Life in Adolescents with Idiopathic Scoliosis	According to this study, adolescents with mild to moderate idiopathic scoliosis benefited from combination workouts on the Cobb angle, ATR, chest expansion, trunk flexion, and quality of life.
11.	JaeYong Park et. al (2020)	Schroth Rehabilitation Exercise	Effect of Schroth Rehabilitation Exercise Program on Scoliometer Readings, Lumbar Lordosis and Calcaneal Valgus Angle in Patients with Idiopathic Scoliosis	This study indicates that, independent of the degree of scoliosis, the SRE program caused discernible changes in lumbar lordosis, calcaneal valgus angle, and scoliometer readings.
12.	Marlette Burger et. al (2019)	Schroth exercises	The effectiveness of Schroth exercises in adolescents with idiopathic scoliosis: A systematic review and meta-analysis	According to the study, Schroth exercises significantly lower the Cobb angle and enhance quality of life in teenagers with idiopathic scoliosis.
13.	Joo-HeePark et. al (2018)	schroth exercise	Effects of the schroth exercise on idiopathic scoliosis: a meta-analysis	The Schroth exercise has a high overall effect size, according to this study. All things considered, schroth exercise is a suggested course of treatment for scoliosis patients.
14.	Min-Jae Kim, Dae-Sung Park (2017)	Combining respiratory muscle exercise with Schroth's three-dimensional exercises	The effect of Schroth's three-dimensional exercises in combination with respiratory muscle exercise on Cobb's angle and pulmonary function in patients with idiopathic scoliosis	This study suggests that SERME might be a more effective solution for scoliosis patients who want to improve their Cobb's angle and pulmonary function.
15.	VanjaDimitrijevic et. al (2017)	Schroth physiotherapeutic scoliosis-specific exercises	Schroth physiotherapeutic scoliosis-specific exercises for adolescent idiopathic scoliosis: how many patients require treatment to prevent one deterioration? - results	In comparison to normal treatment alone, this study indicated that the brief Schroth PSSE intervention added to it had a significant positive impact.





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			from a randomized controlled trial - "SOSORT 2017 Award Winner"	
16.	Tuğba Kuru, İpek Yeldan (2016)	Schroth exercise and home exercise	The efficacy of three-dimensional Schroth exercises in adolescent idiopathic scoliosis: a randomised controlled clinical trial	This study demonstrates that the Schroth exercise program used in the clinic under the supervision of a physiotherapist was better than the exercise done at home.
17.	Kyoung-Don Kim, Pil-Neo Hwangbo (2016)	Schroth exercise	Effects of the Schroth exercise on the Cobb's angle and vital capacity of patients with idiopathic scoliosis that is an operative indication	This study demonstrates that the thoracic trunk inclination, Cobb's angle, and vital capacity were significantly impacted by Schroth exercise.
18.	Sanja Schreiber et. al (2015)	Schroth exercises	The effect of Schroth exercises added to the standard of care on the quality of life and muscle endurance in adolescents with idiopathic scoliosis—an assessor and statistician blinded randomized controlled trial: "SOSORT 2015 Award Winner"	According to this study, Schroth exercises improved SRS-22r pain, self-image ratings, and BME, adding value to the standard of therapy..
19.	Jae-Man Yang et. al (2015)	Stretching, Schroth, and strengthening exercises	Effects of consecutive application of stretching, Schroth, and strengthening exercises on Cobb's angle and the rib hump in an adult with idiopathic scoliosis	According to the study, persons with idiopathic scoliosis may benefit from reducing Cobb's angle and the rib hump by applying stretching, Schroth, and strengthening exercises in succession.
20.	Sanja Schreiber et. al (2014)	Schroth exercise	Effect of Schroth exercises on curve characteristics and clinical outcomes in adolescent idiopathic scoliosis: protocol for a multicentre randomised controlled trial	Over the course of six months, the study discovered that Schroth exercise in addition to regular therapy is more successful at slowing or reversing the advancement of the curve than normal care alone.





A Theoretical Framework to Understand the Concept of Modern Technologies for Injury Prevention in Badminton Players

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

Badminton has evolved significantly in modern world and has become a highly competitive sport worldwide. Despite advancement in sports science and injury prevention, this sport still carries risk of injuries especially in competitive play and intense training. Understanding the concept of modern technologies for injury prevention in badminton players, requires a comprehensive theoretical framework that incorporates sports science, sports medicine and technology. To reduce this gap this review aimed to design theoretical framework to grasp the concept.

Keywords: badminton, injury, prevention, technologies, artificial intelligence, machine learning

INTRODUCTION

Badminton is a racquet sport that traces its origins back several centuries. The game's roots can be found in various ancient civilizations and cultures that played similar racket games. Racket games with shuttlecocks existed in ancient civilizations like China, Greece, and India. It is considered to be the one of the fastest racquet sports as well. The players must have good strength, reaction time, motor coordination, speed, agility, precision and aerobic stamina. There is no gender discrimination to play this sport. There are five main events at the completion level for this sport, i.e., men's singles, women's singles, men's doubles, women's doubles and mixed doubles[1] Badminton is non-contact sport having dynamic and high-intensity nature, which puts significant stress on the body, leading to various types of injuries. Badminton, like any other sport, carries a risk of injuries. The prevalence rate for risk of injury in badminton is around 0.85 per year [2] , 1.6 to 2.9 injuries per 1000 hours of play [3], 2 to 5 injuries in 1000 players [4]. All these badminton injuries contribute around 1% to 5% of all the sport injuries (Kroner K et al, 1990). Some common injuries include, ankle sprains and strains, knee injuries, shoulder injuries, back injuries, Wrist and elbow

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injuries. The most of the injuries are overuse injuries. The overuse of the backhand and forehand strokes can exert more pressure on the upper limb. The players overuse upper limb, axial skeleton and lower limb during the high intensity games and leads to overuse injuries. Quick change in direction, lunges, diving movements, jumps lead to the traumatic injuries to the joints and muscle-tendons. Although contact between players is rare but sometimes collision between the players also lead to certain traumatic injuries⁵. The gender, age, and skill level also influence the risk and type of injury. Male players have been injured frequently than female players but the participatory rate in men is more, so the incidence rate is considered to be almost same. The injury rate for male and female is 0.09 and 0.14 per person in per year respectively [5]. The older aged badminton players have more prone to the injuries and the beginners show more injury than the elite players. The 74% of the injuries in badminton is overuse injuries; the lower limb accounts for 58 to 76% of injuries, the upper limb accounts for 19 to 32% and 11 to 16% of back injuries. And the 42% of eye injuries are also seen in racquet sports [6]. Accurate measurement of physical activity and physical health is critical for better health and the effectiveness of intervention program [7]. It will help to gather and analyze human body and sports data, we will be providing effective advice and assistance to athletes in sports and health⁸. Real-time monitoring of their health and exercise status can assist people in adjusting their exercise intensity or amount in time based on their daily exercise situation, avoiding physical discomfort caused by excessive or insufficient exercise, and reminding themselves to improve their exercise status in time and maintain a healthy body and healthy life. Enthusiasts and professional players are involved in the process of sports, and sports risk factors are frequently generated by the combination of numerous aspects.

Traditional sports injury risk assessment approaches are sport-specific, with a restricted risk calculation scope [7]. In order to cover the gaps left by conventional statistical approaches, data science has developed as a strategic field to use knowledge in sports science. Since it requires expertise on how to integrate statistical and computational tools into a bigger framework, problem by problem, and to answer discipline-specific questions, data science is more than just the combination of statistics and computer science [9]. The Internet of Things emerging in strategic industry. Based on this setting, the Internet of Things application has enormous potential and area[10]. In recent years, the Internet of Things technology has progressively grown, focusing on sensors, software, and so on, while also supporting equipment for the Internet of Things has rapidly developed, particularly the rapid development of fundamental equipment such as smart circuits and transmission networks. The widespread use of modern Internet of Things technologies may bring tremendous technical improvements to sports event research and development, as well as thoroughly boost the growth of sports events as well as the performance evaluation[11]. The development of software and data analytics programmes along with the usage of technologies and wearable devices have drastically changed the role of sports technology in injury detection and prevention. Utilising emerging technologies to better understand and treat patients has become a growing emphasis of healthcare over the past few decades[12].

INJURY PREVENTION BASED ON ADVANCED METHODS**Edge computing**

The goal of edge computing is to describe the fundamental network, computing, storage, and application capabilities as a distributed open platform and integrate them into the data source's network edge [13]. The edge computing is growing rapidly. It builds a network edge computing by merging the five resources of network, processing, storage, application, and intelligence. The demand for the large storage data is also increasing along with the computing speed and power[14]. Prior to the development of edge computing, traditional cloud computing used the network to send all data to the cloud computing centre and employed a centralised approach to problem-solving for processing and storage. Cloud computing will place a lot of pressure on the system because of the massive volume of data that linked devices generate and transfer to the cloud. At this moment, edge computing is necessary to share the burden of the cloud and manage tasks that fall within its boundaries [15]. Cloud computing technology offers customers with nearly limitless processing capacity via several high-performance servers installed in a data center. Mobile edge computing has the potential to successfully address the issue of excessive network load caused by the rapid expansion of mobile Internet and Internet of things[16].



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Smart terminals, multi- access edge computing (MEC) equipment and clouds data center are the major three components of the edge computing. The MEC network architecture's cloud data center performs the same tasks as the standard cloud computing network architecture's cloud data center. It is primarily responsible for huge data storage, data integration, data mining, and worldwide sharing of data. The MEC can be applied through five computing components[13]. (figure-1) The edge computing is having more benefits such as reducing the delay and reducing the energy consumption and also, it is low cost with good scalability. Edge computing gives easiest mode of implementation when compared to another computing method (Yu Wang, 2023). Computing and storage capabilities are delegated to the mobile network's edge, such as base stations and wireless access points, in the MEC network design. Mobile devices can offload application activities for processing to adjacent computing nodes, resulting in low-latency and high-reliability computing services[17]. (figure-2) Sports biomechanics innovation has also led to new developments in the practical application of sports biomechanics. The newness of its application model is biomechanics diagnostic technology. It obtains the collecting of information on the competition venue and training venue, as well as the evaluation of athletes' overall sports status, using a big data platform and high-speed networked information methods. The edge computing performs in the sports environment as: [18,19](figure-3)

With the help of edge computing, the injuries can be prevented. A study has been done in preventive treatment of ankle injury in badminton players using the edge computing. The edge computing model and the firework algorithm are the different type of edge computing methods. This can also be used to assess the badminton related performance.

The study shows the measures to prevent the ankle injury.

- Need to improve the physical fitness
- Mastering of the proper badminton techniques
- Sufficient preparations before exercise

The edge computing provides the factors that contributing to ankle injury and the ways to prevent them. The data generated by edge computing will be accurate and it can be referred for the ideal biomechanics while playing badminton[17].

Internet of things and wireless sensor

Coaches evaluates and assess the badminton players' performances. However, it has drawbacks like the coaches' expertise and experience. The assessments provided by sensor-based systems can be more precise while remaining not visible to coaches. The internet of things (IoT) principle underlies how the sensor system operates. In this instance, the performance is captured on camera, and the data is then Bluetooth-transferred to the smartphone. The data is then moved to a remote server source called cloud storage. The player is also able to assess the data after gathering it all[20]. There are technologies like assembly technology for web image design, but when they are combined, they form the Internet of Things' basis, which is superior to all others because it is built on a complex and connected infrastructure. The development of technologies will be accelerated by the internet of things. The coaches will find it challenging to evaluate each player individually during practise sessions due to the large number of players, so the internet of things will enable them to learn more about each player[20]. To be a strong player, badminton players must be proficient in various kinds of fitness skills such as cardiovascular health, agility, strength, and other abilities. The sensor-based system can provide more accurate data of the players. The working of internet of things will be based on the following diagram. (figure-4) It enables coaches and trainers to assess players' success because physical activity levels are a major motivating factor. The rewards range from a smart badminton action recognition system with Bluetooth power technology to a static measurement device with cloud technology. The entire operating system is made up of three components: a wearable sensor, a mobile application, and a cloud server. The data gathered by the unit of measurement is sent by the mobile phone through Bluetooth Low Energy (BLE). Once the data from the mobile phone is received, the server at that distance transmits data via cloud technology. The data shows the injury prone mechanism of players while playing. This data shows the players to prevent the injury[20].





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Blockchain technology using internet of things

Blockchain is a tamper-proof distributed network ledger system that exclusively stores actual information. Furthermore, blockchain's peer-to-peer (P2P) technology assures that it does not rely on any central entities (Sheping Z et al 2018). As a result, blockchain technology may offer communication between IoT devices without the need of any centralised organisation and they can effectively solve the problems of compute node failure, transaction serial timing mistake, privacy, trust, and dependability of new IoT nodes[21]. The Internet of Things network model based on blockchain technology under the Internet of Things network in order to effectively apply blockchain technology to the Internet of Things network and realise the reliable identity authentication function of devices with certain computing power in the Internet of Things. The data structure of the block body is enhanced based on the features of IoT equipment for sports injury risk assessment, and a set of data interactive authentication methods using cryptographic algorithms is created under this model [7]. Encryption (asymmetric encryption), hashing, chaining blocks, and smart contracts are some of the major characteristics of block chain technology. The data structure of a generic block body, which is made up of blocks that are dispersed and distributed. Each block is often linked to a time stamped transaction set. This technology allows nodes to exchange data by forming transactions, each of which is dependent on another, and where the output of one transaction is referenced as an input in the other, resulting in a chain structure. Blockchain blocks are broken into two parts: block headers and block body. Block headers are similar to database indexes. The block body work according to the device ID and business ID are used to locate Internet of Things devices based on their real existence and uniqueness. The transaction type is primarily stored in the type field, which is used to find and negotiate transactions between gateway nodes [7].

The blockchain technology along with internet of things works on the fusion of the algorithm system. The D-H algorithm of computer power balance is working on the basis of IoT, intelligent data processing algorithm, data fusion of fuzzy sets and D-S evidence theory. Using the fuzzy D-S evidence theory algorithm in a human motion monitoring system, we can determine if the user's motion condition is healthy or not based on the findings of multisensory detection data from blockchain and the Internet of Things [7]. It shows in flowchart (figure-5) The algorithm shows good accuracy in determining human sports health state, which is consistent with application specifications in a typical context and has some practical effects. It is compared to a risk assessment system based on weighted average data fusion for human motion injury. The fuzzy D-S evidence theory method outperforms the weighted average data fusion technique in terms of accuracy and stability. The D-S evidence theory technique is utilized to fuse data from several sensors, and the benefits are optimal. Thus the block chain and internet of things will give accurate assessment of risk factors in sports. So we can prevent injuries with the help of the data provide by the algorithm [7].

CONCLUSION

Every sport has its own set of criteria for determining victory. Multiple preparations are required for an athlete to become an expert in the sport in which he or she participates. Experienced athletes feel that physiological and psychological preparation are essential for achieving consistent performance during training or competition. The badminton is getting popular day by day, both professional and recreational players will be having more playing time. In this case, the players will get prone to injuries without proper health status. The study conducted by M. phomsoupha et al concluded that the badminton performance is related with the physiologic, metabolic, biomechanical, technological and visual factors. The edge computing will give whole anthropometric measurements about the player, it can be stored in cloud data. The coaches and players will get accurate information and will help them to prevent the injuries and its risk factors. Jinil Yang et al conducted a study on the topic internet of things and wireless sensor. The study concludes the internet of things and wireless sensors are the advanced technologies which help both players and coaches to know about the injury risks and the level of performance. JihuaLiu conducted a study on the topic block chain technology. The algorithm fusion technology is used to fuse different type of sensors. It helps to assess the risks for injury in sports. This will help to prevent the further injuries. The recent advances like internet of things, edge computing and block chain technologies with help of different type of sensors. These



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advanced technologies will be giving the accurate data about the performance and health status of the player as well. The data collected will stored in the storage and can be used for further application in the game.

Declaration of competing interest

The authors of this study do not have any direct or indirect financial interest in the subject matter discussed in the manuscript.

Credit authorship contribution statement

All the authors of this study have equal contribution in Conceptualization, Funding acquisition, Formal analysis, writing – original draft, Conception and design of the study, acquisition of data, analysis, and interpretation of data, drafting the manuscript, revising the manuscript critically for important intellectual content

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<p>Figure 1: Basic architecture of multi- access edge computing</p>	<p>Figure 2: Multi- access Edge Computing application diagram</p>
<p>Figure 3: Biomechanics of diagnosis technology</p>	<p>Figure 4: Performance analysis using IoT</p>





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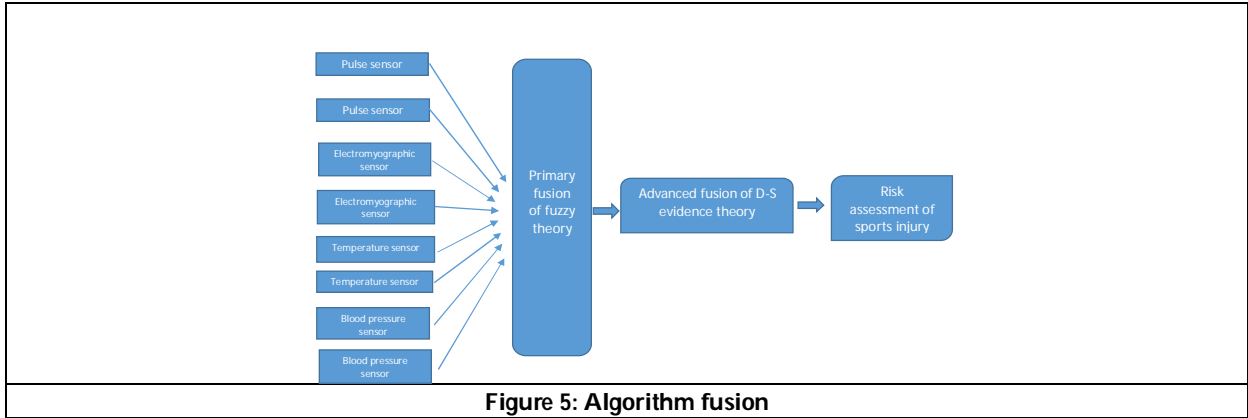


Figure 5: Algorithm fusion





Qualitative Assessment of Pharmaceutical and Personal Care Products (PPCPS) in Water, Sediments and Freshwater Fish from Major Chennai Reservoirs that is Affected by the Anthropogenic Activity

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

India is a global leader in the production of pharmaceuticals and it is considered to be the third-largest pharmaceutical producer in the world. Over the past ten years, pharmaceuticals have become a significant class of environmental contaminants [1]. The purpose of the investigation on three particular PPCPs such as 1-Tetradecanol, Behenic alcohol, and Stigmasterol is they come under Sterols and terpenes that are lipids and highly in soluble in water. The lipids are found on the surface of the water and they are disseminated superficially on the water. Most of the paper concentrate on common pharmaceutical compounds whereas these compounds are not investigated. The aim of this research is to quantitatively determine the presence of three Pharmaceutical and Personal Care Products (PPCPs), viz., 1-Tetradecanol, Behenic alcohol and Stigmasterol in Water, Sediments and Freshwater Fish from five major reservoirs of Chennai namely Korattur lake, Retteri lake, Puzhal lake, Ambattur lake and Chembarambakkam lake. A novel Solid Phase Extraction method was used for the extraction of lipids from biological matrices from the water and Quechers method for the homogenized fish tissue samples which involves a simple and efficient technique for removal of lipids and further analysis is facilitated with the evaluation of extracted samples was performed by High- Performance Liquid Chromatography (HPLC) to detect the three PPCPs. Currently researchers are employing sophisticated methods to retrieve

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the results however this research implies simple methods that mete out the justice for the study proving that this can be done without a sophisticated methodologies on PPCPs in Aquatic Environment. The water sample collected from Retteri lake, Ambattur lake and Chembarambakam lake showed the presence of 1-Tetradecanol, Behenic alcohol and Stigmasterol. In order to effectively manage pharmaceutical contaminants (PPCPs) in developing nations, it is necessary to examine the significance of PPCPs as an emerging pollutant and then conduct routine environmental monitoring. which indicates that the presence of pollution due to human activities.

Keywords: PPCPs, Contaminants, Solid phase extraction, HPLC, Pollution.

INTRODUCTION

Pharmaceutical sector is growing rapidly in India. The pharmaceutical industry produces a large group of human and veterinary drug compounds, used widely in huge quantities. The pharmaceutical industry in India has been unprecedented in the last few decades. A substance intended for use in the diagnosis, cure, mitigation treatment or precaution of disease is called pharmaceutical compounds [1].The reason to choose 1-Tetradecanol, Behenic alcohol, and Stigmasterol is They are sterols and terpenes that come under lipids and mostly researchers have not investigated the contamination of water due to sterols especially in the main Chennai reservoirs. Tetradecanol is a compound used for its emollient qualities (cold creams), Stigmasterol is a nutritional supplement and Behenic alcohol is a plasticizer and a lubricant all these three PPCPs are used extensively in their everyday routine. Pharmaceutical compounds are drugs and personal care cosmetics which is used by human beings in a daily basis. It is comprised of an active pharmacological compound in order to allow it for medicine handling and closing. Pharmaceutical compounds undergo a number of Enzymatic Transformations (metabolism) in Human tissues including liver, kidney and lung. The main part of the metabolism occurs in liver. Every drug is metabolized to different degree resulting in more polar metabolites with loss of some or all pharmacological activity of the parent substance [23]. The environmental exposure routes of pharmaceuticals into the environment are manufacturing units and hospital effluents, land applications (e.g., bio solids and water reuse) etc. Sewage treatment services are not always successful in removing the active chemicals from waste-water. Consequently, PPCPs find their way into the aquatic environment, where they directly affect aquatic organisms and can be incorporated into food chains [15].

The disposal of human organs, syringes and other pharmaceutical compounds illegally into the lakes causes a huge destruction to the health of humans. The long-term exposure of lower concentration of complex PPCPs mixtures on stream biota may result in acute and chronic damages, behavioural changes, accumulation in tissues, reproductive damages and inhibition of cell proliferation [19]. It can enter all type of cycles in drinking water and starts to accumulate in animals and vegetables without human being knowledge. The water from households, industries and drainage are sent for waste water treatment, this treatment is done with the help of microorganisms which will remove the basic hard particles and some of the heavy metals and superficial degradation occurs but it cannot reduce the nanoparticles and microscopic toxic particles which end up in bioaccumulation in plants because this water is let out for the plants in order to save the water [21]. Several studies have been carried out globally to determine the presence of antibiotics in natural resources and wastewater treatment plants. Study source says PPCPs (Sterols, terpenes- Lipids) are the robust indicators to assess the sewage contamination in river waters *Wen, X., Bai, Y., Journal of Chemistry, 2020* [24].The primary sources of pharmaceutical pollution in rivers and oceans are Wastewater treatment plant outputs. Most pharmaceutical pollutants cannot be removed by the current wastewater treatment procedures, removal efficiencies usually range from 12.5% to 100% in Indian water bodies *Balakrishnan., Ecotoxicology and Environmental Safety, 2017*[4]. These findings demonstrates that the accumulation of PPCPs and also some of the waste water treatment plant does not totally eliminate antibiotics from water, and that they are present in river water at the nanoscale. To detect the qualitative information on the presence of various PPCPs kinds in water, sediment and Freshwater Fish from five major water reservoirs is the aim of this study [5-6].





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MATERIALS AND METHODS

Chemical standards with high purity grade (>95%) which is purchased from Sigma Aldrich. Fresh working standard solutions (20 and 1mgL⁻¹) all compounds were prepared in water/methanol before each analytical run. Solvents used throughout the analysis were Methanol. Glassware, bottles, tubes, 50ml vials, conical flasks, 50ml beakers, 50ml measuring cylinder, 1ml pipette, watch glasses, 50 ml centrifuge tubes these materials were used throughout the analytical scheme. In particular all the glassware was rinsed with some number of solvents used in extraction process. The lakes subjected in this study are Puzhal, Chembarambakkam, Retteri, Korattur and Ambattur. Sites were prioritized based on fundamental water reservoirs for the Chennai Metropolitan City and the samples were collected based on high density of impurities. These lakes are chosen due to continuous dumping of biomedical wastes, plastic materials and pesticides due to this water, sediments and living organisms are affected. The Pharmaceutical and Personal Care Products which is selectively detected in the water, sediment and freshwater fish sample has their own physiochemical properties, viz., After purchasing the antibiotic standards from Sigma-Aldrich, a 1000 ppm stock solution was made. From the stock solution, which has concentrations of 500 ppm, 250 ppm, 100 ppm, and 50 ppm, the working solutions were created. Methanol was used to prepare each stock solution. In order to qualitatively determine whether the antibiotics are present in the sample, solutions were introduced into the HPLC, followed by the samples.

SAMPLE COLLECTION AND PREPARATION

A total of five water samples, sediment samples and a freshwater fish (tilapia) collected from five important lakes that is used by people of Chennai, viz., Puzhal, Retteri, Korattur, Ambattur and Chembarambakkam. The samples were retrieved in 1 Litre amber coloured Bottles. Before the samples were collected, the bottles were rinsed with methanol and Millipore water. The pH of the collected samples was measured, and 4M concentrated H₂SO₄ was used to lower the pH to 3 for improved ion exchange during solid phase extraction. After that, all suspended contaminants were eliminated from the samples by filtering them using a 0.45 µm glass membrane filter.

SOLID PHASE EXTRACTION

During filtration and acidification, the material was extracted using a solid-phase extraction device. The solid phase extraction was conducted using an anion-exchange HLB cartridge. C18 Cartridges (Agilent Bond Elute) were used for extracting samples. The cartridges were Preconditioned by Methanol. The samples were loaded in the cartridges and eluted with 20ml of Methanol. The Eluate is dehydrated with 1g of Anhydrous Sodium Sulphate (Na₂SO₄). The Eluate is transferred into 50ml glass vials and condensed with rotary evaporator. The extracted samples were analysed using UV detection in High Performance Liquid Chromatography (HPLC) [6].

The flowcharts 1 and 2 elucidate methodologies that are convoluted in the study and furnishes the Research.

HIGH – PERFORMANCED LIQUID CHROMATOGRAPHY

The HPLC parameters for determining the three Pharmaceutical and Personal Care Products are listed below. XDB C18 column, 250×4.6mm id, 5µm particle size, was the column that was utilized. There was 0.6 ml of flow per minute. 90% acetonitrile and 10% methanol make up mobile phase B for 1 - Tetradecanol and Stigmasterol, whereas 90% water and 10% ammonium acetate make up mobile phase A. Water and 0.2% formic acid were used as mobile phase A while HPLC-grade methanol and 2% formic acid were used as mobile phase B for Behenic Alcohol. There was a 0.6 ml/min flow rate with 80% of A and 20% of B. A calibration graph was constructed using five trials (1000 ppm, 500 ppm, 250 ppm, 100 ppm, and 50 ppm) for each PPCPs [9].

RESULTS AND DISCUSSION

The lakes subjected in this study Puzhal, Chembarambakkam, Retteri, Korattur and Ambattur which are the main water reservoirs for Chennai Metropolitan City. This map illustrates the Anthropogenic activity spots in the different lakes as located.





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Chromatogram and Acquisition Time of Standards

The initial procedure was to inject with all three standards into HPLC while adhering to the parameters specified for each chemical. The Chromatogram is selectively taken according to only the maximum peaks that is shown in the samples at the respective lakes. In the Fig- 2 the chromatogram shows the elevation points of PPCPs in three different lakes and their samples. Table. 3 shows the Illustration of count and Acquisition time in the three PPCPs. The figure explains the highest peaks of the three PPCPs in two lakes out of five lakes. The Retteri water sample is detected with 1- Tetradecanol, Behenic alcohol present in Ambattur lake sediment and Chembarambakkam lake is detected with stigmasterol in freshwater fishes (*Oreochromis.mossambicus*). Compared to many other biological products, steroids are more stable structural elements of animals and are better retained in sedimentary conditions. It is well known that C29 sterols, which are important components of vascular plants, including stigmasterol and -sitosterol, tend to dominate the sterol distributions in lake sediments [7]. In contrast to resulting from routine monitoring, the majority of occurrence data in drinking water and source water have come from focused investigations. The detection of trace amounts of pharmaceuticals in drinking water, surface water, and groundwater has increased due to advancements in sensitivity and accuracy of detection technologies and methodologies. These amounts range from concentrations in the nanogram per litre to low microgram per litre (although largely less than 0.1 µg/l). Wastewater discharges from manufacturing plants with inadequate controls or wastewater treatment effluents contain higher quantities of these pollutants **Edition, F. (2011). Guidelines for drinking-water quality. WHO chronicle, 38(4), 104-8 [25]**. Aquatic organisms might not be the only ones harmed. PPCPs in water may be absorbed by plant roots and accumulate in the plant's edible sections. As water supplies grow scarcer owing to drought, climate change, and increased demand, recycled wastewater for irrigation will become more widespread. However, using these contaminated waters for agricultural irrigation risks introducing wastewater-associated drugs and pathogens into irrigated areas. This information raises concerns regarding the possible uptake and accumulation of PPCP pollutants in plants, as well as their transfer up the food chain.

CONCLUSION

The PPCPs are detected in trace amounts in different lakes. The 1- Tetradecanol was detected In the Retteri lake, the lake is dumped with enormous amount of waste materials and this causes unwanted pollution inside the lake and to surrounding water bodies. The water is also defiled by the drainage system and chemicals. The presence of 1- Tetradecanol indicates the Retteri lake water contaminated by the anthropogenic activity. Behenic Alcohol which is a lubricant that is highly insoluble in water and rich in plasticizer which is accumulated in the lake water causes disadvantages to the human being. The aggregation of microparticle compound in the soil will damage the fertility of the soil and also affect the ecosystem, the Ambattur lake showed a higher count in the sediment samples due to colossal amount waste being dumped by Industries, Hospitals and Human beings. Many medications pass through the human body intact, therefore there are benefits to not dumping human waste into rivers, even after standard sewage treatment, which does not remove the majority of these chemicals. Human faeces and urine should be deposited in fertile soil, where they will be treated more effectively by various bacteria over longer periods of time, rather than in rivers. There are numerous worries concerning the impacts of pharmaceuticals found in surface waters, particularly the hazards to rainbow trout exposed to treated sewage effluents. The presence of Stigmasterol in Chembarambakkam lake Tilapia fish which has history of being discarded with Biomedical wastes by many hospitals that are nearby. Tilapia is a commercially available and often eaten by Chennai people. The deposition of these PPCPs compound in smaller levels into the aquatic bodies for a while will cause biological abnormalities in the fish and when it is consumed by human beings creates menacing situation if they ingest it for a longer time.

ACKNOWLEDGMENT

I thank the National Centre for Sustainable Coastal Management (NCSCM), Ministry of Environment, Forest & Climate Change, Government of India, Anna University Campus for assisting me with the Instruments and giving me the opportunity to utilize the Laboratory without any hindrance. I am grateful that I did my Research work in the Esteemed Centre.





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Table. 1 Physicochemical Properties of Selected PPCPs

PPCPs	FORMULA	MOLECULAR WEIGHT gmol ⁻¹	DESCRIPTION
1-Tetradecanol	C ₂₉ H ₄₈ O	214.39 g/mol	1-tetradecanol is utilized as an ingredient in cosmetics like cold creams for its emollient qualities. Additionally, it serves as a chemical synthesis intermediary for other compounds like surfactants [10].
Behenic alcohol	C ₂₂ H ₄₆ O	326.6 g/mol	Behenic alcohol are also known as fatty alcohol that are frequently used in the manufacturing of medicines, cosmetics, and personal hygiene items Also, it serves as a plasticizer and lubricant [4]
Stigmasterol	C ₁₄ H ₃₀ O	412.7 g/mol	A nutritional supplement called stigmasterol is made from plant sterols. It is used to lower cholesterol, strengthen the heart, and various cancer cell lines have demonstrated its possible anticancer properties [2]

Table. 2 Shows the Method Parameters for HPLC

Column	C8 150X4.6 mm, 2.7 μm at 40°C
Nebulizer Heater	30°C
Filter	None
Mobile phase A	Methanol (750)
Mobile phase B	Acetonitrile (500)
Flow rate	0.8 ml/min
Run time	72 mins
Injection time	10 μl at 10°C
Sample	1:1 upto 1:3
Concentrates	MI in Methanol

Table .3 PPCPs Peaks Count and Acquisition Tim (min)

PPCPS	COUNT %	ACQUISITION TIME (min)
1 – Tetradecanol	80%	5.45
Behenic Alcohol	80%	10.90
Stigmasterol	40%	14.35

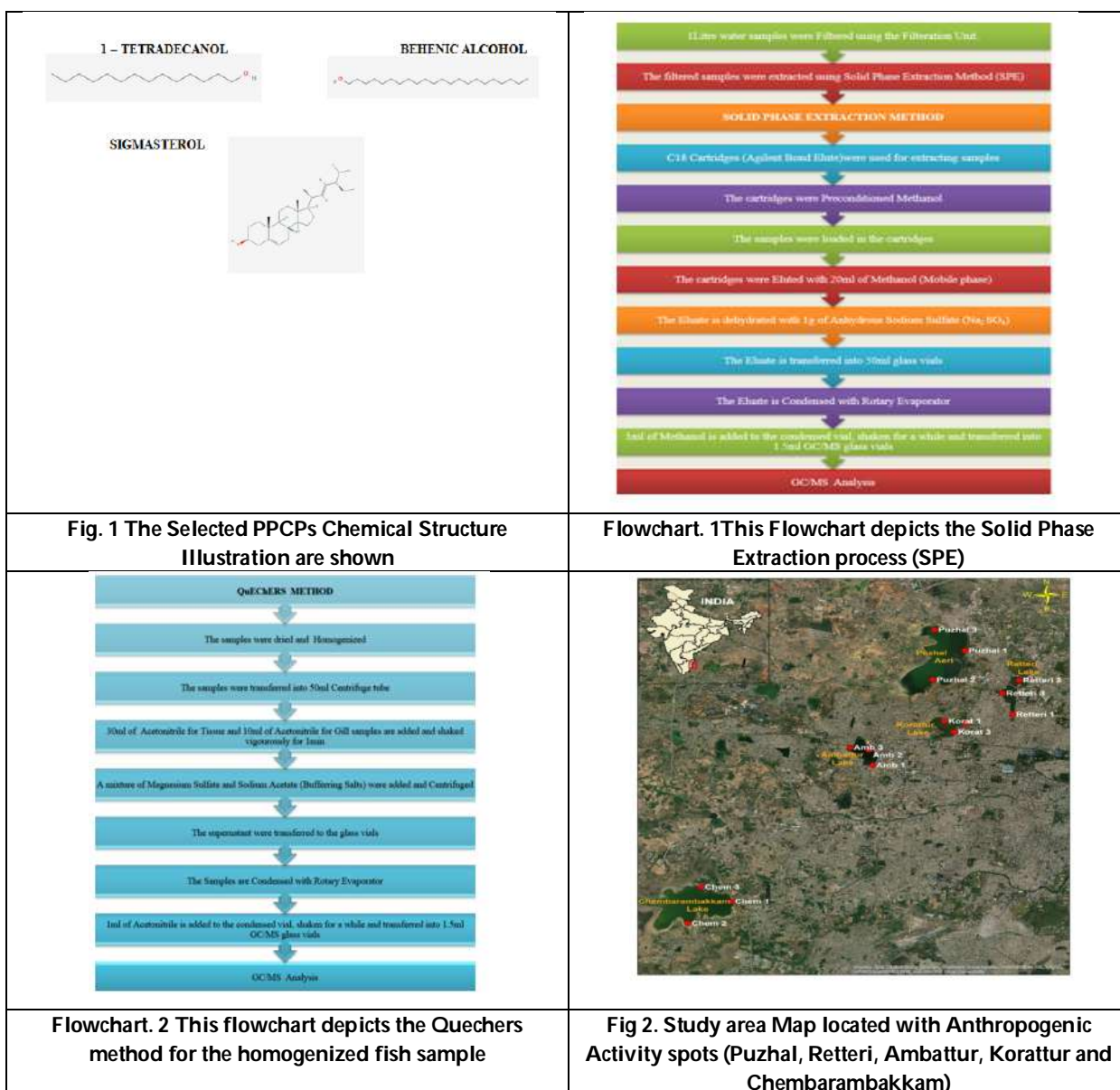




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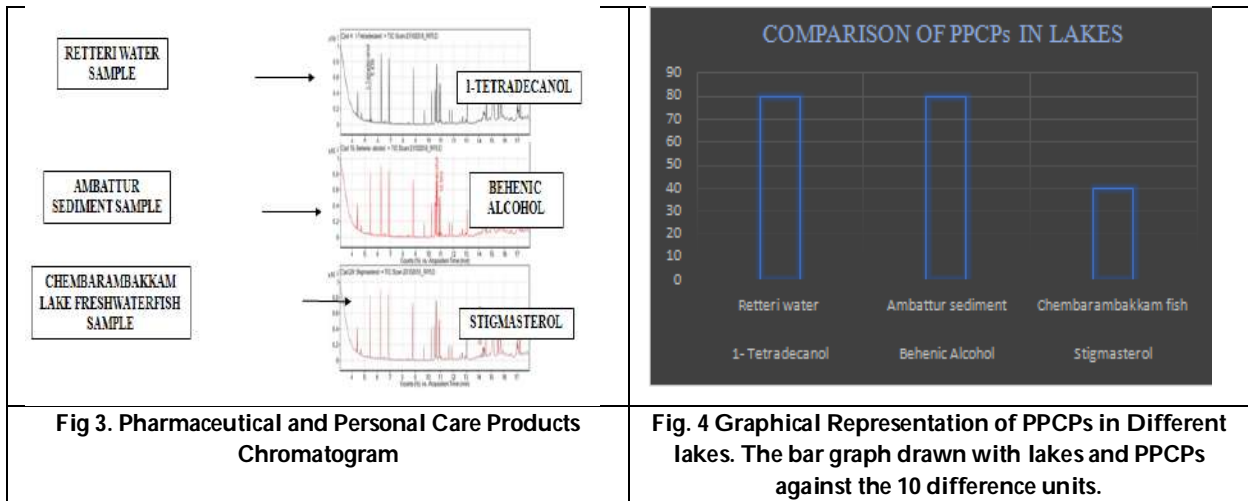
Table 4. Differentiation of PPCPPs in different lakes and samples. The chromatogram is against count (%) and Acquisition time (min)

PPCPs	SAMPLES	LAKES
1 – Tetradecanol	Water	Retteri lake
Behenic Alcohol	Sediments	Ambattur lake
Stigmasterol	Fish	Chembarambakkam lake





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Green Synthesis of Silver Nano-Particles from *Xanthium indicum* and its Antimicrobial Effect on Pathogenic Bacteria *E. coli* and *S. aureus*

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

The Green synthesized traditional nanoparticles are multifunctional in nature as a cost-effective and ecologically alternative to chemical and physical extraction method. In present observation silver nanoparticles were synthesized by using silver nitrate as a precursor and *Xanthium indicum* (Landaga) a noxious weedy plant leaf extract was used as a reducing and capping agent. The synthesized silver nanoparticles were characterized and confirmed by using Visual observation of colour change, X-ray diffraction (XRD) and SEM. The experimental XRD results showed silver nanoparticles having crystalline size 83.03nm, 25.94nm, 25.94nm, 23.09nm, 29.65 nm for 1mM, 2mM, 3mM, 4mM and 5mM concentration of solution respectively with higher stability. Its antimicrobial activity was observed by well discussion method on pathogenic bacteria *Escherichia coli* and *Staphylococcus aureus*. Finally AgNPs from leaf extract of X. Indicum shows 14 mm zone of inhibition against *E. coli* and 12 mm for *S. aureus*.

Keywords: Green synthesis, Silver nanoparticles, *Xanthium indicum*, XRD, *E. coli*, *S. aureus* etc.





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INTRODUCTION

The field of nanotechnology is one of the most active field nowadays in material science and technology. Nanoparticles are fundamental component of nanotechnology. The most important and distinct characteristic of nanoparticles is their exhibits larger surface area to volume ratio [1]. The important Properties associated with nanoparticles like their small size, large surface area to surface volume ratio, optical, magnetic, chemical, and mechanical properties have made them possible for novel applications in the field of biomedical as antibiotic, antioxidant, anticancer and antimicrobial agents [2]. Nanoparticles are mostly prepared from of noble metals like silver, gold, platinum, palladium, iron, copper, zinc, titanium, and magnesium which gained significant attention due to their multifunctional abilities [3]. There are chemical and physical methods employed in the synthesis of nanoparticles but they are associated with hazardous chemicals exhibiting toxicity. Alternatively, large amount of nanoparticles can be easily synthesized from plant and the majority of these are having low toxicity, cost effectiveness, Eco friendliness, and low time consumption [4]. Plants contain secondary metabolites such as terpenoids, polysaccharides, flavonoids, proteins, ketones, polyphenols, alkaloids, amines, tannins, and aldehydes, which act as reducing, capping and stabilizing agents by converting metal ions to metal nanoparticles [5]. Among various biosynthesized metal nanoparticles, silver nanoparticles (AgNPs) are the metal of choice in the field of biological systems, living organisms and medicine [6]. Silver nanoparticles are non-toxic to humans and most effective against bacteria, virus and other eukaryotic microorganisms at low concentrations and without any side effects silver are toxic at higher concentrations but many studies have established that a lower concentration of AgNO₃ has higher chemical stability, catalytic activity, biocompatibility and show higher antimicrobial activity [8].

Many studies have been done on the green synthesis of AgNPs using leaves of plants, but biosynthesis of AgNPs using wild and indigenous species exhibiting potential antibacterial activity has not been explored to a large extent. In this concern, we describe a novel and green protocol that provide important new insights into the synthesis of colloidal AgNPs using plant extract. This suggested technique gives bypass to hazardous and expensive chemicals and offer size controlled AgNPs at mild reaction conditions, which is inexpensive, easy, simple, rapid, quick, simple scale up, easy to control and less energy extensive process. In typical synthesis protocol plant extract of *Xanthium indicum* leaves possessing rich concentration of biomolecules such as vitamins, polysaccharides, proteins, amino acids, enzymes, flavonoids, triterpenoids, polyphenols and organic acids will be used as a reducing as well as capping agent. *Xanthium indicum* belongs to family Asteraceae. It is erect, annual, under shrubs, stems rough with short hairs. Leaves broadly ovate to cordate, hispid. This study highlights the potential use of *Xanthium indicum* in combination with nanotechnology for various biomedical applications. In this study we used the silver nanoparticles synthesized from the leaf extract of *Xanthium indicum* and its antibacterial effect on the bacteria, *Escherichia coli* and *Staphylococcus aureus*.

MATERIAL AND METHODS

Collection of Plant Material

Leaves of *Xanthium indicum* plants were collected from waste land area of Badyachi wadi village, Gadhinglaj, Kolhapur district Fig. 1. Collected fresh plant leaves brought to the laboratory and washed using tap water to remove dirt from the leaf surface, then leaves were shade dried for 15 days under dust free environment. These dried leaves grounded into fine powder with grinder. This powder was sieved using tea mesh and fine powder is store in plastic containers under room temp. for further use.

Preparation of Extract

The extract was prepared by adding 10 gm of power in 100 ml double distilled water and boiled at 100 °C for 20 min [8]. The extract was allowed to cool at room temperature and filtered using Whatmann filter paper No.1 with the help of Buchner funnel. This extract was stored in refrigerator to protect it from fungal growth.



**Sanket Sadashiv Patil****Synthesis of Silver nanoparticles**

The preparation of Ag nanoparticles has been carried out in two steps. Firstly prepare silver nitrate solution of five different molar concentration (1mM to 5mM) by dissolving silver nitrate powder (appropriate amount) in double distilled water (500ml). Secondly add 50 ml of plant extract 450 ml of silver nitrate solution (separately for every molar concentration) drop wise for better reduction Fig. 2. The mixture is kept at room temperature for reduction reaction. The solution was then centrifuged at 10000 rpm for 10 min each; 20 ml acetone was added to the solution in order to separate the precipitated and the surfactant. The precipitate silver nanoparticles were then kept in evaporating dish and allow evaporating the acetone with the help of boiling water bath Fig. 3. After evolution of acetone collect the synthesized nanoparticles in small glass bottles separately

Characterization of synthesized silver nanoparticles**Visual Observation of Colour change**

The synthesis of silver nanoparticles (the reduction process Ag^+ to Ag^0 nanoparticles) was confirmed by visual observation of color change of the solution from white yellow to reddish brown and dark brown upon incubation upon incubation at room temperature for 24 hour. (Fig. 2) [9].

X- Ray Diffraction Spectroscopy (XRD)

XRD technique is the most powerful method for qualitative and quantitative analysis of nanoparticles. XRD analyses are useful technique for determine the crystalline structure of nanoparticles and its formation [10]. Each nanoparticle material has a different diffraction beam so analysis of the materials using this technique depends on the diffraction pattern of every nanoparticle material [11]. The presence, crystalline nature, phase variety, and grain size of synthesized silver nanoparticles were determined by X-ray diffraction spectroscopy. The average crystalline size of the samples 1mM to 5mM was determined by using Scherrer's equation as follows:

$$D = \frac{K\lambda}{\beta \cos\theta}$$

where D is average crystallite size and β is line broadening in radians (full width at half maximum of the peak in radians). λ is wavelength of X-ray and θ is Bragg's angle. K is constant (geometric factor = 0.94). Equation applied to determine in which mM concentration crystallite size is smaller than others [12].

Scanning Electron Microscopy (SEM)

The purified pellets of silver nanoparticles were dried at 50° C in an oven and thin films of dried samples were prepared on a carbon coated copper grid by dropping a very small amount of the samples on the grid. Extra solutions of the samples were removed using a blotting paper. The films on the carbon coated copper grid (SEM grid) were allowed to dry by putting them under a mercury lamp for 5 min. The morphological features, micrograph images, size, and structure of synthesized nanoparticles from leaf extracts were analyzed and recorded. The details regarding applied voltage, magnification used, and size of the contents of the images were implanted on the images itself [13].

Antimicrobial Assay

Antibacterial activities of synthesized silver nanoparticles were analyzed by well diffusion method against two pathogenic bacteria *Escherichia coli* and *Staphylococcus aureus* [14]. The strains bacteria were subcultured on Nutrient Agar (HiMedia) and were incubated at 37° C for 24 h. Fresh overnight bacterial cultures were taken and spread on the Nutrient agar plates using glass rod to cultivate bacteria. Six millimeter diameter wells were made on Nutrient agar plate with the help of gel cork border. Twenty-five microliters of silver nanoparticles and distilled water (as control) were inoculated to the well, and then the plates were incubated in incubator at 37° C for 24 h. The antibacterial activity was measured based on the inhibition zone around the wells. All the practice was done under aseptic condition.





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EXPERIMENTAL RESULTS AND DISCUSSION

Visual Observation of Colour change

When leaf extracts of *Xanthium indicum* were mixed and incubated with AgNO₃ solution, colour change from white yellow to dark brown was visually observed (Figure 2). This colour change is due to the Surface Plasmon Resonance phenomenon in silver nanoparticles as a result of the excitation of free electrons in nanoparticles [15]. These colour changes is due to reduction of Ag⁺ ions to Ag⁰ [16]. No further colour changes were observed after 24 h which indicated the completion of the reduction process. In earlier reports shows approximately 2 to 4 hour is required to reduce 90% of silver nanoparticles from Ag⁺ to Ag⁰ [17].

XRD analysis

Analysis of structure and crystalline size of the synthesized silver nanoparticles were carried out by XRD. The XRD analysis of synthesized silver nanoparticles from leaf extract of *Xanthium indicum* showed diffraction peaks at 1mM to 5 mM concentraion Fig.4. The same result was reported by Roy and indicates that the silver nanoparticles are face-centered, cubic, and crystalline in nature [18]. When compared with the standard, the obtained XRD spectrum and peaks confirmed that the synthesized silver nanoparticles were in nanocrystal form and crystalline in nature. The diffraction peaks represent face-centered cubic active silver nanoparticles, while the the sharp and high peaks in the XRD analysis indicated development of nano-sized particles [19]. The Full Width at Half Maximum (FWHM) values were used to calculate the size of the nanoparticles. The average size of silver nanoparticles synthesized from leaf extract of *Xanthium indicum* was calculated using Scherrer's equation where Scherrer's constant *K* value = 0.94 was selected due to the cubic and crystalline nature of the nanoparticles [20]. By comparing the peaks observed at different concentrations i.e. 1mM to 5mM of shows variation in crystallite size. At 4mM concentration 23.07nm crystallite size (Fig no 4) is obtained which is more smallest nanoparticles as compared to other concentration. A few unassigned peaks observed could be due to the presence of some bioorganic compounds/proteins [21].

Scanning Electron Microscopy (SEM) analysis:

SEM is electron microscopy techniques is useful to determine the surface morphology of nanoparticles, such as their shape, size, and size distribution [22]. The SEM images of sample 4mM nanoparticles (shows very less crystalline size 23.07) show high density of well-dispersed silver nanoparticles spherical in shape as well as number of aggregates with no defined morphology. The presences of biomolecules in the leaf extracts has resulted in the synthesis of spherical silver nanoparticles and the aggregation may be due to the presence of secondary metabolites in the leaf extracts [23]. The SEM image shows the size of the silver nanoparticles ranging below 100 nm. Similar result of the silver nanoparticles size was reported by using *Acacia nilotica* leaf extract [24].

Antimicrobial Activity

Silver nanoparticles have been widely used in health, medicine, and environmental applications. In this study *Xanthium indicum* leaf extract synthesized silver nanoparticles were examined for possible antibacterial activity against the bacterial strains of *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*) using well diffusion technique. The zone of inhibition around the well is shown in Fig. 6 and 7. Maximum zone of inhibition 14 mm was seen against *E. Coli* and 12 mm for *Staphylococcus aureus*. (Figure no. 6,7 and Table 1). No inhibition zone was observed for control, prepared by the stack solution taken in well without silver nanoparticles. The antibacterial activity of silver nanoparticles should be referred with several mechanisms including (i) activity of Reactive Oxygen Species (ROS), (ii) the presence of Ag⁺ ions in silver nanoparticles are making bond with sulphhydryl groups which to de-naturation of proteins in the bacteria and [25] (iii) release of Ag⁺ ions from the silver nanoparticles which simply penetrate into the cell wall and cause severe damage to the bacteria and kill them. From fig.6 and 7 it is observed that silver nanoparticles shows more antimicrobial activity on *E. coli* (Gram negative) than *S. aureus* (Gram positive) bacteria. The different antibiotic activity is due to variation in cell wall membrane of these bacteria. *E. coli* (Gram negative) have very thin layer cell wall membrane, its thickness ranged 7–8 nm and made up of peptidoglycans and lipopolysaccharides. On the other hand, *S. aureus* (Gram positive) bacteria have a very thick cell



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wall membrane, its thickness ranged from 20–80 nm and made up of large number of mucopolysaccharides, lipoteichoic acids and murein [26]. Several similar results were obtained in previous studies. Inhibition against *E. coli* and *Staphylococcus* was observed in the case of silver nanoparticles synthesized using extract from *Ayapana triplinervis* nanoparticles showed high toxicity to *E. coli* than *Staphylococcus aureus* [27].

CONCLUSION

From the present study, we conclude that, silver nanoparticles were successfully synthesized from the leaves of *Xanthium indicum* as a reducing and capping agents. The biosynthesized silver nanoparticles using plant extract were characterized by XRD and SEM. Obtained silver nanoparticles are crystalline nanoparticles in nature. The biosynthesized silver nanoparticles exhibited excellent antibacterial activity against pathogenic bacteria *Escherichia coli* followed by *Staphylococcus aureus*. This green synthesis approach appears to be a cost-effective, non-toxic, ecofriendly alternative to the conventional microbiological method. In this regard, we can confirm that the silver nanoparticles obtained by green method will be a potential tool for antimicrobial field.

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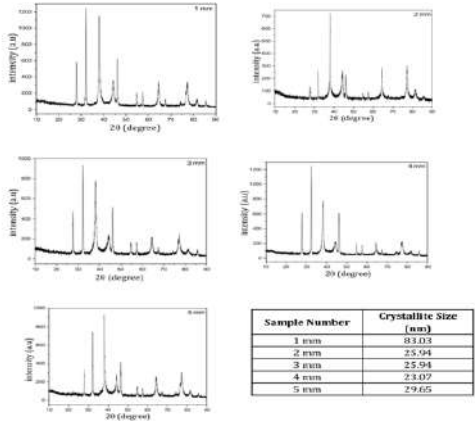
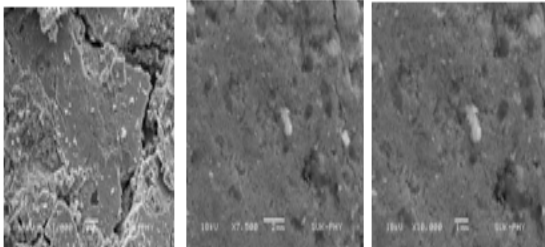

Table 1: Zones of inhibitions of silver nanoparticles obtained from antibacterial activity (*Xanthium indicum*)

Bacterial species	Diameter of inhibition zone (mm)	
	Ag Np from leaf extract of <i>Xanthium indicum</i>	Control
<i>E. Coli</i>	14	0
<i>Staphylococcus aureus</i>	12	0





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<p>Fig.1 <i>Xanthium indicum</i> in its natural habitat</p>	<p>Fig. No. 2 : Synthesis of Silver Nano particles <i>Xanthium indicum</i> a: Silver nitrate solution, b: silver nitrate with plant extract, c: Color change after reduction reaction.</p>												
	 <table border="1"> <thead> <tr> <th>Sample Number</th> <th>Crystallite Size (nm)</th> </tr> </thead> <tbody> <tr> <td>1 nm</td> <td>83.03</td> </tr> <tr> <td>2 nm</td> <td>25.94</td> </tr> <tr> <td>3 nm</td> <td>25.94</td> </tr> <tr> <td>4 nm</td> <td>23.07</td> </tr> <tr> <td>5 nm</td> <td>29.65</td> </tr> </tbody> </table>	Sample Number	Crystallite Size (nm)	1 nm	83.03	2 nm	25.94	3 nm	25.94	4 nm	23.07	5 nm	29.65
Sample Number	Crystallite Size (nm)												
1 nm	83.03												
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3 nm	25.94												
4 nm	23.07												
5 nm	29.65												
<p>Fig. No. 3 : Synthesized metal nanoparticles <i>Xanthium indicum</i></p>	<p>Fig. 4. XRD pattern of <i>Xanthium indicum</i> with crystallite size of Nano practical (calculated by using Scherrer equation)</p>												
													
<p>Fig. No. 5. SEM image of Silver Nanoparticle synthesized from <i>Xanthium indicum</i> leaf extract at different magnification.</p>	<p>Fig. 6. Antimicrobial Effect of Silver nanoparticles (<i>Xanthium indica</i>) on <i>E.coli</i> and <i>Staphylococcus aureus</i></p>												





Overview of Niosomes

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 24 Jun 2024

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ABSTRACT

This article provides an overview of a review on niosomes, which are emerging as promising drug delivery systems. Niosomes are nonionic surfactant vesicles that have gained considerable attention in the field of pharmaceutical research due to their ability to encapsulate various types of drugs and improve their therapeutic efficacy. This review aims to summarize recent advancements and applications of niosomes in drug delivery, highlighting their potential advantages over other conventional drug carriers. The review encompasses a comprehensive analysis of various aspects related to niosome-based formulations, including preparation methods, characterization techniques, stability considerations, and factors influencing drug release kinetics. Additionally, this review discusses the impact of different formulation parameters such as lipid composition, size, and surface charge on the physicochemical properties and performance of niosomes. The current challenges associated with large-scale production and commercialization of niosomal formulations are also addressed. Overall, this comprehensive review emphasizes the potential utility of niosomes as versatile nanocarriers for efficient drug delivery and highlights future directions for further research and development in this field.

Keywords: The current challenges associated with large-scale production and commercialization of niosomal formulations are also addressed.





INTRODUCTION

Poul Ehrlich began developing targeted medicine delivery in 1909. The targeted or desired site is where the targeted drug delivery method demonstrates its direct activity. Targeted drug delivery refers to a medicinal substance's ability to act directly on an intended site with little to no interaction with any other non-targeting sites. The niosome consist of a small amount of ionic surfactant, such as diacetyl phosphate, which is used for stability, and non-ionic surfactant, which contains cholesterol. The first non-ionic surfactant product for cosmetic use was developed and marketed by the L'Oréal Company. Drugs of various kinds can be delivered to the intended location. Because of their multi-environmental structure, niosomes are incorporated. Different types of drugs can be delivered to the desired location. Niosomes are integrated because of their structure that adapts to multiple environments. To lessen formulation aggregation, niosomes, which can be uni- or multi-lamellar vesicles, are composed of cholesterol, non-ionic surfactant, and ionic surfactant. Niosome bilayer structural vesicles can contain hydrophilic, lipophilic, and amphiphilic drugs. Because liposomes are specifically lipophilic, they are more prone to oxidation and degradation than niosomes, which exhibit greater stability. Because of their non-ionic surfactant, niosomal formulations have a longer half-life in the bloodstream and a greater target action. The niosomes are minuscule, microscopic particles. Niosomes are measured in nanometers, with a size range of 20 to 100 nm. While niosomes and liposomes share the same structural details, niosomes have more advantages. Their dimensions are measured in nanometers, which means they are incredibly small. Because of this, they can be administered transdermally without difficulty.

The reticular endothelium system eliminates and metabolises niosomes less efficiently because of their tiny size. A medication that contains niosomal vesicles has several benefits. Not only does it strengthen the stability of unstable drugs, but it also enhances their physicochemical characteristics. In order to minimise the amount of ionic surfactant added to it in order to maintain the same charge in the formulation, niosomes frequently have different charges on their surface as a result of different charges like (+) and (-), which indicate flocculation or aggregation. Niosome formulations typically employ Span-60, a non-ionic surfactant. Unlike liposomes, niosomes do not require any particular preparation or storage conditions. The niosome preparation process is entirely derived from the liposome preparation process. Gel filtration or centrifugation are frequently used to separate drugs that have been untrapped during niosomal formulation. Numerous drugs have the ability to become entrapped in niosomes and be used to treat a variety of illnesses. The fact that niosomes are more stable than liposomes made with phospholipid is one of the best justifications for their formulation. Phospholipids in liposomes have ester bonds, which cause phospholipids to hydrolyse. Cholesterol plays a vital role in the structure of niosomes by giving them rigidity. However, when cholesterol is added in excess to vesicles, it not only affects fluidity but also the drug's ability to penetrate and permeabilize them. Numerous routes, including transdermal, parenteral, oral, ocular, and subcutaneous, are used to administer niosomal formulations. Targeted drug delivery involves the use of various carriers, including liposomes and niosomes, which are well-established drug delivery systems, as well as immunoglobulin, plasma protein, microspheres, synthetic polymers, and occasionally erythrocytes.

Niosomes Structure

In terms of structure, niosomes and liposomes are comparable because both consist of a bilayer. Unlike liposomes, which have phospholipid bilayers, niosomes have non-ionic surface active agents as part of their bilayer. When submerged in water, most surface active agents form micellar structures, but some surfactants form bilayer vesicles that resemble niosomes. Niosomes Perhaps unilamellar or multilamellar, depending on how they were made. The hydrophilic ends of the surfactant bilayer, which makes up the niosome, are exposed both inside and outside of the vesicle, while the hydrophobic chains are facing one another inside the bilayer. Hydrophobic drugs are therefore embedded in the bilayer itself, whereas hydrophilic drugs are held within the space enclosed in the vesicle. A clearer picture of a niosome and the location of the medication within the vesicle can be found in the figure below.





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TYPES OF NIOSOMES

The niosomes are categorized based on the quantity of bilayers, their size, or the preparation technique. The various types of niosomes are described below:

- i) Multi lamellar vesicles (MLV),
- ii) Large unilamellar vesicles (LUV),
- iii) Small unilamellar vesicles (SUV).

Small Uni-lamellar Vesicle (SUV)

The process of sonication and French press extrusion electrostatic stabilization method is used to convert the large unilamellar vesicle into smaller ones. A small Uni-lamellar vesicle with a size range of approximately 25–50 nm or 0.025–0.05 μm .

Multi-lamellar Vesicle (MLV)

Multiple bilayers surround each aqueous lipid compartment independently in MLV. About 0.5–10 μm in diameter is the average size of MLV. 90 MLV niosome are commonly used for drug incorporation. For a longer duration, the MLV is more stable and requires simple preparation. This vesicle is better suited for drug compounds that are lipidic. This kind of niosome is mostly made via the thin-film hydration technique.

Large Uni-lamellar Vesicle (LUV)

The LUVs have large diameters and a single bilayer membrane within their uni-lamellar vesicles. Aqueous and lipidic content of this vesicle is more so that it has more size. Compared to other types, this vesicle has a higher amount of drug entrapment. The large unilamellar vesicle has an average size of 100 nm. These vesicles are prepared using the reverse phase evaporation and ether injection methods. Higher encapsulation of water-soluble drugs, reproducible drug release rates, and lipid economy are some of the advantages that LUV have over MLV.

Methods of Preparation

Thin film hydration

One easy and well-known preparatory technique is the thin-film hydration method. This process involves dissolving surfactants, cholesterol, and certain additions, including charged molecules, in an organic solvent within a flask with a circular bottom. After that, a rotary vacuum evaporator is used to remove the organic solvent for the purpose to form a thin film. On the flask's inside wall. A medication in an aqueous solution is applied, and for the specified amount of time, constant shaking maintains the dry film saturated above the surfactant's transition temperature (T_m). The multilamellar niosomes developed through that method.

Ether injection method

By dissolving additives and surfactants in diethyl ether and gradually adding them via a needle into a water-soluble drug solution that is maintained at a temperature higher than the boiling point of the organic solvent, one can apply the ether injection method. To evaporate the organic solvent, a rotary evaporator is employed. Vaporisation leads to the development of single-layered vesicles.

Reverse Phase Evaporation method

This method is to dissolve niosomal ingredients in a chloroform and ether mixture, subsequently adding them to an aqueous phase which has the drug. After the organic phase has evaporated, the mixture is sonicated to create an emulsion. The formation of large unilamellar vesicles occurs when the organic solvent evaporates.





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Micro fluidization

After the organic phase has evaporated, the mixture is sonicated to create an emulsion. When the organic solvent evaporates, large unilamellar vesicles form. Niosomes form as a consequence of the high energy and speed of impingement. This method produces niosomes with higher reproducibility, smaller size, and unilamellar vesicles.

Proniosome

The proniosome technique involves coating a water-soluble carrier with a surfactant, like mannitol or sorbitol. A Dry formulation is developed during the coating process. This preparation is known as "Proniosomes," and it needs to be hydrated in order to be utilised. The aqueous phase is added to create the niosomes. This method, which produces better results than conventional niosomes, helps to reduce physical stability issues like aggregation, leaking, and fusion problems. It also offers convenience in dosing, transportation, storage and distribution .

Transmembrane pH Gradient

This method involves dissolving cholesterol and surfactant in chloroform and allowing the mixture to evaporate, forming a thin lipid film on the wall of a flask with a circular bottom. Through vortex mixing, the film is hydrated with a citric acid solution (pH = 4), and the resulting product is freeze-thawed to allow for the formation of niosomes. To keep the pH of this niosomal suspension between 7.0 and 7.2, the drug's aqueous solution is added first, and then phosphate buffer. This method indicates that the niosome's interior possesses an elevated acidic pH value Than the outer medium. The additional unionised medication enters the niosome by passing through the membrane. The medication ionises in an acidic environment and is unable to exit The bilayer niosomal.

Heating Method

This patented technique was developed by Mozafari et al. using surfactants and cholesterol. The mixture is heated to 120°C while being stirred in order to dissolve cholesterol. The constituents are hydrated separately in buffer. After lowering the temperature and continuing to stir, additives and surfactants are added to the buffer containing the dissolved cholesterol. At this point, niosomes form and are stored at room temperature until they are needed, when they are stored at 4-5°C in a atmosphere of Nitrogen.

The "Bubble" Method

The glass flask with three necks is filled with additives, buffers and surfactants in this method. At 70°C, the components of niosomes disperse. Additionally, homogenizer is combined with dispersion. The flask is then immersed in water and heated to 70 degrees Celsius so that nitrogen gas can bubble. The nitrogen gas moves through. A sizable unilamellar vesicle was created using a homogenised surfactant sample.

Niosome Formation From Pro-Niosome

Pro-niosomes can be converted to niosomes by adding an aqueous phase, like water. to create a niosome. The development of pro-niosomes and the niosome depicted in Figure 2.

It takes a little agitation to form a niosome from a pro-niosome. When the temperature surpasses the average transition phase pH of the surfactant.

$$T > T_m$$

Where,

T = Temperature

T_m = mean phase transition temperature

Separation of Untrapped Drug from the Niosomes

There are several methods for removing the untrapped solute from the vesicles, including: -

Dialysis method

Through the use of a dialysis tubing and normal saline, or glucose solution, phosphate buffer the aqueous niosomal dispersion is dialyzed.



**Gel Filtration method**

By passing niosomal dispersion through a Sephadex-G -50 column and eluting with either normal saline or phosphate buffered saline, the untrapped drug is extracted using gel filtration.

Centrifugation method

After centrifuging the niosomal suspension, the supernatant is extracted. After washing, the pellet is reconstituted to create a niosomal suspension devoid of drug entrapment.

Niosomes Characterization**Morphology, Size and Shape**

Photon correlation spectroscopy has been used to calculate the average diameter of the vesicles, and freeze fracture microscopy has been used to investigate and determine the structure of surfactant-based vesicles. A laser beam is often utilized to ascertain the mean surface diameter, mass distribution and size distribution of niosomes, whereas electron microscopy is employed for morphological investigations of vesicles.

Entrapment efficiency

Once the niosomal dispersion is prepared, the drug that is not entrapped is separated using centrifugation, dialysis, or gel filtration as previously described. The drug that is still entrapped in niosomes is then determined by completely disrupting the vesicles using either 0.1% Triton X-100 or 50% n-propanol, and analyzing the resulting solution using a suitable assay method for the drug. % Entrapment efficiency (% EF) is calculated as follows:

$\% \text{ Entrapment efficiency (\% EF)} = (\text{Amount Of drug entrapped} / \text{total amount of drug}) \times 100.$

Vesicle diameter

Photon correlation microscopy, Light microscopy and freeze-fracture electron microscopy may all be used to measure the diameter of niosomes. The process of freezing thawing (maintaining vesicles suspension at 20°C for 24 hours, followed by a return to room temperature, results in an increase in vesicle diameter. This phenomenon may be explained by vesicles fusing together during the cycle.

In-vitro release

Dialysis tubing is used as part of an in-vitro release rate testing technique. A cleansed dialysis sac is placed in distilled water. The vesicle suspension is pipetted into a bag, which is then sealed with tubing. In a 250 ml beaker, the vesicles' bag is submerged in 200 ml of buffer solution. and shaken constantly at either 25°C or 37°C. Using the proper test technique, the buffer's drug content is examined at different intervals.

Vesicle charge

The character of niosomes both in vitro and in vivo can be significantly influenced by the vesicle surface charge. Compared to uncharged vesicles, charged niosomes are often more stable against fusion and aggregation. Microelectrophoresis may be used to determine the zeta potential of individual niosomes in order to estimate their surface potential. An alternative approach is to use pH-sensitive fluorophores. Recently, the zeta potential of the niosomes has been measured using dynamic light scattering.

Homogeneity and Bilayer Rigidity

The stiffness of the bilayer affects the biodegradation and biodistribution of niosomes. It may be happens both inside niosome formations and in between niosomes that are dispersed. Methods such as NMR, differential scanning calorimetry (DSC) and Fourier transform-infrared spectroscopy (FT-IR), are used to identify that. Fluorescence resonance energy transfer, or FRET, has recently been employed to learn more about the size, shape, and structure of niosomes.



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APPLICATION OF NIOSOMES

Drug targeting

The capacity of niosomes to target medications is one of their most advantageous features. It is possible to target medications to the reticuloendothelial system using niosomes. The reticulo-endothelial system (RES) particularly absorbs niosome vesicles. Opsonins, which are circulating serum factors, regulate the uptake of niosomes. These opsonins identify the niosome for removal. Drugs that are localised in this way are used to treat tumours in animals that have a history of spreading to the liver and spleen. Drugs localised in this way can also be used to treat liver parasite infections. Niosomes can also be used to direct medication delivery to organs other than the RES. Since immunoglobulins bind to the lipid surface of niosomes easily, a carrier system (such as antibodies) can be attached to niosomes to direct them to particular organs.

Anti-neoplastic treatment

The majority of antitumor drugs have serious adverse effects. Niosomes have the ability to change a drug's metabolism, increase its half-life, and increase its circulation, all of which reduce the drug's adverse effects. Niosomes are associated with a slower rate of tumour elimination, increased plasma levels, and a decreased rate of tumour proliferation.

Leishmaniasis

A parasite belonging to the genus *Leishmania* infects the liver and spleen cells, causing leishmaniasis. The use of niosomes in tests revealed that higher dosages of the medication could be given without causing side effects, allowing for increased treatment efficacy.

CONCLUSION

Innovative nano drug carriers called niosomes can be used to create efficient drug delivery systems. They present an excellent chance to load lipophilic, hydrophilic or both types of drugs simultaneously. Because of their ability to encapsulate various types of drugs within their multi environmental structure, niosomes can be considered alternative vesicular systems to liposomes due to their similar structural makeup. Niosomes are a promising drug delivery technology that can be used for a variety of drug delivery applications, including topical, parenteral, ophthalmic, targeting, and more.

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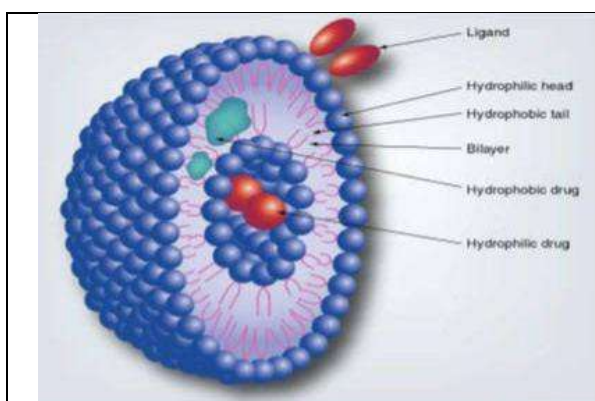


Fig 1: Niosomes structure

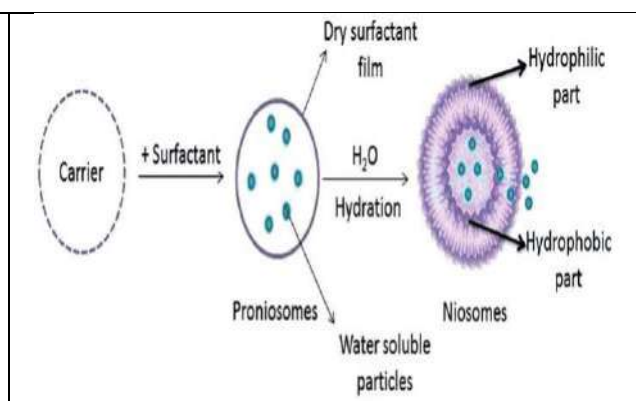


Fig 2: Niosome Formation From Pro-Niosome





Mental and Physical Health Issues Among Health Care Workers during the COVID-19

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

The COVID-19 pandemic has brought unprecedented challenges to healthcare systems worldwide. While healthcare workers have been at the forefront of the battle against the virus, their mental and physical health has been significantly impacted. This paper aims to explore the mental and physical health issues faced by healthcare workers during the COVID-19 pandemic, highlighting the contributing factors and potential long-term implications. Relevant studies, articles, and reports were analyzed to gather information on the mental and physical health issues among healthcare workers during the COVID-19 pandemic. This study examines the various factors contributing to the mental health challenges faced by healthcare workers during the pandemic. These factors include increased workload and stress, fear of infection, witnessing patient suffering and death, and the lack of adequate resources and support. The findings indicate that healthcare workers are facing significant physical and mental health challenges due to the COVID-19 pandemic. Increased workloads, long hours, and exposure to the virus have led to high levels of stress, anxiety, and burnout among healthcare professionals. Additionally, inadequate access to personal protective equipment (PPE), fear of infection and the emotional toll of witnessing patient suffering and death have further contributed to their distress. Physical health issues, such as fatigue and sleep disturbances, have also been reported. The impact of COVID-19 on healthcare workers' health cannot be underestimated. It is crucial to recognize and address the challenges they face to ensure their well-being and ability to provide quality care. It is essential to provide adequate provision of PPE, support systems, including accessible mental health resources, counseling services, and strategies to



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promote self-care and resilience. By prioritizing the well-being of healthcare workers, we can ensure their continued dedication and provide the best possible care to patients during these challenging times.

Keywords: Covid-19, Well-being, Health, Pandemic, Healthcare Workers

INTRODUCTION

Background

The COVID-19 pandemic came forth in late 2019 in Wuhan, China, caused by the novel coronavirus SARS-CoV-2. It quickly spread globally; COVID-19 had spread to several countries, such as the USA, Italy, Spain, Germany, France, and Iran, after causing significant morbidity and mortality in China [1-3]. The World Health Organization officially recognized Coronavirus disease 2019 as a pandemic on March 11th, 2020 [4]. The spread of COVID-19 to 198 countries has resulted in the infection of 2.4 million people and the deaths of 150,000 worldwide as of April 18. This is therefore regarded as a global pandemic [5-7].

Global Impact

The COVID-19 pandemic has had far-reaching consequences on various aspects of society, including public health, the economy, and social dynamics. The number of confirmed cases and deaths has been staggering, with millions of people affected worldwide. Governments and healthcare systems have faced immense challenges in managing the outbreak and providing adequate care. Healthcare workers (HCWs) are also part and a little attention was paid to them but they too faced mental as well as physical health issues. Healthcare workers (HCWs) are among the groups with the highest risk of acquiring this infection [8–10].

Healthcare workers (HCWs)

HCWs are professionals who provide medical care and support to individuals in various healthcare settings. They play a critical role in promoting and maintaining the health and well-being of patients. In India, health system and health care services consist of various categories of health professionals such as doctors, nurses allied health professionals, physiotherapists, pharmacists and others. Healthcare workers encompass a wide range of roles and specialties, including but not limited to:

1. **Doctors and Physicians:** These are medical professionals who diagnose and treat illnesses, prescribe medications, and perform medical procedures.
2. **Nurses:** Nurses provide direct patient care, administer medications, monitor vital signs, and assist in medical procedures. They work closely with doctors and other healthcare professionals.
3. **Pharmacists:** Pharmacists are responsible for dispensing medications, providing medication counseling, and ensuring the safe and effective use of drugs.
4. **Medical Laboratory Technologists:** These professionals perform laboratory tests on patient samples, such as blood or tissue, to aid in the diagnosis and treatment of diseases.
5. **Allied Health Professionals:** This category includes a diverse group of professionals, such as physiotherapists, occupational therapists, speech therapists, radiographers, and medical social workers. They provide specialized care and therapies to patients.
6. **Medical Assistants:** Medical assistants support healthcare professionals by performing administrative and clinical tasks, such as taking patient histories, measuring vital signs, and scheduling appointments.
7. **Paramedics and Emergency Medical Technicians (EMTs):** These professionals provide emergency medical care in pre-hospital settings, responding to emergencies and transporting patients to medical facilities.
8. **Home Health Aides:** Home health aides provide personal care and assistance to individuals who require healthcare services in their homes, such as the elderly or individuals with disabilities.



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9. **Support Staff:** This includes various roles such as medical receptionists, medical coders, medical billing specialists, and hospital administrators who contribute to the smooth functioning of healthcare facilities. These are a few examples of the many healthcare professionals who work tirelessly to provide quality care and support to patients in different healthcare settings. The COVID-19 pandemic has placed an unprecedented burden on healthcare workers worldwide. These frontline heroes have been tirelessly working to combat the virus, often at the expense of their own mental and physical well-being.

Impact of Pandemic on Health Care Workers (HCWs)

Health professionals are required to handle multiple responsibilities, such as administrative, clinical, and educational ones. [11]. Health care workers, who are the front-line workers dealing with such affected patients, are in the risk of being directly affected by this disease was making this situation more complex. Their job requires them to work in such conditions that do not provide them adequate personal protection equipment (PPE). Their worries are being increased by inadequate lockdown policies, the general public's lack of seriousness towards social distancing and sanitization measures, and the rising number of cases in addition to sensational media reports about mortality of health care workers. As the virus can be spread by either close contact or small droplets produced during coughing, sneezing, or talking [12, 13], the transmission of disease is a threat to both themselves and their families. If there is suspected infection, the policy of strict quarantine and isolation from family are additional factors that are causing psychological and mental health problems [14]. The COVID-19 pandemic has had significant and varied impacts on health care workers (HCWs) globally. Some of these effects include:

The mental impact of COVID-19 on healthcare workers

The mental impact of COVID-19 on healthcare workers has been profound and multifaceted, with many experiencing heightened levels of stress, anxiety, depression, burnout, and even post-traumatic stress disorder (PTSD). Here are some key aspects of the mental impact:

1. **Increased Stress and Anxiety:** Healthcare workers have faced heightened levels of stress and anxiety due to the increased workload, fear of contracting the virus themselves or transmitting it to their loved ones, and uncertainty surrounding the pandemic. They often deal with the emotional burden of caring for severely ill patients and witnessing death on a regular basis.
2. **Burnout:** Long hours, intense workloads, and the relentless nature of the pandemic have contributed to burnout among healthcare workers. Burnout can lead to emotional exhaustion, depersonalization, and a decreased sense of accomplishment, affecting both job performance and personal well-being.
3. **Trauma and PTSD (Post-Traumatic Stress Disorder):** Healthcare workers may experience traumatic events, such as the loss of patients or colleagues, overwhelming patient volumes, and difficult ethical decisions. These experiences can lead to symptoms of PTSD, including intrusive thoughts, flashbacks, hyper vigilance, and emotional numbing.
4. **Grief and Bereavement:** Healthcare workers have faced immense grief and loss throughout the pandemic, both personally and professionally. Witnessing the suffering and death of patients, as well as losing colleagues to the virus, can take a significant toll on their mental health.
5. **Social Isolation and Stigma:** Some healthcare workers have experienced social isolation and stigma due to fears of transmitting the virus to others. They may feel ostracized by their communities or even by their own families, leading to feelings of loneliness and alienation.
6. **Ethical Dilemmas and Moral Distress:** Healthcare workers have been forced to make difficult decisions about resource allocation, triage, and end-of-life care during the pandemic. These ethical dilemmas can cause moral distress, as healthcare workers struggle to reconcile their professional responsibilities with their personal values.
7. **Lack of Support and Resources:** Many healthcare workers have faced inadequate support and resources from their employers, such as insufficient personal protective equipment (PPE), limited access to mental health



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services, and a lack of recognition for their contributions. This lack of support can exacerbate feelings of stress and burnout.

8. **Uncertainty and Anxiety about the Future:** The constantly evolving nature of the pandemic, coupled with uncertainties about vaccine efficacy, new variants, and potential future waves, can contribute to ongoing anxiety and stress among healthcare workers. They may worry about their own safety, the well-being of their patients, and the long-term impact of the pandemic on the healthcare system.

The majority 160 (66.95%) of the studies were focused on depression, while there were also 179 (74.90%) that focused on anxiety, 57 (23.85%) that focused on acute stress/distress, 55 (23.01%) that focused on sleep problems, 39 (16.32%) that focused on post-traumatic symptoms, and 24 (10.04%) focused on burnout. Across five continents, the studies involved HCWs from 50 countries, with 150 (61.7%) coming from Asia, 55 (23.01%) coming from Europe, 20 (8.37%) coming from America, 11 (4.66%) coming from Africa, and 2 (0.84%) coming from Oceania [15] Overall, the mental impact of COVID-19 on healthcare workers is profound and complex, with many experiencing a range of psychological symptoms and challenges. It is essential for healthcare organizations and policymakers to prioritize the mental health and well-being of healthcare workers by providing adequate support, resources, and recognition for their tireless efforts during this unprecedented time.

The impact of COVID-19 on physical health of healthcare workers

The COVID-19 pandemic has had a significant impact on the physical health of healthcare workers. Here are some of the key effects:

1. **Increased workload and long working hours:** Healthcare workers have experienced a surge in work demands, often leading to extended shifts and increased workloads. Prolonged periods of physical exertion can cause fatigue, muscle strain, and related injuries.
2. **Exposure to the virus:** Healthcare workers are at a higher risk of contracting COVID-19 due to their close proximity to infected patients. Despite following proper precautions, they face a constant risk of exposure and transmission, leading to potential illness and complications.
3. **Psychological stress:** Dealing with the pandemic's uncertainties and witnessing the suffering of patients can lead to immense psychological stress for healthcare workers. Chronic stress can contribute to physical health issues, including weakened immune systems, increased blood pressure, and cardiovascular problems.
4. **Inadequate personal protective equipment (PPE):** Shortages in PPE supply during the beginning of the pandemic exposed many healthcare workers to unnecessary risks. Without proper protection, their chances of contracting the virus and experiencing physical health consequences increased.
5. **Exacerbation of pre-existing health conditions:** The physical demands, long working hours, and constant stress associated with the pandemic can worsen pre-existing health conditions among healthcare workers. This includes conditions like musculoskeletal problems, respiratory issues, mental health disorders, and cardiovascular diseases.
6. **Lack of rest and recovery:** The pandemic has disrupted the work-life balance for healthcare workers, leaving little time for adequate rest and recovery. Insufficient sleep, irregular meal schedules, and reduced physical activity can further impact physical health and increase the risk of various health problems.
7. **Exhaustion:** The combination of increased workload, stress, and exposure to the virus can contribute to exhaustion among healthcare workers. Which can lead to physical symptoms such as fatigue, insomnia, headaches, and even chronic conditions like hypertension and cardiovascular diseases. To support the physical health of healthcare workers, it is crucial to ensure sufficient PPE, provide mental health support services, implement strategies to manage workload, allow for adequate rest and recovery periods, and prioritize the overall well-being of these frontline heroes.



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CONCLUSION

Healthcare workers' well-being has been affected negatively by the COVID-19 pandemic, resulting in depression, anxiety, and stress. The mental and physical health issues faced by healthcare workers during the COVID-19 pandemic are significant and require attention. It is crucial to prioritize the well-being of these frontline heroes who have been selflessly serving their communities. By providing the necessary support, resources, and recognition, we can help mitigate the impact of these challenges and ensure the continued well-being of healthcare workers as they navigate through this unprecedented crisis.

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Crop Disease Detection through the Utilization of Image Processing in Agriculture : A Review

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 27 Jun 2024

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ABSTRACT

The digitization of agriculture has revolutionized disease detection and image processing, leveraging advanced artificial intelligence systems to extract valuable insights from the vast and continually expanding data generated by various agricultural and environmental sources. Machine learning and the Internet of Things (IoT), as integral components of artificial intelligence, have the capability to address several challenges in developing knowledge-based agricultural systems, including disease identification. In this review paper provides a summary of the most recent developments in machine learning algorithms and image processing techniques for plant disease identification. Through an in-depth examination of current scholarly literature, we aim to highlight the significance of machine learning and image processing in the agricultural sector. We've carried out a thorough review of the various imaging methods and computer vision approaches that are successfully employed for plant disease detection and classification. Additionally, we've examined the prevailing trends and obstacles in utilizing advanced imaging techniques and computer vision for plant disease detection. Enhancements in algorithms have the potential to augment existing efforts, leading to greater speed and precision.

Keywords: Image processing, Plant disease detection, Machine learning, Imaging sensors and system, and IoT





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INTRODUCTION

Throughout history, agriculture has played a vital role in sustaining human life. To tackle the challenges that put pressure on the agricultural industry, there is a pressing need to improve agricultural practices' effectiveness while reducing their environmental impact. Plant diseases pose significant threats to agriculture-based products, leading to social, ecological, and economic losses for farmers. Timely and accurate diagnosis of plant diseases becomes essential to mitigate these losses. However, manual disease diagnosis requires extensive effort, knowledge of plant diseases, and time-consuming processing. To address this, machine learning and image processing methods are employed for effective plant disease identification. As illustrated in Figure 1, the input image undergoes pre-processing to enhance its features, based on the dataset. Subsequently, the images are classified using specific classifier techniques according to the dataset in use. For the review paper, various search engines such as Google Scholar, Shodhganga, Science Direct, and Krishikosh were utilized. The articles selected for the review were primarily focused on research, articles, and review papers published in reputed journals. The keyword combinations used in the search included "image processing," "disease detection," and "Internet of Things (IoT)." The methodology and exclusion criteria for the systematic review were conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) standards, as depicted in Fig. 2.

REVIEW OF LITERATURE

Crop diseases are a major risk to agriculture, causing a decrease in the quality and volume of yield at different phases, including storage and transport. Early detection of diseases is vital for effective disease control. Observable symptoms of pathogens, like spots on leaves and fruits, wilting, changes in color, and curvature of leaves, signal the existence of disease and alterations in the plant's look. Furthermore, there have been significant improvements in computer vision recently. **Kurniawati et al. (2009)** created a diagnosis system for paddy diseases. In the diagnostic system, three techniques were employed to establish threshold values: variable, global, and Otsu Threshold. Analyzing the ratio between the height and width of the lesion spot served as a distinctive shape feature to identify the lesion type. Among the three methods utilizing the variable threshold, the highest accuracy achieved is approximately 86%. Due to variations in intensity values across different images, both the global threshold value and the automated threshold determined by the Otsu method struggle to accurately perform the segmentation task. The upcoming objective is to employ Artificial Neural Networks (ANN) for the classification of paddy diseases. **Yao et al. (2009)** conducted experiments to apply a Support Vector Machine (SVM) in the detection of rice diseases, utilizing shape and color texture features. The findings indicated that the SVM achieved a high accuracy rate of 97.2% in precisely recognizing and classifying the disease spots.

The low classification accuracy resulted from the instability of the shape features observed in the RSB and RB spots. This approach could be applied to categorize diseases in other crops as well. **Gunjar and Gulhane (2012)** proposed a system aims to regularize and extract Eigen features from cotton leaf images. To achieve this, scatter matrices are created using 100 sample images. These scatter matrices represent within-class variations and are decomposed into different subspaces corresponding to various diseases based on the variations in pixel values. The final stage involves feature extraction and dimensionality reduction. Eigen feature extraction outperforms other methods with a success rate of 90% in detecting red spot disease. Less accuracy to detect the diseases other diseases red spot disease of cotton. In the future, the research will be facilitated by leveraging Eigen features for disease detection in a wide range of crops. **Revathi et al. (2012)** conducted a study focusing on the detection of affected areas in cotton leaf diseases. Initially, they used an edge detection method for image segmentation, and eventually introduced the Homogenous Pixel Counting Technique for Cotton Disease Detection (HPCCDD) Algorithm for disease analysis and classification in the images. The aim of this study is to identify cotton leaf spot diseases using image processing techniques. This involves analyzing input images by counting RGB pixels and identifying the affected areas of the leaf spot using both



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the Sobel and Canny Edge detection methods. The proposed HPCCDD algorithm achieves an impressive detection accuracy of 98.1%, the highest among the methods tested. The system is highly complex. In the future, the Homogenous Pixel Counting Technique will be extended to various field crops such as maize and paddy. **Orillo et al. (2014)** created a program that utilizes image processing combined with a back propagation neural network, successfully implemented using MATLAB, to identify the diseases present in rice leaves. In general, the program demonstrated complete accuracy, achieving a perfect score of 100%. They lack any data pertaining to the severity of the disease in rice. Increasing the number of images in the neural network dataset could lead to more precise and accurate outcomes. **Abdulridha et al. (2018)** introduced a well-defined initiative designed to combat Laurel wilt in Florida's CAPA (Center for Advanced Public Safety). To accomplish this goal, Multilayer Perceptron (MLP) and Decision Tree (DT) neural networks were utilized. The study incorporated data from 40 nm and 10 nm broad bands, along with Vegetative Indices (VIs). Irrespective of the development stage, MLP demonstrated higher classification accuracy (approximately 100%) compared to DTs. Spectral markers can be leveraged to detect Laurel wilt-infected trees at an early stage and distinguish them from other abiotic and biotic factors. For identifying Laurel wilt during its asymptomatic (early) phase, the MLP classification method with the Tetracam achieved an accuracy rate of 99%. Classifying different stressors using the visible light spectrum poses a challenge, necessitating the use of higher spectral resolution cameras capable of observing the Near-Infrared (NIR) range of the spectrum.

Eliminating non-relevant or redundant features significantly enhances prediction accuracy, and reducing the number of features is a crucial step in data analysis. **Ferentinos (2018)** employed a Faster R-CNN, which is a region-based convolutional neural network, as their object detection system. Their main objective was to detect insects in stored grain under field conditions, even amidst contaminants. The VGG convolutional neural network, which emerged as the most effective model structure, attained a remarkable accuracy of 99.53% (with a top-1 error of just 0.47%) when evaluated on 17,548 plant leaf images that the model had not previously seen. This outstanding result evidently shows that convolutional neural networks are extremely efficient for automating the identification and diagnosis of plant diseases by analyzing simple leaf images. The expansion of the existing database to include a broader range of plant species and diseases is a process that can be difficult in several ways and time-consuming. Further development in that direction will require the collection of a far wider range of training data from different regions, types of cultivation, and image-capturing modes and sets. **Fuentes et al. (2018)** proposed a deep neural network-based framework that performs on promising object-specific bounding boxes for efficient real-time recognition of plant diseases and pests of tomatoes. This implementation allows the suggested method to achieve an amazing detection rate of approximately 96%, a significant improvement of 13% over earlier attempts in the difficult task of tomato disease and pest recognition. The imbalance between classes brought about by the conditions and the scarcity of available data are the primary challenges preventing the system from achieving higher precision.

Subsequent studies will focus on extending the methodology to different crops. **Kerkech et al. (2018)** proposed a technique aimed at identifying symptoms present in vineyards. This method approaches a Convolutional Neural Network (CNN) in conjunction with color data. During the investigation, multiple color spaces, vegetation indices, and combinations of these data were employed to evaluate and compare the CNNs' performance. The most outstanding outcomes, achieving an accuracy exceeding 95.8%, were achieved by CNNs utilizing the YUV color space in conjunction with the ExGR vegetation index, as well as CNNs employing a combination of ExG, ExR, and ExGR vegetation indices. The number of expert's labeled data in this study was limited, which is a common issue in many deep-learning approaches. They must include vineyard plots and fresh samples of vine disease in the UAV multispectral image database for our next research and system improvement. **Abdulridha et al. (2019)** proposed an UAV to validate a remote sensing technology designed for the detection of citrus cankers under laboratory conditions. The research utilized a hyperspectral imaging system covering the range of 400–1000 nm. The detection of citrus canker in the lab was performed using two different classification methods: (i) K nearest neighbor (KNN) and (ii) radial basis function (RBF), both integrated into the UAV system. The RBF technique outperformed the KNN method in identifying leaf canker, showcasing higher accuracy levels. The RBF technique achieved impressive classification accuracies of 94%, 96%, and 100%, whereas the KNN method achieved accuracies of 94%, 95%, and



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96%. Furthermore, the proposed technique effectively classified late-stage canker-infected fruit with an accuracy of 92%. In distinguishing canker-infected trees from healthy trees, the UAV-based method achieved a flawless classification accuracy of 100%. The use of immature fruit as a diagnostic tissue for early canker detection proved to be inaccurate, mainly because of its low detection rate for canker-infected immature fruit in the asymptomatic stage (only 47%). The UAV-based imaging technology can be implemented to quickly and cheaply cover broad regions and locate canker-infected trees. **Coulibaly et al. (2019)** presented a method for establishing a pearl millet mildew disease detection system that combines morphological operations and transfer learning. The testing results show a promising performance, with an accuracy of 95.00 percent, a precision of 90.50 percent, a recall of 94.50 percent, and an F1-score of 91.75 percent. The performance of transfer learning gives 95.00% accuracy. The early stopping technique is required to avoid over fitting and to assist in determining this convergence value with the lowest possible validation loss. Mildew disease detection in tropical and diverse crops (cotton, potatoes, etc.) can be merged with a digital camera or smartphone for helping farmers to identify plant diseases. **Dhingra et al. (2019)** the proposal suggests evaluating a region of interest using a distinct fuzzy set, which extends from the application of neutrosophic logic-based segmentation in basil research. In this approach, new feature subsets such as histogram, texture, and color are utilized to determine the health status of leaves, distinguishing between healthy and diseased ones. Additionally, the segmented regions are analyzed to identify disease sequence regions within the plant.

The proposed system is validated using a total of 400 instances (200 healthy, 200 diseased). The suggested method could serve as an effective tool for detecting leaf diseases. A novel feature set demonstrates potential, achieving a classification accuracy of 98.4 percent. The system does not employ real-time monitoring. Major challenges include overfitting, overtraining, small sample sets, and sample sets with poor representativeness. Exploring an untested mix of feature extraction, feature selection, and learning techniques could further enhance the effectiveness of disease detection and classification models. **Geetharamani G. (2019)** proposed a novel plant leaf disease identification model (Deep CNN). The Deep CNN model is trained on an open dataset of 39 different plant leaf and background image classes. The proposed model has an average accuracy level of 96.46% in the testing classification set of plant leaf images, with individual class accuracy ranging between 92% and 100%. Gradient descent is difficult to implement with a large training set. The primary purpose of the feature work will be to broaden the scope of plant disease identification and diagnosis beyond plant leaves to include additional plant components like flowers, fruits, and stems. **Jenifa et al. (2019)** introduced a novel method for the automated detection of diseases in cotton leaves, utilizing a Deep Convolutional Neural Network (DCNN). The technique was developed in MATLAB and tested using a comprehensive dataset of healthy and diseased cotton leaf images. The processes of classification and detection were thoroughly evaluated using this dataset to assess the performance and effectiveness of the proposed method. The researchers were able to detect diseases in cotton leaves and achieved a classification accuracy of up to 96% for diseased cotton leaves, including Cercospora, Bacterial blight, Ascochyta blight, and Target spot images. The evaluation was conducted using MATLAB as the platform for their method.

The primary challenge in disease detection and classification for this project is the resemblance between leaves with different diseases, which often results in misclassification as the leaves may be incorrectly categorized into the wrong disease classes. Future work aims to expand the study by incorporating a larger image dataset and exploring various other disease categories. This expansion is anticipated to benefit many farmers by enabling improved disease identification in cotton leaves. **Huet et al. (2019)** was conducted research with the aim of preventing and controlling tea leaf diseases more effectively. To achieve this, a low-shot learning approach was introduced for disease identification. The study proposed an improved method known as Conditional Deep Convolutional Generative Adversarial Networks (C-DCGAN) for data augmentation. By utilizing segmented images of disease spots, this method generated new training samples, which were subsequently used to train the VGG16 deep learning model. This approach significantly improved the model's ability to accurately detect tea leaf diseases. Compared to SVM, the typical accuracy rate of tea red scab, tea red leaf spot, and tea leaf blight is 90%, which is a 30% improvement. The overall detection success rate by using DS images is about 21.5% higher than that by using TLD images. Due to the constraints posed by photographic conditions and field scenes, images of Tea Leaf Diseases (TLD) exhibit significant



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noise and complex backgrounds. To develop a better data generation method and a low-risk approach to learning with strong generalization performance to improve the robustness and accuracy of disease identification in tea leaves with few training samples. **Huanget al. (2019)** used a UA (Unmanned Aerial Vehicle) data collection and ground examination was undertaken in two wheat fields in their study. For the classification of HLB illness categories, a CNN (Convolutional Neural Network) was used. The CNN method outperformed other techniques in terms of both stability and accuracy, achieving an overall accuracy of 91.43 percent with a standard error of 0.83 percent. The results of the experiments conducted in this study demonstrated that UAV remote sensing holds great potential as a valuable technique for detecting HLB disease. It can be seen that a low learning rate slows the cost function's convergence, while a too-large learning rate leads to neural network divergence. To gather UAV data from different illnesses and create an efficient classifier, then add more data and utilize transfer learning to solve the over fitting issue. **Ozguven and Adem (2019)** developed an Updated Faster R-CNN architecture was developed for the automated detection of the leaf spot disease (*CercosporabeticolaSacc.*) in sugar beet, which was constructed by altering the parameters of a CNN model. This method was suggested for imaging-based expert systems to assess disease severity. The results showed that with 155 images, the overall accuracy rate for correct classification was found to be 95.48 percent. Moreover, the proposed method demonstrated that modifying the parameters of the Convolutional Neural Network (CNN) based on the specific image and regions to be detected can improve the efficiency of the Faster R-CNN architecture. The main reason for misclassifications was primarily due to the presence of solar shines and shadows in the images of sugar beet leaves.

Various deep learning algorithms were trained on a larger dataset to enhance disease detection accuracy. **Zhang et al. (2019)** a novel approach was introduced for automated detection of yellow rust in winter wheat fields using UAV hyperspectral images, employing a Deep Convolutional Neural Network (DCNN). The researchers developed a new DCNN model that incorporated multiple Inception-Resnet layers for effective feature extraction. The model was fine-tuned to determine the optimal depth and width, enhancing its performance in detecting yellow rust accurately. The proposed model exhibited a higher overall accuracy (0.85) compared to the random forest classifier (0.77). These results indicated that integrating spectral and spatial information using high-resolution UAV hyperspectral images can enhance the accuracy of crop disease detection. Spectral patterns of hyperspectral data obtained by UAVs vary greatly. So, it would be impossible to distinguish between rust-free fields and healthy ones. The proposed model will undergo validation using additional UAVs and datasets containing hyperspectral images of diverse crop fields and crop diseases. Moreover, new algorithms for dimensionality reduction will be developed specifically for large hyperspectral images, aiming to improve the efficiency of data analysis in the process. **Abdu et al. (2020)** the study explored a technique to extract specific features from individual chlorotic and necrotic lesions in potato crops. The main goal was to minimize feature redundancy and vector size while effectively generating a Color Coherence Vector (CCV). This feature represents distinct and coherent patterns related to the progression of the disease. The SVM classifier demonstrated exceptional performance with an impressive accuracy of 99.67% and a perfect AUC (Area Under Curve) score. Even when utilizing only four-color features, the SVM classifier still achieved remarkable results, with an overall accuracy of 99.33% and an AUC of 0.99.

Factors such as lighting variations and disease severity that may be present in images captured in the field would affect the importance of ML technique eloped with images captured in controlled conditions under real-world conditions. To assess the effectiveness of the proposed approach under varying conditions. **Agarwal et al. (2020)** proposed a more straightforward CNN model with eight hidden layers was used to identify the type of disease for prompt treatment of the tomato crop. The data for the experiment was obtained from the Plant Village dataset. The proposed lightweight model surpasses traditional machine learning methods as well as pre-trained models on the publicly available Plant Village dataset, achieving an accuracy of 98.4 percent. Among classical ML methods, k-NN has the highest accuracy of 94.9 percent, while VGG16 has the highest accuracy of 93.5 percent among pre-trained models. The model may have limitations when the leaves overlap and are not on a plain background, as in the proposed work, where the leaves are given on a grey background, and when multiple diseases affect a plant and the suggested model can only predict the most likely disease. The goal for future work is to detect disease in tomato



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crops. The proposed work can also be expanded to show how far the disease has spread in the plant. To distinguish between infected and healthy maize leaves, **Dhingra et al. (2020)** worked on creating an automatic classification model using an ensemble approach. This involved using two pre-trained convolutional neural networks, VGG16 and VGG19, within the ensemble model. The OLPSO optimization algorithm was used to optimize a subset of hyperparameters for each model that contributes to the ensemble model's performance. The suggested diagnostic approach for classifying plant images is highly effective and accurate. The proposed AE Model has an accuracy of 98.2%. Because each image contains inherent variety, the data should be more diverse. In the future, the dataset used for training can be acquired from diverse sources with various environmental, agronomic, geographic, and image-capture settings. **Hernandez et al. (2020)** Advanced techniques based on probabilistic programming, such as Bayesian deep learning, can be applied to identify state-of-the-art diseases in apple, berry, and grape plants. These methods enable the measurement of uncertainty, which serves as a metric for misclassification during the detection process. Bayesian inference outperforms standard optimization procedures for fine-tuning deep learning models in classification performance. Real-world implementations of deep learning-based plant disease detection systems faced challenges such as decreased performance due to covariate shift, issues with image quality in field conditions, and various other factors. Despite these challenges, there is a significant opportunity for the development and deployment of deep learning-based computer systems that can automatically detect and diagnose plant diseases. **Karlekar and Seal (2020)** the proposed strategy consists of two components.

The initial module focuses on removing the complex background from the entire image to isolate the leaf component. The subsequent module introduces SoyNet, a deep-learning convolutional neural network (CNN) designed for disease recognition in soybean plants. This module utilizes leaf image segmentation techniques to accurately identify and classify diseases. The suggested model achieves a 98.14 percent identification accuracy with good precision, F1 Score, and recall. These types of models do not always perform well on all datasets because they are too specific. In the future, SoyNet will be tested and trained against other available soybean plant leaf databases to see how it performs. **Karthik et al. (2020)** described two distinct deep architectures in the study for recognizing the infection in tomato leaves. On top of the residual deep network, the second architecture employed an attention mechanism. Plant Village Dataset was utilized in the experiments, which included three diseases: early blight, late blight, and leaf mold. The suggested study revealed that the attention mechanism utilized the features learned by the CNN at various processing hierarchies and achieved a 5-fold cross-validation accuracy of 98 percent on the validation sets. The deep learning network has to be trained with a large collection of samples to ensure better generalization of features. The more computational effort will help in the classification and recognition of the experimental results. **Kim et al. (2020)** introduced crop monitoring system using images was created for automatic monitoring of onion fields. The method entailed building a setup for periodic picture capturing in fields, training a model of deep neural networks to recognize illness signs, and then testing the performance of the generated system.

Across all models, the MAP (Mean Average Precision) at IoU (Intersection Over Union) criteria of 0.5, which requires more than 50% overlap, exhibited the highest values, ranging from 74.1 to 87.2. It was challenging to differentiate between downy mildew's early symptoms and those of other illnesses due to the low intensity of the lighting in some of the collected photographs, making it impossible to identify the disease region. By improving model performance and various imaging data, including the accurate location of the infected area, it will be possible to improve diagnostic accuracy at the onsite level; thus, the developed system can contribute to the realization of unmanned agriculture. **Sun et al. (2020)** introduced new method for detecting maize leaf blight has been introduced. This approach utilizes a Convolutional Neural Network (CNN) and involves a multi-scale feature fusion instance detection technique. The MAP (Mean Average Precision) of the new models was higher (from 71.80% to 91.83%) than the SSD model. The new model's FPS had also increased (from 24 to 28.4) and had attained the requirement for real-time detection. The data set studied in the field with high light intensity resulted in the appearance of 'reflection' phenomena in some images. As a result, detecting the diseased position is difficult. The model might transfer to an embedded system, laying the theoretical groundwork for precise drug application technology development and detection robots for maize leaf blight. **Wang et al. (2020)** compared several conventional classifiers and proposed two



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improved automatic classifiers, KMSVM and KMSEG, to differentiate between CRR-infected and healthy plants in cotton fields. A drone was used to capture detailed remote sensing images showing areas affected by Cotton Root Rot (CRR). KMSEG emerged as the top performer among the classifiers assessed, achieving an overall accuracy of 88.39%, a Kappa coefficient of 0.7198, an error of commission of 16.13%, and an error of omission of 11.44%. However, traditional KMSVM and supervised classifications struggled to differentiate between CRR-infected plants and non-sown regions. Future studies should focus on enhancing image classification methods to minimize misclassifications and enhance practicality. **Yang Zhang et al. (2019)** presented an enhanced version of Faster RCNN (Regional Convolutional Neural Networks) designed specifically for identifying healthy tomato leaves and four diseases: leaf mold fungus, blight, powdery mildew, and ToMV. The main objective of this improvement was to enhance the accuracy of the recognition model for crop disease leaves and to precisely locate the affected leaves. Crop leaf disease detection outperformed the original Faster RCNN by 2.71% in terms of recognition accuracy and speed. Only one leaf Disease is easily recognizable in the image because the dataset only contains laboratory data. Future research should use these elements to conduct complex diagnoses that will aid when it comes to advancing smart agriculture. The study's data is sourced from 28 literature reviews focusing on disease detection, all duly cited in the paper. Between 2018 and 2024, there has been a notable surge in favoring UAVs over satellites due to their reliability, faster and more cost-effective outcomes, superior resolution, and adaptability to diverse weather conditions. This growth in the drone market, coupled with advancements in sensor technologies, has made UAV systems financially viable, leading to their increased adoption in agriculture.

Furthermore, the establishment of legal frameworks for UAV operations and the simplification and automation of operational and analytical procedures have significantly contributed to their rising popularity. Concerning disease detection specifically, RGB photographs emerge as the most commonly utilized input data for image processing systems. Deep learning methods such as Convolutional Neural Networks (CNNs) are frequently utilized to train classifiers that differentiate between healthy and diseased leaves using photos. CNNs employ specialized techniques to amplify the important features of RGB images, prioritizing images with favorable attributes. This distinguishing feature sets CNNs apart from other types of neural networks. After CNNs, the Support Vector Machine (SVM) emerged as another notable approach, employed in roughly 20% of the studies. SVM's primary advantage lies in its consistent learning of patterns from data, resulting in high levels of accuracy. This paper leverages comprehensive survey methodologies and techniques employed by diverse researchers to tackle issues related to disease identification and challenges in agriculture. A thorough literature review reveals that the CNN (Convolutional Neural Networks) algorithm is the favored choice among researchers due to its exceptional accuracy. Following CNN, the SVM (Support Vector Machine) algorithm is also widely used. Research endeavors predominantly concentrate on rice, soybean, and fruit crops in the realm of plant disease identification. RGB images stand out as the most prevalent data type, justifying the prevalent use of CNNs, given their efficacy in handling such data. However, it's worth noting a gap in disease observation in other parts of crops, particularly in crops like cotton. Given that the cotton ball holds economic significance in cotton plants, it should be incorporated into disease detection image processing techniques. There's scope for enhancement through exploring innovative algorithms and deepening the understanding of various tools to ensure more dependable outcomes, considering the precision and quality standards essential in this competitive and dynamic industry. Farmers' demands for reliable information to improve crop management can be met efficiently by providing accessible software-based services. To expand on the key insights from prior studies, future research should delve deeper into the following areas.

RESEARCH GAP ANALYSIS

This paper utilizes a wide array of survey concepts and methodologies employed by numerous researchers to address the identification of diseases and the complex issues faced in agriculture. An examination of existing literature highlights the Convolutional Neural Networks (CNN) algorithm as the favored choice among researchers due to its superior accuracy. Subsequent to CNN, the Support Vector Machine (SVM) algorithm is also frequently utilized. RGB images are the predominant data type used, which justifies the widespread adoption of CNNs given their effectiveness in processing this data format. However, it's important to note from the literature review that there



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is a gap in disease observation in other parts of crops, particularly in crops like cotton. Since the cotton ball holds economic significance in cotton plants, it should be integrated into disease detection image processing techniques. There is potential for improvement by exploring novel algorithms and deepening the understanding of various tools to ensure more dependable outcomes, considering the precision and quality parameters required in this competitive and ever-evolving industry. Farmers' needs for reliable information to enhance crop management can be effectively met by providing accessible software-based services. To expand on the key insights from past studies, future research should delve deeper into the following areas.

CONCLUSIONS AND FUTURE WORK

The review study revealed a notable discovery concerning the input data utilized in image processing algorithms and the sensors linked to them. RGB images stood out as the most commonly used data format, mainly due to CNNs' adeptness at processing this type of data, which clarifies their extensive usage. Remote sensing techniques such as satellite, UAV, and UGV imaging emerged as the favored approaches for acquiring measurements in image processing applications. Nevertheless, laboratory measurements were also employed to supplement the data collection process. However, most Information and Communication Technology (ICT) involves substantial initial costs, such as considerable investments in infrastructure, which frequently hinder broad adoption. Consequently, farmers are deterred from using this technology, presenting a significant challenge, particularly in developing nations where agriculture holds pivotal economic importance. Making a substantial impact with ICT demands a sustained commitment. It requires all stakeholders to embrace a fresh mindset, acquire proficiency in new skills, acknowledge the potential financial advantages of managing big data, and allocate the required resources.

In the future, Enhancing the efficiency of detection and classification techniques can be achieved by exploring uncharted territory, combining feature extraction, selection, and learning methods. Further research can be conducted to explore recognition techniques in mixed lighting conditions. It is crucial to verify whether classification accuracy can be upheld in such challenging scenarios. To achieve higher accuracy, it is imperative to augment the quantity of data used for training and testing. By advancing algorithms, existing efforts can be extended to attain elevated levels of speed and accuracy. The development of mobile-based applications can offer farmers prompt solutions, while online web portals can be utilized to provide plant disease solutions.

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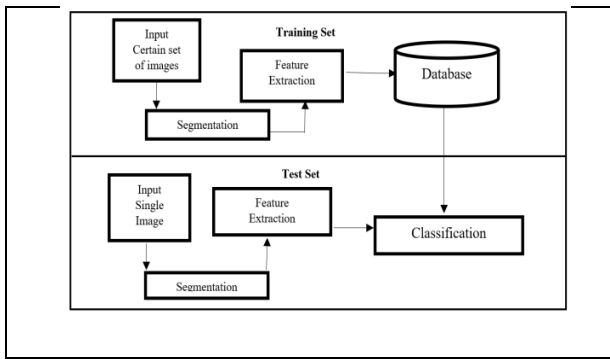


Fig. 1. General process of detection of plant disease in image processing

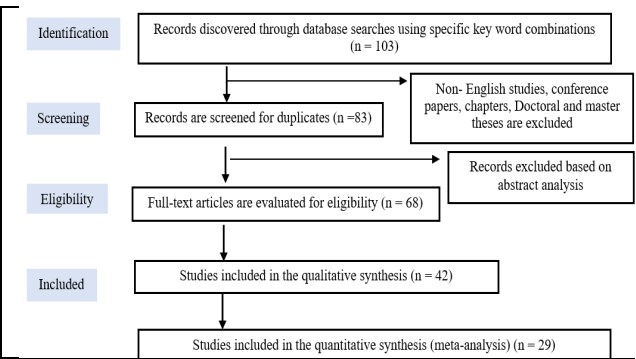


Figure 2: The methodology of the current systematic review, the flow of information regarding the exclusive criteria, according to PRISMA guidelines





Enhancing Sports Performance: A Comprehensive Guide to Ergogenic AIDs and Exercise Interactions - A Scoping Review

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 17 Jul 2024

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ABSTRACT

Ergogenic aids play a crucial role in enhancing athletic performance, yet their interactions with exercise remain complex and multifaceted. This scoping review aims to provide a comprehensive examination of the literature on ergogenic aids and their interactions with exercise across various sports and performance contexts. A systematic search of electronic databases and hand-searching of reference lists was conducted to identify empirical research articles examining the effects of ergogenic aids on exercise performance outcomes. Studies were screened based on predefined inclusion and exclusion criteria, and data were synthesized using a narrative synthesis approach. The review highlights the diverse array of ergogenic aids, including caffeine, creatine, beta-alanine, nitric oxide precursors, branched-chain amino acids, carbohydrate supplements, electrolyte replacements, beta-blockers, anabolic steroids, erythropoietin, blood doping, and compression garments. Ergogenic aids exert exercise-specific effects, influencing factors such as aerobic capacity, muscle strength, power output, and recovery. Understanding the exercise-specific interactions of ergogenic aids is essential for tailoring supplementation strategies to the unique demands of different sports and training modalities. Methodological considerations and recommendations for optimizing ergogenic aid use in athletic settings are discussed. This scoping review provides valuable insights into the application of ergogenic aids to enhance sports performance while ensuring safety, efficacy, and ethical considerations.

Keywords: Ergogenic aids, Exercise performance, Caffeine, Creatine, Beta-alanine, Nitric oxide precursors, Branched-chain amino acids, Carbohydrate supplements



**Alagappan****INTRODUCTION**

In the quest for athletic excellence, athletes and coaches are constantly seeking ways to enhance performance. One avenue explored is the use of ergogenic aids—substances or techniques that can improve athletic performance. From caffeine to creatine, these aids come in various forms and have different mechanisms of action. Understanding their benefits, risks, and legality is crucial for athletes aiming to optimize their performance safely and effectively.(1) In the pursuit of athletic excellence, athletes and sports professionals constantly seek innovative strategies to optimize performance. One such avenue is the utilization of ergogenic aids, encompassing a wide range of substances, techniques, and interventions designed to enhance physiological functioning and improve athletic performance. From caffeine and creatine to specialized training protocols and technological advancements, ergogenic aids offer promising avenues for achieving competitive advantage and maximizing athletic potential. However, understanding the intricate interactions between ergogenic aids and exercise is crucial for their effective application and integration into training regimens. This scoping review endeavors to provide a comprehensive examination of the current literature on ergogenic aids and their interactions with exercise across various sports and performance contexts.(2)

Ergogenic aids used for sports performance**Caffeine**

Caffeine is one of the most widely consumed psychoactive substances globally, primarily found in coffee, tea, and energy drinks. As an ergogenic aid, caffeine has been extensively studied for its performance-enhancing effects. It acts as a central nervous system stimulant, reducing perceived exertion and increasing alertness. Moreover, caffeine can enhance endurance performance by mobilizing fatty acids for fuel and sparing glycogen stores. Athletes often strategically use caffeine before competitions or training sessions to improve focus and prolong endurance.(3)

Creatine

Creatine is a naturally occurring compound found in muscle cells, primarily used to regenerate adenosine triphosphate (ATP), the body's primary energy source during short bursts of intense activity. Creatine supplementation has been shown to increase muscle creatine stores, leading to improved performance in high-intensity, short-duration activities such as sprinting and weightlifting. Additionally, creatine may promote muscle hypertrophy and enhance recovery between bouts of exercise. Its widespread use among athletes, coupled with its safety profile, makes creatine a popular ergogenic aid in strength and power-based sports.(4)

Beta-Alanine

Beta-alanine is a non-essential amino acid that combines with histidine to form carnosine, a dipeptide found in muscle tissue. Carnosine acts as a buffer, helping to maintain intracellular pH during high-intensity exercise and delaying the onset of fatigue. Supplementation with beta-alanine has been shown to increase muscle carnosine levels, particularly in type II muscle fibers, which are predominant in activities requiring explosive power. Consequently, beta-alanine may benefit athletes engaged in activities such as sprinting, jumping, and high-intensity interval training (HIIT).(5)

Nitric Oxide Precursors

Nitric oxide (NO) is a vasodilator that plays a key role in regulating blood flow and oxygen delivery to working muscles. Supplements containing nitric oxide precursors, such as nitrate or citrulline malate, can increase NO production, leading to improved blood flow, nutrient delivery, and exercise performance. Enhanced vasodilation may benefit endurance athletes by reducing the oxygen cost of exercise and delaying the onset of fatigue. Moreover, nitric oxide precursors may promote post-exercise recovery by facilitating nutrient uptake and waste removal.(6)

Branched-Chain Amino Acids (BCAAs)

Branched-chain amino acids, including leucine, isoleucine, and valine, are essential amino acids that play crucial roles in protein synthesis and muscle metabolism. BCAA supplementation has been suggested to reduce exercise-





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induced muscle damage, attenuate muscle soreness, and improve recovery following intense training sessions or competitions. Additionally, BCAAs may serve as an alternative energy source during prolonged endurance exercise, potentially sparing glycogen stores and delaying fatigue. Athletes often consume BCAA supplements before, during, or after workouts to support muscle growth, repair, and adaptation.

Carbohydrate Supplements

Carbohydrates are the body's primary source of energy during exercise, particularly in endurance sports where glycogen depletion can impair performance. Consuming carbohydrate supplements before, during, or after exercise can optimize glycogen stores, delay fatigue, and improve endurance capacity. Moreover, carbohydrate ingestion during prolonged exercise can maintain blood glucose levels and spare endogenous glycogen, enhancing performance in events lasting more than 60 minutes. Athletes often utilize carbohydrate-loading strategies to maximize glycogen storage before competitions or engage in carbohydrate supplementation during prolonged exercise to sustain energy levels and performance.(7,8,9)

Electrolyte Replacements

Electrolytes, such as sodium, potassium, and chloride, play essential roles in fluid balance, nerve function, and muscle contraction. During prolonged exercise, especially in hot and humid conditions, athletes may lose significant amounts of electrolytes through sweat, leading to dehydration, muscle cramps, and impaired performance. Electrolyte replacement supplements or sports drinks containing sodium, potassium, and other minerals can help maintain electrolyte balance, prevent dehydration, and sustain exercise performance. Proper hydration strategies, coupled with electrolyte replacement, are vital for athletes participating in endurance events or training sessions in challenging environmental conditions.(10)

Beta-blockers

Beta-blockers are medications that block the effects of adrenaline and noradrenaline, reducing heart rate and blood pressure. While primarily used to treat cardiovascular conditions such as hypertension and arrhythmias, beta-blockers have also been abused by athletes seeking to improve performance in sports requiring steady hands and precision, such as shooting and archery. By dampening sympathetic nervous system activity, beta-blockers can enhance fine motor control, reduce tremors, and promote a sense of calmness under pressure. However, the use of beta-blockers in sports is controversial and subject to strict regulations due to their potential for abuse and adverse effects on cardiovascular function.

Anabolic Steroids

Anabolic steroids are synthetic derivatives of testosterone, the primary male sex hormone, with potent anabolic and androgenic properties. These performance-enhancing drugs are abused by athletes and bodybuilders to increase muscle mass, strength, and power, thereby gaining a competitive advantage. Anabolic steroids exert their effects by enhancing protein synthesis, inhibiting protein breakdown, and promoting muscle hypertrophy. However, their use is associated with numerous adverse health effects, including liver damage, cardiovascular complications, hormonal imbalances, and psychological disturbances. Consequently, anabolic steroids are banned in sports and classified as controlled substances in many countries.(11,12)

Erythropoietin (EPO)

Erythropoietin (EPO) is a glycoprotein hormone that regulates red blood cell production in the bone marrow. Synthetic forms of EPO, known as erythropoiesis-stimulating agents (ESAs), have been illicitly used by endurance athletes to increase red blood cell mass and oxygen-carrying capacity, thereby enhancing aerobic performance. By stimulating erythropoiesis, EPO can improve oxygen delivery to working muscles, delay the onset of fatigue, and enhance endurance capacity. However, EPO abuse carries significant risks, including thrombotic events, cardiovascular complications, and potentially fatal consequences. Consequently, EPO is prohibited in sports and subject to rigorous anti-doping testing to detect its misuse.(13)





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Blood Doping

Blood doping involves the illicit manipulation of blood components to enhance athletic performance, primarily through the infusion of autologous (one's own) or homologous (donor) blood, red blood cells, or blood substitutes. By increasing the oxygen-carrying capacity of the blood, blood doping can improve aerobic performance, endurance capacity, and recovery between bouts of exercise. However, blood doping is prohibited in sports due to its unfair advantage and potential health risks, including blood-borne infections, immunological reactions, and thrombotic events. Athletes found guilty of blood doping face severe penalties, including disqualification, suspension, and loss of medals or titles.(14)

Compression Garments

Compression garments, such as socks, sleeves, and shorts, apply graduated pressure to specific body parts, promoting venous return, reducing muscle oscillation, and improving circulation. By enhancing blood flow and oxygen delivery to working muscles, compression garments can attenuate muscle fatigue, minimize muscle damage, and accelerate recovery following intense exercise. Additionally, compression garments may provide proprioceptive feedback, enhance joint stability, and reduce the risk of injury during sports activities. Athletes often wear compression garments during training sessions, competitions, or post-exercise recovery periods to optimize performance and recovery outcomes.(15)

METHODOLOGY

In conducting this scoping review on the interactions between ergogenic aids and exercise performance, our primary objective is to provide a comprehensive synthesis of the existing literature in this field. By systematically searching 11 articles in electronic databases and hand-searching reference lists, we aim to identify empirical research articles that examine the effects of various ergogenic aids on exercise performance outcomes across different types of exercise, including endurance activities, strength training, high-intensity interval training (HIIT), and team sports. Through a rigorous selection process based on predefined inclusion and exclusion criteria, we will screen and analyze studies to extract key data regarding study characteristics, participant demographics, intervention details, exercise protocols, and objective measures of exercise performance. Utilizing a narrative synthesis approach, we will synthesize findings from included studies, categorizing them by exercise type and ergogenic aid category, to elucidate patterns and trends in ergogenic aid efficacy across different exercise modalities. Furthermore, we will explore potential moderators of ergogenic aid effects, such as participant characteristics and methodological factors, to provide insights into factors influencing ergogenic aid efficacy. The findings of this scoping review will be reported according to established guidelines, with implications for practice, research, and policy discussed to guide future investigations and interventions aimed at optimizing athletic performance while ensuring safety and ethical considerations. Through systematic dissemination of our findings, we aim to contribute to the advancement of knowledge in sports science and enhance the evidence base for informed decision-making among athletes, coaches, practitioners, and policymakers alike.

Discussion on exercise interactions of ergogenic aids

The interaction between ergogenic aids and exercise performance is multifaceted and varies depending on the type of exercise involved. For endurance exercise, such as long-distance running or cycling, ergogenic aids like caffeine, nitric oxide precursors, and carbohydrate supplements have been shown to enhance aerobic capacity, delay fatigue, and improve time-to-exhaustion. These aids may exert their effects by increasing oxygen utilization, promoting vasodilation, and optimizing glycogen availability, thereby enhancing endurance performance. Conversely, for strength training exercises like weightlifting or powerlifting, creatine supplementation is widely recognized for its ability to enhance muscle strength, power output, and lean body mass. By increasing phosphocreatine stores in muscle tissue, creatine facilitates the rapid regeneration of ATP, allowing for greater force production and performance gains during high-intensity resistance exercise. Moreover, ergogenic aids such as beta-alanine and BCAAs have demonstrated benefits for buffering acidosis, reducing muscle fatigue, and improving recovery between





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sets in strength-based activities. In the context of high-intensity interval training (HIIT), ergogenic aids like caffeine and beta-alanine may enhance anaerobic performance, sprinting ability, and metabolic responses to repeated bouts of intense exercise. These aids can augment energy substrate availability, buffer intramuscular acidity, and delay the onset of fatigue during HIIT protocols, ultimately improving training adaptations and performance outcomes. Overall, understanding the exercise-specific interactions of ergogenic aids is essential for tailoring supplementation strategies to the unique demands of different sports and training modalities, thereby optimizing athletic performance while minimizing potential risks and maximizing benefits.(16)

CONCLUSION

In conclusion, ergogenic aids encompass a diverse array of substances, techniques, and treatments used to enhance athletic performance. From caffeine and creatine to blood doping and compression garments, these aids exert their effects through various physiological mechanisms, targeting different aspects of sports performance. While some ergogenic aids are legal, widely accepted, and supported by scientific evidence, others are banned, prohibited, or associated with significant health risks. Athletes and coaches must critically evaluate the benefits, risks, and ethical considerations associated with ergogenic aids, seeking evidence-based strategies to optimize performance safely and effectively. Ultimately, the pursuit of athletic excellence should prioritize integrity, fairness, and respect for the spirit of sport, upholding the values of sportsmanship, camaraderie, and personal achievement.

Recommendations

Tailor ergogenic aid use to individual athlete needs, integrate them into comprehensive training programs, and provide evidence-based education on their use.

Limitations

Recognize variability in study designs, consider potential confounding factors, and address ethical and safety concerns associated with ergogenic aid use.

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A Computational Exploration of Alizarin Derivative as Next – Generation Photosensitizers for Dye Sensitized Solar Cells

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 18 Jul 2024

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ABSTRACT

We have designed a series of new dyes (Az1–Az6) through introducing different donor and acceptormoieties on the natural dye 1,2-dihydroxyanthraquinone (alizarin) as a π spacer, and their photoelectrical properties were systematically investigated. To evaluate the photoelectrical properties of the designed dyes, the intramolecular charge transfer (ICT) characteristics, open-circuit voltage (V_{oc}), light harvesting efficiency (LHE), electron coupling constant (V_{RP}), electron regeneration driving force (ΔG^{reg}), free-energy change driving force (ΔG^{inject}) and chemical reactivity parameters were investigated. All these calculations were performed using density functional theory (DFT) and time dependent DFT methodologies. The designed dyes (Az1–Az6) display the lowest energy gap, widest absorption spectrum, which indicates that these designed dyes would present the best photoelectrical properties to be used in DSSC's.

Keywords: DSSC, DFT, Frontier molecular orbitals, LHE, absorption spectra





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INTRODUCTION

Considering the growing need of energy globally, one of the most vital areas of research is the utilization of photovoltaic technology to extract energy from sunlight. Hence it was highly desirable to develop low-cost solar energy harvesting technology. The dye-sensitized solar cell (DSSC), is a third-generation solar cell which can provide simple light-to-electrical energy conversion, which may replace the familiar but expensive silicon-based solar cell [1]. Dye-sensitized solar cells (DSSCs) are gaining much attention because of simple device fabrication relatively low-cost production processes, moderate conversion efficiencies and quick [2]energy payback time [3].The two phases involved in the conversion of solar energy to electric energy by DSSC are the generation of charge by photoactive species because of the absorption of incident photons of the visible-range and the transportation of charge by a semiconductor and electrolyte [4].The photosensitizer, which is a crucial component of the DSSC's operation may be metal-containing inorganic dyes or metal-free organic dyes [5]. It is essential to build DSSC based on organic dyes due to the high cost and environmental hazards of inorganic dyes [6]. Organic dyes are environmentally friendly, have a high extinction coefficient, low cost and easily available due to simple synthesis techniques [7].

Photosensitizers with D- π -A configuration are known to offer high efficiency [8]. In this configuration, the donor (D) should be an electron-rich moieties that donates electrons, and the acceptor (A) is an electron-deficient moieties that accepts electrons and these are connected by the π -spacer, whereas the acceptor is directly attached to the surface of semiconductors usually TiO₂[9-10].The optical properties of D- π -A dyes could be finely tuned by substituting suitable(D) and (A) moieties and a π bridge at suitable positions [10-11].The basic purposes of the dyesensitizers are absorption of light and transfer of charge, which are strongly dependent on their structure and electronic properties [11].Therefore, the present work has been focussed on designing dyes that are more efficient with improved power conversion efficiency. We have thoroughly examined how the donor, acceptor, and π -spacer groups affect the tunable photophysical characteristics of developed sensitizer for DSSC's. As shown in fig.1 we therefore designed six new organic dyes, Az1 to Az6, for DSSCs based on the molecular architecture of AD- D- π - A with triphenylamine (TPA) and diphenylamine (DPA) moieties as an electron donor (D) and cyano, nitro as an electron acceptor (A), and alizarin as a π spacer. The CH₃ group has been added to the D- π - A structure to study the impact of the auxiliary donor (AD).Alizarin (1,2-dihydroxyanthraquinone), is an organic compound with formula C₁₄H₈O₄ that has been used as a prominent red dye for dyeing textile fabrics [12]. Historically it was derived from the roots of plants of the madder genus[13].Fig. 2depicts the structure of alizarin and newly developed dyes. The various optical and electrical properties of these designed dyes are computed using density functional theory (DFT) and time-dependent DFT (TD-DFT) calculations to realize the improvement in DSSC performance.

COMPUTATIONAL METHODS

The optimized geometries and electronic properties of all the designed dyes (Az1-Az6) at ground state were calculated using the density functional theory (DFT) with B3LYP /6-311++ G(d, p) level of theory [14]. The vertical excitation energy and absorption spectra were simulated using the TD-DFT with same level of theory [15]. The Solvent effects were explored using the self-consistent reaction field (SCRF) method and the polarizable continuum model (PCM)[16].These calculations were performed using dichloromethane (DCM) and dimethylformamide (DMF) as the solvent. All these calculations were performed using the Gaussian 09 program[17].

RESULTS AND DISCUSSION

Frontier molecular orbitals

The optimized structure of dye molecules at the B3LYP/6-311++G(d,p) level of theory was used to investigate the frontier molecular orbitals (FMO)of the dyes [18].In dye sensitizers, the intramolecular charge transfer (ICT) takes place from the electron donor moiety to the electron acceptor moiety through the π -spacer [18]. The highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO), which are shown in figure3, allow us





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to examine the ICT behaviour. All designed dyes (Az1–Az6) had an electron density of the HOMO that is primarily distributed on the electron-donating moiety with delocalization onto the π -spacer. The LUMO electronic density is mainly localized onto the π -spacer and electron acceptor moiety. All dyes' anchoring groups significantly contribute to the LUMO orbital. Consequently, this might result in a potential electronic injection into the TiO₂ semiconductor's conduction band (CB). This significant HOMO-LUMO overlap at the π -spacer ensures an effective transfer of electrons from the donor (D) to acceptor (A) through the π -spacer. Table 1 displays the frontier molecular orbital energies and energy gap (E_{gap}), and Fig. 4 presents the energy level diagram of the dyes in gas and solvent phases. Dyes with a stronger electron-donating group have higher HOMO energy level, whereas dyes with strong acceptor groups own lower LUMO energy level [19]. The HOMO energy level of all the designed dyes ranges from -6.0246 eV to -5.5247 eV, which are lower than the reduction potential of I⁻/I₃⁻ electrolyte (-4.8 eV), indicating a thermodynamically favourable regeneration of the oxidised sensitizer species [19]. The LUMO energy levels of all designed sensitizers range from -3.8556 eV to -3.2106 eV, which are much higher than the conduction band of TiO₂ (-4.0 eV) which means that the excited electron injection of all the designed dyes is very efficient [20-21]. The designed dyes Az3, Az4, Az5 and Az6 shows greater HOMO energies which implies that the introduction of TPA donor could increase the HOMO energy compared to DPA donor substituted dyes Az1- Az2 and further improve the ability of electron transition. When compared to the other dye molecules, the dye molecule Az5 with the auxiliary donor CH₃ exhibits a stronger ability to donate electrons. Therefore, the effective injection of excited electrons and subsequent efficient regeneration of the oxidized dyes are energetically favourable [22]. This shows that the designed dyes are appropriate for DSSC systems. The energy gap can reflect the ability of electrons transition from HOMO to LUMO under light irradiation, in which the dye with lower energy gap would exhibit the more red-shifted absorption spectrum [23]. Table 1 indicates that the energy gap of the designed dyes is smaller than that of alizarin (Az). The dye Az6 has the smallest energy gap of the dyes under investigation and is therefore more reactive, which suggests that this dye will have the best optical performance.

Absorption spectra

For effective performance of DSSC, its absorption spectrum must match the solar irradiation spectrum. The absorption bands of the singlet-singlet transitions with the oscillator strength larger than 0.01 were listed in Table 2 because for the conversion of photons to current, absorption in the visible and near-UV range is the most important region. The absorption property of the dye determines its light harvesting capability and thus affects the performance of dye sensitizers in DSSCs [24-25]. Fig. 5 displays the simulated UV-Vis absorption spectra for all dyes in the gas and solvent (DFM, DCM) phases using the TD-DFT method and the B3LYP/6-311++G (d, p) level of theory. In both the gas and solvent phases of the UV-Vis absorption spectra, all of the proposed dyes (Az1–Az6) show extremely strong, well-separated absorption bands with increased oscillator strength. Absorption spectra in the solvent phase are red shifted when compared to those in the gas phase due to solvent effects. An essential property of a DSSC dye is its absorption wavelength, which is enhanced by the addition of an auxiliary donor group.

Light Harvesting efficiency

Light harvesting efficiency (LHE) is a key aspect for photo excitation and it affects the photo conversion. The light-harvesting efficiency (LHE) of the dye sensitizer is obtained from equation (1)

$$LHE = 1 - 10^{-f} \quad \text{----- (1)}$$

Where f is oscillator strength of the dye associated with the wavelength corresponding to the peak absorbance through intramolecular charge transfer [26-27]. Six newly designed sensitizers (Az1-Az6) have stronger oscillators due to improved π -conjugation. The newly developed sensitizers perform better than Alizarin in terms of average LHE for the main absorption peaks. Only the transitions with considerable oscillator strengths are given in table 2. Among the studied dyes Az5, and Az6 dyes can be used as a potential sensitizer for DSSC. These dyes will convert more light to electrical energy.





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Free energy change of electron injection and oxidation potential

The driving force energy for electron injection from the excited state into the conduction band of TiO₂ can be estimated by calculating the Gibbs energy changes of electron injection of dyes [28] (ΔG^{inject}). The following equation was used to calculate the free energy change for the process of electron injection [29]

$$\Delta G^{\text{inject}} = E_{\text{ox}}^{\text{dye}^*} - E_{\text{CB}}^{\text{TiO}_2} \quad \text{----- (2)}$$

In equation (2) $E_{\text{ox}}^{\text{dye}^*}$ is the excited state oxidation potential of the dye and $E_{\text{CB}}^{\text{TiO}_2}$ is the energy of conduction band of the TiO₂ semiconductor (-4.0 eV). The $E_{\text{ox}}^{\text{dye}^*}$ can be determined by [30] equation (3).

$$E_{\text{ox}}^{\text{dye}^*} = E_{\text{ox}}^{\text{dye}} - \lambda_{\text{max}}^{\text{ICT}} \quad \text{----- (3)}$$

Here, $E_{\text{ox}}^{\text{dye}}$ is the oxidation potential energy of the dye in the ground state ($E_{\text{ox}}^{\text{dye}} = -E_{\text{HOMO}}$) and $\lambda_{\text{max}}^{\text{ICT}}$ is the vertical transition energy [30] corresponding to λ_{max} . Table 3a & 3b illustrates that the electron injection free energy change (ΔG^{inject}) for the designed dyes (Az1-Az6) is negative. This suggests that the excited states of the dyes are situated above the conduction band edge of the TiO₂ semiconductor, and that the electron injection process from the dye to a semiconductor occurs spontaneously.

Dye degeneration

The dye regeneration process is affected by the free energy change of the hole transport from the dye to the electrolyte [31]. The driving force energy for dye regeneration ΔG^{reg} from the redox system [32] can be calculated by using equation 4.

The free energy change of dye regeneration ΔG^{reg} can be evaluated from

$$\Delta G^{\text{reg}} = E_{\text{ox}}^{\text{dye}} - E_{\text{I}^-/\text{I}_3^-} \quad \text{----- (4)}$$

where $E_{\text{I}^-/\text{I}_3^-}$ is the redox potential energy of the redox electrolyte (-4.8 eV). The faster electron transfer would result from the lower ΔG^{reg} . The designed dyes all exhibit lower ΔG^{reg} values than alizarin, as shown in Table 3a & 3b, indicating that they will exhibit better electron transfer properties. The dye Az5 has the lowest ΔG^{reg} value among the investigated dyes, indicating that it will have the best electron transfer characteristics.

Open circuit Voltage

The open circuit voltage (V_{oc}) can be estimated approximately by the analytical methods as follows [33-34] by equation (5):

$$V_{\text{oc}} = E_{\text{LUMO}} - E_{\text{CB}} \quad \text{----- (5)}$$

As listed in Table -4, among the designed dyes the open circuit voltage is higher for dye Az5.

Electron coupling Constant

V_{RP} is the coupling constant between the reagent and the product potential curves and the higher V_{RP} leads to larger rate constant that could result better sensitizer [35]. Using the extended generalized Mulliken-Hush (GMH) formalism, V_{RP} for a photo-induced charge transfer can be calculated as follows [36].

$$V_{\text{RP}} = \frac{\Delta E_{\text{RP}}}{2} \quad \text{----- (6)}$$

The injection driving force can be expressed within Koopmans approximation as

$$\Delta E_{\text{RP}} = [E_{\text{LUMO}}^{\text{dye}} + 2E_{\text{HOMO}}^{\text{dye}}] - [E_{\text{LUMO}}^{\text{dye}} + E_{\text{HOMO}}^{\text{dye}} + E_{\text{CBO}}^{\text{TiO}_2}] \quad \text{----- (7)}$$

Where $E_{\text{CBO}}^{\text{TiO}_2}$ is the conduction band energy of TiO₂ semiconductor (-4.0 eV) which is an experimental value corresponding to conditions where the semiconductor is in contact with aqueous redox electrolytes of fixed pH 7.0, whereas the HOMO energy is related to the potential of the first oxidation [37].

$$-E_{\text{HOMO}}^{\text{dye}} = E_{\text{OX}}^{\text{dye}}$$

$$\Delta E_{\text{RP}} = -[E_{\text{OX}}^{\text{dye}} + E_{\text{CBO}}^{\text{TiO}_2}] \quad \text{----- (8)}$$

The designed dyes Az1 and Az2 were showed larger coupling constant compare with the reference dye Az which are represented in Table-4.





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Global reactivity descriptors

Density functional methodology provides an excellent framework to evaluate a set of known Global reactivity descriptors such as electron affinity (EA), ionization potential (IP), chemical potential (μ), global hardness (η), chemical softness (S), and electrophilicity index (ω), electron donating power (ω^-), and electron accepting power (ω^+) which are linked to their electronic structure and chemical reactivity [38]. According to molecular orbital theory, ($IP = -E_{HOMO}$) and ($EA = -E_{LUMO}$) are the first ionisation chemical softness (S) energy and electron affinity, respectively [39]. The Global reactivity descriptors can be calculated using the following equations [40]:

$$\mu = \frac{IP+EA}{2} \quad \text{----- (9)}$$

$$\eta = \frac{IP-EA}{2} \quad \text{----- (10)}$$

$$S = \frac{1}{\eta} \quad \text{----- (11)}$$

$$\omega = \frac{\mu^2}{2\eta} \quad \text{----- (12)}$$

$$\omega^+ = \frac{(IP+3EA)^2}{16(IP-EA)} \quad \text{----- (13)}$$

$$\omega^- = \frac{(3IP+EA)^2}{16(IP-EA)} \quad \text{----- (14)}$$

Calculated global reactivity parameters of the reference and designed dyes are listed in Table 5. A smaller IP value is more important to evaluate hole injection, while a larger EA value will be used to facilitate the electron injection into the conduction band of TiO₂ semiconductor [41]. The designed dyes Az3–Az6 have lower IP values than the alizarin (Az) reference dye, these dyes lose electrons more readily, leading to better photoelectric properties because of structural modifications. In addition, the EAs of the designed dyes are higher than those of the (Az) reference dye, implies that the designed dyes have a greater tendency to accept electrons than the reference dye (Az). When compared to alizarin, all the designed dyes have a lower chemical hardness and a higher electro accepting power, which suggests that the designed dyes would exhibit a higher short-circuit current density. However, the stabilization energies of molecular structures may be measured by the value of electrophilicity (ω); the highest ω^+ value indicates the highest electron-accepting ability and therefore, higher ω and ω^+ are preferable [42-43]. In addition, the computed electron-donating power of all the designed dyes exhibit the same trend of electrophilicity and electron-accepting power. The designed dyes Az1-Az6 dyes have a higher power conversion efficiency (PCE), a better electron-accepting capacity, and a lower chemical hardness.

CONCLUSIONS

To enhance the dyes photophysical properties, we developed a range of AD-D- π -A dyes through the introduction of auxiliary donors with distinct donor and acceptor moieties to the reference dye alizarin. The electronic structures and optical absorption characteristics of the reference and designed dyes for DSSC devices were studied using DFT and TD-DFT methods. All the proposed dyes displayed a relatively low energy gap in comparison to the reference dye alizarin, which led to a broad UV-Vis absorption spectrum and a wavelength redshift. The DSSCs owning these designed dyes (Az1-Az6) may show higher V_{oc} values, possess a smaller energy gap (E_{gap}), larger λ_{max} , higher light harvesting efficiency value and superior ΔG^{inject} and regeneration driving force (ΔG^{reg}). These organic dyes can be used as dye sensitizers to increase the absorption wavelength and enhance the overall efficiency of energy conversion in DSSC devices.

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Table1. The E_{HOMO}, E_{LUMO} and energy gap (E_{gap}) of dyes in eV at DFT/ B3LYP/6-311++G (d, p) level of theory.

Dye	GAS PHASE			DMF			DCM		
	HOMO	LUMO	E _{gap}	HOMO	LUMO	E _{gap}	HOMO	LUMO	E _{gap}
Az	-5.7062	-3.1688	2.5374	-5.7133	-2.5587	3.1546	-5.7089	-2.5538	3.1551
Az1	-5.9482	-3.8556	2.0933	-5.9245	-3.8545	2.0699	-5.9250	-3.8531	2.0718
Az2	-6.0246	-3.5288	2.4958	-5.9032	-3.5704	2.3328	-5.9076	-3.5668	2.3407
Az3	-5.6608	-3.2958	2.3649	-5.5938	-3.3350	2.2588	-5.5903	-3.3312	2.2591
Az4	-5.6472	-3.4087	2.2384	-5.5691	-3.5489	2.0221	-5.5669	-3.5323	2.0346
Az5	-5.5247	-3.2106	2.3140	-5.4967	-3.3037	2.1929	-5.4883	-3.2939	2.1943
Az6	-5.5952	-3.5535	2.0416	-5.5530	-3.6172	1.9358	-5.5457	-3.6126	1.9331

Table2. Absorption peak maxima (λ_{max}), Oscillator Strength (f), Light Harvesting Efficiency (LHE), average Light Harvesting Efficiency (LHE_{avg}) of dyes at B3LYP/6-311++G (d, p) level of theory in Gas and solvent phases.

DYE	GAS PHASE				DMF				DCM			
	λ _{max}	f	LHE	LHE _{avg}	λ _{max}	f	LHE	LHE _{avg}	λ _{max}	f	LHE	LHE _{avg}
Az	498.47	0.0064	0.0146	0.0152	502.58	0.0092	0.0209	0.0122	502.31	0.0090	0.0200	0.0118
	306.84	0.0070	0.0159		390.75	0.0016	0.0036		391.09	0.0016	0.0036	
Az1	511.51	0.0457	0.0998	0.1706	725.60	0.0242	0.0541	0.1712	604.58	0.0065	0.0148	0.1552
	477.36	0.1201	0.2415		456.62	0.1478	0.2884		464.31	0.1523	0.2957	
Az2	572.35	0.0303	0.0673	0.2387	617.15	0.0204	0.0458	0.2844	614.95	0.0223	0.0500	0.2868
	429.48	0.2293	0.4102		458.51	0.3216	0.5231		456.77	0.3222	0.5237	
Az3	613.54	0.1129	0.2289	0.4345	651.79	0.1394	0.2745	0.4982	651.47	0.1392	0.2742	0.4966
	432.95	0.4440	0.6402		447.44	0.5559	0.7219		447.79	0.5513	0.7190	
Az4	653.32	0.0357	0.0789	0.3558	733.83	0.0248	0.0550	0.3541	728.23	0.0270	0.0602	0.3586
	460.16	0.4350	0.6327		503.05	0.4600	0.6532		499.87	0.4649	0.6571	
Az5	628.73	0.1039	0.2127	0.3892	672.86	0.1274	0.2542	0.4701	672.30	0.1271	0.2537	0.4690
	438.47	0.3624	0.5658		455.30	0.5032	0.6860		455.57	0.5008	0.6843	
Az6	721.76	0.0639	0.1368	0.3551	769.14	0.0549	0.1187	0.3681	770.69	0.0580	0.1250	0.3718
	496.08	0.3701	0.5735		532.52	0.4174	0.6175		531.44	0.4188	0.6187	

Table3a. Calculated maximum absorption wavelength (λ^{max}), vertical excitation energy (λ^{ICT}_{max}), excited state oxidation potential (E^{dye*}_{ox}), driving force of electron injection (ΔG^{inject}), driving force of dye degeneration (ΔG^{reg}) of dyes at B3LYP/6-311++G (d, p) level of theory in Gas phase.

DYE	GAS PHASE				
	λ _{max}	λ ^{ICT} _{max}	E ^{dye*} _{ox}	ΔG ^{inject}	ΔG ^{reg}
Az	498.47	2.4873	3.2189	-0.7811	0.8562
Az1	511.51	2.4239	3.5243	-0.4757	1.0982
Az2	572.35	2.1662	3.6584	-0.1416	1.1746
Az3	613.54	2.0208	3.6328	-0.3600	0.8108





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Az4	653.32	1.8978	3.7494	-0.2506	0.7972
Az5	628.73	1.9720	3.5527	-0.4473	0.6747
Az6	721.76	1.7178	3.8774	-0.1226	0.7452

Table 3b. Calculated maximum absorption wavelength (λ_{\max}), vertical excitation energy ($\lambda_{\max}^{\text{ICT}}$), excited state oxidation potential ($E_{\text{ox}}^{\text{dye}}$), driving force of electron injection (ΔG^{inject}), driving force of dye degeneration (ΔG^{reg}) of dyes at B3LYP/6-311++G (d, p) level of theory in Solvent phases.

DYE	DMF					DCM				
	λ_{\max}	$\lambda_{\max}^{\text{ICT}}$	$E_{\text{ox}}^{\text{dye}}$	ΔG^{inject}	ΔG^{reg}	λ_{\max}	$\lambda_{\max}^{\text{ICT}}$	$E_{\text{ox}}^{\text{dye}}$	ΔG^{inject}	ΔG^{reg}
Az	502.58	2.4670	3.2463	-0.7537	0.8633	502.31	2.4683	3.2406	-0.7594	0.8589
Az1	602.38	2.0607	3.8575	-0.1425	1.0745	604.58	2.0508	3.8742	-0.1258	1.075
Az2	617.15	2.0090	3.8942	-0.1058	1.0532	614.95	2.0162	3.8914	-0.1086	1.0576
Az3	651.79	1.9022	3.6916	-0.3084	0.7438	651.47	1.9031	3.6872	-0.3128	0.7403
Az4	733.83	1.6896	3.8795	-0.1205	0.7191	728.23	1.7025	3.8644	-0.1356	0.7169
Az5	672.86	1.8426	3.6541	-0.3459	0.6467	672.30	1.88442	3.6441	-0.3559	0.6383
Az6	769.14	1.6120	3.9410	-0.0590	0.7030	770.69	1.6088	3.9369	-0.0631	0.6957

Table4. The open-circuit Voltage (V_{oc}) and electron coupling constant (V_{RP}) in eV.

DYE	GAS PHASE		DMF		DCM	
	V_{oc}	V_{RP}	V_{oc}	V_{RP}	V_{oc}	V_{RP}
Az	0.8312	0.8531	1.4413	0.8566	1.4462	0.8544
Az1	0.1444	0.9741	0.1455	0.9622	0.1469	0.9625
Az2	0.4712	1.0123	0.4296	0.9516	0.4332	0.9538
Az3	0.7042	0.8304	0.6650	0.7969	0.6880	0.7951
Az4	0.5913	0.8236	0.4511	0.7845	0.4677	0.7834
Az5	0.7894	0.7623	0.6963	0.7483	0.7061	0.7441
Az6	0.4465	0.7976	0.3828	0.7765	0.3874	0.7728

Table 5. The ionization potentials (IP) electron affinities (EA), chemical potential (μ), chemical hardness (η), softness (S), electrophilicity (ω), electron donating power (ω^-), and electron accepting power (ω^+) in eV calculated at B3LYP/6-311++G (d, p) level of theory.

DYE	IP	EA	μ	η	S	ω	ω^+	ω^-
Az	5.7062	3.1688	4.4375	1.2687	0.7882	7.7604	5.700	10.1378
Az1	5.9482	3.8556	4.9019	1.0463	0.9557	11.4826	9.1625	14.0644
Az2	6.0246	3.5288	4.7767	1.2479	0.8013	9.1421	6.9097	11.6864
Az3	5.6608	3.2958	4.4783	1.1825	0.8456	8.4799	6.3886	10.866
Az4	5.6472	3.4087	4.5279	1.1192	0.8934	9.1591	7.0348	11.5628





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Az5	5.5247	3.2106	4.3676	1.1543	0.8663	8.2629	6.2188	10.5967
Az6	5.5952	3.5535	4.5743	1.0208	0.9796	10.2489	8.0882	12.6621

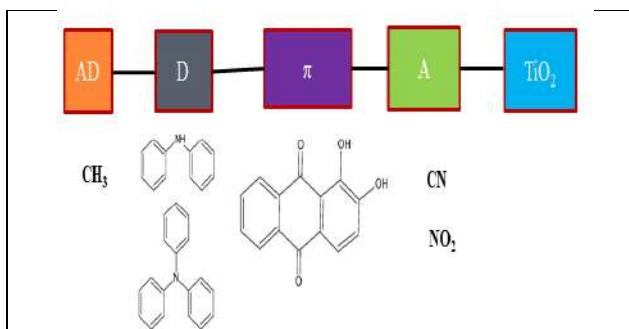


Fig. 1. Different parts of AD-D- π -A system. AD = auxiliary donor, D = donor, π = pi-spacer, A = acceptor.

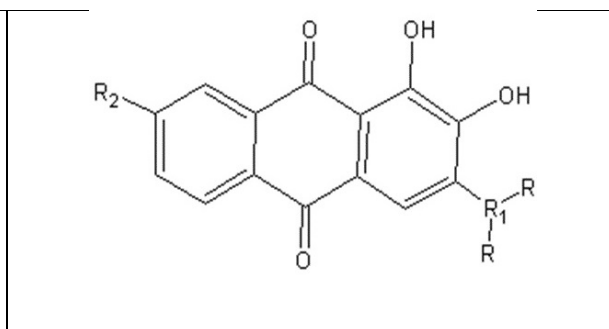


Fig. 2 - Chemical structure of designed dyes.

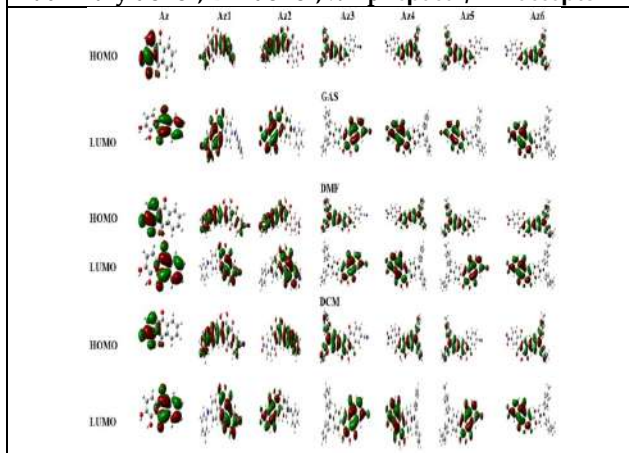


Fig. 3. HOMO and LUMO orbitals of Alizarin and designed dyes in gas and solvent phases.

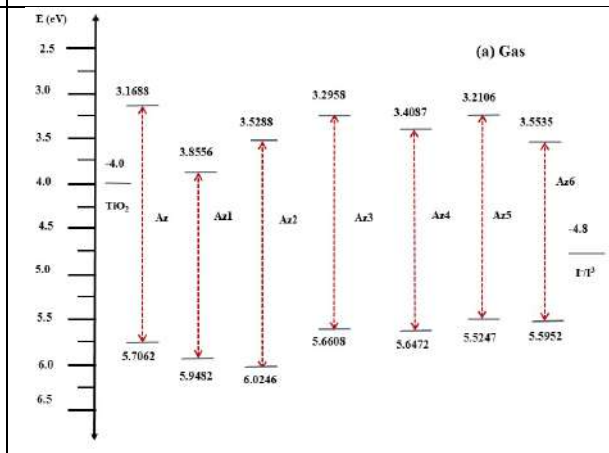


Fig. 4 Molecular Orbitals Energy Level diagram of designed dyes in (a) Gas

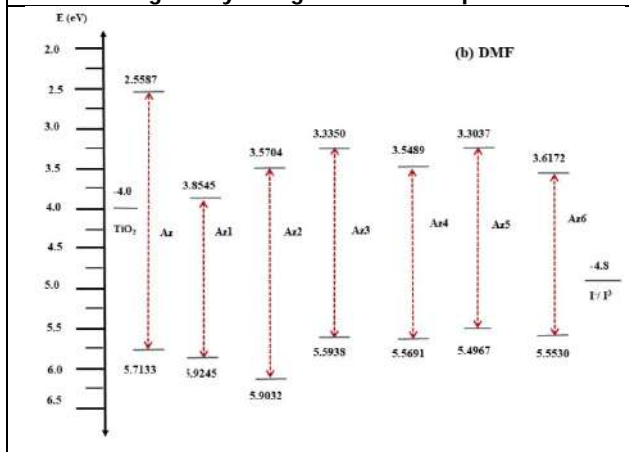


Fig. 4 (b) DMF

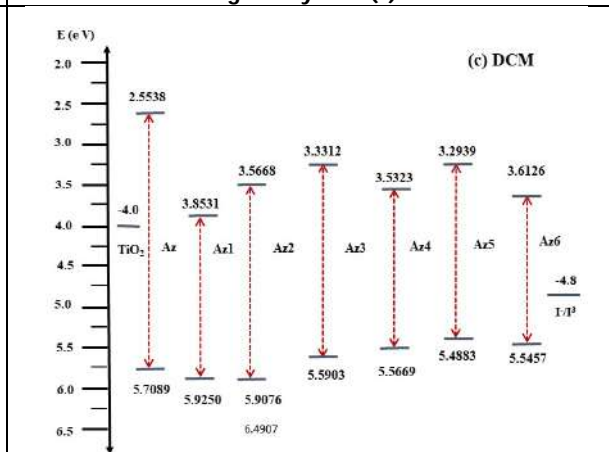


Fig. 4(c) DCM solvents.





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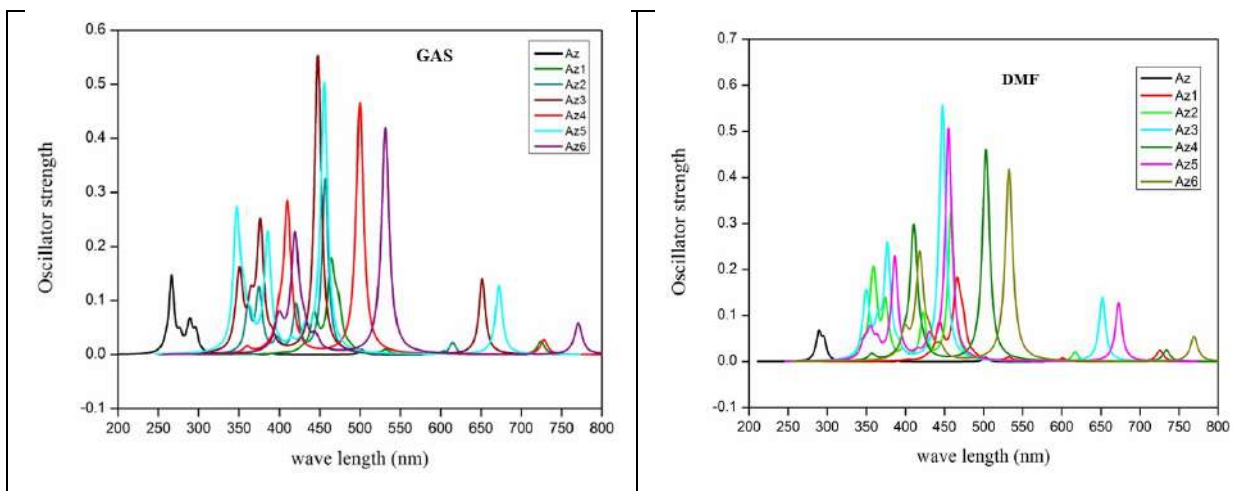


Fig. 5. Stimulated UV-visible absorption spectra of Alizarin and designed dyes in (a) gas phase

Fig. 5. (b) DMF

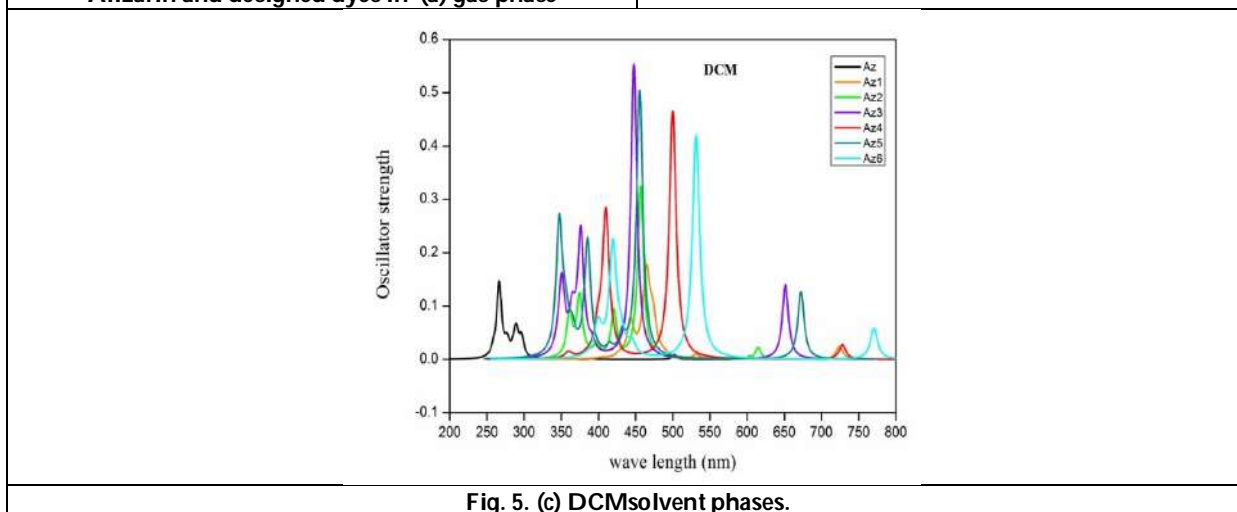


Fig. 5. (c) DCM solvent phases.





Extracting Salient Sentences: A Graph-Based Approach to Text Summarization

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 18 Jul 2024

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ABSTRACT

The rapid development of technologies produce enormous amount of data which have lot of hidden insights. Extracting these hidden insights are challengeable for researchers and industrialists. Most of the data are in textual and unstructured format. Text mining is the prominent research area that has being utilized for the textual data analysis. Document summarization is an effective application which provides the summary of given content. This research work mainly focused on extractive summarization from the multiple documents. The core objective of this research is to collect content from the various resources for a single event and provide extractive summarization on multiple documents. This research work contributes extractive summarization using the graph network. Lot of duplicate or redundant sentences are there in the multiple documents. Proposed CATSum graph based extractive summarization identifies the duplication based on the similarities of the sentences. The proposed technique used ALBERT encoder model to train the datasets. Then it has built the content summary based on the connection between the sentences. The proposed work is measured using the ROUGE-1, ROUGE-2 and ROUGE-L metrics and produced better accuracy than the baseline methods.

Keywords: Text summarization, Graph Based Technique, CATSum, Extractive Summarization, ALBERT encoder First Section





INTRODUCTION

Extractive Summarization

Extracting the subset of sentences and short summaries from the document is referred to as extractive summarization. Current research focuses on corresponding the salience and redundancy of sentences in the documents. The text summarization is to select the important sentences with great semantic similarity and to resolve the redundancy between selected sentences using gold summary standard. The function of automated text compression is to summarize a text document as a short highlight while retaining important information in the original text. In general, Extractive Summarization provides a sentence that is semantically and grammatically corrected [1] [2] and calculated fast. The following table explains a case for extracting message from Jackson County Prose. In which, the salience score is an approximate assessment derived from the semantics and the label is changed from gold abstract to ensure the summary and accuracy of the extracted abstractions. In the above Table 1, a document has five sentences, each of which is assigned a special mark and a label, indicating whether this sentence should be in the extracted abstract. S1, S3 and S4 are assigned a higher score, but S3 and S4 are selected as abbreviated phrases because there is too much redundant information between the unmarked s1 and the marked s3. That is, whether a sentence can be selected depends on its merits and redundancy with the other sentences selected. Although, some difficulties are there while modeling the dependency correctly yet. Many existing techniques use the auto-improvement framework [3] [4] which model the unilateral bias between sentences, i.e., based on the previous sentence label of the current sentence. These types of model qualified to forecast the current sentence label given by the basic truth labels of the previous sentences, while at the same time feeding the predicted labels of the previous sentences as input at the hypothetical stage. As already mentioned, the automation development pattern faces problems related to error propagation and exposure [5]. Apart from, the reinforcement learning has been established for considering the semantics of the separated summary or abstract [6] which integrates the maximum possible cross-entropy loss with the service provided by the rule slope to frankly improve the assessment metric for the abstract task. In recent, a popular solution has been created for abbreviation system with a two-level decoder.

These solutions extract key phrases, rewrite, abbreviate these sentences [7]. In general, preceding models utilize the top-k approach like the best approach to diverse documents, the amount of chosen sentences is fixed, which contradicts the actual world. For instance, approximately all preceding models take out three phrases from the actual articles [8] however, 40% of documents on CNN / DM are more or less than 3-sentences or abbreviations. This is because such models make it difficult to measure excitement and redundancy simultaneously with the spread of error. At present, most neural extractive-modulation systems vote on the individual text one at a time from the real text and then model a number of sentences to create a synopsis. In [9], they created an extractive sequence labeling problem and solve it with an encryption decoder structure. These models achieve more redundancy because it makes autonomous dual conclusions for all sentences. To solve the above problem, an autoregressive decoder is used that permits the gaining functions of diverse sentences to control each other [10]. Moreover, the recent developments focus on balancing the specialization and redundancy of sentences, i.e. choose more semantic similar phrases to solve the encountered problems among chosen phrases. One of the most popular methods which works on the similar motivation is Trigram blocking [11]. At the point of selecting phrases to create the abstract, this will avoid the sentence where the trigram overlaps with the previously selected phrases. Amazingly, this method of duplicate removal brings significant enhancement in the performance to CNN /Daily Mail. The systems for developing the association among sentences are mostly sentence-level separators, regardless of the semantics of the whole summary. This gives them more choice to choose the most common phrases, while ignoring the link of multiple phrases. Reinforcement learning (RL) used to attain abstract level assessment, but is still limited to the structure of sentence-level summaries.

Problem Statement

To solve the above discussed problems, we make the original article like a categorical multidimensional map (CHG) and develop a graphical focus web [12] based model (CATSum) to take out sentences by balancing excitement and





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redundancy simultaneously. Both words and sentences are structured as nodes, and the relationships between them are structured as different types of margins in CHG. In the former work this categorical map can be seen as a three-level diagram namely, named entity level, sentence level and word level. The proposed work used four-level diagram is presented.

Aim and Scope of the Research

The objectives of this research work are as follows:

- To process the document into a meaningful format
- To provide summaries accurately using the graph attention neural network model

The scope of the research work is to increase the accuracy of extractive summarization on the news textual data.

RESEARCH METHODOLOGY

Introduction

The detailed overview of the research methods which are used for this research contribution is given in this chapter. The following sections explain the process of dataset collection and preparation methods. Technique proposed for this research is explain with the mathematical notations and algorithms in the consecutive section. The tools and techniques that was utilized for data collection and analysis are discussed in this section. Consider $Sen = \{sen_1, sen_2, \dots, sen_N\}$, which represents the collected multi-document's sequences that contains N number of sentences, where sen_1 is i -th sentence of the collected document. Assume the human-generated summary as H . Extractive summarization targets to yield the summaries $Sen^* = \{sen^*_1, sen^*_2, \dots, sen^*_N\}$ by choosing P sentences from Sen , where $P \leq N$. Labels $X = \{x_1, x_2, \dots, x_N\}$ are resulting from H , where $x_i \in \{0, 1\}$ represents whether sentence sen_i should be comprised in the extracted summary. "Oracle summary is a subset of S , which achieves the highest ROUGE score calculated with H ." To demonstrate the repetition connection between the sentences, this research work utilizes a heterogeneous graph. As it is given in the fig. 1, the graph contains multi-granularity levels of data to represent the sentences. Three sorts of nodes such as NE (named entity), sentence and word are present in the proposed graph. The proposed technique replace the object that holds the information of the NE with the different tokens (e.g. [person_1], [person_2], [country_1], [org_1] and [date_1]) to reduce the semantic complexity. To represent the word-level data, word node is considered to process the graph. Most of the existing research work, eliminated the repeated words that contain the same meaning. In this proposed work, it keep the repeated or identical words as a separate node to avoid the misperception between different circumstances. The relationship between the sentences is represents by the sentence node. Categorized Attentive Graph Network Summarization (CATSum) defines five types of edges to represent the different structural information that are as follows:

- Directed next edges: It is used to connect the sequential NE and words in a single sentence.
- Directed in edges: It is used to connect the NE node or word from one sentence node to another sentence node if the NE node is repeated in another sentence node
- Directed out edges: It is used to connect the sentence node that preceded from the previous sentence node using NE word appeared in different sentence node
- Undirected sentence_similar edge: It is used to connect the sentence nodes that has overlapping phrases (trigrams)
- Undirected NE_same edge: It is used to connect the NE if it is redundant.

Category levels of the graph is represented by adjacency matrix Adj , where the presence of edges among the nodes is indicated by Boolean value. The CATSum consists of four subgraphs that are as follows:

- 1 Word (A_{word}): Next edge and NE_same edge is used to construct graph between entity and word node.
- 2 Word-named entity (A_{word_NE}): Directed in and directed out edge is used to build relationship between NE, word and sentence nodes.
- 3 Word-sentence (A_{word_sen}): Sentence_similar and NE_same edges are used to build relationship between word and sentence nodes.





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4 Sentence (A_{sen}): This builds relationship between A_{word_sen} and sentence_similar edges. It is like a nested edges.

Graph Attention Network

The Graph attention network (GAN) is modified to represent the A_{adj} and nodes in the framework. GAN is utilized to learn the hidden information of every node and it is given in the following equation (1):

$$e_{ij} = \text{LeakReLU}(a(Wx_i || Wx_j)) \quad (1)$$

where W and a is the shared linear transformation weight matrix and shared attentional weight vector respectively. In the neural network, softmax plays an important role to sort the attention coefficients between the various nodes for an easy comparison. The following equation is the normalized of softmax:

$$a_{ij} = \text{softmax}(e_{ij}) = \frac{\exp(e_{ij})}{\sum_{k \in N_i} \exp(e_{ik})} \quad (2)$$

Where N_i represents the "neighbors of node i " conferring to adjacency matrix A_{adj}

ALBERT Encoder

The proposed CATSum is based on the architecture BERTSUMEXT. The graph is built with a variant of different edges. The ALBERT encoder is used to learn the contextual representations of words. ALBERT is a pre-trained model that provides the summary using BERTSUMEXT model. For the hidden layer in the neural network, the ALBERT encoder considers the word and sentence nodes as the hidden layer. It takes sub word as the input. In this research work average pooling function is used to produce the output from ALBERT encoder. The given inputs in the

ALBERT encoder are analyzed by the following three layers:

- Abstract layer: It contains the GAN subgraphs. The word and sentence level subgraphs are processed and passed in to the redundancy layer.
- Redundancy layer: This layer works with the sentence level to identify the similar sentences and provides the scores.
- Output layer: The average pooling function is used to process the output from the above two layers.

The abstract layer is designed to learn the semantic recurrence of each word in the word-level diagram. Then, convert the word level map to a sentence-level one by merging each word into the corresponding sentence node. Design a redundancy layer in the sentence-level diagram which first pre-labels each sentence and renews the label dependencies by spreading the reuse information. The redundancy layer controls the size of the reception field for redundancy information, and the transmission of information is guided by the ground-true labels of the sentences. After receiving a threshold, the whole structure extracts simultaneous abstract sentences instead of the automated progress model, which takes over the top-k strategy. Unlike the previous work, the directed out edge is used to find the similarity and coherent of the sentences that are connected with the previous sentences. The directed in edge, finds the coherent from sentence_1 to sentence_2 whereas the directed out edge finds the coherent from sentence_2 to sentence_1. This ensures the relationship among the sentences more accurately.

RESULTS AND DISCUSSIONS

Datasets

As in Table 1 and fig. 1, this research work utilizes four datasets generally utilized with various sentences summary that are as follows:

- NEWSROOM [4]
- CNN [2]
- Daily Mail [2]
- NYT (New York Times) [7]





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In the above datasets, newsroom is purely built for the extractive summarization. The other datasets were utilized for abstractive summarization.

Evaluation Metric

ROUGE is the usual measurement used for assessing the nature of text summarization. In this research work, it reports the following metrics for evaluation of proposed CATSum:

- ROUGE-1,
- ROUGE-2, and
- ROUGE-L

Parameter Settings

For abstract layer, it separates the named elements (for example [Person], [Organization], [Date], [Location], and [Country]) utilizing spacy, and supplant them by a anonymized tokens ([Person_1], [Organization_1], [Date_1], [Location_1], and [Country_1]). Like [20], this work have attempted to add reliance parse edges and as the results the work didn't show huge advantages. But it shows the attributable to the realities that

- The dependent tree is generously a stage consecutive structure, with little headways for unique data;
- The presentation is affected by the precision of the inward stream annotators.

Baseline Methods

- *Lead*: It is a base technique for extractive content outline that picks initial a few sentences as a synopsis [13].
- *Summa RuNNer*: It takes content, striking nature, curiosity, and position of each sentence into thought when choosing if a sentence ought to be remembered for the extractive outline [14].
- *PNBERT*: It attempts to utilize the solo adaptable information [15].
- *BERTSUMEXT*: It applies pretrained BERT in content outline and proposes an overall structure for both extractive and abstractive models[16].
- *MATCHSUM*: It is a two-level strategy for extricate then-coordinate, and the primary stage is BERTSUMEXT[17].

Evaluation

The investigation results on four benchmark datasets are appeared in Table 2, Table 3, Table 4, Table 5 and Table 6. There are disregarded situations for Newsroom (Ext), which is intended for extractive methodologies, taking out the requesting of abstractive ones. Clearly CATSum nearly beats all the baselines across the majority of the assessment measurements. For CNN/DM, there is little hole between the presentation of extractive graphs, especially showing the prevalence and over-simplification of this dataset [18]. While NYT likes to abstractive techniques, and NEWSROOM (Ext) is developed by removing sentences straightforwardly. For extractive methodologies, CATSum, MATCHSUM, and BERTSUMEXT are remarkable with the force of pre-prepared BERT-like models. For abstractive techniques, these variations of Transformer perform incredibly with profound structures and huge scope unlabeled corpus [19]. CATSum beats any remaining extractive methodologies for that:

- CATSum accomplishes upgrades to relieve the repetition predisposition by estimating notability and excess at the same time, while this would not be conceivable with any structure in the autoregressive writing since striking nature and repetition are treated as two unique cycles because of the reliance among target names.
- The promising aftereffects of heterogeneous sequence graph models beat untainted succession models. Succession encoders with a chart part can reason about significant distance connections in pitifully organized information, for example, text, which requires nontrivial comprehension of the information, while mindful consecutive structures like to figure the pertinence simply.

The Fig.2, Fig. 3, Fig. 4 and Fig.5 illustrates the performance measures of various models with sample datasets respectively. It also interprets that CATSum model outperforms well when compared to all other model which ignores redundancy. This model produces more intensive summarized text with less redundant information.





CONCLUSIONS

This research work, proposed a categorical attentive different graph. It is targeting salience measure and redundancy concurrently to provide the advance text extractive summarization. The proposed CATSum approach model did not ignore the redundancy (near-similar) sentences to build the graph. The redundant information provides new scores to evaluate the importance of the sentences. The newly added directed out edge ensure the sentence similarity. The proposed CATSum produces more intensive summaries along with less redundant information. In future, the proposed technique will be enhanced to produce abstractive text summarization for multiple documents.

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Table 1. Sentence as extracted abstract

Saliency	Label	Sentence
Sent1:0.7	0	Deanna Holleran is charged in murder
Sent2:0.1	0	Jackson Country Prosecutor Jean Peters Baker announced today.
Sent3:0.7	1	Deanna Holleran faces a charge of traffic accident.
Sent4:0.7	1	The fatal traffic accident is a murder
Sent5:0.2	0	It took the life of Marrianna Hernandez near 9 th Hardesty.
Summary:		Woman faces a charge of murder for a fatal traffic accident

Table 2. Data Description

S. No.	Datasets	Average document length		Average summary length	
		Words	Sentences	Words	Sentences
1	Newsroom	610	29	41	2
2	NYT	801	36	46	3
3	Daily mail	654	30	55	4
4	CNN	761	34	46	4

Table 3. Evaluation of CNN dataset

S. No	Techniques	Rouge – 1	Rouge – 2	Rouge – L
1	MATCHSUM	46.43	21.96	42.35
2	BERTSUMNEXT	44.95	21.35	40.90
3	PNBERT	43.69	20.70	39.85
4	Summa RuNNer	40.70	17.29	36.40
5	Lead	41.34	18.64	37.78
6	CATSum	46.68	24.40	41.89

Table 4. Evaluation of Dailymail dataset

S.No	Techniques	Rouge – 1	Rouge – 2	Rouge – L
1	MATCHSUM	47.33	22.56	42.35
2	BERTSUMNEXT	41.85	22.45	41.70
3	PNBERT	41.69	21.60	38.75
4	SummaRuNNer	40.60	18.39	37.50
5	Lead	41.44	19.74	38.78
6	CATSum	47.68	25.40	42.89

Table 5. Evaluation of NYT dataset

S.No	Techniques	Rouge – 1	Rouge – 2	Rouge – L
1	MATCHSUM	46.45	23.96	45.45





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2	BERTSUMNEXT	46.56	24.35	43.20
3	PNBERT	47.34	23.70	44.75
4	SummaRuNNer	42.65	20.29	40.37
5	Lead	44.54	20.64	41.8
6	CATSum	48.78	28.40	46.89

Table 6. Evaluation of Newsroom dataset

S.No	Techniques	Rouge – 1	Rouge – 2	Rouge – L
1	MATCHSUM	48.33	21.96	44.35
2	BERTSUMNEXT	46.15	21.35	42.90
3	PNBERT	45.89	20.70	41.85
4	SummaRuNNer	43.30	17.29	41.40
5	Lead	45.24	28.64	43.78
6	CATSum	51.48	34.40	52.89

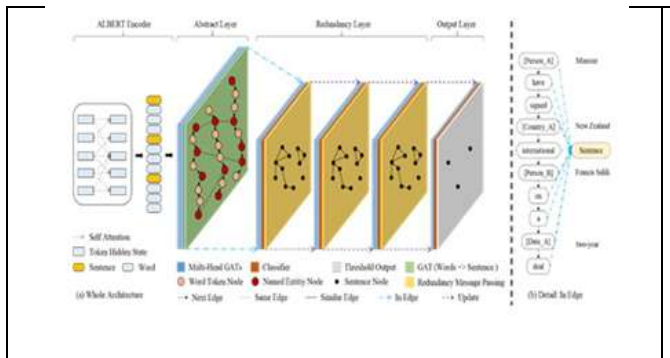


Fig. 1. Overview of CATSum

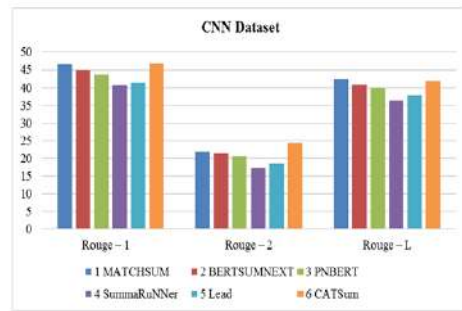


Fig. 2. Evaluation of CNN dataset

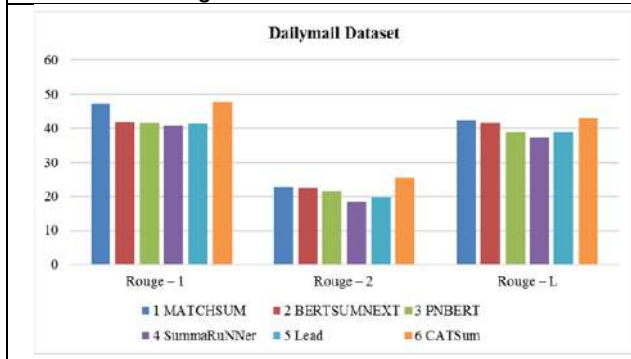


Fig. 3. Evaluation of Daily mail dataset

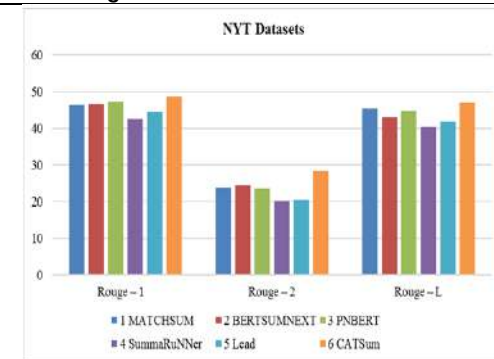


Fig. 1. Evaluation of NYT dataset





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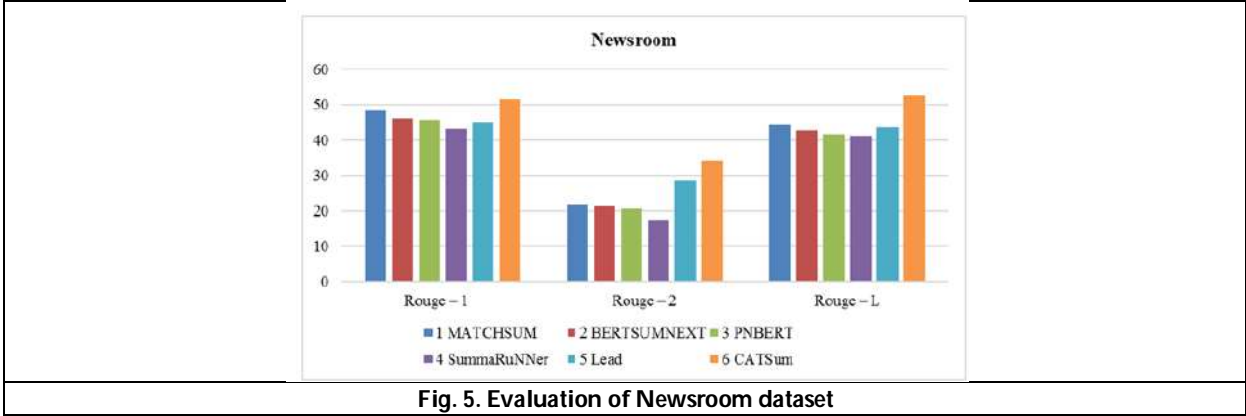


Fig. 5. Evaluation of Newsroom dataset





A Comparative Study between Millets Vs Junk Foods

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

This study presents a comparative analysis between millets and junk foods, examining their nutritional profiles and health implications. Millets, a group of ancient grains, have gained renewed interest due to their potential health benefits, while junk foods are known for their poor nutritional quality and adverse effects on health. We employ software to analyze data from a comprehensive survey and dietary assessment to shed light on the dietary choices and health outcomes associated with these two contrasting food categories. Our analysis reveals significant differences in the nutritional content of millets and junk foods. Millets are found to be rich in essential nutrients such as fiber, vitamins, and minerals, while junk foods are typically high in unhealthy fats, sugars, and sodium. To assess the health implications, we also analyze data related to various health markers, including body mass index (BMI), cholesterol levels, and blood pressure.

Keywords: Millets, Junk foods, ANOVA, Correlation

INTRODUCTION

In today's generation, we are all addicted to social media and junk food. As for junk food it leads to inflammation our body that causes poor food choices and lead to risk of depression. The refined carbohydrates found in a lot of junk food can cause your blood sugar to fluctuate in your body if consumed more. The government of India, has been given awareness and increased the production of millets. The Government of India, declared 2023 to be the International Year of Millets. Millets are a group of small-seeded grasses that have been cultivated for thousands of



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years as a staple food source in various parts of the world, particularly in Africa and Asia. Millets played a crucial role in the diets of early agricultural societies. Millets can be used in a variety of culinary preparations, including flatbreads, porridges, soups, salads, and even as a rice substitute. Junk food is a term used to describe food and beverages that are high in calories and low in nutritional value. These items are often convenient, inexpensive, and widely available, making them popular choices for quick meals and snacks. They are enjoyable to eat, more consumption of junk food is associated with several health concerns. Junk food is heavily processed and may contain artificial additives, preservatives, and flavor enhancers. Regular consumption of junk food has been linked to various health problems, such as obesity, cardiovascular disease, type 2 diabetes, and certain cancers. SPSS stands for Statistical Package for the Social Sciences, is a widely used software program for statistical analysis and data management. It was originally developed by IBM and is designed to assist researchers, social scientists. Variables in SPSS refer to the characteristics or attributes of data that you want to analyse. There are different types variables such that numeric variables, categorical variables, ordinal variables etc.

OBJECTIVE OF THE STUDY

- To examine the comparative study between millets and junk food.
- To explore an idea about the health benefits of millets.
- To study the impact of junk food and millets in the aspects of economy, culture, and health.
- To study what people of different age, prefer between millets and junk food.

REVIEW OF LITERATURE

Aakriti Gupta et al (2018) examined the consumption of junk foods by school -aged children in rural Himachal Pradesh, India. In their life style there has been an increase in the consumption of junk food among school children. Junk food are classified as food products which are high in salt, sugar, fats, and energy (calories)and contains little or no proteins, vitamins, or minerals. Junk foods are prepared and served fast. There was a lack of scientific data on consumption of junk food in rural area among SACin India. A study conducted in Baroda reported higher consumption of junk food items is 56% such as chocolates and sweets. High consumption of fried foods and sugary drinks has been observed to be significantly associated with high body mass index and weight status in children. The formation of laws to regulate marketing and advertising of junk food in and around school premises may be helpful in reducing the consumption of junk food among children. **Vilas, A. Tonapi et al (2017)** identified the factors about Nutritional and Health Benefits of millet. Millets are important crops for dry landforms. Due to drudgery in preparation, their consumption has decreased over the years in India. To revive the demand for millet in India, there is a need to bring all the stakeholders in production to the consumption system value chain on a common platform and link the poor to dry the land farms with the market and the consumers at large. The product development on sorghum products whose nutritional values were quite encouraging. The millets food products are known for nutrition, its awareness among consumers is scanty, especially on their nutritional and therapeutic values. It is also found that there a many Nutritional and Health Benefits in Millet.

RESEARCH METHODOLOGY

Sample size: 200 responses have been received.

Sampling Technique: Convenience method.

Data collection method: Primary data.

Primary data: Collected through structured questionnaire.

Statistical tools used for data analysis: Correlation, Regression, Chi-square, ANOVA, t-test, Rank correlation.

MAJOR FINDINGS OF THE STUDY

- The study has a majority (11.5%) of the respondents in the age category between 19-22.
- The study shows that a majority (45%) of the respondents are students.



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- The study shows that a majority (40.5%) of the respondents rated 3 out of 5 on how often they consume millet.
- The study shows that a majority (44.5%) of the respondent's first thought on millets is that they have health benefits.
- The study shows that a majority (44.5%) of the respondents have tried ragi.
- The study shows that a majority (33.5%) of the respondents say the side effect of millets is iodine uptake.
- The study shows that a majority (37%) of the respondents have grandparents, parents, and kids as the most consuming family members as all above.
- The study shows that a majority (42.5%) of the respondents consume millet 1-2 times weekly.
- The study shows that a majority (63%) of the respondents say the health benefits of millet are that it controls blood sugar, maintains weight, and provides high fibre as all the above.
- The study shows that a majority (42%) of the respondents say the best pair with millets is both vegetarian food and non-vegetarian food.
- The study shows that a majority (52%) of the respondents have tried growing millets in their back yard. The study shows that a majority (59%) of the respondents say millet is more versatile than junk food only in cooking.
- The study shows that a majority (57%) of the respondents agree that millet is more filling than junk food.
- The study shows that a majority (52.3%) of the respondents say that to differentiate millet and junk food in terms of taste is by different flavours in general.
- The study shows that a majority (40.5%) of the respondents have rated 3 out of 5 as to how often they consume junk food.
- The study shows that a majority (55.5%) of the respondents' first thought on junk food is that they have an addictive taste, addictive colour, and addictive smell as of all the above.
- The study shows that a majority (51.5%) of the respondents tried chips & chocolate, pasta & pizza, and chat items as of all the above.
- The study shows that a majority (60%) of the respondents say that the side effects of consuming junk food are tooth decay, obesity, and fatigue as of all the above.
- The study shows that a majority (58.5%) of the respondents are kids who consume junk food mostly
- The study shows that a majority (37.5%) of the respondents consume junk food rarely in a week.
- The study shows that a majority (49.5%) of the respondents say that junk food is more convenient than millet in preparation, cost, and storage as of all the above.
- The study shows that a majority (48.5%) of the respondents have both millet and junk food readily available in their area.
- The study shows that a majority (43.5%) of the respondents would replace junk food with millet in their diet with refined wheat, white rice, and buckwheat as of all the above.
- The study shows that a majority (41.5%) of the respondents would choose millets for special occasions over junk food.
- The study shows that a majority (36.5%) of the respondents think junk food is more satisfying for their taste buds than millets.
- The study shows that a majority (44%) of the respondents think that both millet and junk food are sustainable for environmental impact.
- The study shows that most (51%) of the respondents think millet has more cultural significance than junk foods. The study has shown that junk food brings more environmental impact and it has been accepted by the respondents., plastics and e-waste from junk food affects the environment as many are accepted by different age.
- The result shows that there exists a positive relationship between millet and junk food ($p < 0.05$). Thus, the people chose both millet and junk food equally.
- There is a significant difference between both millet and junk food.
- Both millets and junk food respondents say that millets are more versatile and not convenient than junk food.
- Based on the analysis of the survey questions, here is a brief report of the key findings



**Sakthikala et al.,****Millets Consumption**

On average, respondents reported consuming millets around 3-4 times a week. The most common first thought about millets was their nutritious nature. Grandparents, parents, and children were identified as the main consumers of millets in the family.

Junk Food Consumption

Respondents reported consuming junk food approximately 3-4 times a week on average. The most common first thought about junk food was its addictive taste. Adults in the family were identified as the primary consumers of junk food.

Comparison

A statistical test (t-test or Mann-Whitney U test) showed that there was a significant difference in how often millets and junk food were consumed among respondents.

Opinions and Perceptions

Most respondents believed that millets were best paired with vegetarian food. Most respondents considered millets more filling than junk food. Respondents thought that millets were more versatile than junk food in both cooking and recipes.

Environmental and Cultural Impact

Respondents generally believed that millets had a more significant environmental impact and cultural significance compared to junk food.

Key findings of the study include**Nutritional Content**

Millets are rich in essential nutrients like fibre, vitamins, minerals, and antioxidants. Junk foods typically contain high levels of unhealthy fats, sugars, and sodium, with limited nutritional value.

Health Impact

Consumption of millets is associated with numerous health benefits, including better control of blood sugar levels, weight management, and reduced risk of chronic diseases. Regular consumption of junk foods is linked to obesity, heart disease, diabetes, and other health issues.

Sustainability

Millets are considered more sustainable due to their lower water and resource requirements compared to some traditional grains like rice or wheat. The production and distribution of junk foods often involve resource-intensive processes and packaging, contributing to environmental concerns.

Cultural and Culinary Aspects

Millets have been staple foods in many cultures for centuries and are often used in traditional dishes. Junk foods are often associated with convenience and are widely available in the modern fast-food industry.

SUGGESTIONS AND CONCLUSION

The results of this study highlight the importance of dietary choices in maintaining overall health. Consuming millets as a part of the diet is associated with better health outcomes, including lower BMI, improved cholesterol profiles, and lower blood pressure. Conversely, a diet high in junk foods is linked to negative health effects, including higher BMI, increased cholesterol levels, and elevated blood pressure. This comparative study using SPSS software provides valuable insights into the nutritional differences and health implications of choosing millets over junk foods. It underscores the significance of making informed dietary choices and opting for nutrient-rich foods like millets to promote better health and well-being.





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Table 1: ANOVA

ANOVA						
Particular		Sum of Squares	df	Mean Square	F	Sig.
cultural significance between junk food and millets	Between Groups	8.407	4	2.102	2.677	.033
	Within Groups	153.113	195	.785		
	Total	161.520	199			
environmental impact between millets and junk food	Between Groups	6.481	4	1.620	2.108	.081
	Within Groups	149.899	195	.769		
	Total	156.380	199			
millets and junk food, more satisfying for your taste	Between Groups	4.404	4	1.101	1.751	.140
	Within Groups	122.591	195	.629		
	Total	126.995	199			
millets and junk food for a special occasion	Between Groups	5.587	4	1.397	2.040	.090
	Within Groups	133.533	195	.685		
	Total	139.120	199			
replace junk food with millets in diet	Between Groups	1.547	4	.387	.246	.912
	Within Groups	306.408	195	1.571		
	Total	307.955	199			

Table 2: CHI – SQUARE

Test Statistics			
	Age	millets are more versatile than junk food	junk food is more convenient than millets
Chi-Square	114.350 ^a	62.290 ^b	64.120 ^c
df	4	2	3





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Asymp. Sig.	<.001	<.001	<.001
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 40.0.			
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 66.7.			
c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 50.0.			

Table 3: Correlation

Correlation			
		Age	consuming millets weekly
Age	Pearson Correlation	1	-.201**
	Sig. (2-tailed)		.004
	Sum of Squares and Cross-products	206.720	-36.040
	Covariance	1.039	-.181
	N	200	200
consuming millets weekly	Pearson Correlation	-.201**	1
	Sig. (2-tailed)	.004	
	Sum of Squares and Cross-products	-36.040	156.155
	Covariance	-.181	.785
	N	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

		Age	consuming junk food weekly
Age	Pearson Correlation	1	.326**
	Sig. (2-tailed)		<.001
	Sum of Squares and Cross-products	206.720	55.120
	Covariance	1.039	.277
	N	200	200
consuming junk food weekly	Pearson Correlation	.326**	1
	Sig. (2-tailed)	<.001	
	Sum of Squares and Cross-products	55.120	138.395
	Covariance	.277	.695
	N	200	200

**. Correlation is significant at the 0.01 level (2-tailed).





Prognosis of Heart Failure Risk using Classification Algorithms

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 16 Jun 2024

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ABSTRACT

Nowadays heart failure has become common among people in which age between 35 and 54. Heart failure increases the risk of death. So it is highly important to predict heart failure risk earlier and treat it to save the life. In this paper, data mining techniques in machine learning were applied to predict heart failure risk. Classification is one of the data mining techniques which is used to predict heart disease. This system uses the classification models of Naïve Bayes Simple, C4.5, Random Forest and Simple Cart algorithms. This paper hopes to find a quicker and more efficient technique of diagnosing the heart disease which leading to timely treatment of the patients using classification techniques with feature selection. Classification is done with the heart disease dataset which contains 270 instances and 14 attributes. Comparing these four algorithms, a best classifier can be found which classifies the dataset accurately. Random Forest classification algorithm has the highest accuracy rate 99.63% with feature selection which proves to be a better algorithm to predict the heart failure risk in earlier stage.

Keywords: Heart Disease, Classification, Naïve Bayes Simple algorithm, C4.5(J48) algorithm, Random Forest algorithm, Simple CART algorithm

INTRODUCTION

Heart failure is a complex clinical syndrome that results from a functional or anatomical cardiac problem that impairs ventricular filling or blood ejection to the systemic circulation causes heart failure, a complex clinical condition. By definition, it is a failure to satisfy the underlying needs of blood circulation. Worldwide, heart failure continues to be a condition with a significant death and morbidity rate. It is thought to affect 26 million people worldwide and is a factor in rising healthcare expenses [1]. Heart failure can be brought on by many different diseases. The treatment regimen varies to some extent depending on the cause of heart failure, although the majority of recommendations are

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made based only on the diagnosis of heart failure, independent of the cause. Heart failure is classified according to its symptoms and determined Left Ventricular Ejection Fraction (LVEF). Heart failure with reduced ejection fraction (HFrEF), heart failure with preserved ejection fraction (HFpEF), and heart failure with mid-range ejection fraction are the three subtypes of heart failure caused by left ventricular dysfunction (HFmrEF). The later could include a variety of left ventricular dysfunction (a combination of systolic and diastolic heart failure). Although the term "HFrEF" has been defined differently in various studies and recommendations, it is typically understood to mean an ejection fraction (EF) of less than 40%. Heart failure with an EF of greater than 50% is known as heart failure with preserved ejection fraction (HFpEF). Heart failure with an EF of 40% to 50% is known as HFmrEF [2]. Heart failure can significantly reduce a patient's functional capacity and raise their mortality risk. To avoid repeated hospital stays, optimize patient outcomes, and improve quality of life, it is crucial to correctly diagnose and treat the disease. Heart failure must be treated using a multimodal strategy that includes patient education, the best medical regimen to increase cardiac contractility, and the prevention or restriction of exacerbations. To improve patient care, an inter-professional team approach is necessary[3]. In this paper, the WEKA tool is used to perform the experiments with heart disease dataset. This paper uses the classification models of Naïve Bayes Simple, C4.5, Random Forest and Simple Cart algorithms and finds a quicker and more efficient technique of diagnosing the heart disease in earlier stage.

LITERATURE SURVEY

The following analysis of related work gives results on different healthcare datasets, where the predictions were carried out with the different methods and techniques. Despite the fact that the patho-physiology of HF has been extensively studied by the medical community, the vast number of data that needs to be examined and their complexity make HF diagnosis and treatment selection extremely difficult and time-consuming jobs. Moreover, because the NYHA classification system is based on subjective assessment, it adds significant intra-observer variability as a tool for HF severity estimation [4]. Machine learning approaches have the ability to evaluate, predict, and classify medical data effectively and efficiently in an effort to address these difficulties [5]. A neuro-fuzzy expert system was proposed by Akinyokun et al. [6]. Six of the seventeen variables that were recorded and used to express the signs and symptoms of HF were used for each patient. Using four distinct classifiers—a Neural Network (NN), Support Vector Machine (SVM), Decision Tree (DT), and a Fuzzy-Genetic (FG) algorithm—Guidi et al. [7] categorised a patient as having mild HF, moderate HF, or severe HF. Anamnestic and instrumental data were used to train and evaluate the classifiers. The same research team [8] evaluated Random Forests (RF) and Classification and Regression Tree (CART) classifiers two years later. To account for the fact that the dataset contained correlated data, a subject-based cross validation strategy was used for the classifier evaluation (baseline and follow-up data of the same patient). A decision support system was built to provide prediction of de-compensations and assessment of the HF severity based on the RF algorithm, and it is reported in [9] as a multi-layer monitoring system for clinical management of congestive HF (CHF). Yang et al. [10] presented a scoring model that allowed subjects to be divided into three groups: the healthy group (without cardiac dysfunction), the HF-prone group (with asymptomatic stages of cardiac dysfunction), and the HF group (with symptomatic stages of cardiac dysfunction). The SVM classifier served as the model's foundation. In order to determine the severity of HF, Pecchia et al. [11], Mellilo et al. [12], and Shahbazi et al. [13] took advantage of the discrimination power of long-term heart rate variability (HRV) values that may be derived by electrocardiogram (ECG). The aim of this work is to early detect the heart disease and treat them in earlier stage to save the life.

MATERIALS AND METHODS

This section explains the materials and methodology used for prognosis the risk of heart failure.



**Sumathi and Mahalakshmi****Dataset**

The proposed method is evaluated using a dataset of 270 patients respectively. The datasets consists of patients: (i) diagnosed with HF (Framingham criteria) who have continuous symptoms with frequent recurrence, (ii) belonging to the functional class followed by an optimal treatment, (iii) who have been recently hospitalized, (at least one in the last six months), who have undergone one electrocardiogram (in the last 12 months) and have HF symptoms. Patients who are underage, with very severe HF, with obesity and advanced chronic kidney failure are not included. The features recorded for each patient can be grouped to the following seven categories: (i) General Information, (ii) Allergies, (iii) Medical Condition, (iv) Drugs, (v) Biological data related with the HF disease, (vi) Clinical Examinations, (vii) Adherence. Totally, 14 features are recorded for each patient that according to the literature and experts knowledge are correlated with the severity of the HF. This dataset provides the information that are needed to predict the failure risk of the heart. The 14 attributes are age, sex, chest, resting blood pressure, serum cholesterol, fasting blood sugar, resting electrocardiographic results, maximum heart rate achieved, exercise induced angina, oldpeak, slope, number of major vessels, thal, class. Out of the 14 attributes, 13 attributes are numeric and the last attribute 'class' is nominal. Figure 1 shows the Heart Disease dataset.

The proposed method

The proposed method consists of three main phases: i) Data preprocessing, ii) Feature selection, and iii) Classification. The first step focuses on the pre-processing of data in order to solve the issues such as missing values, null values to be addressed to improve the performance of the classification algorithms. Missing values induced by different clinical practices in each center and consequently different type of collected respective clinical data. The proposed methodology is shown in Figure 2.

Data pre-processing

The input of the first phase is 270 instances in which each one consisting of 14 features plus the class label. The class label present and absent are considered as intermediate severity to the corresponding classes. For this reason each one of those instances is merged with the straight following class of higher risk. Imputation of missing values cannot be performed due to the nature of data. The sample of preprocessed result is shown in the Figure 3.

Feature selection

In the second phase, feature selection can be performed either utilizing a filter or a wrapper approach. Both approaches have been tested in the second step of the proposed method. Information Gain, Gain Ratio, and feature selection measures are used in the filter technique, whereas wrapper and the Correlation-based Feature Selection (CFS) algorithm are combined with the classifiers in the wrapper approach.

Classification

In the third phase, the following four classifiers are used to prognosis the risk of heart failure with the feature selection which was completed in second phase : (i) Naive Bayes Simple, (ii) C4.5 (J48), (iii) Random Forest (RF), (iv) Simple CART.

NAIVE BAYES SIMPLE

Naive Bayesian classifiers assume that the effect of an attribute value on a given class is independent of the values of the other attributes. This assumption is called *class conditional independence*. It is made to simplify the computations involved is considered "naive" [15].

PSEUDOCODE [15]

1. Let X be a training set of tuples and their associated class labels.
2. Each tuple is represented by an n -dimensional attribute vector, $X = (x_1, x_2, \dots, x_n)$, depicting measurements made on the tuple from m attributes, respectively, A_1, A_2, \dots, A_m .
3. There are p classes, C_1, C_2, \dots, C_p . Given a tuple, X , the classifier will predict the X belongs to the class having the highest posterior probability, conditioned on X .





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4. The naive Bayesian classifier predicts that tuple X belongs to the class C_i if and only if $P(C_i/X) > P(C_j/X)$ for $1 \leq j \leq m, j \neq i$ (1)
5. To maximize $P(C_i/X)$. The class C_i for which $P(C_i/X)$ is maximized is called the *maximum posteriori hypothesis*. By Bayes' theorem, $P(C_i/X) = \frac{P(X/C_i)P(C_i)}{P(X)}$ (2)

C4.5 (J48)

Decision trees create models that are understandable by humans. To make predictions, the J48 algorithm generates decision trees. It is the ID3 algorithm in its extended form. It strives to generalize until it becomes accurate and adaptable. The steps in this algorithm are as follows. Each attribute's potential information or entropy is identified, and its information gain is calculated. The attribute with the largest gain is chosen as the node, and the leaf node returns the class. Both discrete and continuous values are supported by C4.5. Also taken care of are missing values. There is also generalizing pruning done to the tree. It creates the tree based on the value of the attribute [16][17].

RANDOM FOREST

As an ensemble learning technique for classification, regression, and other tasks, random forests or random decision forests build a large number of decision trees during the training phase and output the class that represents the mean of the classes (classification) or mean prediction (regression) of the individual trees. Decision trees habit to over-fit their training set is corrected by random decision forests. The bootstrap aggregating or bagging general technique is used to tree learners via the random forest training algorithm. Bagging repeatedly (B times) chooses a random sample with replacement of the training set and fits trees to these samples given a training set $X=x_1, \dots, x_n$ with responses $Y=y_1, \dots, y_n$ [14]:

For $b = 1, \dots, B$ [17]:

1. Sample, with replacement, n training examples from X, Y ; call these X_b, Y_b .
2. Train a classification or regression tree f_b on X_b, Y_b .

After training, predictions for unseen samples x' can be made by averaging the predictions from all the individual regression trees on x' :

$$\hat{f} = \frac{1}{B} \sum_{b=1}^B f_b(x') \tag{3}$$

an estimate of the uncertainty of the prediction can be made as the standard deviation of the predictions from all the individual regression trees on x' [15]:

$$\sigma = \sqrt{\frac{\sum_{b=1}^B (f_b(x') - \hat{f})^2}{B-1}} \tag{4}$$

The number of sample/trees, B , is a free parameter [17].

PSEUDOCODE [17]

1. A training set is $S=(x_1, y_1), \dots, (x_n, y_n)$, features F , and number of trees in Forest B
2. Call the function RANDOMFOREST(S,F)
3. Initially H tends to null set
4. For each i equal to 1 to B do
5. A bootstrap sample from S belongs to $S(i)$
6. RANDOMIZEDTREELEARN(S(i),F) value is assigned to $h(i)$
7. H union $h(i)$ value is assigned to H
8. End for
9. Return H
10. End function
11. Call the function RANDOMIZEDTREELEARN (S,F)
12. At each node, very small subset of F is assigned to f
13. Split on the best feature in f





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14. Return the learned tree
15. End function

SIMPLE CART

Binary decision trees were created according to Classification and Regression Trees (CART), which was described. Breiman is the author of the classification and regression trees, or CART. The binary division of the attributes serves as the foundation for CART's classification tree development. It can be implemented serially and is based on Hunt's decision tree construction concept. While choosing the dividing attribute, it makes use of the Gini index splitting measure. Using a portion of the training data set, CART performs pruning. The CART builds the decision tree using both numerical and categorical variables, and it contains built-in mechanisms to handle missing attributes [15]. Because it additionally uses regression analysis with the use of regression trees, the CART differs from other Hunt's-based algorithms. The regression analysis feature is used to predict a dependent variable over a predetermined time period given a set of predictor factors. The data is sorted at each node to discover the appropriate splitting point, and it applies numerous single variable splitting criteria, including the Gini index, Symgini, etc., and one multi-variable (linear combination). The regression analysis employs the linear combination splitting criteria [15].

PSEUDOCODE [18]

1. Create to node N ;
2. if tuples in D are all of the same class, C , then
3. return N as a leaf node labeled with the class C ;
4. if *attribute list* is empty then
5. return N as a leaf node labeled with the majority class in D ; //majority voting
6. apply *Attribute selection method*(D , *attribute list*) to find the "best" *splitting criterion*;
7. label node N with *splitting criterion*;
8. if *splitting attribute* is discrete-valued and multiway splits allowed then // not restricted to binary trees
9. *attribute list* ← *attribute list* - *splitting attribute*;
10. for each outcome j of *splitting criterion*
 - // partition the tuples and grow subtrees for each partition
11. let D_j be the set of data tuples in D satisfying outcome j ; // a partition
12. if D_j is empty then
13. attach a leaf labeled with the majority class in D to node N ;
14. else attach the node returned by Generate decision tree(D_j , *attribute list*) to node N ;
- End for
15. return N ;

EXPERIMENTAL RESULTS

WEKA tool provides a number of classification techniques which includes fuzzy logic, Bayesian, decision tree and support vector machine. This paper analyses the algorithms of Naive Bayes Simple, C4.5, Random Forest and Simple CART for the Heart Disease dataset. The experiment is conducted in WEKA tool. The efficiency of these algorithms is calculated in terms of accuracy. The experiment was conducted using training set. All the classification methods are compared with feature selection & without feature selection and then evaluated with accuracy.

INFO GAIN

The expected information needed to classify a tuple in D is given by

$$Info(D) = - \sum_i p_i \log_2(p_i) \quad (5)$$

where p_i is the nonzero probability that an arbitrary tuple in D belongs to class C_i and is estimated by $jC_i, D_j / jD_j$. A log function to the base 2 is used, because the information is encoded in bits. $Info(D)$ is just the average amount of information needed to identify the class label of a tuple in D . Note that, at this point, the information is based solely on the proportions of tuples of each class. $Info(D)$ is also known as the entropy of D [15].





$$Info_A(D) = -\sum_j (|D_j|/|D|) \times Info(D_j) \quad (6)$$

$$Gain(A) = Info(D) - Info_A(D) \quad (7)$$

GAIN RATIO

An extension to information gain known as *gain ratio*, which attempts to overcome this bias. It applies a kind of normalization to information gain using a "split information" value defined analogously with $Info(D)$ as [15]

$$SplitInfo_A(D) = -\sum |D_j|/|D| \times \log_2(|D_j|/|D|) \quad (8)$$

This value represents the potential information generated by splitting the training data set, D , into v partitions, corresponding to the v outcomes of a test on attribute A [15].

$$Gain\ Ratio(A) = \frac{Gain(A)}{SplitInfo_A(D)} \quad (9)$$

The performance of all the classification algorithms without feature selection is shown in the table Table 1. The performance of all the classification algorithms after feature selection with Gain Ratio attribute evaluator is shown in the table Table 2. The overall performance comparison of all four classification algorithms are shown in Table 3

Figure 4 shows the performance comparison of four classification algorithms with Mean Absolute Error. From this figure Random Forest algorithm gives the minimum Mean Absolute Error value compared to remaining three classification algorithms. Figure 5 shows the performance comparison of four classification algorithms with Weighted average of precision. From this figure Random Forest algorithm provides the better weighted average of precision value compared to remaining three classification algorithms. Figure 6 shows the performance comparison of four classification algorithms with accuracy. From this figure Random Forest algorithm provides the better accuracy compared to remaining three classification algorithms.

CONCLUSION

As nothing has a cost equal to the worth of life, efficiency is defined in terms of accuracy rather than time. The proposed method is evaluated on a dataset of 270 instances each one consisting of 14 features plus the class label. It is noticeable that Random Forest classification algorithm is efficient than other three classification algorithms of C4.5, Naïve Bayes Simple and Simple CART in terms of Mean Absolute Error, Weighted average of precision and accuracy. So classification obtained from Random Forest proves to be better one to predict the heart failure risk. Thus this system suggests that Random Forest classification with feature selection produces more accurate classification to predict heart failure risk. Thus the system helps to predict heart failure risk earlier and treat them so as to lead a healthy life.

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Table 1. Performance of Classification Algorithms Before feature selection

	NaiveBayesSimple	J48	RandomForest	Simple CART
Correctly Classified Instances	229	245	268	239
Incorrectly Classified Instances	41	25	2	31
Kappa Statistics	0.6922	0.8111	0.985	0.7673
Mean absolute error	0.1663	0.1579	0.0867	0.1978
Weighted avg of TP Rate	0.848	0.907	0.993	0.885
Weighted avg of FP Rate	0.156	0.102	0.009	0.119
Weighted avg of Precision	0.848	0.909	0.993	0.885
Weighted avg of F-Measure	0.848	0.907	0.993	0.885
Number Of Leaf Nodes	-	17	-	10
Size of the Tree	-	33	-	19
Time Taken to build model	0.03s	0.03s	0.12s	0.06s
Accuracy	84.82 %	90.74%	99.26 %	88.52%





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Table 2. Performance of Classification Algorithms After feature selection with Gain Ratio attribute evaluator

	NaiveBayesSimple	J48	RandomForest	Simple CART
Correctly Classified Instances	232	247	269	249
Incorrectly Classified Instances	38	23	1	21
Kappa Statistics	0.714	0.8268	0.9925	0.8429
Mean absolute error	0.1607	0.1484	0.0844	0.1351
Weighted avg of TP Rate	0.859	0.915	0.996	0.922
Weighted avg of FP Rate	0.148	0.091	0.005	0.077
Weighted avg of Precision	0.859	0.915	0.996	0.923
Weighted avg of F-Measure	0.859	0.915	0.996	0.922
Number Of Leaf Nodes	-	18	-	16
Size of the Tree	-	35	-	31
Time Taken to build model	0s	0.06s	0.14s	0.08s
Accuracy	85.93 %	91.49%	99.63 %	92.22 %

Table 3. Performance Comparison of Classification Algorithms

METHODOLOGY		No. of attribute selected	Correctly Classified %	Incorrectly Classified %	TP Rate	Time Taken
With feature selection	NaiveBayes	10	85.9259%	14.0741 %	0.859	0s
	J48		91.4815%	8.5185 %	0.915	0.03s
	RF		99.6296%	0.3704 %	0.996	0.03s
	CART		92.2222%	7.7778%	0.922	0.12s
Without Feature selection	NaiveBayes	14	84.8148%	15.1852 %	0.848	0.06s
	J48		90.7407%	9.2593 %	0.907	0.14s
	RF		99.2593%	0.7407 %	0.993	0.08s
	CART		88.5185%	11.4815 %	0.885	0.06s

A	B	C	D	E	F	G	H	I	J	K	L	M	N		
1	Age	Sex	Chest	Resting_Blo_Suam_Chole_Fasting_Elctro_Recor_ECG_Ro_Max_Heart_Emissio_Infuco_Om_Pu_Slope	No_of_Mag_Thal	Class									
2	63	male	typ_angina	160	231	1	no	2	3	down	0	fixed_defect	<S>F		
3	67	male	atyp_angina	160	288	1	no	128	yes	3	5	normal	>S>F		
4	67	male	atyp_angina	120	229	1	no	123	yes	2	5	fixed	>S>F		
5	39	male	non_anginal	150	264	1	normal	70	no	3	5	normal	<S>F		
6	41	female	atyp_angina	130	204	1	no	172	no	1	4	up	0	normal	<S>F
7	66	male	atyp_angina	120	230	1	normal	170	no	0	8	up	0	normal	<S>F
8	62	female	atyp_angina	140	208	1	no	160	no	3	6	down	2	normal	>S>F
9	57	female	atyp_angina	120	264	1	normal	163	yes	0	5	up	0	normal	<S>F
10	63	male	atyp_angina	130	254	1	no	147	no	1	4	flat	1	reversible_defect	>S>F
11	53	male	atyp_angina	140	203	1	no	165	yes	3	1	down	0	reversible_defect	>S>F
12	57	male	atyp_angina	140	150	1	normal	144	no	0	4	flat	0	fixed_defect	<S>F
13	60	female	atyp_angina	140	284	1	no	120	no	1	3	flat	0	normal	<S>F
14	66	male	non_anginal	130	250	1	no	142	yes	0	6	flat	1	fixed_defect	>S>F
15	44	male	atyp_angina	120	252	1	normal	177	no	0	5	up	1	reversible_defect	>S>F
16	52	male	non_anginal	172	198	1	normal	162	no	0	5	up	0	reversible_defect	<S>F
17	57	male	non_anginal	150	168	1	normal	174	no	1	6	up	0	normal	<S>F
18	48	male	atyp_angina	110	228	1	normal	160	no	1	6	down	0	reversible_defect	>S>F
19	54	male	atyp_angina	140	233	1	normal	160	no	1	2	up	0	normal	<S>F
20	48	female	non_anginal	130	275	1	normal	130	no	0	2	up	0	normal	<S>F
21	49	male	atyp_angina	130	255	1	normal	171	no	0	5	up	0	normal	<S>F
22	64	male	typ_angina	110	211	1	no	161	yes	1	8	flat	0	normal	<S>F
23	58	female	typ_angina	150	203	1	no	160	no	1	1	up	0	normal	<S>F
24	59	male	atyp_angina	120	204	1	no	160	no	1	8	flat	0	normal	>S>F
25	58	male	non_anginal	150	228	1	no	170	no	3	2	up	2	reversible_defect	>S>F
26	60	male	atyp_angina	130	208	1	no	130	yes	2	4	flat	2	reversible_defect	>S>F
27	60	female	non_anginal	120	210	1	normal	150	no	1	6	flat	0	normal	<S>F
28	58	female	non_anginal	130	240	1	normal	170	no	0	5	up	0	normal	<S>F
29	66	female	typ_angina	150	226	1	normal	114	no	2	6	down	0	normal	<S>F

Figure 1. Heart Disease dataset

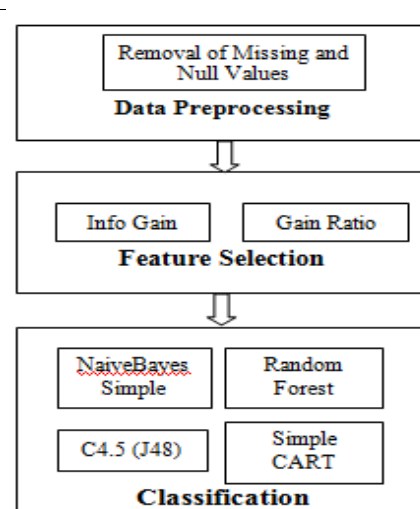


Figure 2. Proposed Methodology





Relation: HeartDisease

```

1 83,male,typ,angina,145,233,1,left_vent_hypr,150,no,2,3,down,0,fixed_defect,'50'
24 79,male,non_anginal,150,230,normal,1,up,0,normal,'50'
35 42,male,asympt,149,226,f,normal,178,no,0,up,0,normal,'50'
36 48,male,asympt,129,177,f,left_vent_hypr,120,yes,2,2,flat,0,reversible_defect,'50','1'
37 57,male,asympt,150,275,f,left_vent_hypr,112,yes,0,2,flat,1,fixed_defect,'50','1'
38 85,male,asympt,132,253,f,normal,132,yes,1,2,flat,1,reversible_defect,'50','1'
39 81,male,non_anginal,150,243,f,normal,137,yes,1,flat,0,normal,'50'
40 85,female,asympt,150,225,f,left_vent_hypr,114,no,1,flat,3,reversible_defect,'50','1'
41 40,male,typ_angina,140,199,f,normal,176,yes,1,4,up,0,reversible_defect,'50'
42 71,female,atyp_angina,160,302,f,normal,152,no,0,4,up,2,normal,'50'
43 59,male,non_anginal,150,212,f,normal,157,no,1,5,up,0,normal,'50'
44 81,female,asympt,130,330,f,left_vent_hypr,169,no,0,up,0,normal,'50','1'
45 58,male,non_anginal,112,230,f,left_vent_hypr,195,no,2,2,flat,1,reversible_defect,'1'
46 81,male,non_anginal,150,175,f,normal,123,no,0,0,up,0,normal,'50'
47 50,male,asympt,159,243,f,left_vent_hypr,128,no,2,8,flat,0,reversible_defect,'50','1'
48 86,female,non_anginal,140,417,f,left_vent_hypr,157,no,0,8,up,1,normal,'50'
49 53,male,non_anginal,130,197,f,left_vent_hypr,182,no,1,2,down,0,normal,'50'
50 41,female,atyp_angina,165,190,f,normal,188,no,0,up,1,normal,'50'
51 85,male,asympt,129,177,f,normal,140,no,0,4,up,0,reversible_defect,'50'
52 44,male,asympt,112,250,f,left_vent_hypr,153,no,0,up,1,normal,'50','1'
53 44,male,atyp_angina,130,219,f,left_vent_hypr,189,no,0,up,0,normal,'50'
54 80,male,asympt,130,253,f,normal,144,yes,1,4,up,1,reversible_defect,'50','1'
55 54,male,asympt,124,266,f,left_vent_hypr,109,yes,2,2,flat,1,reversible_defect,'50','1'
56 50,male,non_anginal,140,233,f,normal,163,no,0,5,flat,1,reversible_defect,'50','1'
57 41,male,asympt,110,172,f,left_vent_hypr,158,no,0,up,0,reversible_defect,'50','1'
58 54,male,non_anginal,125,273,f,left_vent_hypr,152,no,0,0,down,1,normal,'50'
59 81,male,typ_angina,125,213,f,left_vent_hypr,125,yes,1,4,up,1,normal,'50'
60 81,female,asympt,130,305,f,normal,142,yes,1,2,flat,0,reversible_defect,'50','1'
61 46,female,non_anginal,142,177,f,left_vent_hypr,190,yes,1,4,down,0,normal,'50'
62 58,male,asympt,128,215,f,left_vent_hypr,131,yes,2,2,flat,3,reversible_defect,'50','1'
    
```

Figure 3. Sample of Preprocessed Data

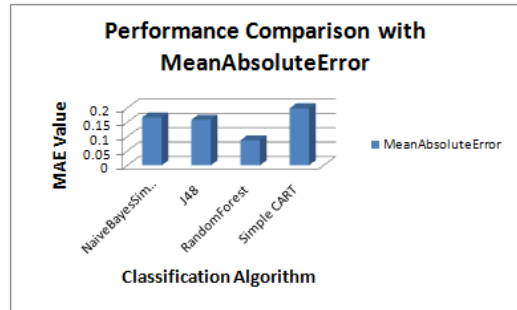


Figure 4. Performance Comparison with Mean Absolute Error

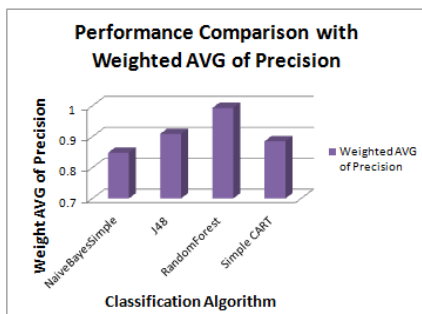


Figure 5. Performance Comparison with Weighted average of precision

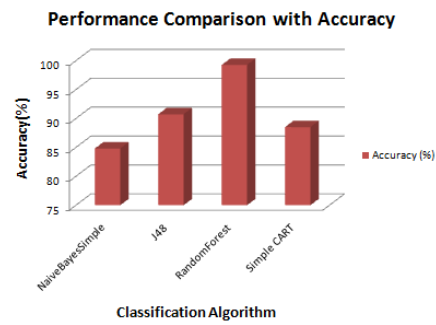


Figure 6. Performance Comparison with Accuracy





Exploring Deep Learning Strategies for Next-Generation Object Detection in Precision Agriculture

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 27 Jun 2024

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ABSTRACT

This research presents an integrated approach for detecting and classifying objects in agricultural images, explicitly focusing on distinguishing between crop and weed instances. The proposed methodology combines deep learning and support vector machine (SVM) techniques to achieve accurate and efficient results. Visual Geometry Group 16 (VGG16) is used for transfer learning. A pre-trained deep learning model is employed for feature extraction, while an SVM classifier complements the model by making fine-grained classifications. Extensive experiments are conducted on a diverse agricultural dataset, demonstrating the system's ability to identify and categorize objects accurately. The results highlight the potential of this approach to automated farm tasks, which can contribute to enhanced crop management and weed control strategies. The code and models used in this research are available for broader accessibility and application in the agricultural domain.

Keywords: Weed detection, Deep learning, Support vector machine (SVM), VGG16.

INTRODUCTION

Agriculture is growing plants and raising animals for food, fiber, and other products essential for human life. It's the foundation of our food supply and plays a crucial role in the economy. Farmers use various techniques to cultivate crops and rear livestock, adapting to different climates and environments. Agriculture involves planting, watering,



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fertilizing, harvesting, and managing pests. It's not just about farming; it has many activities, including forestry, fisheries, and aquaculture. Agriculture is essential for food security, providing sustenance for rural and urban populations worldwide. Agriculture has undergone progressive transformations by continually improving technologies to boost productivity and profitability [1]. Weeds are unwanted plants that grow alongside crops and compete with them for resources like sunlight, water, and nutrients. They can significantly reduce crop yields if not managed effectively. Weeds can also harbor pests and diseases, further impacting crop health. Identifying and controlling weeds is essential for maximizing crop productivity and ensuring profitability for farmers. Traditional weed control methods involve manual labor or herbicides, but these approaches can be costly, labor-intensive, and environmentally damaging. Farmers are careful about using particular things in their fields because they're worried about weeds growing and ruining their crops, which can cost them a lot of money [2]. Utilizing advanced technology to detect and manage crop weeds can improve agricultural sustainability and profitability. Machine learning is a branch of artificial intelligence focused on creating algorithms that allow computers to learn from data and make decisions or predictions without explicit programming. These algorithms analyze large amounts of data to identify patterns and relationships, enabling them to improve their performance over time. With applications ranging from healthcare and finance to marketing and robotics, machine learning has become crucial for solving complex problems and driving innovation in various industries. By harnessing the power of data, machine learning empowers computers to adapt and improve their decision-making capabilities, ultimately leading to more efficient and effective systems. Machine learning can analyze agricultural data about crop yield in different soil conditions and changing weather patterns. Based on this information, it can recommend the best crops to plant or additional nutrients to achieve maximum production [3]. Farming is changing a lot because of new technology. One significant change is using computers to see and learn from farm pictures. Knowing what's in these pictures, especially the difference between crops and weeds, is essential. The old ways of dealing with weeds are expensive and sometimes harmful. So, a more innovative way to help farmers is needed. The big problem is making an excellent system to find and tell the difference between crops and weeds in farm pictures. This is hard because farms change a lot with the weather and things blocking the view. The old ways of using computers to see things haven't worked well enough. The goal is to find crops and weeds and tell them apart accurately. The weed detection system can depend upon the picture patches on crops, soils, and weeds [4]. This can help farmers care for crops and get rid of weeds better. This method can help with food security and farming and make farming more profitable. Precision agriculture ensures food availability while maintaining environmental sustainability [7]. By managing weeds better and caring for crops, we can grow more food with less waste. This research is a big step toward a future where technology helps farmers grow more food responsibly.

Problem Statement

One of the significant challenges in modern agriculture is effectively distinguishing between crops and weeds in farm images. Traditional methods of weed management are often inefficient and environmentally harmful. Current computer vision systems struggle to accurately differentiate between crops and weeds, especially in dynamic farm environments where weather conditions and obstructions can impact image quality. This limitation hinders farmers' ability to implement targeted weed control strategies, leading to decreased yields and increased production costs.

Objective

The primary objective is to develop a robust and accurate weed detection system using computer vision technology. This system aims to analyze farm images and precisely identify crops and weeds, enabling farmers to implement targeted weed control measures while minimizing herbicide usage. Improving weed management practices aims to enhance crop productivity, reduce production costs, and promote environmental sustainability in agriculture.

Motivation

Chemical pesticides and insecticides have become more prominent in recent agricultural practices, increasing the risk of human exposure to such chemicals. Exposure to such chemicals has made humans prone to harmful diseases such as cancer. This proposed method could potentially resolve such problems.





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Organization

Section 2 gives a literature review to find new ways to approach the problem's solution. Section 3 provides a detailed account of the methodology, explaining the technical aspects of the approach. Section 4 presents the experimental results, including performance metrics and object detection and classification visualizations. Finally, Section 5 offers a conclusion, summarizing the findings.

LITERATURE REVIEW

"Computer Vision for Weed and Crop Classification" [5] classifies weeds and crop species using RGB image texture features with the comparison of the Support Vector Machine (SVM) classification model and deep learning-based visual group geometry 16 (VGG16) classification models. CNN for Anomaly Detection in Smart Agriculture", [6]. After analysing the number of epochs needed for training, we can see that VGG16 needs the least. "Deep Learning Techniques in Agriculture" [7] Deep learning is an intelligent technology that helps with many things. It's used a lot in farming to make things like smart farms, which can run independently. It also helps manage water and soil, control pests and weeds, determine if plants are sick or stressed, and determine how much food we'll get from crops and fruits. "Crop Yield Improvement" [8] is proposed to improve deep learning methods, making it easier to sort different kinds of pictures in real life. Collect photos of sick plant leaves, pests, and weeds from different crops to help identify them, and add more pictures to the collection using data augmentation because deep learning works better with more pictures. Then a particular computer model using different types of deep learning technology is made, and the best results are obtained by looking at how well each model worked and checking how accurate and effective they were. "CNN Models for Weed Detection" [9] The old ways of dealing with weeds aren't suitable for modern farming machines. But when computers are taught to recognize and sort weeds independently, they can help grow more food. Intelligent machines that spray only where there are weeds need these computer programs to work well. So, the better these programs are at seeing and identifying weeds, the better the farms can be at getting rid of them. This means less spray is used overall, keeping our crops safe from weeds.

"ELM-Based Weed Segmentation in Pastures", [10]. By the year 2050, about 9.7 billion people will live on our planet. As the population keeps growing, it's getting more and more important to figure out how to grow enough food using the available resources, like land, chemicals, and people who work on farms. Precision agriculture is a big part of the solution. This means using ingenious technology, like artificial intelligence, to help farmers make better decisions about how to grow their crops. With precision agriculture, farmers can use resources more efficiently, like making sure they use just the right amount of water and fertilizer and plant crops in the best places. This is super important because it means producing more food without harming the environment as much as possible, and that's important for ensuring everyone has enough to eat in the future. "Improved RetinaNet for Weed Detection" [11]. Weeds are a big problem for rice farmers. They compete with rice for things like sunlight, water, and space, and they can even attract bugs that make plants sick, which leads to less rice being grown. Farmers often use weed killers because they're cheaper than having people pull weeds by hand, and they work well against many different kinds of weeds. But sometimes, these chemicals can harm the environment and cost much money. One solution is to use innovative technology to spray weed killer only where it's needed, which saves money and helps the environment. It aims to use a special kind of intelligent technology called deep learning to help farmers find and eliminate weeds in their rice fields. By doing this, farmers can save money, protect the environment, and grow more rice to feed more people. "Lightweight DL Models for Weed Detection", [12]. Detecting weeds is essential in modern farming, especially because they can cause many problems for crops. They compete with crops for resources, leading to significant losses in how much food we can grow. This study suggests using innovative technology, like deep learning, to spot weeds in soybean fields. If they can find and deal with weeds quickly and accurately, it is possible to prevent much of the damage they cause. This method uses cameras and special computer programs to identify weeds among the plants. By doing this, farmers can protect their crops better and grow more food for everyone. "Segmentation Algorithm" [13]. When developing an intelligent robot to weed lettuce, there's a challenge with





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recognizing seedlings and weeds because they overlap. So, a new method is suggested using small parts of pictures and a program called Support Vector Machine (SVM) to tell them apart accurately and draw lines around them.

Selective Search CNN-based SVM (SS-CNN-SVM)

The research methodology combines deep learning and support vector machine (SVM) techniques to achieve robust object detection and classification in agricultural images.

Selective Search

Selective Search efficiently generates many possible object locations within an image. These regions contain objects of interest, such as crops and weeds in agricultural images. In this project,, selective Search is used to detect crops or weeds within the input image to improve classification speeds. Selective Search is an algorithm used to generate region proposals within an image. It is a region-based approach that aims to identify potential object locations by grouping pixels into segments based on color, texture, and shape similarities. These segments are then merged hierarchically to form object candidates. Selective Search was employed as the region proposal method in the object detection pipeline. It analyzes the image's content to propose a set of bounding boxes that likely contain objects of interest. This algorithmic approach efficiently generates diverse region proposals across different scales and aspect ratios, facilitating subsequent object detection tasks

Intersection over Union (IoU)

The IoU measures the overlap between two bounding boxes, B1 and B2. It is calculated as the ratio of their intersection's area to their union's area. (Eq.1)

$\text{IoU} = \text{Area of Intersection} / \text{Area of Union}$	Eq 1
---	------

Intersection over Union (IoU) is a measure used to evaluate the performance of object detection algorithms, particularly in tasks like image segmentation or bounding box detection. It's a metric that quantifies the overlap between two bounding boxes or regions of interest. The Area of Intersection refers to the area where the predicted bounding box and the ground truth bounding box overlap, and The Area of Union refers to the total area covered by both the predicted bounding box and the ground truth bounding box. Calculate the coordinates of the overlapping rectangle between the two bounding boxes B1 and B2, if it exists. Compute the area of the intersection using the coordinates of the overlapping rectangle. Calculate the area of the union as the sum of the areas of both bounding boxes minus the area of intersection. Finally, compute the IoU using the formulas provided. IoU is used to calculate the intersection in case a detected crop or weed has a bounding box within the range of one another

Non-Maximum Suppression (NMS)

Non-maximum suppression (NMS) is used in the code to eliminate redundant and overlapping bounding box predictions generated by the object detection system. NMS is used after generating bounding box predictions for crops and weeds detected in agricultural images. It ensures that only the most relevant and confident predictions are retained, leading to more accurate and reliable detection results. Sort the list of bounding boxes based on their confidence scores in descending order. Initialize an empty list to store the selected bounding boxes after NMS. Iterate through the sorted list of bounding boxes and select the bounding box with the highest confidence score. Remove any other bounding boxes in the list with a high overlap (determined by a predefined IoU threshold) with the selected bounding box. Add the selected bounding box to the list of final detections. Repeat the process until all bounding boxes are processed. Return the final detections list containing the most confident and non-overlapping bounding boxes.

Convolutional Neural Network (CNN)

A Convolutional Neural Network is a deep learning model for processing and analyzing visual data. It consists of multiple layers, including convolutional, pooling, and fully connected layers. CNNs are trained on large datasets to learn hierarchical representations of features from input images automatically. We employ a CNN architecture called VGG16, which is pre-trained on the ImageNet dataset. The VGG16 model consists of multiple convolutional layers





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followed by fully connected layers, enabling it to capture hierarchical representations of image features. By leveraging the pre-trained weights of the VGG16 model, we can effectively extract meaningful features from agricultural images without the need for extensive training data. CNN plays a crucial role by enabling feature extraction, classification, and object detection in agricultural images. The model is trained on a dataset containing labeled images of crops and weeds during training. The weights of the fully connected layers are updated using backpropagation and gradient descent to minimize the classification loss. The VGG16 model is instantiated and loaded with pre-trained weights, excluding the fully connected layers at the top. These layers are removed to retain only the convolutional base of the model, which is responsible for feature extraction. Input images are preprocessed before feeding them into the CNN model. Preprocessing typically involves resizing images to a standard size (224x224 pixels) and normalizing pixel values to a specific range (usually between 0 and 1). The output of the convolutional base is flattened and connected to fully connected layers, followed by a softmax activation function to perform multiclass classification (crop or weed).

Convolutional Layers

The convolutional layers in the VGG16 model apply a set of learnable filters (kernels) across the input image to compute feature maps. Mathematically, the output of a convolutional layer can be represented as (Eq.2)

$H_l = f \left(\sum_{i=1}^{N_l} (W_l * X_{l-1}^{(i)}) + b_l \right)$	Eq.2
---	------

Where H is the output feature map, W is the set of learnable weights (filters), X(i) is the input feature map from the previous layer, b is the bias term, N is the number of filters in the layer, the activation function (softmax)

Pooling Layers

Pooling layers downsample the feature maps generated by convolutional layers, reducing the spatial dimensions while retaining the most relevant information. Everyday pooling operations include max-pooling and average-pooling

Flattening and Fully Connected Layers

After several convolutional and pooling layers, the feature maps are flattened into a vector and passed through fully connected (dense) layers. These layers perform classification based on the extracted features. Mathematically, the output of the final fully connected layer can be represented as (Eq.3)

$Y = \text{soft max}(W_{fc} \cdot X_{flatten} + b_{fc})$	Eq.3
--	------

Where Y is the predicted probability distribution over classes, Wfc and bfc are the weights and biases of the fully connected layer. CNN model was utilized for feature extraction from the proposed regions generated by Selective Search. The CNN model was trained on a large dataset to learn discriminative features relevant to classifying objects in agricultural images. By using the learned representations encoded in the CNN's convolutional layers, meaningful features were extracted from the image regions for subsequent classification tasks

Support Vector Machine (SVM)

SVM classifiers offer a comprehensive approach to classification tasks, making them a suitable choice for functions like crop and weed detection in agricultural images. SVM for Binary Classification is better suited as our task is to classify image features into two classes, 'crop' and 'weed'. The SVM classifier is well-suited for this task as it finds the optimal hyperplane that best separates the features belonging to the different classes. A Support Vector Machine is a supervised learning algorithm for classification and regression tasks. In classification, SVM aims to find the hyperplane that best separates data points into different classes (crop/weed) while maximizing the margin between them. SVMs can handle high-dimensional feature spaces and are effective for binary and multiclass classification problems. A trained SVM classifier was employed to classify the features extracted by the CNN model into distinct





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classes, namely "crop" and "weed." The SVM model was trained on labeled feature vectors derived from agricultural images to learn the decision boundaries between different classes. During inference, the SVM assigns class labels to the extracted features based on the learned classification rules, enabling the identification of crop and weed regions within the images. The decision function for SVM is denoted as(Eq.4)

$f(x)=\text{sign}(w \cdot x+b)$	Eq.4
---------------------------------	------

Where , $f(x)$ represents the decision function predicting the class of input vector . w denotes the weight vector. x represents the input vector (features). b stands for the bias term sign, which indicates the sign function determining the class label based on the sign of the expression.

Optimization Objective

The optimization objective in SVM is to find the best possible line or boundary that separates different groups of data points in the most precise way feasible. This line or boundary should have as much space as possible between the data points of other groups, making it easier to classify new data accurately. The goal is to achieve the widest possible gap between the groups while ensuring that the line or boundary doesn't misclassify data points. The optimization objective to be minimized is(Eq.5)

$\min_{w,b} \frac{1}{2} \ w\ ^2 + C \sum_{i=1}^n \xi_i$	Eq.5
---	------

Where w Represents the weight vector in the feature space, it determines the orientation of the hyperplane that separates the classes. b : Denotes the bias term, which shifts the hyperplane away from the origin. ξ_i : Slack variables associated with each data point i . They measure the degree of misclassification or the distance of data points from the margin. $\frac{1}{2} \|w\|^2$: Represents the regularization term, also known as the squared norm of the weight vector. It controls the complexity of the model and the margin width. C : The regularization parameter that balances the trade-off between maximizing the margin and minimizing the classification error. A higher value of C allows for fewer misclassifications but may lead to a narrower margin. $\sum_i \xi_i$: The sum of slack variables over all data points. The objective is to minimize the sum of these variables while maintaining a wide margin and minimizing misclassifications. In essence, the formula aims to find the optimal values for the weight vector (w) and the bias term (b) that minimize the classification error and maximize the margin between classes. The regularization parameter (C) controls the trade-off between margin width and classification error, while the slack variables (ξ_i) allow for some degree of misclassification.SVM employs a kernel function to implicitly transform the input space into a higher-dimensional space where linear separation is feasible. These representations concisely and clearly depict the key concepts and formulations used in Support Vector Machines (SVM).

SS+CNN+SVM

Feature extraction via CNN and classification via SVM. Combining these techniques allows the system to analyze images effectively and make decisions based on learned patterns. This approach enables automated identification of crops and weeds in agricultural settings, aiding in weed detection and crop monitoring.

Feature Extraction

Feature extraction is like discovering the most critical elements of a puzzle. Imagine a vast box filled with puzzle pieces; the task is to find and select only those necessary to complete the picture. In machine learning, this process is like searching through data to uncover the most essential pieces. Consider a photograph, it contains a lot of details like colors, shapes, and textures. Feature extraction isolates the most crucial elements, such as object outlines or primary colors, simplifying the image for a better understanding of that image. This process is vital because it makes the computer's job easier. The computer can process data faster and make better decisions when unnecessary information is reduced. Similarly, in text, there are lots of words. Some words appear often, while others are rare.





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Feature extraction helps figure out which words are most important for understanding the meaning of a piece of text. Different feature extraction techniques depend on the type of data being worked with.

1. In image processing, various methods such as edge detection, Gabor filters, and Histogram of Oriented Gradients (HOG) are employed to identify significant features within images. These techniques help isolate essential aspects like edges, textures, and patterns.
2. Text data undergoes feature extraction using approaches like Bag of Words and TF-IDF. These techniques analyze the frequency of words in a document, identifying key terms that contribute to its meaning.
3. Features such as Mel-frequency cepstral coefficients (MFCCs) and spectral contrast are utilized in audio processing. These features capture essential aspects of sound, aiding in tasks like speech recognition and audio classification.

One important thing to consider is that data can come in different scales. For example, in a dataset about people, features like age and salary might have very different ranges. Feature normalization is a process that helps scale these features to contribute equally to the analysis. Overall, feature extraction is like finding the most critical pieces of information in a sea of data. It's a crucial step in machine learning that helps computers make sense of the world.

$FE = CNN(I)$	$FE = CNN(I)$	Eq.6
---------------	---------------	------

Where Feature Extraction(FE), Convolutional Neural Networks(CNN), and CNN are applied to the images to obtain FE, feature extraction using Convolutional Neural Networks (CNNs) is a powerful technique in image processing and computer vision tasks. CNNs are particularly effective at automatically learning and extracting relevant features from images. (Eq.6)

Selective Search in CNN

Object localization poses a significant challenge in object detection, with exhaustive Search being one approach to address it. However, this method, which involves sliding windows of varying sizes over the image, is computationally expensive due to the large number of windows generated, even for small images. To mitigate this issue, the selective search algorithm combines exhaustive Search with segmentation techniques, which separate objects based on color differences.

The selective search algorithm follows several steps:

- It begins by generating an initial segmentation of the input image using a method described by Felzenszwalb et al. This segmentation divides the image into smaller regions.
- These smaller regions are then recursively combined using a greedy algorithm to form the most significant areas. This algorithm iteratively merges the most similar regions until no further merges are possible.

The similarity between regions is determined based on four factors, Color similarity, which compares histograms of color channels between regions, texture similarity, which considers histograms of Gaussian derivatives of the image, Size similarity, which encourages the merging of smaller areas, fill similarity, which measures how well two areas fit together. The algorithm computes a final similarity score between regions by combining these similarities. This score is used to guide the merging process. In object recognition tasks, the selective search algorithm generates region proposals, fed into a support vector machine (SVM) classifier.

```

segments = initial_segmentation(image)
While regions can be merged:
    similarity_matrix = calculate_similarity(segments)
    region_i, region_j = find_most_similar(similarity_matrix)
    merged_region = merge_regions(region_i, region_j)
    segments = update_segmentation(segments, merged_region)
region_proposals = extract_region_proposals(segments)
evaluate(region_proposals)
```





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Where,

1. `initial_segmentation(image)`: This function generates an initial segmentation of the input image, dividing it into smaller regions. Each region represents a potential Region of Interest (ROI).
2. `calculate_similarity(segments)`: This function calculates the similarity between different regions based on specific criteria, such as color similarity, texture similarity, size similarity, and fill similarity.
3. `find_most_similar(similarity_matrix)`: This function identifies the most similar pair of regions based on the calculated similarity matrix.
4. `merge_regions(region_i, region_j)`: This function merges the two most similar regions into a larger area.
5. `update_segmentation(segments, merged_region)`: This function updates the segmentation by replacing the original two regions with the merged region.
6. `extract_region_proposals(segments)`: This function extracts the final region proposals from the updated segmentation. These region proposals represent the image's potential Regions of Interest (ROIs).
7. `Evaluate (region_proposals)`: This function evaluates the region proposals, typically using metrics such as Mean Average Best Overlap (MABO), to assess the quality of the generated ROIs.

The Region of Interest(ROI) is now obtained using this Selective Search algorithm. In the Selective Search algorithm, the concept of a Region of Interest (ROI) is fundamental to its operation. Selective Search aims to generate a set of region proposals likely to contain objects of interest within an image. These proposed regions are potential ROIs for subsequent object detection or recognition tasks.

- **Segmentation into Regions:** The initial step of Selective Search involves segmenting the input image into multiple regions. Each of these regions represents a potential ROI.
- **Region Merging:** Selective Search iteratively merges regions based on their similarity, creating more significant areas likely to contain objects. These merged regions serve as candidate ROIs.
- **Extraction of Region Proposals:** The Selective Search algorithm extracts the final set of region proposals from the merged regions after region merging. These region proposals represent potential ROIs likely to contain objects of interest.
- **ROI Evaluation:** The generated region proposals can be evaluated based on metrics such as overlap with ground truth annotations or objectness scores. This evaluation helps determine which regions are most likely to contain objects and are prioritized as ROIs for subsequent processing.

$$ROI = SS.FE(I) \quad \text{Eq.7}$$

Where 'ROI' stands for Region Of Interest, 'SS' stands for Selective Search, FE stands for Feature Extraction, and 'I' stands for Images. This takes an input image extract features and then performs the Selective Search algorithm to identify regions of interest (ROIs) within the image. Selective Search is a method for generating potential object locations within an image. With this, locating the crop and weed in the given image will be easier. (Eq.7)

Non-maximum suppression

Non-maximum suppression (NMS) is a post-processing algorithm commonly used in object detection tasks, particularly in bounding box prediction. Its purpose is to reduce the number of overlapping bounding boxes output by an object detection model to retain only the most relevant and accurate ones. Regions of Interest (ROIs) represent specific areas within an image where objects of interest are likely to be located. In object detection, these regions are proposed by algorithms like Selective Search or Region Proposal Networks (RPNs). ROIs are typically defined as bounding boxes that enclose potential objects in the image. After generating ROIs using methods like Selective Search or RPNs, the resulting bounding boxes often overlap with each other due to the nature of the proposal generation process. NMS is applied to these ROIs to filter out redundant detections and retain only the most confident and non-overlapping ones. This ensures that each object in the image is represented by a single bounding box prediction, improving the accuracy and efficiency of the object detection system. NMS helps refine the proposed ROIs by removing redundant detections and selecting the most relevant ones. By eliminating overlapping bounding





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boxes with lower confidence scores, NMS ensures that the final set of ROIs accurately represents the objects in the image without redundancy.

```
def non_maximum_suppression(boxes, scores, threshold):
    sorted_indices = argsort(scores, descending=True)
    picked_boxes = []
    while len(sorted_indices) > 0:
        picked_index = sorted_indices[0]
        picked_boxes.append(boxes[picked_index])
        ious = calculate_iou(boxes[picked_index], boxes[sorted_indices[1:]])
        valid_indices = where(ious <= threshold)
        sorted_indices = sorted_indices[valid_indices + 1]
    return picked_boxes
```

Where,

1. boxes: Represents the input bounding boxes, which can be considered as proposed ROIs.
2. scores: Corresponding confidence scores for the bounding boxes, indicating the likelihood of each ROI containing an object of interest.
3. threshold: IoU threshold used to determine the level of overlap allowed between ROIs.
4. calculate_iou: A function to calculate the Intersection over Union (IoU) between two bounding boxes, measuring their overlap. By applying NMS to the proposed ROIs, redundant and overlapping ones are eliminated, and only the most relevant ones are retained. This helps refine the set of ROIs and improves the accuracy and efficiency of object detection systems.

$MCR = NMS(ROI)$	Eq.8
------------------	------

Where, Max Confident Region(MCR) is the maximum confidence value obtained from the Regions Of Interests (ROI) using NMS. This takes a list of bounding boxes representing ROIs and applies the Non-maximum Suppression algorithm to select the bounding box with the highest confidence score. (Eq.8)

$FE(MCR) \rightarrow SVM$	Eq.9
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These extracted MCRs are sent to the SVM model. This performs classification using a Support Vector Machine (SVM) classifier based on the extracted features. SVM is a supervised learning model used for classification and regression tasks. (Eq.9)

SVM Classification

Support Vector Machine (SVM) is a versatile tool in machine learning that can be used for various tasks like classifying different types of data. It works by finding the best way to draw a line or a boundary between different groups of data points. This boundary is called a hyperplane, and SVM aims to maximize the space between this boundary and the nearest points of each group. For instance, imagine data points of two categories, like red and blue circles, scattered on a graph. SVM helps to find the line separating these circles as much as possible, ensuring the margin or space between the line and the closest circles is maximized. When a straight line can't separate the data, It uses a clever trick by transforming it into a higher-dimensional space where it becomes easier to draw a separating boundary. This transformation is done using a kernel function, which applies complex mathematical operations to the data to make it detachable.SVM also can handle outliers, data points that don't fit neatly into one category or another. Instead of being thrown off by these outliers, SVM adjusts its boundary to accommodate them while maximizing the group margin.

1. Initialize parameters:





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```

- Learning rate (alpha)
- Regularization parameter (C)
- Threshold for convergence (epsilon)
- Initialize weights (w) and bias (b) to zeros

2. Train the SVM model:
a. Repeat until convergence:
i. For each training example (X_i, y_i):
1. Compute the decision function:
   f(X_i) = w^T * X_i + b
2. Compute the margin:
   margin_i = y_i * f(X_i)
3. If margin_i < 1, update weights and bias:
   w = w + alpha * (y_i * X_i - 2 * C * w)
   b = b + alpha * y_i
ii. Check for convergence:
    If all examples satisfy the margin condition within epsilon, stop training

3. Output the trained SVM model parameters (w, b)
    
```

The pseudo-code outlines training a Support Vector Machine (SVM) model with a linear kernel. Initially, the necessary parameters, such as the learning rate (alpha), regularization parameter (C), and convergence threshold (epsilon) are initialized. Weights (w) and bias (b) are also set to zero. The training process iteratively updates these parameters until convergence is achieved. For each training example, the decision function is computed based on the current weights and bias, and the margin is calculated to determine the distance of the data point from the decision boundary. If the margin is less than 1, indicating misclassification or proximity to the margin boundary, the weights and bias are adjusted using stochastic gradient descent to correct the classification. This process continues until all examples satisfy the margin condition within the given epsilon, signifying convergence. Finally, the trained SVM model parameters, including weights and bias, are outputted to define the decision boundary separating the classes in the dataset.

In this case, the SVM is used to classify between the "Weed" and "Crop" from the provided Max Confident Region(MCR).

$C = SC \cdot \frac{W}{C} (MCR)$	Eq.10
----------------------------------	-------

Where, SC classifier(c) compares the obtained features with the existing labels(crops and weeds) and detects whether the given image is crop or weed. This integrates the entire pipeline for automated crop and weed detection. It sequentially applies CNN feature extraction, Selective Search, Non-maximum Suppression, and SVM classification to predict the input image's class label (crop or weed).

RESULT AND DISCUSSION

Object Detection Performance

Our goal to create a crop weed detection system is validated after testing the performance of the system in various test environments. By testing our object detection system on various images containing crops and weeds, we have found its performance to fulfill the set objectives. The system successfully identified and distinguished between crops and weeds. The system's overall performance, including the integration of selective Search, Convolutional Neural Networks, and SVM classifier, was satisfactory. It is observed that the system performed well in detecting





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different types of crops and weeds, which consisted of pictures taken from various angles in diverse environmental conditions.

Model Evaluation Metrics

Confusion Matrix

A confusion matrix is a table often used to describe the performance of a classification model on a set of test data for which the true values are known. It allows visualization of the performance of an algorithm by comparing actual and predicted values. From the confusion matrix, we can obtain TruePositive(TP), TrueNegative(TN), FalsePositive(FP), and FalseNegative(FN).

1. True Positive (TP): These are cases in which the model predicted correctly that an instance belongs to a particular class.
2. True Negative (TN): These are cases in which the model predicted correctly that an instance does not belong to a particular class.
3. False Positive (FP): These are cases in which the model predicted incorrectly that an instance belongs to a particular class when it does not (Type I error).
4. False Negative (FN): These are cases in which the model predicted incorrectly that an instance does not belong to a particular class when it does (Type II error).

Precision

Precision is a metric used to measure the accuracy of a classification model, particularly in binary classification tasks. It answers the question: "Out of all the instances predicted as positive, how many were actually positive?" precision tells us how precise or accurate the model is when it predicts a positive outcome. It is calculated as the ratio of true positive predictions to the total number of positive predictions made by the model. (Eq.11)

$Precision = \frac{TruePositive}{TruePositive + FalsePositive}$	Eq.11
---	-------

True Positives (TP) are the instances correctly classified as positive by the model. False Positives (FP) are the instances that were incorrectly classified as positive by the model.

Recall

Recall, also known as sensitivity, is a metric used to measure the completeness of a classification model, especially in binary classification tasks. It answers the question: "Out of all the actual positive instances, how many did the model correctly identify?" recall tells us how many actual positive instances the model managed to capture or recall. It is calculated as the ratio of true positive predictions to the total number of actual positive instances.(Eq.12)

$Recall = \frac{TruePositive}{TruePositive + FalsePositive}$	Eq.12
--	-------

True Positives (TP) are the instances correctly classified as positive by the model. False Negatives (FN) are the instances that were incorrectly classified as negative by the model but are positive

F1 Score

The F1 score is a metric that combines both precision and recall into a single measure, providing a balanced evaluation of a classification model's performance, especially in binary classification tasks. The F1 score considers both how precise the model is (precision) and how well it captures all the relevant instances (recall)(Eq.13)

$F1score = 2 \cdot \frac{Precision * Recall}{Precision + Recall}$	Eq.13
---	-------

Precision tells us how accurate the model is when it predicts a positive outcome. Recall tells us how many of the actual positive instances the model manages to capture





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Accuracy

Accuracy measures how often a classifier model makes correct predictions out of all its predictions. In simple English, it's like asking: "Out of all the things I guessed, how many did I get right?" The formula for accuracy is. Just count how many predictions the model got right, then divide that by the total number of predictions it made. (Eq.14)

$$\text{Accuracy} = \frac{\text{Number Of Correct Prediction}}{\text{Total Number Of Prediction}} \quad \text{Eq.14}$$

Results obtained from this method show that the weeds and crops are distinguished better than previously used methods.

Obtained Confusion Matrix is

Obtained TruePositive(TP), TrueNegative(TN), FalsePositive(FP) and false negative(FN) are:

Class	TP	TN	FP	FN
0	1479	403	32	21
1	214	1674	22	25
2	174	1725	14	22

Obtained Precision, Recall, F1 Score and Accuracy are

Epoche	Precision	Recall	F1 score
0	0.98	0.99	0.98
1	0.91	0.90	0.90
2	0.93	0.89	0.91
Accuracy	0.96		

The classification results are pretty promising. The model shows a solid ability to classify instances of the majority class accurately, "background," achieving high precision and recall scores. This indicates that it's good at identifying cases in this category. Even though it's not as perfect with the minority classes, "crop" and "weed," it still manages to do a pretty decent job, maintaining reasonable precision and recall. With an overall accuracy of 96%, it's clear that the model is performing admirably across all classes. This is a positive sign and suggests that the model is well on its way to being a reliable tool for classification tasks.

CONCLUSION

This study introduces a new way to find and classify things in farm pictures using R-CNN and SVM. This method can change how farmers manage crops and control weeds, giving them accurate and practical solutions. Combining R-CNN with SVM Identifies and categorizes with better accuracy, makes a robust tool for analyzing farm pictures. Many tests are done in different farm situations to ensure this method works well and helps farmers. This work supports sustainable farming by reducing waste and chemical use and promoting responsible farming.

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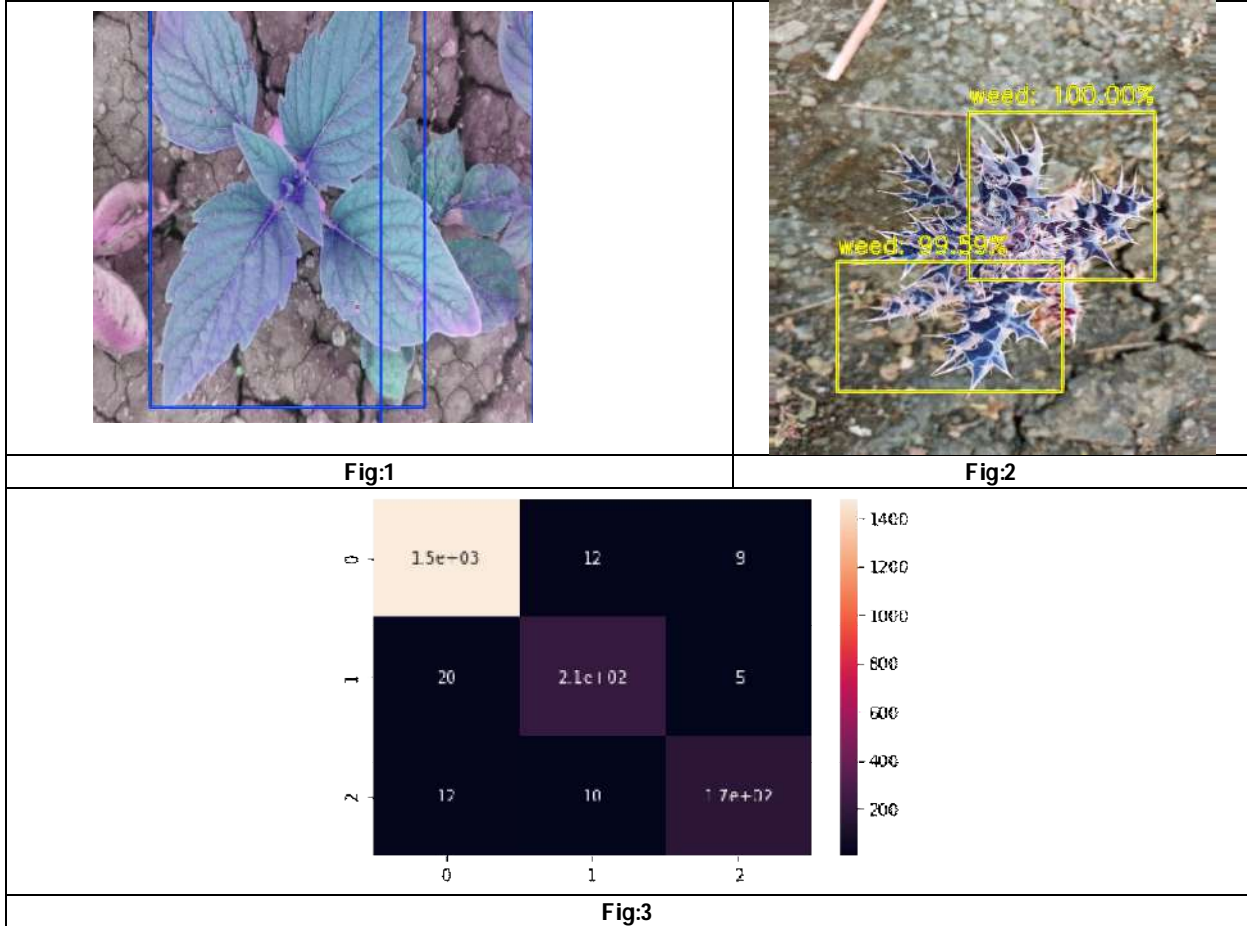
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The Effectiveness of Comprehensive Corrective Exercise Program Along with Janda's Approach and Lacrosse Ball Massage Technique in the Improvement of Posture in Subjects with Lower Crossed Syndrome

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

Lower crossed syndrome is a muscle imbalance caused by the weakening and lengthening of the posterior Back muscles. This imbalance leads to abnormal posture and joint dysfunction. The study aimed to find out the effectiveness of a comprehensive corrective exercise program along with Janda's approach and lacrosse ball massage technique in the improvement of posture in subjects with the Lower crossed syndrome. A experimental study design consisting of 30 patients with Back pain for 1 month.30 patients were included, and the average age was about 20 to 50 years. All the patients underwent pre and post-test scores of Costo vertebral angle and Lumbo sacral angle. The pre and post-test values were assessed by smartphone mobile application on protractor in group A and group B. The calculated 't' test





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values by the unpaired test in group A & group B is 20.0946 & 17.3618. The calculated 't' test values were more in group A than in B. In the present sample, the Comprehensive corrective exercise program along with Janda's approach has a positive effect.

Keywords: Smartphone mobile application on the protractor, Janda's approach exercise, Costovertebral angle and Lumbo Sacral angle.

INTRODUCTION

According to the World Health Organization, musculoskeletal disorders are one of the main causes of disability in persons between the ages of 20 and 50, and the most prevalent complaints worldwide are headaches and persistent Back pain. Muscles, ligaments, joints, peripheral nerve fibres, and supporting blood arteries are all affected by a variety of inflammatory and pathological conditions together referred to as musculoskeletal disorders [1]. The human body is prone to several musculoskeletal illnesses, including those that affect the lower limbs, the back, and the upper extremities. Depending on the kind of condition, the symptoms of upper extremity musculoskeletal disorders include typically pain, pains, discomfort, numbness, stiffness, and/or weakness [2]. Muscular disparity known as Lower crossed syndrome is frequently brought on by stiffness in the Back area. Distal or Pelvic girdle syndrome is another name for the Lower crossed syndrome. In addition to postural deviations (Hyperlordotic, increased thoracic kyphosis), Lower crossed syndrome refers to a specific altered muscle activation pattern (especially in the Back, trunk, and Pelvic muscles) and altered movement patterns. Vladimir Janda (1923-2002) defined it as an abnormal posture [3]. The lower crossed syndrome is the result of muscle strength imbalances in the lower segment. These imbalances can occur when muscles are constantly shortened or lengthened in relation to each other. The lower crossed syndrome is characterized by specific patterns of muscle weakness and tightness that cross between the dorsal and the ventral sides of the body. In LCS there is over activity and hence tightness of hip flexors and lumbar extensors. Along with this there is under activity and weakness of the deep abdominal muscles on the ventral side and of the gluteus maximus and medius on the dorsal side. [1] The hamstrings are frequently found to be tight in this syndrome as well. This imbalance results in an anterior tilt of the pelvis, increased flexion of the hips, and a compensatory hyperlordosis in the lumbar spine [4]. It is a movement system disorder characterised by hyperlordosis in the Lumbar region. The ailment known as Lower crossed syndrome, which can draw an "X" (a cross) over the lower body, was given this name because it causes predominantly muscular imbalance, which eventually affects tonic and phasic muscles. There are a few potential side effects of the Lower crossed syndrome, including impingement syndrome, deterioration of the body's hard and soft tissues, and Pelvic instability [5].

Dr. Janda claimed that the Lower crossed condition, which she referred to as the issue with the Hyperlordotic, developed when a slouched sitting position was maintained for an extended length of time. Here, a muscle that has been overworked in the same direction for an extended amount of time shortens and tightens, an action known as "adaptive shortening." All antagonists elongate and weaken a condition known as "stretch weakness," as a result of becoming strained [6]. Dr. Janda observed that these focused regions of stress in the spine correlate to transitional zones where the morphology of nearby vertebrae changes. This is one of the methods that is mostly applied to people with Lower crossed syndrome to address their posture alignment. Stretching and strengthening exercises are the key tools used in this strategy. The main muscles that become tensed in this situation should be stretched for flexibility, while the weaker muscles should be given strengthening exercises. In the realm of corrective exercises intended to treat musculoskeletal diseases and avoid subsequent issues like pain and injury, the entire approach is innovative. Rather than concentrating simply on the area of the body where the problem is, comprehensive corrective exercise regimens concurrently address muscle activation, movement pattern, and posture throughout the entire body [7]. Stretching involves extending the range of motion in the specific joints to lengthen the contracted muscles and increase flexibility. It is a manual treatment technique. The ability of a joint to move through its full range of motion is referred to as flexibility. Flexibility varies from person to person, relies on workouts, and is specific to particular joints. Additional forms of stretching exercises include proprioceptive neuromuscular facilitation stretching, dynamic



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stretching, ballistic stretching, and static stretching. A crucial technique for extending the range of motion is static stretching. Static stretching is a sort of stretching exercise that involves applying low force for a prolonged period to lengthen the muscle. The act of performing a controlled stretch is called dynamic stretching [8]. Specific muscles, such as the thoracolumbar extensor and Hip flexor should be stretched using specific methods. Muscles are worked by strengthening exercises or resistance training employing resistance, such as a dumbbell or your body weight. Rachael Return explained this. Here, Abdominals and Gluteus maximus are the major targets of the strengthening exercise. Professionals in rehabilitation and fitness frequently utilise self-myofascial release to improve myofascial mobility. Tools used often for self-myofascial release include foam rollers and different roller massagers. By reducing the effects of acute muscle soreness, delayed onset muscle soreness, and post-exercise muscle performance, it is possible that these tools can improve joint range of motion and the healing process. There are various sizes and foam densities available for foam rollers and roller massage bars [9]. One method of self-myofascial release that makes use of hard and thick balls is lacrosse ball massage. Additionally, it resembles a tennis ball. By releasing the connective tissue that might become tight around muscles due to extended sitting, bad posture, or exercise, this ball helps to reduce discomfort and enhance function in sore muscles.

METHODS

PARTICIPATION

A total of 30 patients were included in this study all subjects provided written informed consent before entering the study. The patient's age is between 20 years to 50 years. Inclusion criteria were as follows: The persons were in the age group of 20-50 years. The usage of handheld devices, reading, working and travelling for > 3 hours, sleeping in a fetal position and unsupported back chair are the factors, Back pain over one month

STUDY DESIGN

The study design that was used for this study is experimental.

OUTCOME MEASURES

The Costovertebral angle is the angle which is used to measure the posture that was given at any time of day. Lumbo Sacral angle is the angle which is used to measure the posture that was given at any time of day.

INTERVENTION

15 patients in this group A underwent a comprehensive corrective exercise program along with Janda's approach for duration of 30 minutes, and 15 patients in this group B lacrosse ball massage technique for duration of 10 minutes. This reduces muscle pain and improves posture One method of self-myofascial release that makes use of hard and thick balls is lacrosse ball massage. Additionally, it resembles a tennis ball. By releasing the connective tissue that might become tight around muscles due to extended sitting, bad posture, or exercise, this ball helps to reduce discomfort and enhance function in sore muscles by following the exercises. All these exercises are demonstrated to the subjects individually under the therapist's guidance. The following interventions are taught to the patient as a home programme and the patients are regularly monitored to know the accuracy of results.

Training Program

Group A

Exercises included

Comprehensive corrective exercise program along with Janda's approach:

1. Pelvic bridging
2. Slight leg Raising
3. Lunges
4. Janda's approach:

Thoracolumbar extensor Stretch





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Hip flexor Stretch

Group B**Exercises included**

Lacrosse ball massage technique

STATISTICAL ANALYSIS

The data were evaluated by using an unpaired 't' test. The unpaired t-test was used to find out the statistical significance between post and post-t-test values of Costovertebral angle and Lumbosacral angle.

Data Presentation**Table 1 Data Analysis and Presentation**

Data values	Costovertebral Angle	Lumbosacral Angle
Mean values	24.13	12.73
Standard Deviation	1.64	1.03
The unpaired t test	20.09	17.36
Table value	2.15	2.15
p value	0.0456	0.0425

RESULTS

A protractor is used to measure the Costovertebral angle, which is presented in table 4.1, for the Paired 't' test analysis for the pre-test and post-test variables. The pre-test and post-test values varied significantly between the two groups. Group A's "t" value is 44.9941, whereas Group B's "t" value is 20.6148. The Costovertebral angle is measured using a smart phone mobile application on a protractor for both groups in the unpaired 't' test analysis for the post-test variables, which are reported in table 4.2. Between the Groups, a sizable variation was evident. Subjects in Group A outperform those in Group B. The post-test variables for both groups have a 't' value of 20.0946. The Lumbo Sacral angle is measured using a smart phone mobile application employing the Paired 't' test analysis for the pre-test and post-test variables, as shown in Table 4.3. Between the two groups, there were substantial differences in the pre-test and post-test values. The "t" value for Group A is 29.8642, while the "t" value for Group B is 11.4492. The unpaired 't' test analysis for the post-test variables for both groups is displayed in table 4.4. These variables are assessed by smart phone mobile on protractor for Lumbo Sacral angle. Between the Groups, a sizable variation was evident. Subjects in Group A outperform those in Group B. The post-test variables for both groups have a 't' value of 17.3618.

DISCUSSION

This study aimed to evaluate the efficacy of a complete corrective exercise programme, Janda's method, and lacrosse ball massage technique in the treatment of Lower crossed syndrome in patients. The predefined inclusive and exclusive criteria were met by 30 participants. Ten each were assigned to two groups of subjects. While Group B got a lacrosse ball massage technique, Group A had a thorough remedial exercise programme coupled with Janda's method. There was a considerable correction of posture in both Groups' before and after treatment values, which was validated by the following research. In both groups, the post-test value shows that there was a significant correction of posture in the comprehensive corrective exercise program along with Janda's approach compared to the lacrosse ball massage technique, which was supported by studies as follows. This study examines how Back and pelvic muscle stretching and strengthening activities affect the corrective posture of the Back in those who have a hyperlordotic. Yoo claims that by extending the muscles and ligaments of the posterior Back and correcting posture, it is possible to reduce the pain brought on by pelvic Back syndrome to some extent. He also determined that the simplest technique was to stretch by pressing the head with a hand. The thorocolumbar extensor and Hip flexor were

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stretched, while the Abdominals and Gluteal maximus were strengthened, throughout this investigation [6]. The research conducted by Mahajan R and his colleagues in 2012 on the comparative efficacy of muscle energy technique and static stretching conducted a study for the treatment of sub-acute mechanical Back pain supports the findings of our study regarding the effectiveness of muscle energy technique in reducing pain and increasing ROM. This study's utilization of the Comprehensive Corrective Exercise Program suggests that it has a respectable impact on reestablishing equilibrium in the pelvic stabilizer muscles. In recent years, there has been a greater focus on studying how various exercise regimens affect Lower-crossed syndrome. The bulk of the research included both male and female participants, showing that Back problems can affect people of either sex [8]. Through the Comprehensive Corrective Exercise Program, the participants steadily improved their ability to perform the activity in various postures while creating concentric and eccentric contractions. Earlier studies have supported the rationale of exercise progression (from isometric to dynamic). Our findings revealed an improvement in some muscle activations throughout all three contraction phases—concentric, isometric, and eccentric—which may have been brought on by training in all three. An app for smart phones measures the angle [10]. The findings revealed that smart phone agreements were greater from both sides. These results show that smart phone applications for evaluating cranial angles have a good level of validity. In a research titled "Smartphone and Universal Goniometer for Measurement of Elbow Joint Motions: A Comparative Study," Behnam Behnoush and his colleagues utilized a smart phone application and universal goniometer to measure elbow range of motion (ROM). The findings demonstrated that the elbow joint supination had the best level of measurement reliability. After eight weeks of corrective exercises, these therapies are anticipated to improve and minimise UCS symptoms, including postural mal alignment and muscle imbalance [10]. The results of this study's data analysis show that comprehensive corrective exercise programmes combined with Janda's method are more effective than lacrosse ball massage in treating people with Lower-crossed syndrome. The substantial improvement is therefore founded on his idea.

This study found that complete corrective exercise programmes and Janda's method were more effective in reducing pain and improving posture than lacrosse ball massage.

CONCLUSION

The goal of this study was to determine if an extensive schedule of corrective exercises, Janda's method, and a massage technique using a lacrosse ball might improve posture in participants with Lower crossing syndrome. The analysis of the data appears to support the claim that people with nonspecific Back discomfort may improve their posture by using Janda's method, the Comprehensive Corrective Exercise Program, and the lacrosse ball massage technique. These workouts help to improve functional abilities while also reducing discomfort. This is evidenced by the fact that the groups significantly improved, demonstrating the value of the Comprehensive Corrective Exercise Program, Janda's method, and lacrosse ball massage therapy in increasing posture improvement and pain relief. In light of this, it can be said that the Comprehensive Corrective Exercise Program, in conjunction with Janda's method and lacrosse ball massage technique, is very effective in treating a patient with Nonspecific Back Pain and leads to a significant improvement in functional activities and pain relief. The null hypothesis is not the primary hypothesis in this investigation.

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Implications of Endophytic Bacterial Community and Pharmacological Activity Associated with *Kalanchoe pinnata* and *Tinospora cordifolia*

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 16 Jun 2024

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ABSTRACT

Endophytes colonizing the medicinal plants act as the prospective source of valuable secondary metabolites. Prior research substantiates the belief that endophytic bacteria living in plant tissues have similar biological activity and produce similar metabolites in their host plants. Thus, various ethnobotanical pharmaceutical plants serve as reservoirs for drug discovery. In 2020, after the arrival of COVID-19, due to the lack of vaccines, various scientists explored the use of several medicinal plants. For instance, studies proved that the phytochemical berberine from *Tinospora cordifolia* can regulate the function of 3-chymotrypsin-like proteases (3CLPro) proteins and thus contribute in controlling the viral replication. Moreover, the flavonoids isolated from *Kalanchoe pinnata* were used for the treatment of COVID-19 because of their anti-viral properties. Further, *Streptomyces* sp. BJS4 isolated from *K. pinnata* is also thought to possess anti-malarial activity. Traditionally, it acts as a miracle plant that serves as therapeutic for kidney stones and gastric ulcers as well as used in facilitating the dropping of the placenta during childbirth.

Keywords: Endophytes, *Tinospora cordifolia*, *Kalanchoe pinnata*, *Streptomyces*, Phytochemicals



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INTRODUCTION

Wehmeier (2000) defined disease as the abnormal functioning of the organism, which is not a consequence of impairment (Anizoba, 2023). It has been conclusively shown that diseases are the major challenges faced by people in each generation. Prior research substantiates the belief that a large population heavily depends on medicinal plants for fulfilling their primary healthcare needs. Ayurveda is exploited for thousands of years for medication and cure of several diseases. In Atharveda, Charak Samhita, and Sushrut Samhita brief information on about 700 different plants is available. According to the data assembled by World Health Organization (WHO), about 80% of the world's population prefers herbal medicines for curing various infectious diseases (Kumar *et al.*, 2023). Medicinal herbs are efficacious remedies for various protozoan diseases, which are difficult to cure and affect human health globally (Kamaraj *et al.*, 2022), for instance, malaria, which is a life-threatening parasitic disease, caused by female *Anopheles* mosquitos. Data collected substantiate that it is a serious problem affecting the tropical and subtropical regions of the world (Omara, 2020). Quinine and artemisinin are derivatives of medicinal plants that are beneficial for curing malaria (Keshamma *et al.*, 2022). Therefore, medicinal plants prove to be the potent source of medicines and drug development. Medicinal plants possess several unique endophytic bacteria that enhance plant growth, deal with the disease-causing agents that reside in the soil, and help the host in conquering the stress response to adverse environmental conditions (Walitang *et al.*, 2018). Endophytic bacteria extracted from medicinal plants aid in the synthesis of bioactive metabolites and in boosting the secondary metabolite production from their host plants (Chen *et al.*, 2021). Medicines obtained from pharmaceutical ethnobotanical plants kill harmful microorganisms with fewer side effects (Huang *et al.* 2022).

Phytochemical review and endophytic bacterial diversity present in *Kalanchoe pinnata* and *Tinospora cordifolia*

Kalanchoepinnata

Kalanchoe pinnata belonging to the Crassulaceae family, native of Madagascar is distributed worldwide because of its ethnobotanical efficacy. It is highly beneficial plant that is usually found in temperate parts of Macaronesia, West Indies, New Zealand, Hawaii, Melanesia, the Galapagos Islands, the Mascarenes, Asia, and Australia. Its height usually varies from 1-1.5 m. The aroma is caused by essential oils found in the plant's leaves and other sections. Due to the carminative and analgesic nature, the leaves as well as the bark is bitter and are used in the treatment of diarrhea. *K. pinnata* also acts as a potent source of various secondary metabolites, like alkaloids, flavonoids, glycosides, cardenolides, triterpenes etc. Bufadienolides observed in the leaves of plants shows chemo-preventive, insecticidal, anti-tumor, and anti-bacterial activity (Rahman *et al.*, 2019). Studies carried for characterizing the solvent extract of Cathedral bells showed the presence of n- alkane, n-alkanol, sitosterol, α -amyrin, and β -amyrin in it (Zanzabil, Hossain and Hasan, 2023). Every part of the plant has proved to be efficacious for hypertension, dysentery, dysuria, insect bites, asthma, jaundice, cough, urinary stones, epilepsy, boils, bronchial infections, inflammation, nephrolithiasis, kidney stones, tuberculosis, diabetes, arthritis, and ureterolithiasis (Rahman *et al.*, 2019). In USA, it is extensively used in the treatment of fevers as well as chickenpox. Moreover, it is widely used in the Himalayas, Karnataka, Mexico, Nigeria, Bundelkhand, Kerala, Nicaragua, Peru, Vietnam, Brazil, Ecuador, Guatemala, Arunachal Pradesh etc. for various purposes. All the applications associated with *K. pinnata* proved it to be effective against several dreadful diseases (Singh, Garg and Shrimali, 2022). Several studies proved that 60% methanolic extract of leaf juice of *K. pinnata* inhibited the activity of many bacteria, like *Staphylococcus aureus*, *Proteus vulgaris*, *Shigella dysenteriae*, *Bacillus subtilis*, and *Escherichia coli*(Stefanowicz-Hajduk *et al.*, 2020). Among these, antibacterial action associated with methanolic extract is more effective against *S. aureus*, *Pseudomonas aeruginosa*, *Candida albicans*, *Cryptococcus neoformans*, and *Salmonella typhi* (Wu *et al.*, 2021). The endophytes inhabiting the internal environment of the host medicinal plant generally induce the assembly of secondary metabolites and bioactive compounds (Khasim *et al.*, 2020). Apart of these, the structure of bacterial community is altered by elements, such as season, soil conditions, latitude, altitude, and longitude (Sun *et al.*, 2022). Based upon the tissue, health status, and host genotype the endophytic bacteria possess either the property of parasitism or mutualism (Cope-Selby *et al.*, 2017). Various endophytic bacterial community belonging to *Streptomyces* species has been reported in *K. pinnata*. *Streptomyces* sp. BJS4 strain isolated from the plant is believed to produce metabolites that possess anti-malarial



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potential. Prior research substantiates that *in vitro*, the purified fraction derived from the BJS4 strain has inhibitory activity against *Plasmodium falciparum* 3D7. Another application of the metabolite produced by the endophytic bacteria is that when this endophytic bacterial metabolite is mixed up with the extract collected from *Anabaena sphaerica*, it is believed to possess antioxidant and antibacterial activities (Sankarganesh and Joseph, 2019) [Fig.1].

Pharmacological properties associated with *Kalanchoe pinnata***Anti-inflammatory activity**

Lolos et al., 2023 investigated the anti-inflammatory potential of *K.pinnata* stem extract on acetic acid-induced inflammation in mice (*Mus musculus*). They observed decline in thickness of inflammation with increase in stem extract concentration of *K. pinnata* and proved it as an anti-inflammatory source (Fig.2).

Anti-oxidant activity

Investigations reported the presence of phenolics i.e., gallic acid (GA) and flavonoids i.e., quercetin in the methanolic extract and β -carotene as well as the lycopene in the extract of petroleum ether. But apart from these, various alkaloids and tannins are also present in the leaves. Prior research shows that the phenolic content of leaves ($28.4 \pm 2\mu\text{g}/\text{mg}$) is mainly responsible for the anti-oxidant activity (Hernández-Caballero et al., 2022).

Anti-cancerous activity

Some studies proved the anti-cancer potential of GA in *K. pinnata* by the regulation of the proliferation, programmed cell death, and angiogenesis that affects cancer cells. Further research in this field showed that when GA is added to food then it results in the inhibition of lung adenomas. It is also responsible for inducing apoptosis by the production of the hydrogen peroxide (Hernández-Caballero et al., 2022).

Anti-angiogenic effect

The presence of quercetin (3,5,7,3',4'-pentahydroxyflavone, Qu) in *K. pinnata* is majorly responsible for the anti-angiogenic impact in the prostate tumor cells and umbilical vein endothelial cells in humans by inhibiting VEGF-induced phosphorylation of the VEGF receptor 2 as well as signaling pathways involving protein kinases AKT, mTOR, and ribosomal protein S6. In addition to these functions, it also enhances PTEN expression and apoptosis but inhibits invasion and cell proliferation (Hernández-Caballero et al., 2022).

Anti-viral activity

A study of Cryer et al., 2017 reported the isolation of two compounds KPB-100 and KPB-200 showing antiviral activities against Vaccinia virus (anti-VACV) and Human alpha herpes virus (anti-HHV-2). The result obtained proved that both compounds were effective in inhibition of both viruses, and KPB-100 is also found to possess anti-HHV-1 activity [Table 1].

Tinosporacordifolia

Tinospora cordifolia belonging to the Menispermaceae family, is commonly known for treating diabetes, jaundice, fever etc. The stem part consists of several alkaloids, like berberine, palmatine etc. along with glycosides, such as cordifoliside A, B, C, D, and E, cardioside, palmatoside F, 18-norclerodane glycoside, palmatoside C, furanoid diterpene glucoside etc. Studies reveal that the aerial part of the plant contains steroids, like δ -sitosterol, β -sitosterol and root contains alkaloids, like palmatine, choline, tinosporin, tembetarine, tetrahydropalmatine, isocolumbin, and magnoflorine. *T. cordifolia* is associated with several pharmacological activities, like anti-diabetic, anti-viral, hepatoprotective, anti-rheumatoid arthritis, antiarrhythmic, neuroprotective, anti-microbial activity etc. Prior research by Duhan, Bansal and Rani (2020) showed the presence of 38 endophytic bacteria from *T. cordifolia* and found that the dominant genera belongs to *Bacillus* species in both leaves as well as stem. Some recent reports show the presence of the endophytic bacteria belonging to *Pseudomonas* species i.e., strain TCA1 in the stem part of *T. cordifolia* (Kaur, Devi and Vyas, 2017). When the bacterial isolate of *Pseudomonas* species TCA1 strain was tested for its activity against various fungi, like *Curvularia lunata*, *Fusarium verticillioides*, *Alternaria alternata*, and *Fusarium*



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moniliforme, it resulted in antagonistic activity (Kaur, Devi and Vyas, 2017). The pandemic situation due to beta-coronavirus SARS-CoV-2 belonging to the subgenus Sarbecovirus and Coronaviridae family, led to the death of thousands of people in the whole world during this acute respiratory syndrome has paid a very high toll in respect of financial conditions as well as the human lives. This situation enabled other scientists to focus on the limited spread of the virus (Pal et al., 2020). In this view, dexamethasone was proved to be useful in recovery of the patients who were receiving oxygen support and resulted in the reduction of deaths. Apart from the use of Dexamethasone, some herbal Chinese medicines for the treatment of SARS-CoV-2, like Lianhuaqingwen showed anti-inflammatory and anti-viral properties (Chu et al., 2021). Hence, the investigation of herbal medicines is found to be useful in treatment of various diseases. Another tri-herbal medicine for the pathology treatment of SARS-CoV-2 developed in India i.e., Coronil consists of the stem extracts of *T. cordifolia* (Giloy), complete plant extract of *Withania somnifera* (L.) (Ashwagandha), along with the leaf extract of *Ocimum sanctum* (L.) (Tulsi) (Máthé and Khan, 2022). With the advancement in the field, scientists used the zebrafish model for studying the reduction in the pathology caused due to SARS-CoV-2 spike protein using tri-herbal medicine Coronil via cytokine modulation and have become successful somewhat in manifesting the effect of tri-herbal medicine Coronil with the apparent therapeutic benefits and disease-modulating properties on SARS-CoV-2 induced pathology.

To interpret the pathophysiology of SARS-CoV-2 infection several authentic animal models indicating the COVID-19 clinical symptoms have been developed (Balkrishna, Khandrika and Varshney, 2021). Research showed that there has been a reduction in granulocyte and macrophage infiltration caused due to SARS-CoV-2 spike protein upon treatment with Coronil that highlights the anti-inflammatory action of the ingredients present in the Coronil (Balkrishna et al., 2020). Studies carried out regarding the phytoconstituent of *T. cordifolia* show that Magnoflorine and tinosporide that are isolated from *T. cordifolia* possess high affinity against HIV-1 protease active site (Balkrishna et al., 2020). Similarly, another polyherbal ayurvedic medicine i.e., *MahaSudarshanaGhanvati* is considered for the treatment of liver and spleen disease, malaria, fever etc. This medicine consists of *T. cordifolia* along with other 51 constituents among which *Kiratatika* (*Swertia chirata*) serve as the major ingredient with 50% of the total proportion of all the ingredients. In a research, patients suffering from COVID-19 were selected and tablets of *MahaSudarshanaGhanvati* were given to them and it was found that there has been improvement in physical strength and appetite in the respective patients (Rao et al., 2022). Thus, the arbitration of Ayurvedic medicines exhibits high potential as a protective prophylactic measure for the treatment of COVID-19. During the advancement in the field of research, a patient suffering from Ankylosing Spondylitis (AS), which is a chronic inflammatory disease, was given Ayurvedic treatment. The main symptom of the disease is lower back pain but during the disease, other symptoms, like reduction in the expansion of the chest, lumbar lordosis, and thoracic kyphosis are commonly observed.

During an Ayurvedic treatment given to the patient, *MahaSudarshanaGhanvati* was used for the *Aampachana* and changes in the inflammation in the joints. The patient suffering from AS faces other problems, like the stiffness of the spine and joint pain, left relieved by taking *Swarna Sameer pannaga rasaas* ayurvedic medicines (Khedekar et al., 2019). Thus, Ayurvedic medicines and the involvement of medicinal plants in Ayurvedic medicines contribute to the treatment of various diseases with lesser adverse effects and better results. Endophytic bacteria serve as a potent source for the generation of antibiotics, biofertilizers, medicines as well as biopesticides. Similarly, medicinal plants associated with several endophytic bacteria also display an important role in the elimination of harmful pathogens with improvement in the growth of plants (Pathma et al., 2021). For instance, an endophytic bacterium belonging to *Pseudomonas* sp. TCA1 was found to be effective against 4 pathogenic fungi i.e., *F. moniliforme*, *A. alternate*, *C. lunata* and *F. verticillioides* (Kaur, Devi and Vyas, 2017). In another study, 38 different endophytic bacteria isolated from *T. cordifolia* were screened. Among those 38 different bacterial isolates, 20 were obtained from the leaf and 18 were isolated from stem explants. Among these isolates, the dominant genera observed was *Bacillus* with some bacterial isolates belonging to *Aneurinibacillus* and *Pseudomonas* species. The extracts of these isolates i.e., ethyl acetate showed the presence of secondary metabolites, like terpenoids, alkaloids, and flavonoids (Duhan, Bansal and Rani, 2020). These bacterial isolates showed the antifungal activity against fungi, such as *Helminthosporium nodulosum* and *A. alternata* and antibacterial activity and bacteria, like *E.coli*, *P. vulgaris*, *S. aureus*, and *Staphylococcus hominis* (Duhan, Bansal and Rani, 2020).



Himani *et al.*,**Pharmacological properties associated with *Tinospora cordifolia*****Anti-inflammatory activity**

Both high-performance liquid chromatography (HPLC) and high-performance thin layer chromatography (HPTLC) were used to identify berberine, an isoquinoline alkaloid found in the dry stem of *T. cordifolia*, which showed the anti-inflammatory effects. Alcoholic extract of *T. cordifolia* has been found to possess anti-inflammatory activities in numerous types of subacute and acute inflammation (Girme *et al.*, 2022).

Anti-toxin effect

Several alkaloids present in *T. cordifolia*, such as choline, magnoflorine, isocolumbin, tetrahydropalmatine, tinosporin, palmatine show inhibitory effects against aflatoxin-induced nephrotoxicity. Various extracts of stem and leaves usually found to be effective against the toxicity caused due to the presence of lead nitrate in Swiss albino male mice (Upadhyay, 2023).

Anti-diabetic potential

Berberine possesses anti-hyperglycemic and antioxidant activity and shows an inhibitory effect on FOXO 1, which is associated with the integration of insulin signaling with the mitochondrial function that stimulates AMP-activated protein kinase, resulting in blood pressure maintenance and decreased level of cholesterol and blood sugar (Li *et al.*, 2022).

Anti-HIV potential

The root extract has anti-HIV activity, which has been evidenced by a drop in eosinophil count, stimulation of B lymphocytes, macrophages, polymorphonuclearleucocytes, and hemoglobin levels (Thakur *et al.*, 2022). Studies substantiate the belief that *T. cordifolia* acts as a beneficial plant that can boost up the immune system of the patients suffering from immune disorders or HIV (Sajith and Farhan, 2022).

Hepatic disorders

Usually, a tremendous increase in alanine transaminase, triglyceride, cholesterol, aspartate transaminase, gamma-glutamyl transferase was observed in alcoholic samples but after the use of *T. cordifolia* water extract, the level of these compounds somewhat normalized in these patients. It was also found that the intake of alcohol also reduces intestinal absorption and found to be highly hepatotoxic (Sharma and Dabur, 2016).

Anti-cancer activity

Palmatine is another alkaloid reported in *T. cordifolia*, which is associated with anti-cancer activity. In Swiss albino mice, 7,12-dimethylbenz(a)anthracene (DMBA) act as an effective anti-cancer agent against cutaneous carcinomas. Diethylnitrosamine causes hepatocellular carcinoma and led to skin carcinomas for which palmatine proves to be effective and shows anti-cancer activity (Singh *et al.*, 2021). For its therapy, a diterpenoid epoxy clerodane produced from chloroform: methanol extraction of Giloy's alcoholic extract is useful since it has anti-cancer activity against the hepatocellular carcinoma. The advancement in further investigation reveals that the Miracle plant extracts in chloroform and hexane Giloy (Chl-TCE and Hex-TCE) inhibit cell migration and proliferation while targeting cellular pathways in IMR-32 neuroblastoma cell lines and U87MG glioblastoma thereby, inducing the senescence as well as differentiation. Therefore, chloroform and hexane extract serve as phytotherapeutic interventions for the treatment of neural cancers (Sharma *et al.*, 2019) [Table 2].

FUTURE PERSPECTIVES

The medical science known as Ayurveda focuses on using naturally occurring plant products for healing. Ayurveda has been documented to use a wide range of neuroprotective medicines. Ayurvedic plant extracts are known to include a variety of bioactive components from several categories. An ethanolic extract of Brahmi has been found to contain a total of 20 phytochemicals. Similarly, alkaloids, saponins, alcohols, and other chemicals are found in the extracts of other Ayurvedic plants. Ayurveda is a domain that has a wealth of information on medicinal plants and

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their role in the treatment of a variety of maladies, including neoplastic, cardiovascular, neurological, and immunological disorders. The usage of such medicinal herbs is crucial for preventing various diseases, particularly "cancer", which is a leading cause of death worldwide. As several deadly side effects arise during chemotherapy; thus, natural remedies, such as, using plant-derived medicines to treat cancer, may lessen the negative side effects. Currently, a few plant-based products and phytoconstituents are being used to treat cancer. We have concentrated on a variety of plant-derived phytochemicals and prospective compounds derived from these plants to act as anticancer medicines, as well as their mechanisms of action. Plant endophytic bacteria colonize plant interior tissues without creating visible disease or causing symptoms in their host. Endophytes in the plant endobiome perform a variety of tasks, including plant growth promotion, stress tolerance, and chemical modulation. Medicinal plants serve as the natural source for many bioactive phytochemicals but recent finding on plant-microbe interactions has revealed that a substantial proportion of these compounds are produced by related microbial partners. As a result, endophytes, particularly from medicinal plants, have piqued the scientific community's interest in bio-prospecting for bioactive metabolites.

Declaration of interest statement

The authors report there are no competing interests to declare.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Ethical statement

Ethics approval not required

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Table1: Pharmacological activities associated with compounds present in *Kalanchoe pinnata*

S.No.	Compound	Phytochemical	Function	Reference
1.	Phenolic Acid	Gallic Acid	Possess anti-cancerous, antioxidant as well as anti-inflammatory activities	Hernández-Caballero <i>et al.</i> , 2022
		Caffeic Acid	Hinder the cancerous cell's movement and has anti-apoptotic potential	Kabała-Dzik <i>et al.</i> , 2018
2.	Sterol	Campesterol	Contributes to intensifying the effect of paclitaxel as well as cisplatin; thus, exciting the signals for cell death	Hernández-Caballero <i>et al.</i> , 2022
		Bufadienolids	Exhibit anti-tumourous, anti-microbial and anti-inflammatory activity	Kolodziejczyk-Czepas and Stochmal, 2017
3.	Flavonoids	Kaempferol	Help in intrinsic induction of apoptosis of MCF-7 cancer cell line of breast	Hernández-Caballero <i>et al.</i> , 2022
		Quercitrin	Scavenge free radicals; thus, exhibit anti-oxidant activity	Cincin <i>et al.</i> , 2015

Table 2: Pharmacological activity associated with *Tinospora cordifolia* (Menispermaceae family and *Kalanchoe pinnata* (Crassulaceae family)

S. No.	Medicinal plant	Pharmacological activity	Chemical constituents	Reference
1.	<i>Tinospora cordifolia</i>	Anti-viral activity against SARS-CoV-2	Berberine, choline, octacosanol, β -sitosterol	Ahsan <i>et al.</i> , 2023
		Angioinhibitory and antimetastatic effect	Palmatine (having pharmacophore group of octacosanol)	Ahsan <i>et al.</i> , 2023
		Anti-cancer activity	Berberine, palmatine, temberatine	Sharma <i>et al.</i> , 2019
		Cardioprotective activity	Furanolactone, tinosporin, tinosporide, jateorine, columbin and clerodane derivatives	Kattupalli <i>et al.</i> , 2019
		Aflatoxin-induced nephrotoxicity	Choline, palmatine tetrahydropalmatine, isocolumbin, tinosporine, magnoflorine	Sharma <i>et al.</i> , 2019
		Anti-diabetic activity	Magnoflorine, jatrorrhizine, palmatine	Sharma <i>et al.</i> , 2019
		Anti-oxidant activity	Epicatechin, palmatine, isocolumbin, tinosporin	Kattupalli <i>et al.</i> , 2019
		Antidyslipidemic activity	Berberine	Kumar, 2015
2.	<i>Kalanchoe pinnata</i>	Anti-angiogenic effect	Quercitrin	Hernández-Caballero <i>et al.</i> , 2022
		Anti-cancerous activity	Gallic acid (GA)	Hernández-Caballero <i>et al.</i> , 2022





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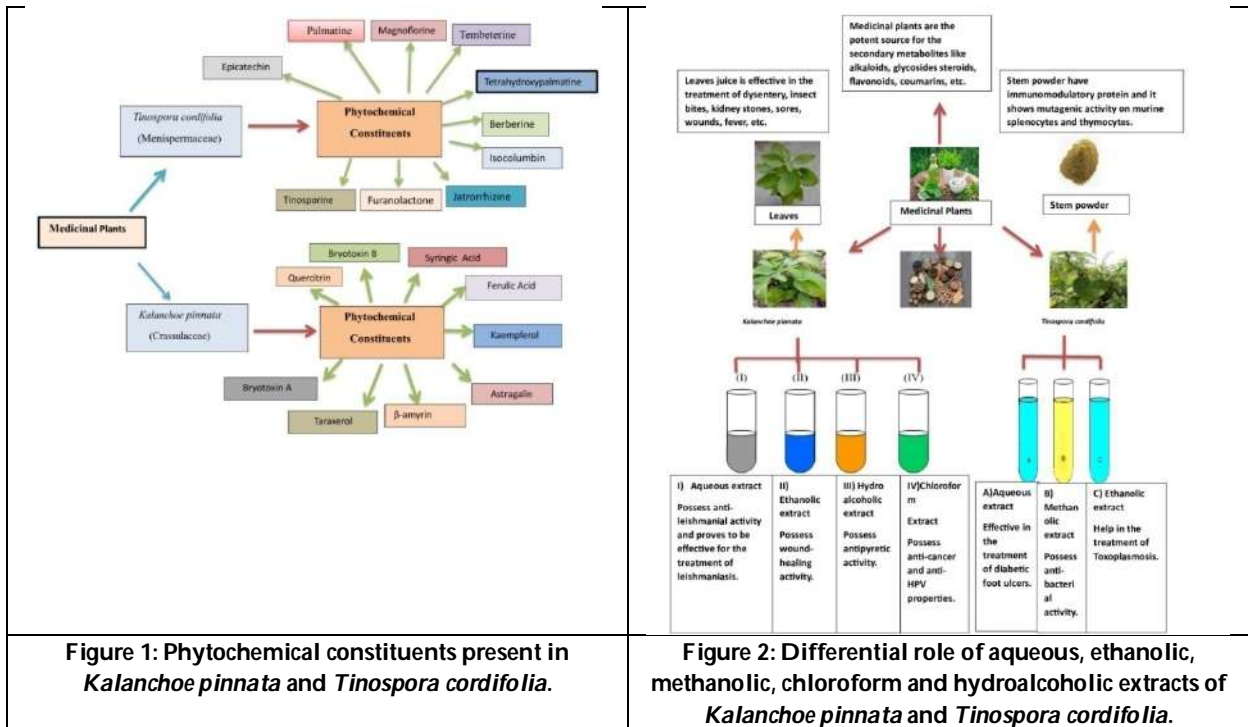


Figure 1: Phytochemical constituents present in *Kalanchoe pinnata* and *Tinospora cordifolia*.

Figure 2: Differential role of aqueous, ethanolic, methanolic, chloroform and hydroalcoholic extracts of *Kalanchoe pinnata* and *Tinospora cordifolia*.





First Zagreb Matrix and Energy of a 3-Uniform T_2 Hypergraph

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 10 Jun 2024

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ABSTRACT

Let H be a 3-uniform T_2 hypergraph with $n \geq 5$. The first Zagreb matrix of H , denoted by $Z(H)$ is defined as the square matrix of order n , whose (i, j) th entry is $d_i + d_j$ if x_i and x_j are adjacent and zero for other cases. The first Zagreb energy $ZE(H)$ of H is the sum of the absolute values of the eigenvalues of $Z(H)$. It is shown that the first Zagreb energy of a 3-uniform T_2 hypergraph is $[ZE(H)] \leq n(n-1) + \delta(3\Delta - 1) + \sqrt{\frac{\delta-1}{2m}}$. Equality holds if $n=7$ & 9 in H . Also $(2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})]^2}$ yields the approximate first Zagreb energy of a 3-uniform T_2 hypergraph.

Keywords: hypergraph, T_2 hypergraph, 3-uniform T_2 hypergraph, First Zagreb matrix, First Zagreb Energy

AMS Subject Classification: 05C65





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INTRODUCTION

The basic definitions and terminologies of a hypergraph are not given here, we refer to Vitally Volosin, ‘Introduction to Graph and Hypergraph Theory’. The concept of hypergraph was introduced by Berge in 1967. 2017 Seena V and Raji Pilakkat introduced the Hausdorff, T_0 , and T_1 hypergraphs. Based on the above authors we introduced a family of hypergraphs namely T_2 hypergraph, and 3-uniform T_2 hypergraph, and studied the energy of a 3-uniform T_2 hypergraph concerning the adjacency matrix, Randic matrix[6], First Zagreb matrix[7], and its corresponding bounds are obtained. In 1977 Gutman defined graph energy. H.Shosthari introduced new bounds on the energy of graphs [2]. In [1] K.C. Dasran through the Zagreb energy of the graphs. Also, found some new lower and upper bounds of the graph. B.R.Rakshith introduced the relation between Zagreb energy and edge Zagreb energy of a graph with a minimum degree [3]. The energy of the hypergraph and adjacency energy of the hypergraph are introduced in [4, 5]. This paper studies the first Zagreb energy and bounds of the 3-uniform T_2 hypergraph. Throughout this article, H is a simple connected 3-uniform T_2 hypergraph with order n , and size m , where the order and size are the minimum numbers of edges needed to define a 3-uniform T_2 hypergraph. The following definitions and theorems are used in the sequel.

T_2 hypergraph

In this section, we see the definition of a T_2 hypergraph with an example.

Definition 2.1. A hypergraph $H=(X, D)$ is said to be a T_2 hypergraph if for any three distinct vertices u, v , and w in X , there exists a hyper edge containing u and v but not w and a hyper edge containing w but not u and v .

Result 2.2. (i) The minimum number of edges needed to define a T_2 hypergraph is $m = \lceil \frac{2n+5}{4} \rceil$

(ii) For a T_2 hypergraph H , the minimum degree $\delta(H) = 2$.

(iii) For a T_2 hypergraph H , rank $r = \lfloor \frac{2n+1}{4} \rfloor$ where $n \geq 5$.

Example 2.3.

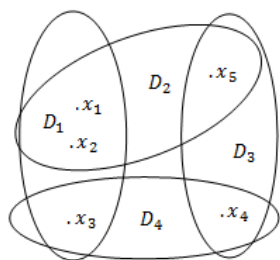


Figure 1: T_2 hypergraph

Figure 1 is a T_2 hypergraph with vertices x_1, x_2, \dots, x_5 and hyper edges D_1, D_2, D_3, D_4 . It is easily seen that for every three vertices x_i, x_j , and x_k there exists a hyper edge containing x_i, x_j but not x_k and a hyper edge containing x_k but not x_i and x_j .

3-Uniform T_2 hypergraph

Definition 2.4.1. A T_2 hypergraph $H=(X, D)$ is said to be a 3-uniform T_2 hypergraph if every hyperedge contains exactly three vertices.





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Example 2.4.2

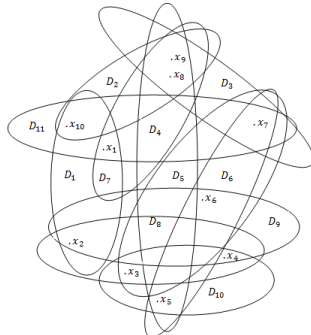


Figure 2: 3-uniform T_2 hypergraph

First Zagreb matrix and energy of a 3-uniform T_2 hypergraph

The first Zagreb energy of a graph G was introduced by Ivan Gutman, and we introduce the same concept in 3-uniform T_2 hypergraph

Definition 2.5.1. The first Zagreb matrix of a T_2 hypergraph is defined by

$$Z(H) = \begin{cases} d_i + d_j & \text{if } x_i x_j \in D \\ 0 & \text{otherwise} \end{cases}$$

Where d_i is the degree of the vertex.

Definition 2.5.2. The first Zagreb energy of a T_2 hypergraph H is $\sum_{i=1}^n |\lambda_i|$.

Where λ_i is the Zagreb eigenvalue of H .

Example 2.5.3. Consider a 3-uniform T_2 hypergraph given in Figure 2 with 10 vertices and 11 edges.

First Zagreb matrix of H is given by $Z(H) = \begin{pmatrix} 0 & 6 & 0 & 0 & 0 & 0 & 7 & 7 & 7 & 6 \\ 6 & 0 & 6 & 6 & 0 & 6 & 0 & 0 & 0 & 6 \\ 0 & 6 & 0 & 6 & 6 & 6 & 7 & 0 & 0 & 0 \\ 0 & 6 & 6 & 0 & 6 & 6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 6 & 6 & 0 & 6 & 7 & 7 & 7 & 0 \\ 0 & 6 & 6 & 6 & 6 & 0 & 7 & 0 & 0 & 0 \\ 7 & 0 & 7 & 0 & 7 & 7 & 0 & 8 & 8 & 7 \\ 7 & 0 & 0 & 0 & 7 & 0 & 8 & 0 & 8 & 7 \\ 7 & 0 & 0 & 0 & 7 & 0 & 8 & 8 & 0 & 7 \\ 6 & 6 & 0 & 0 & 0 & 0 & 7 & 7 & 7 & 0 \end{pmatrix}$

The first Zagreb eigenvalues of $Z(H)$ are $\lambda = 36.22, 17.56, 6.9, -2.08, -6, -6, -8, -9.66, -13.22, -15.78$

Therefore, the first Zagreb energy $ZE(H) = 121.42$

RESULTS AND DISCUSSION

In this section, we find the bounds of the first Zagreb energy of a 3-uniform T_2 hypergraph. Throughout this section, we use $B = \sum_{i=1}^n \sum_{j=1}^n (d_i + d_j)^2 = \sum_{i=1}^n \lambda_i^2$ (1)

Result 3.1. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$. Then $|ZE(H)| \leq n(n-1) + \delta(3\Delta - 1) + \sqrt{\frac{\delta-1}{2m}}$. Equality holds if $n=7$ & 9 in H .

Solution: In Figure 2, $n=10, m=11, \delta = 3, \Delta = 4$ then $n(n-1) + \delta(3\Delta - 1) + \sqrt{\frac{\delta-1}{2m}} = 123.30$





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$ZE(H) = 121.42$. Also, if $n=7, m=6, \delta = 2, \Delta = 3$ then $n(n-1) + \delta(3\Delta - 1) + \sqrt{\frac{\delta-1}{2m}} = 58.3, ZE(H) = 58.3$

Hence (3.1.) is true.

Result 3.2. For a 3-uniform T_2 hypergraph the independence number $\alpha(H) = 2$. (2)

Result 3.3. For every 3-uniform T_2 hypergraph of order n , three eigenvalues are positive and $n-3$ eigenvalues are negative.

Theorem 3.4. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$.

Then $ZE(H) < \sqrt{B} + \frac{(n-1)B}{(\det Z(H))^{\frac{1}{n}}}$ (3)

Proof: We have $|\lambda_1| > |\det Z(H)|^{\frac{1}{n}}, \lambda_1$ is the largest eigenvalue of H

$$|\lambda_1| \sum_{i=2}^n |\lambda_i| > |\det Z(H)|^{\frac{1}{n}} \sum_{i=2}^n |\lambda_i|$$

Since λ_1 is the largest eigenvalue of H , We have, $|\lambda_i| < |\lambda_1| \quad \square \quad i = 2, 3, \dots, n$

$$(n-1) |\lambda_1| > |\det Z(H)|^{\frac{1}{n}} (ZE(H) - \lambda_1)$$

$$ZE(H) < \frac{(n-1)|\lambda_1|^2}{|\det Z(H)|^{\frac{1}{n}}} + |\lambda_1|$$

Let $h(z) = z + \frac{(n-1)z^2}{|\det Z(H)|^{\frac{1}{n}}}$, where $\lambda_1 = z$ (4)

$$h'(z) = 0 \Rightarrow 1 + \frac{(n-1)2z}{|\det Z(H)|^{\frac{1}{n}}} \Rightarrow z = \frac{-|\det Z(H)|^{\frac{1}{n}}}{2(n-1)}$$

Also $h''(z) = \frac{2(n-1)}{|\det Z(H)|^{\frac{1}{n}}} > 0$, therefore h is minimum

$$\text{Minimum value} = h\left(\frac{-|\det Z(H)|^{\frac{1}{n}}}{2(n-1)}\right) = \frac{-|\det Z(H)|^{\frac{1}{n}}}{4(n-1)}$$

Also, $h(z)$ is increasing in the interval $\frac{-|\det Z(H)|^{\frac{1}{n}}}{2(n-1)} = z < B$

Hence, $z < h(z) < h(B)$ then we obtain (3)

Theorem 3.5. Let H be a 3-uniform T_2 hypergraph with $6 \leq n \leq 11$.

Then $ZE(H) < \sqrt{2nB - 2\alpha(H)B}$. (5)

Proof: Let $\lambda_1, \lambda_2, \lambda_3$ be the positive eigenvalues of H and $\tau_1, \tau_2, \dots, \tau_z$ ($z = n-3$) be the negative eigenvalues of H .

In $H, \alpha(H) < n - 3 - z + \min(3, z)$ where z is the number of negative eigenvalues.

Hence $z < n - \alpha(H) \& 3 < n - \alpha(H)$ (6)

$$\text{Since } \sum_{i=1}^3 \lambda_i + \sum_{i=1}^z |\tau_i| = 0$$

$$ZE(H) = 2 \sum_{i=1}^3 \lambda_i = 2 \sum_{i=1}^z |\tau_i|$$
 (7)

From Cauchy Schwarz inequality, $ZE(H) = 2 \sum_{i=1}^3 \lambda_i \leq 2 \sqrt{3 \sum_{i=1}^3 \lambda_i^2}$ (8)

$$ZE(H) = 2 \sum_{i=1}^z \tau_i \leq 2 \sqrt{z \sum_{i=1}^z \tau_i^2}$$
 (9)

$$\frac{(ZE(H))^2}{2} = \frac{(ZE(H))^2}{4} + \frac{(ZE(H))^2}{4}$$

$$\leq 3 \sum_{i=1}^3 \lambda_i^2 + z \sum_{i=1}^z \tau_i^2$$

$$< (n - \alpha(H)) (\sum_{i=1}^3 \lambda_i^2) + (n - \alpha(H)) (\sum_{i=1}^z \tau_i^2)$$

$$< (n - \alpha(H)) (\sum_{i=1}^3 \lambda_i^2 + \sum_{i=1}^z \tau_i^2)$$

$$< (n - \alpha(H)) (\lambda_1^2 + \lambda_2^2 + \lambda_3^2 + \tau_1^2 + \dots + \tau_z^2)$$

$$< (n - \alpha(H)) (\sum_{i=1}^n \lambda_i^2)$$

$$< (n - \alpha(H)) B \quad (\text{by 1})$$

$$(ZE(H))^2 = 2B (n - \alpha(H))$$





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$$ZE(H) < \sqrt{2nB - 2\alpha(H)B}$$

Lemma 3.6. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$.

Then $\lambda_1 + \lambda_2 \leq 5n + \delta + 1 + \sqrt{\frac{\delta}{5}}$, where λ_1 is the largest eigenvalue and λ_2 is the second largest eigenvalue of H . Equality holds only if $n=5$ in H .

Theorem 3.7. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$.

$$\text{Then } ZE(H) < 5n + \delta + 1 + \sqrt{\frac{\delta}{5}} + \sqrt{(n-2)B}$$

Proof: From Cauchy Schwarz inequality, $(\sum_{i=3}^n \lambda_i)^2 \leq (n-2)(\sum_{i=3}^n \lambda_i^2)$

$$\sum_{i=3}^n \lambda_i \leq \sqrt{(n-2)(\sum_{i=3}^n \lambda_i^2)}$$

$$ZE(H) - (\lambda_1 + \lambda_2) \leq \sqrt{(n-2)(\sum_{i=1}^n \lambda_i^2 - \lambda_1^2 - \lambda_2^2)}$$

$$\leq \sqrt{(n - \alpha(H))(B - \lambda_1^2 - \lambda_2^2)} \quad \text{From (1) \& (2)}$$

$$ZE(H) < (\lambda_1 + \lambda_2) + \sqrt{(n - \alpha(H))(B - \lambda_1^2 - \lambda_2^2)}$$

$$\text{Since } \lambda_1 + \lambda_2 \leq 5n + \delta + 1 + \sqrt{\frac{\delta}{5}}$$

$$ZE(H) < 5n + \delta + 1 + \sqrt{\frac{\delta}{5}} + \sqrt{(n - \alpha(H))(B - \lambda_1^2 - \lambda_2^2)} \tag{10}$$

$$\text{Let } z(a,b) = 5n + \delta + 1 + \sqrt{\frac{\delta}{5}} + \sqrt{(n - \alpha(H))(B - a^2 - b^2)} \tag{11}$$

Differentiating partially concerning a and b ,

$$z_a = \frac{-a\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)}, \quad z_b = \frac{-b\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)}$$

Stationary points are given by $z_a = 0$ and $z_b = 0$

$$z_a = 0 \Rightarrow z_a = \frac{-a\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)} = 0 \Rightarrow a = 0$$

$$z_b = 0 \Rightarrow z_b = \frac{-b\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)} = 0 \Rightarrow b = 0$$

$$z_{aa} = \frac{-(B-b^2)\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)^{\frac{3}{2}}}$$

$$z_{bb} = \frac{-(B-a^2)\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)^{\frac{3}{2}}}$$

$$z_{ab} = \frac{ab\sqrt{(n-\alpha(H))}}{(B-a^2-b^2)^{\frac{3}{2}}}$$

$$\text{At } (0,0), z_{aa} = z_{bb} = \frac{-\sqrt{(n-\alpha(H))}}{B}, z_{ab} = 0$$

$$\Delta = z_{aa}z_{bb} - (z_{ab})^2 > 0$$

$$\text{The maximum value at } z(0,0) \text{ is } z(0,0) = 5n + \delta + 1 + \sqrt{\frac{\delta}{5}} + \sqrt{(n - \alpha(H))B}$$

$$\text{Hence } ZE(H) < 5n + \delta + 1 + \sqrt{\frac{\delta}{5}} + \sqrt{(n - \alpha(H))B}$$





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Lemma 3.8. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$.

Then $\lambda_1 \geq 2n + \frac{3}{2}$. Equality holds only if $n=6$ in H .

Theorem 3.9. Let H be a 3-uniform T_2 hypergraph with $6 \leq n \leq 11$.

$$\text{Then } ZE(H) < (2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})^2]} \tag{12}$$

Proof: From Cauchy Schwarz inequality, $(\sum_{i=2}^n \lambda_i)^2 \leq (n-1)(\sum_{i=2}^n \lambda_i^2)$

$$(\sum_{i=1}^n \lambda_i - \lambda_1)^2 \leq (n-1)(\sum_{i=1}^n \lambda_i^2 - \lambda_1^2)$$

$$(ZE(H) - \lambda_1)^2 \leq (n-1)(B - \lambda_1^2) \text{ By (1)}$$

$$ZE(H) < \lambda_1 + \sqrt{(n-1)(B - \lambda_1^2)} \tag{13} \quad \text{Let } \lambda_1 = z \text{ and } h(z) = z + \sqrt{(n-1)(B - z^2)}$$

We have $\sqrt{\frac{B}{n}} < z < \sqrt{B}$

From (3.8) we have $\lambda_1 \geq 2n + \frac{3}{2} > \sqrt{\frac{B}{n}}$

Hence $h(\lambda_1) < h(2n + \frac{3}{2})$

$$(10) \text{ Gives, } ZE(H) < (2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})^2]}$$

Observation 3.10. Let H be a 3-uniform T_2 hypergraph with $n \geq 5$.

Then $\Gamma|\lambda_n| \geq \Gamma(\det Z(H))^{\frac{1}{n-1}}$, where λ_n is the smallest eigenvalue. Equality holds if $n=5$ in H .

Observation 3.11. Let H be a 3-uniform T_2 hypergraph with $n = 6, 8, 10 \dots$

Then $\Gamma|\lambda_n| = 7+3t$ where $t \in N$.

Theorem 3.12. Let H be a 3-uniform T_2 hypergraph with $n = 6, 8, 10 \dots$

$$\text{Then } ZE(H) > (7+3t) + \frac{\Gamma(\det Z(H))^{\frac{1}{n-1}}}{(7+3t)^{\frac{1}{n-1}}} \text{ } t \in N.$$

Proof: From an arithmetic and a geometric mean inequality,

$$\frac{\sum_{i=1}^{n-1} |\lambda_i|}{n-1} \geq |\lambda_1 \lambda_2 \dots \lambda_{n-1}|^{\frac{1}{n-1}}$$

$$\sum_{i=1}^{n-1} |\lambda_i| \geq \frac{\sum_{i=1}^{n-1} |\lambda_i|}{n-1} \geq |\lambda_1 \lambda_2 \dots \lambda_{n-1}|^{\frac{1}{n-1}}$$

$$ZE(H) - \Gamma|\lambda_n| > ZE(H) - |\lambda_n| > \frac{(\det Z(H))^{\frac{1}{n-1}}}{\Gamma|\lambda_n|^{\frac{1}{n-1}}}, \text{ where } \lambda_n \text{ is the smallest eigenvalue of } H.$$

$$\text{Hence, } ZE(H) > (7+3t) + \frac{\Gamma(\det Z(H))^{\frac{1}{n-1}}}{(7+3t)^{\frac{1}{n-1}}} \text{ } t \in N.$$

Theorem 3.13. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$.

$$\text{Then } n(\det Z(H))^{\frac{1}{n}} < ZE(H) < \frac{n(4n+3)^2}{4(\det Z(H))^{\frac{1}{n}}} \tag{14}$$

Proof: From arithmetic and a geometric mean inequality,

$$\frac{\sum_{i=1}^n \lambda_i}{n} > (\det Z(H))^{\frac{1}{n}} \tag{15}$$

$$\sum_{i=1}^n \lambda_i > n(\det Z(H))^{\frac{1}{n}} \tag{16}$$

$$ZE(H) > n(\det Z(H))^{\frac{1}{n}}$$





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We have $|\lambda_1| > (\det Z(H))^{\frac{1}{n}}$
 $|\lambda_1| \sum_{i=1}^n \lambda_i > (\det Z(H))^{\frac{1}{n}} \sum_{i=1}^n \lambda_i$
 Since, $|\lambda_1| > |\lambda_i| \quad \square \quad i = 2, 3, \dots, n$
 $|\lambda_1|^2 \sum_{i=1}^n \lambda_i > (\det Z(H))^{\frac{1}{n}} \sum_{i=1}^n \lambda_i$
 $ZE(H) < \frac{|\lambda_1|^2 \sum_{i=1}^n \lambda_i}{(\det Z(H))^{\frac{1}{n}}} < \frac{n(4n+3)^2}{4(\det Z(H))^{\frac{1}{n}}}$ (17)
 From (15) & (16) inequality (13) is proved.

Example 3.14. Consider a 3-uniform T_2 hypergraph with $n = 10$.
 Here, first Zagreb energy, $ZE(H) = 121.41$ (By Example 2.5.3)

Also, $n (\det Z(H))^{\frac{1}{n}} = 10 \times 9.38 = 93.8$

And $\frac{n(4n+3)^2}{4(\det Z(H))^{\frac{1}{n}}} = \frac{10(4 \times 10 + 3)^2}{4 \times 9.38} = 492.66$

Therefore, $93.8 < 121.41 < 492.66$ hence the Theorem (3.13) is verified.

Theorem 3.15. Let H be a 3-uniform T_2 hypergraph with $5 \leq n \leq 11$.

Then $\sqrt{B} < ZE(H) < \sqrt{nB}$ (18)

Proof: From Cauchy - Schwarz inequality, $(\sum_{i=1}^n \lambda_i)^2 \leq n (\sum_{i=1}^n \lambda_i^2) = nB$

$ZE(H) < \sqrt{nB}$ (19)

$(\sum_{i=1}^n \lambda_i)^2 = (ZE(H))^2 > (\sum_{i=1}^n \lambda_i^2) = B$

$ZE(H) > \sqrt{B}$ (20)

From (19) & (20) inequality (18) is proved.

Example 3.16. Consider a 3-uniform T_2 hypergraph with $n = 10$.

$\sum_{i=1}^n \lambda_i^2 = B = 2325.46$, $ZE(H) = 121.41$

$\sqrt{2325.46} < 121.41 < \sqrt{10 \times 2325.46}$

$48.22 < 121.41 < 152.49$ hence the Theorem (3.15) is verified.

Example 3.17. In Theorem 3.4. $n = 10$, $B = 2326$, $(\det Z(H))^{\frac{1}{n}} = 9.3827$, $ZE(H) = 121.41$

$121.41 < \sqrt{2326} + \frac{2326 \times 9}{9.382} = 48.23 + 2231.29 = 2279.51$

In Theorem 3.5. $n = 10$, $ZE(H) = 121.41 < \sqrt{2 \times 10 \times 2326} - 2 \times 2 \times 2326 = 192.91$

In Theorem 3.7. $n = 10$, $\delta = 3$, $B = 2326$, $ZE(H) = 121.41 < 54 + .7745 + 136.41 = 191.19$

In Theorem 3.9. $ZE(H) < 21.5 + \sqrt{9(2326 - (21.5)^2)} = 151.01$

Therefore, $ZE(H) = 121.41 < 151.01 < 191.19 < 192.91 < 2279.51$

That is, $ZE(H) < (2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})]^2} < 5n + \delta + 1 + \sqrt{\frac{\delta}{5}} + \sqrt{(n - \alpha(H))B}$

$< \sqrt{2nB - 2\alpha(H)B} < \sqrt{B} + \frac{(n-1)B}{(\det Z(H))^{\frac{1}{n}}}$. Hence, it is that $(2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})]^2}$ is the closest upper bound of

$ZE(H)$. Thus $(2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})]^2}$ gives the approximate first Zagreb energy of a 3- uniform T_2 hypergraph.





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CONCLUSION

In this article, we studied the first Zagreb energy of a 3- uniform T_2 hypergraph with some examples. Also, we originated the bounds of a 3-uniform T_2 hypergraph concerning various graph parameters. Among these bounds, we identified that $(2n + \frac{3}{2}) + \sqrt{(n-1)[B - (2n + \frac{3}{2})]^2}$ yields the approximate first Zagreb energy of a 3- uniform T_2 hypergraph.

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The Scientific Analysis of the Working Conditions of Labourer in Tea Factories in Meghalaya

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 10 Jun 2024

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ABSTRACT

The research paper examines the working conditions of labourer in Tea factories, Meghalaya, India. The primary data were collected from 185 labourers' from different tea factories. In exploit of this objective, based on the findings of the labour management system the solution has been established with a conceptual justification. Questionnaire based interviews were conducted with the factory labours. To know the extent in which the labourers' are satisfied with their working condition, percentage analysis and descriptive statistics has been used. Hypothesis were used whether the significance difference between male and female differ towards the satisfaction of working condition. Independent sample t-test has been used. The study findings reveal that the poor infrastructural facilities, poor socio-economic conditions, lack of welfare measures and the management responsibilities towards the labours have influenced the labour productivity.

Keywords: Tea Factory Laboure, Working Condition, Working Environment, Welfare measures, Nature of Job, Safety, overall job satisfaction.



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INTRODUCTION

Tea is the second-popular beverage after water, having its own unique features and being a low-cost beverage in the world. Tea is known for its health benefits and has been recognized as a medicinal substance for thousands of years. Besides soothing the nerves of drinkers, it is believed to reduce the risk of cancer and heart disease. The tea plant belongs to the species *Camellia sinensis*, or *Camellia* tea. These are the five countries that are leading the top list for tea production: China, India, Kenya, Sri Lanka, and Indonesia (Athanasios Valavanidis, 2019). India has cultivated tea in 16 states, viz., Assam, West Bengal, Meghalaya, Tripura, Nagaland, Mizoram, Manipur, Arunachal Pradesh, Himachal Pradesh, Sikkim, Bihar, Odisha, Tamil Nadu, Kerala, Karnataka, and Uttarakhand. Out of these four states, viz., Assam, West Bengal, Tamil Nadu, and Kerala, were the highest tea-producing states and accounted for more than 95% of the tea production, and India itself is one of the states that has foreign exchange earners, and the industry also needs a continuous supply of workers; it is one of the most important employment generators in the country (Nurujjaman Laskar, April 2018). The Indian tea industry and tea estates provide employment opportunities to large numbers of people in rural and urban areas, both directly and indirectly. Next to water, tea has become the universally most affordable drink in the world. The Plantation Labour Act, which was passed in 1951, controlled the working conditions for tea employers. It set pay, set facilities, and restricted working hours for workers on tea estates (Baishya, 2016). Numerous risks in their workplace, together with psychological, biological, chemical, mechanical, and health-related elements, that all have an impact on the challenges faced by workers (Borgohain Parijat, 2013).

The majority of workers are uneducated, ignorant of living standards, unaware of their rights as employees, and facing financial difficulties. The Assam Plantation Labour Act was passed in 1951 and established welfare measures, social security regulations, and labour laws that were approved and put into effect for all of India's tea plantations in 1956. The effectiveness of worker production is increased by welfare measures and facilities such as housing accommodations, family welfare programs, and education training. Offering welfare measures, which are crucial to raising labour productivity, is one of the finest ways to ensure that successful workers provide positive results (Ananda Das Gupta, 2017). Meghalaya is a state in Northeast India that is now pursuing organic certification. In Meghalaya, several brands of tea are available at varying rates, and most farmers sell their supply in its raw state for very little money. In comparison to farmers who can produce and sell the product through to the end, it was discovered that the share of producers was quite low. They were compelled to sell their tea leaf to the processors due to a lack of technological expertise and processing knowledge (K.D. Sawian, 2022). The Meghalaya tea has a distinct flavor, excellent flavor, and scent that makes it stand out above other teas. In Meghalaya, tea plantations are still in their infancy. The list of private, societal, and government tea factories included many well-known brands. These factories include Upper Shillong Tea Farm, Nalari Tea, Anderson Tea, Areng, Durama, Meg Tea Umsning, Arsla Tea, Laksriew Tea, Denmar, Urlong Tea, Sharawn Tea, Jonglang Tea, and Alokpang Tea. They produce a variety of teas, such as CTC Tea, Oolong and Orthodox tea, black tea, green tea, and white tea, among others.

Statement of the Problem

The manufacturing tea industry and its workers were facing many problems, like absenteeism, strikes, scarcity of labour, a lack of welfare facilities, etc., that led to reduced production and productivity. The manufacturing process of the company is mainly affected by the inefficiency of labour. The workers are not provided with additional facilities to motivate them. Thus, by gathering the knowledge and opinions of the workers and also knowing the reasons for their dissatisfaction, the study aims to know the impact of the working environment and the working conditions of factory workers in Meghalaya.

REVIEW OF LITERATURE

The researcher has reviewed 104 articles for the study of which 85 are Indian review and remaining are foreign review. The important review which is highly associated with the tea estates and factories are as follows: Selvakumar Marimuthu (2019) concluded that there are number of factors that contribute to workers job discontent in tea



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factories, including a shortage of labor in the estates, financial difficulties, and the execution of government programs that affect tea growers. Additionally, the producers face numerous difficulties as a result of their ignorance of the resources offered by the tea Board Schemes, their ignorance of the sophisticated techniques used in tea production, and their ignorance of the benefits of organic farming. In addition to having numerous financial difficulties. Priyadarshan S. (2019), states that, work satisfaction level is a positive or negative point of view that the workers having while working. The study has found that, the most of the labours were illiterate. Also found that, the four factors were highly problematic factors that is, workplace environment, disability, payment, and tight work timing that leads to the dissatisfaction towards the workers. Subhasri Sarkar (2019), states the problems of the tea industry workers were paid low wages. The main causes of poor wages in the industry were due to the lack of implementation of labour law, large number of female tea worker, lack of mobility of the tea labours due to competition and decline in auction price in real time. In the North East, insufficiency of wages determination modes and discontinued the tea estates and that leads to large scale starvation of tea workers. Sajitha Dishanka, and Yukio Ikemoto (2013) the authors were identified the management traditional work norms, the workers socio-economic condition were poor, lack of cooperations among the workers and the management responsibility towards the stockholders which is adversely affected productivity of labours. Sohrab Ansari (2016), has that, the majority of the workers are illiterate and despite that now they are encouraging their children to study. Despite the fact that the workers have lived for generation on the tea garden but they don't have any property right on the land they are living. Santhosh Kumar R (2019), The study examines that, how job discontent might lead to more arguments, insufficient commitment, a person's likelihood of filing a grievance, apathy, workplace injuries, and other problems with wellbeing. Other warning indicators could be low self-esteem, active participation in the workplace, absenteeism, employee preservation, a lack of commitment, and dread of the profession. There is a correlation between job unhappiness and other factors that lower a company's production and industry.

Objectives of the Study

To analyse the working condition of tea factory labourers in Meghalaya State.

METHODOLOGY

To assess the working conditions of tea factory workers, the survey was conducted in the tea factories of Meghalaya in three Districts. The survey covered 185 respondents from the 10 tea factories. The questionnaires were used for the survey. In addition to surveys, secondary data were gathered from government publications, census data, newspapers, and journals to support and enhance the study and advance the research. With the aid of a carefully thought-out, structured questionnaire, information was gathered from the ten manufacturing workers. The secondary data was gathered from pertinent articles that were published in various newspapers, periodicals, websites, and journals. The ten factories, which were divided into three categories—Private, Society, and Government—were spread throughout three districts in Meghalaya: Ri-Bhoi District, East Khasi Hills, and West Garo Hills. These factories employed people. The categorization of tea factories within the study area is displayed in Table 1. There are more than 221 labourers were working in all these 10 tea factories. Since, the population is known, it is decided to take the sample from the entire population and therefore convenience sampling method has been used. The 185 respondents were completely responded. Therefore, the size of the sample which is taken for the study is 185. The labourers from tea industry in the study area is shown in the Table 2.

Tools and Techniques

The researcher has employed the necessary tools, such as factor analysis and percentage analysis through SPSS (Statistical Packages for Social Science Research), to analyze the working circumstances of laborers in the Meghalaya tea sector.





Hypothesis

Null Hypothesis: There is no significant difference between Male and Female with respect to factors of job description of labourers.

A Scientific Analysis of Socio-Economic Factors of the Labourers.

The results of the socioeconomic background of the tea industry laborers in the state of Meghalaya are displayed in Table 3. The working conditions of tea industry laborers in the state of Meghalaya are influenced by their socioeconomic status. The socioeconomic characteristics of the employees, including their age, gender, marital status, level of education, ethnicity, place of residence, daily pay, and type of employment, have been examined.

Working Profile of labourers in Tea Industry

A working profile is a personal assessment that measures and individual's work personality. An employee work profile is a combination of the employee work description, performance plan and evaluation assessment. To work in a good environment, it is usual form to create the team work and the services like canteen facility, welfare measures, family welfares, housing, sufficient workload, less risk, work place, lower job related strain and sanitary facilities that cause will make the higher satisfaction for the job performance of workers. The following Table 4 reveal the working profiles offered by the labourers from the tea industry in Meghalaya. The working profile showing in above Table 4 reveal that the labourers involvement and satisfaction level. The working environments, working hours, wages, welfare measures, shift and all, they feel happy and sufficient, but they need additional training when the new machines and equipment were installed. Hence, individual satisfaction level are appreciable but overall satisfaction level shows 44.9%.

Working Condition of Labourers- A Scientific Analysis

Working Conditions is a very important on the moral of the employees and cost effectiveness. The effectiveness of work is done to a large extent by the workers is purely depends on the work place environment. A poor work environment can also have a negative effect on employees like stress, decrease productivity etc. A healthy work environment can improve employee motivation, engagement and overall well-being which can also leads to increase the productivity. Also, the wellbeing of workers also has direct impact on their productivity. The researcher has identified 20 statements in given Table 5 below of working conditions of factory workers, Linkert's five point scale by adopting scaling technique, namely. S.A-Strongly Agree; A-Agree; N- Neutral; D.A- Disagree; S.D.A- Strongly Disagree. Table 5 reveal the statement of job description and working conditions in tea industry that, majority of them stated that they are neutral except the statements, such as, Satisfied with the production schedule, feelings about the work not burden, amenities to the laborers are adequate and satisfied to the laborers efficiency, family welfare measures availability, benefit from training, effectively supported for productivity, completion of work in time, reaching time to the work places are derived from scientific approach.

Hypothesis

There is no significant difference between Male and Female with respect to factors of working condition of labourer. Independent sample t-test for significant difference between Male and Female with respect to factors of Working Condition of Laborers.

Note: 1. ** denotes significant at 1 % level

2. * denotes significant at 5% level

** Since P value is less than 0.01, null hypothesis is rejected at 1% level with regard to Working Environment. Hence, there is significant difference between male and female of labourers with regard to the factors of Working Environment. Based on the mean score, it reveals that the male labourers have better opinion in Working Environment than female labourers towards the satisfaction level of working condition of labourers in Meghalaya tea factories. *Since P value is less than 0.05, null hypothesis is rejected at 5% level with regard to Nature of Work. Hence there is significance difference between male and female labourers with regard to factors of Nature of Work. Based on mean score, the male labourers have better opinion in Nature of Work than female labourers towards the working condition and satisfaction of laborers in tea factories in Meghalaya.



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There is no significance difference between male and female labourers with regard to factors of Welfare measures, Safety and Overall Job Satisfaction. Since P value is greater than 0.05. Hence the null hypothesis is accepted at 5% level with regard to factors of Welfare measures, Safety and Overall Job Satisfaction. The satisfaction score of the male respondents (73.41) is high followed by female respondents (66.22). It reveals that male respondents are more satisfied with the working condition in Meghalaya tea factories.

CONCLUSION

The purpose of the study is to examine the working conditions that tea factory workers in the state of Meghalaya endure. On the contentment of labourers in Meghalaya tea factories, however, it can be concluded that male workers have a better attitude about working conditions than do female workers. It also shows that there were several issues with tea workers, which had a negative impact on the rise in productivity indices. Among those many variables, the effects of manufacturing, technical inefficiencies, and working conditions on labour productivity are examined in detail for this purpose. The lack of staff is by far the biggest factor affecting production in tea factories. The labourers usually face problems due to the lack of social and welfare facilities and that leads to dissatisfactory level. In order to guarantee increased productivity, cordial working relationships, lower absenteeism, a pleasant work environment, job satisfaction, and security, labor welfare policies are essential in tea factories. Welfare programs should be seen as prudent investments that increase worker efficiency and pleasure while also yielding significant financial returns. Therefore, in order to improve the living conditions and quality of life of workers, all interested stakeholders should make every effort to provide welfare amenities. The rise in productivity was also impacted by technical inefficiencies. Modern machinery and technology should be introduced in factories to increase productivity.

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Table 1: Classification of tea factories in Meghalaya

S. No	List of the factories	Total
1	Private sector Factory	7
2	Cooperative society Factory	1
3	Government Factory	2
	Total	10

Source: Tea Board, Umsning, The Ri-bhoi District (Compiled Data)

Table 2: Sample size of Tea factory workers.

S. No	Taluk- wise Tea factories	No. of Tea factories	No. of workers as on December 2022	Sample
1	Ri-Bhoi	4	86	74
2	East Khasi Hills	4	53	34
3	West Garo Hills	2	82	77
	Total	10	221	185

Source: Official Records of Inspector of Factories (Compiled Data)

Table 3: Results of Socio-Economic Background of the labourers.

SI. No	Socio economic variables	Results
1	Gender	86.5% of the respondents were male
2	Age	70.3% of the labourers were under the age group of 26-35 years
3	Marital Status	62.2% of them were married workers in the industry.
4	Educational Qualification	32.4% of them were studied S.S.L.C level.
5	Ethnicity	47.6% of them were Khasi labourers in Meghalaya tea industry workers,
6	Place of residence	83.2% of the respondents were from the local areas.
7	Daily wages	43.2% have earned 300 Rs. daily wages
8	Nature of job	57.8% of the labourers are employed as permanent workers in the tea industry.
9	Payment of wages	98.4 % of the labourers received the monthly basis.

Source: Primary Data





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Table 4: Working Profile of Laborers in Tea Industry

Sl. NO	Working conditions	Result
1.	Welfare measures provided for the workers	62.4% of the workers were provided the housing facilities.
2	Problems faced by the worker in the work place	75.7% of the respondent were faced the problems sometimes in work.
3	Opinion with the present job	91.9% of the labourers were satisfied with their present Job.
4	Number of Working hours per day	98.4 % of the respondents are working 8 hours per day in the work place.
5	Offered over time with additional pay.	84.3 % of the respondents work for the overtime and receive the additional payment.
6	Working environment comfortable	91.4 % of the respondents were comfortable with the work environment.
7	Working area required for improvement	61.6 % of the respondents states that hygiene is required to improve in the working area.
8	Working shift	92.4 % of them works in day shift.
9	Equal payment of wages for male and female.	71.4% of the organisations are not providing the equal wages to for male and female.
10	Received training assistance	87.6% of the labours were trained after the workers are employed in the industry.
11	Additional Training requirement	58.9% of the respondents required additional training.
12	Satisfied with the production schedule	96.8% of the respondents were satisfied with the production schedule.
13	Factories are effectively supported and maintained for productivity	98.9% of the factories are effectively supported and maintained for productivity.
14	Works are completed in time	65.9% were completed the works in time
15	Feel burden about their work	51.9% of the workers were feeling burdened about their job
16	Providing sanitary facility	60.5% of them have the availed necessary sanitary facility in the work place.
17	Sufficiency of leave facilities	74.6% of the respondents feels that the leave facilities is sufficient.
18	More work pressure (time)	78.9 % feels more pressure with work in the evening time.
19	Family welfare	70.3% of the workers received the rations.
20	Overall satisfaction	44.9% of the respondents were satisfied with the work performance in the factory.

Source: Primary Data

Table 5: Tea Labourers Opinion about Working Condition in Tea Factories.

Sl. No	Statement	S.A	A.	N.	D.A	S.D.A	Total
1	Working hours is satisfactory	20 (10.5)	53 (28.6)	78 (42.2)	33 (17.8)	1 (.5)	185 (100)
2	Offered overtime work with additional pay	23 (12.4)	58 (31.4)	75 (40.5)	26 (14.1)	3 (1.6)	185 (100)
3	Satisfied with the production schedule	-	23 (12.4)	55 (29.7)	90 (48.6)	17 (9.2)	185 (100)
4	Feelings about the work not burden	-	16 (8.6)	50 (27.0)	98 (53.0)	21 (11.4)	185 (100)





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5	Works gives feeling of personal accomplishment	12 (6.5)	44 (23.8)	85 (45.9)	42 (22.7)	2 (1.0)	185 (100)
6	Amenities to the laborers are adequate and satisfied to the laborers efficiency	9 (4.9)	13 (7.0)	60 32.4	85 (45.9)	18 (9.7)	185 (100)
7	First aid appliance facilities availability in the industry	24 (13.0)	44 (23.8)	63 (34.1)	46 (24.9)	8 (4.3)	185 (100)
8	Adequate facilities provided in the work place	1 (.5)	41 (22.2)	92 (49.7)	44 (23.8)	7 (3.8)	185 (100)
9	Satisfactory holidays facilities availability in the work place	15 (8.1)	73 (39.5)	78 (42.2)	14 (7.6)	5 (2.7)	185 (100)
10	Pay package is satisfactory	15 (8.1)	66 (35.7)	82 (44.3)	22 (11.9)	-	185 (100)
11	Family welfare measures availability	-	15 (8.1)	68 (36.8)	86 (46.5)	16 (8.6)	185 (100)
12	Training facilities	39 (21.1)	62 (33.5)	71 (38.4)	8 (4.3)	5 (2.7)	185 (100)
13	Benefit from training	69 (37.3)	63 (34.1)	46 (24.9)	7 (3.8)	-	185 (100)
14	Effectively supported for productivity	55 (29.7)	78 (42.2)	52 (28.1)	-	-	185 (100)
15	Procurement of quality green leaves are maintained at the required level	43 (23.1)	54 (29.0)	68 (36.6)	21 (11.3)	-	185 (100)
16	Completion of work in time	-	38 (20.5)	63 (34.1)	70 (37.8)	14 (7.6)	185 (100)
17	Reaching time to the work place	71 (38.4)	71 (38.4)	43 (23.2)	-	-	185 (100)
18	Leaving time from the work place	32 (17.3)	55 (29.7)	64 (34.6)	34 (18.4)	-	185 (100)
19	All things considered, feel very satisfied when I think about my job.	18 (9.7)	43 (23.2)	75 (40.5)	41 (22.3)	8 (4.3)	185 (100)
20	Satisfied with the present job tea factories environment.	31 (16.8)	47 (25.4)	71 (38.4)	31 (16.8)	5 (2.7)	185 (100)

Source: Primary Data.

Table 6 :Gender and satisfaction towards Working conditions in Tea Factories

Factors of Working Condition	Gender						t value	P value
	Male			Female				
	N	Mean	SD	N	Mean	SD		
Working Environment	151	16.27	3.58	34	15.47	4.08	0.321	<0.006**
Welfare measures	151	15.03	3.98	34	8.72	3.83	0.433	0.497
Nature of Work	151	14.58	4.18	34	14.48	4.16	0.638	0.042*
Safety	151	15.82	2.72	34	14.85	3.64	0.684	0.162
Overall job satisfaction	151	73.41	11.57	34	66.22	0.64	0.640	0.831

Source: Primary Data

Note: 1. ** denotes significant at 1 % level

2. * denotes significant at 5% level





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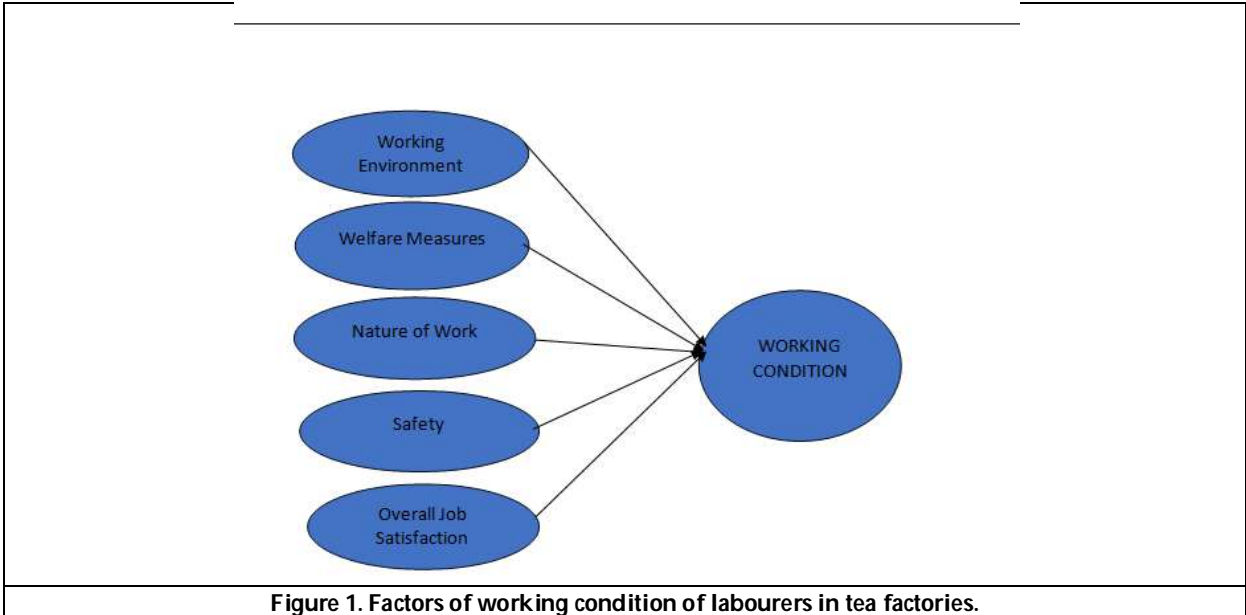


Figure 1. Factors of working condition of labourers in tea factories.





Effects of Therapeutic Taping on Functional Status in Peripheral Neuropathies: A Systematic Review with Meta-Analysis Protocol

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 06 Jun 2024

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ABSTRACT

Peripheral neuropathies are one of the most disabling and debilitating broad spectrum of syndromes. Diabetic peripheral neuropathy (DPN) and carpal tunnel syndrome (CTS) are two most eminent peripheral neuropathies characterized as pain and paraesthesia's throughout the distribution of involved nerve. Physiotherapy has been a gratuity for the conservative management of symptoms of peripheral neuropathies and is gaining applaudable vision by reducing neuropathic pain, improving proprioception, increasing muscular strength and functional status. In the modern era of physiotherapy, taping has come to the forefront and proved effective in reducing symptoms of peripheral neuropathies. The electronic databases: PubMed, Science Direct, Scopus, Knimbus, Springer, EBSCO and CINHALL will be searched from January 2013 to January 2024 using Boolean operators "OR" and "AND". Randomised controlled trials will be included in the review. Titles and abstracts of articles to be included in the study will be reviewed by two independent reviewers. Data will be analysed by comparing the mean change in difference, 95% confidence interval and p value for functional status. This systematic review and meta-analysis will highlight the effectiveness of taping in treating the symptoms of peripheral neuropathies and will aid in rehabilitation of peripheral neuropathies due to DPN and DPN associated CTS.

Keywords: Peripheral neuropathy, diabetic peripheral neuropathy, carpal tunnel syndrome, physiotherapy, taping, kinesiotaping



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INTRODUCTION

Peripheral neuropathies are one of the most common neurological disorder, having an annual incidence of 77 per 100,000 and a prevalence of 1-12% in all age groups. [1] Peripheral neuropathies comprises a broad spectrum of syndromes that can be classified according to the distribution across anatomical region and in the peripheral and nervous system. Mononeuropathies, multifocal neuropathies, and polyneuropathies are three main types of peripheral neuropathies that can be further subdivided according to the cause of the disease, the duration of the disease, and the type of neuropathy.[2] Diabetic Peripheral Neuropathy (DPN) and DPN associated Carpal Tunnel Syndrome (CTS) are the two most prevalent peripheral neuropathies. Polyneuropathy associated with diabetes is often characterized as painful, sensorimotor neuropathy with a slowly progressive course, although rapidly progressive painful neuropathies can also occur especially just after the start of insulin therapy. [3] 60-70% of the diabetic population experience mild to severe damage to the nervous system which leads to DPN that usually involves distal body parts and is characterized as distal symmetrical sensorimotor neuropathy which is progressive and follows a "glove and stocking pattern".[4,5] Polyneuropathy associated with CTS is considered mononeuropathy which is characterized by pain and para-aesthetic accusation throughout the distribution of a median nerve.[6,7,8] Women are more prone to CTS than men with 491/ 100,000 cases per year.[9] The surgical approach had been proven to be an effective outcome, especially in cases with long-standing cases but with the advancement of technologies conservative management has gained popularity as well proven an effective approach to treat CTS. Conservative management includes pharmacological agents, splinting, physiotherapy, and acupuncture and among all physiotherapy management has its own importance in managing the symptoms of CTS. [10] Physiotherapy has been a boon for the treatment of symptoms associated with polyneuropathies and the role of physiotherapy in improving symptoms of DPN and CTS has gained popularity by reducing neuropathic pain, improving proprioception, increasing muscular strength, improving quality of life, and functional status. It is a real need of the hour to gather all the existing literature stating the effectiveness of therapeutic taping in improving the functional status of patients with peripheral neuropathies to provide summarized data that may allow physiotherapy professionals to understand the beneficial effects of taping in improving the functional status of patients with DPN and DPN associated CTS.

OBJECTIVES

To determine the effectiveness of therapeutic taping on the functional status in patients with peripheral neuropathies.

REVIEW QUESTION

Does therapeutic taping have an impact on the functional status in patients with peripheral neuropathies?

METHODS

This review will be done in accordance with the recommendations of Preferred Reporting Items for Systematic Reviews and Meta-Analysis-P (PRISMA-P) [11] and is registered in International Prospective Register of Systematic Reviews (PROSPERO) (Id: CRD42022372677)

Literature Database Search

A comprehensive electronic literature searches will be conducted to gather the latest research evidence in context to taping as an intervention in patients with peripheral neuropathies. When all searched databases; PubMed, Science Direct, Scopus, Knimbus, Springer, EBSCO and CINHALL, allowed limits, searches will be restricted to (randomi*controlled trials) and (randomi* pilot trials) AND (physiotherapy OR physical therapy OR exercise therapy OR electrotherapy OR rehabilitation) AND (diabetic peripheral neuropathy) AND (carpal tunnel syndrome) OR (entrapment neuropathy) AND (tarsal tunnel syndrome) AND (chemotherapy induced peripheral neuropathy) AND (functional status) AND (therapeutic taping) OR (taping) with Boolean operators "OR" and "AND" to



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combine all search terms which will be used to identify relevant studies. The following filters will be used to limit the search – Year: January 2013 to January 2024; Language: English; Full-text.

Criteria for inclusion of studies

The studies will be included based on the following criteria:

Inclusion criteria

All available randomized trials will be included based on PICO method (participants, interventions, control group and outcome measures). Refer Table 1.

Exclusion criteria

Studies will be excluded if 1) they are published in any language other than English language 2) Any study designs other than randomized controlled trial.

Hand Searching

Hand searching of subject specific journals will be done to search any other study. At last, manually screening of reference list of included studies will be done.

Data Extraction

Two reviewers will independently screen and select titles and abstracts of relevant trials. Full text articles will be obtained and assessed for all potential eligible studies based on selection criteria. In the case of any discrepancy or dispute a third reviewer will be accessed to reach a final decision of included studies. All the retrieved articles will be exported and saved into Mendeley reference manager software.

Assessment of risk of bias of included studies

The Cochrane Risk of Bias Assessment Tool will be used to assess the risk of bias in the included studies. [12] High, low, and unclear risk of bias grades will be used. For inclusion in the systematic review, a study that followed an experimental procedure and applied any intervention to patients with peripheral neuropathy with a 11 item PEDro scale score of ≥ 5 will be included.

Assessment of methodological quality of included studies

The Physiotherapy Evidence Database (PEDro) scale (https://www.pedro.org.au/wp-content/uploads/PEDro_scale) for RCT will be used to evaluate the methodological quality and threat of bias of the included studies. Each domain of scale will be judged as low risk of bias, high risk of bias or uncertain. The scale has fair to good reliability for most of the items with intra-class correlation coefficient (0.56, 95% CI = 0.47 to 0.65). The methodological quality scores will be assigned as: 9-10 (high quality, low risk of bias); 6-8 (acceptable quality, moderate risk of bias); 3-5 (low quality, high risk of bias); 0-2 (unacceptable, reject).

Measurement of treatment effect

Data related to statistical information will also be extracted on the type of descriptive (e.g., mean, median) and inferential statistics (e.g., standard deviation, inter-quartile range, 95% confidence interval) used; type of tests (either parametric or non-parametric) used for hypothesis testing.

Data synthesis

The feasibility of meta-analysis will be expedited if included studies will exhibit no heterogeneity. All the included studies will be assessed statistically for between study heterogeneity using forest plot, I² statistics (Table 2) and Chi-square test [13] (Table 3). Sub-group analyses will be conducted in case heterogeneity exists between the studies. The data will be analysed by comparing the mean change, mean change in difference, 95 % confidence interval and p-value for quality of life, pain, and nerve conduction. All p-values ≤ 0.05 will be considered statistically significant. For the interpretation of the results, the level of evidence algorithm given by Van Tulder et al [14] will be used: Strong



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evidence - consistent findings among multiple high quality randomized controlled trials; Moderate evidence – consistent findings among multiple lower quality randomised controlled trials or controlled clinical trials or one high quality randomized controlled trial; Limited evidence – one lower quality randomised controlled trial or controlled clinical trial; Conflicting evidence – inconsistent findings among multiple randomised controlled trials; No evidence – No randomised controlled trials.

DISCUSSION

To the reviewer's best knowledge, this systematic review will be the first to determine the effectiveness of therapeutic taping on functional status. The findings of this study will allow the physiotherapist to get an insight into the therapeutic effects of taping in treating peripheral neuropathies and will allow timely and wise use of taping to prevent and treat the symptoms of peripheral neuropathies. The findings of this study will also fulfil the need for future research.

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Table 1: Inclusion criteria for review

PICO Process	Inclusion
Population	The review will consider studies if they included participants aged 18 years and above, both, males, and females, diagnosed with diabetic peripheral neuropathy and carpal tunnel syndrome Studies of DPN will be included if they included the participants having Hb1Ac of 6.5 and above and BMI less than 34. Studies of CTS will be included if they included the participants having symptoms of paraesthesia or pain in the distribution of median nerve distribution in hand, symptoms lasting longer than one month, and at least one of the Tinel, Phalen, or Reverse Phalen tests positive on physical examination.
Intervention	Intervention group should have received taping as an intervention in the affected area.
Comparison	Shamt aping Conventional physiotherapy treatment Not aping
Outcome Measure	Functional performance will be taken as an outcome measure which was assessed by Boston Carpal Tunnel Questionnaire in patients having CTS and 6-minutewalktest in patients having DPN.

Table 2 : I2 Test of Heterogeneity

I ²	Heterogeneity level
0%to 40%	Minimal
30%to 60%	Moderate
50%to 90%	Substantial
90%to 100%	Considerable

Table 3: Interpretation of Chi 2 test

Chi ²	Heterogeneity level
P<0.05	Strong likelihood of statistical heterogeneity
P=0.05<0.1	Likely to be heterogeneous
p>0.1	Not likely to be heterogeneous





Boundary Degree Equitable Dominating Set in Graphs

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 10 Jun 2024

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ABSTRACT

Let $G = (V, E)$ be a finite, simple, connected and undirected graph. Let $u, v \in V(G)$, where $V(G)$ is the vertex set of G . v is a boundary vertex of u if $d(u, w) \leq d(u, v)$ for all $w \in N(v)$. K.M. Kathiresan et. al. defined boundary dominating set of G . A vertex u boundary dominates a vertex v if v is a boundary vertex of u . A subset S of $V(G)$ is called a boundary dominating set if every vertex in $V - S$ is a boundary dominated by some vertex of S . (i.e) for every $v \in V - S$, there exists $u \in S$, such that v is a boundary vertex of u . The minimum cardinality of a boundary dominating set is called a boundary domination number of G and it is denoted by $\gamma_b(G)$. The maximum cardinality of a minimal boundary dominating set of G is denoted by $\Gamma_b(G)$. A subset D of $V(G)$ is a boundary degree equitable dominating set of G if for any $v \in V - D$ there exists a $u \in D$ such that v is a boundary vertex of u and also v and u are boundary degree equitable. (i.e) $|\deg_b(u) - \deg_b(v)| \leq 1$. The minimum cardinality of a boundary degree equitable dominating set of G is called the boundary degree equitable domination number of G and it is denoted by





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$\gamma_b^e(G)$. In this paper we introduce boundary degree equitable irredundant set and establish boundary degree equitable domination chain of graphs.

Keywords: Boundary degree, Boundary degree equitable dominating set, Private bdeneighbor, bde irredundant set.)
 2010 Mathematics Subject Classification .05C20.

INTRODUCTION

Let G be a non-trivial connected graph. We refer [1], for all basic graph definitions. The distance between two vertices $u, v \in V(G)$ is the length of the shortest distance between two vertices u and v . If a $u - v$ path is a $u - v$ geodesic, then for any neighbor w of u , $|d(u, v) - d(w, v)| \leq 1$. A vertex v is an eccentric vertex of u if v is at maximum distance from $u \in V(G)$, denoted by $e(u)$. If v is an eccentric vertex of u and w is a neighbour of v , then $d(u, w) \leq d(u, v)$. [2] The boundary neighbour of a vertex $u \in V(G)$ is v if v is a nearest boundary of u . A vertex u boundary dominate a vertex v if v is a boundary neighbor of u . The number of boundary neighbors of a vertex u is called the boundary degree of u . [3,4].

KM. Kathiresan et. al. [5] introduced and studied the concept of boundary domination in graphs. In this work, we define and study boundary degree equitable domination and boundary degree equitable irredundant sets and find the relationship between boundary degree equitable domination and these new parameters. In this Paper, Boundary Degree Equitable is abbreviated as bde.

Boundary Degree Equitable Dominating Set

Definition 2.1:

Let $v \in V(G)$. The boundary degree of v in G is the number of vertices u such that u is a boundary vertex of v and it is denoted by $deg_b(v)$. Also $N_b(v) = \{u \in V(G) : u \text{ is a boundary vertex of } v\}$.

Example 2.2:



$$N_b(v_1) = v_4, N_b(v_2) = v_1, v_4, N_b(v_3) = v_1, v_4, N_b(v_4) = v_1.$$

Definition 2.3:

Let G be a connected graph. Let $u \in V(G)$. The equitable boundary degree of $u \in G$ is the number of vertices $v \in G$ such that v is a boundary vertex of u and $|deg_b(u) - deg_b(v)| \leq 1$. The equitable boundary degree of $u \in G$ is denoted by $deg_b^e(u)$. Also $N_b^e(u) = \{v \in V(G) : v \text{ is a boundary degree equitable vertex of } u\}$.

Example 2.4:

- (a) let $G = K_{1,n}$. The Pendant vertices have equal boundary degree and hence they are equitable boundary degree vertices.
- (b) Let $G = P_n$. The end vertices of the path have equal boundary degree and the internal vertices have also equal boundary degree 0.
- (c) Let $G = K_{3,4}$. Let $V_1 = \{u_1, u_2, u_3\}$ and $V_2 = \{v_1, v_2, v_3, v_4\}$ be the partition of G . The boundary degree of any vertex of V_1 is 2 and the boundary degree of any vertex of V_2 is 3. Hence any vertex of V_1 is adjacent with any vertex of V_2 and also boundary degree equitable.





Definition 2.5:

Let G be a simple connected graph. A subset D of $V(G)$ is a boundary degree equitable dominating set of G if for any $v \in V - D$ there exists a $u \in D$ such that v is a boundary vertex of u and v and u are boundary degree equitable. (i.e) $|deg_b(u) - deg_b(v)| \leq 1$. The minimum cardinality of a boundary degree equitable dominating set of G is called the boundary degree equitable domination number of G and it is denoted by $\gamma_b^e(G)$. The maximum (minimum) of $deg_b^e(u)$ for $u \in V(G)$ is denoted by $\Delta_b^e(G)$. ($\delta_b^e(G)$).

Remark 2.6:

$$\gamma_b(G) \leq \gamma_b^e(G)$$

γ_b^e for some known classes of graphs:

- i. $\gamma_b^e(K_n) = 1$.
- ii. $\gamma_b^e(K_{1,n}) = \begin{cases} 1 & \text{if } n = 1 \\ 2 & \text{if } n \geq 2 \end{cases}$
- iii. $\gamma_b^e(K_{m,n}) = \begin{cases} 2 & \text{if } |m - n| \leq 1 \\ m + n - 2 & \text{if } |m - n| \geq 2 \end{cases}$
- iv. $\gamma_b^e(P_n) = n - 1$
- v. $\gamma_b^e(C_n) = \begin{cases} \lfloor \frac{n}{2} \rfloor & \text{if } n \geq 4 \\ 1 & \text{if } n = 3 \end{cases}$
- vi. $\gamma_b^e(W_n) = \begin{cases} \lfloor \frac{n-1}{2} \rfloor + 1 & \text{if } n \geq 5 \\ 1 & \text{if } n = 4 \end{cases}$
- vii. $\gamma_b^e(D_{r,s}) = 3$, where $r, s \geq 1$.
- viii. $\gamma_b^e(P) = 3$, where P is the Petersen graph
- ix. $\gamma_b^e(K_{n_1, n_2, \dots, n_r}) = r + 1$
- x. $\gamma_b^e(K_m(a_1, a_2, \dots, a_m)) = m + 1$

Remark 2.7:

Let G be a connected graph such that for any two vertices u, v either u is not a boundary vertex of v or $|deg_b(u) - deg_b(v)| \geq 2$. Then $\gamma_b^e(G) = n$.

Theorem 2.8:

If G is a connected graph with n vertices, then $\lfloor \frac{n}{1 + \Delta_b^e(G)} \rfloor \leq \gamma_b^e(G) \leq n - \Delta_b^e(G)$.

Proof:

Let u be a vertex of equitable boundary degree $\Delta_b^e(G)$. Then there exists $\Delta_b^e(G)$ vertices v such that v is a boundary vertex of u and $|deg_b(u) - deg_b(v)| \leq 1$. Let the $\Delta_b^e(G)$ - vertices be $\{v_1, v_2, \dots, v_{\Delta_b^e(G)}\}$. Let $D = V - \{v_1, v_2, \dots, v_{\Delta_b^e(G)}\}$. Therefore $|D| = n - \Delta_b^e(G)$. Clearly $u \in D$ and D is a bde dominating set of G . Therefore $\gamma_b^e(G) \leq |D| = n - \Delta_b^e(G)$. Let D be a minimum bde dominating set of G . Every $u \in D$ boundary equitably dominates atmost $\Delta_b^e(G)$ vertices of G and hence Δ_b^e - vertices of $V - D$. Therefore D bde dominates atmost $\Delta_b^e(G) \cdot |D|$ vertices of $V - D$. Therefore $|D| + \Delta_b^e(G) |D| \geq n$. Therefore $|D| \geq \lfloor \frac{n}{1 + \Delta_b^e(G)} \rfloor$. Hence $\lfloor \frac{n}{1 + \Delta_b^e(G)} \rfloor \leq \gamma_b^e(G) \leq n - \Delta_b^e(G)$.

Remark 2.9:

(i) In C_4 , $\Delta_b^e(C_4) = 1$ and $\gamma_b^e(C_4) = 2$. $\therefore \lfloor \frac{n}{1 + \Delta_b^e(C_4)} \rfloor = \lfloor \frac{4}{2} \rfloor = 2 = \gamma_b^e(C_4)$.

(ii) When $G = K_n, n \geq 3$, $\gamma_b^e(K_n) = 1$ and $\Delta_b^e(K_n) = n - 1$, $\therefore \gamma_b^e(K_n) = n - \Delta_b^e(K_n)$.





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Definition 2.10:

A boundary degree equitable dominating set D of a graph G is said to be a minimal boundary degree equitable dominating set if no proper subset of D is a boundary degree equitable dominating set of G .

Remark 2.11:

Any superset of a boundary degree equitable dominating set of a graph G is also a boundary equitable dominating set of G . Hence a boundary degree equitable dominating set is minimal if and only if it is 1-minimal.

Definition 2.12:

u is called a boundary equitable isolate if $N_b^e(u) = \emptyset$. (i.e) for every vertex $v \neq u$, u is not a boundary vertex of v or $|deg_b(u) - deg_b(v)| \geq 2$.

Theorem 2.13:

A boundary degree equitable dominating set D of a graph G is minimal iff for every vertex $u \in D$, any of the following condition holds.

- (a) u is not a bde vertex of any vertex of $D - \{u\}$ with respect to G .
- (b) there exists a vertex $v \in V - D$ such that u is the only vertex in D where v is a bde vertex of u .

Proof:

Let D be a minimal bde dominating set of G . Then for any $u \in D$, $D - \{u\}$ is not a bde dominating set of G . Therefore either u is not a bde vertex of any vertex of $D - \{u\}$ with respect to G or there exists a vertex $v \in V - D$ such that u is the only vertex in D satisfying the condition that v is a boundary vertex of u and bde vertex of u . Hence u satisfies condition (a) or (b). Conversely, suppose $u \in D$ satisfies (a) or (b) then clearly $D - \{u\}$ is not a bde dominating set of G . Therefore, D is a minimal bde dominating set of G .

Private Boundary Degree Equitable Neighbor

Definition 3.1:

Let u be a vertex in G . $N_b^e(u) = \{v \in V(G) : v \text{ is a boundary degree equitable vertex of } u\}$

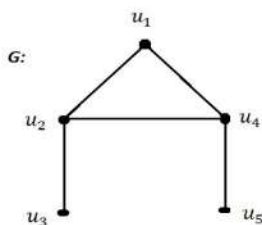
Definition 3.2:

Let S be a subset of $V(G)$. Then $N_b^e(S) = \cup_{u \in S} N_b^e(u)$.

Definition 3.3:

Let S be a subset of $V(G)$. $N_b^e[S] - N_b^e[S - \{u\}]$ is called the private bde neighbor of u with respect to S .

Example 3.4:



- (a) Let $S = \{u_2, u_5\}$. Then $N_b^e[\{u_2\}] \cup N_b^e[\{u_5\}] = \{u_2\} \cup \{u_1, u_3, u_5\} = \{u_1, u_2, u_3, u_5\}$
 $N_b^e[S - \{u_1\}] = N_b^e[S]$
 Therefore $N_b^e[\{u_1\}] = N_b^e[S] - N_b^e[S - \{u_1\}] = N_b^e[S] - N_b^e[S] = \emptyset$.
 Therefore u_1 has no private bde neighbour with respect to S .
 $N_b^e[S - \{u_2\}] = N_b^e[\{u_5\}] = \{u_1, u_3, u_5\}$
 Therefore $N_b^e[\{u_2\}] = N_b^e[S] - N_b^e[S - \{u_2\}] = \{u_1, u_2, u_3, u_5\} - N_b^e[\{u_5\}]$





$$= \{u_1, u_2, u_3, u_5\} - \{u_1, u_3, u_5\} = \{u_2\}.$$

Therefore u_2 is a private bde neighbour of u_2 with respect to S .

(b) Let $S = \{u_1, u_2, u_3, u_4, u_5\}$

$$N_b^e(S) = \cup_{u \in S} N_b^e(u)$$

$$= N_b^e[\{u_1\}] \cup N_b^e[\{u_2\}] \cup N_b^e[\{u_3\}] \cup N_b^e[\{u_4\}] \cup N_b^e[\{u_5\}]$$

$$= \{u_1, u_3, u_5\} \cup \{u_2\} \cup \{u_1, u_3, u_5\} \cup \{u_4\} \cup \{u_1, u_3, u_5\}$$

$$= \{u_1, u_2, u_3, u_4, u_5\}$$

$$N_b^e[S - \{u_1\}] = N_b^e[\{u_2, u_3, u_4, u_5\}] = \{u_1, u_2, u_3, u_4, u_5\}$$

Therefore u_1 has no private neighbour with respect to S .

$$N_b^e[S - \{u_2\}] = N_b^e[\{u_1, u_3, u_4, u_5\}] = \{u_1, u_3, u_4, u_5\}$$

$$N_b^e[S] - N_b^e[S - \{u_2\}] = \{u_2\}$$

Therefore u_2 is a private bde neighbour of u_2 with respect to S .

Remark 3.5:

Suppose u is a private bde neighbour of v with respect to S . Then u is not a bde vertex of any vertex of S other than itself.

Remark 3.6:

S is a minimal bde dominating set of G if and only if for any $u \in S$, u is not a bde vertex of any vertex of $S - \{u\}$ or there exists a vertex $v \in V - S$ such that v is a bde vertex of only $u \in S$.

Theorem 3.7:

A graph G has a unique minimal boundary degree equitable dominating set if and only if the set of all boundary equitable isolates forms a bde dominating set of G .

Proof:

Let G have a unique minimal bde dominating set D (say). Let S be the set of all boundary equitable isolates of G . Therefore S is a subset of D . Suppose $D - S \neq \emptyset$. Let $v \in D - S$. Therefore v is not a boundary equitable isolate. Therefore $N_b^e(v) \neq \emptyset$. (i.e) there exists $u \in V$ such that u is a boundary equitable vertex of v . Therefore u is a boundary vertex of v and $|deg_b(v) - deg_b(u)| \leq 1$. Therefore $V - \{u\}$ is a bde dominating set of G . Let D_1 subset of $V - \{u\}$ be a minimal bde dominating set of G . Since $u \in D$ and $u \notin D_1$, there exists a minimal bde dominating set of G different from D , a contradiction to the uniqueness of D . Therefore $D - S = \emptyset$. (i.e) $D = S$. Therefore the set of all boundary equitable isolates of G forms a bde dominating set of G . Conversely, suppose the set of all boundary equitable isolates of G , S (say) forms a bde dominating set of G . Let D be a minimal bde dominating set of G . Then $S \subseteq D$. But S is a bde dominating set of G and D is minimal. Therefore $D = S$. Therefore D has a unique minimal bde dominating set of G .

Theorem 3.8:

Let G be a graph without boundary equitable isolate vertices. (i.e) for any $u \in V$, there exists $v \in V$ such that u is a boundary of v and $|deg_b(v) - deg_b(u)| \leq 1$. If D is minimal bde dominating set of G then D is a bde dominating set of G .

Proof:

Let D be a minimal bde dominating set of G . Let u be a boundary equitable isolate of D . Therefore u has a boundary equitable neighbour in $V - D$ (since D has no boundary equitable isolates). Suppose u is not a boundary equitable isolate of D . Since D is minimal, for any $u \in D$, either u is not a bde vertex of any vertex of $D - \{u\}$ or there exists a vertex $v \in V - D$ such that u is the only vertex in D where v is a bde vertex of u . Since u is not a boundary equitable isolate of D , the condition (i) is not satisfied. Therefore u is boundary dominated by v and u and v are bde. Therefore $V - D$ is a bde dominating set of G .





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Remark 3.9:

If G has no boundary equitable isolate, then $\gamma_b^e(G) \leq \frac{n}{2}$.

For:

Let D be a minimum bde dominating set of G . Then $V - D$ is a bde dominating set of G . Therefore $\gamma_b^e(G) \leq |V - D| = n - |D| = n - \gamma_b^e(G)$.

Therefore $2\gamma_b^e(G) \leq n$. (i.e) $\gamma_b^e(G) \leq \frac{n}{2}$.

Remark 3.10:

When $G = C_4$, $\gamma_b^e(G) = 2 = \frac{4}{2} = \lfloor \frac{V(G)}{2} \rfloor$.

Definition 3.11:

Let G be a connected graph. Let $S \subseteq V(G)$ such that for any $u \in S$, any of the following two conditions holds.

- (a) u is not a bde vertex of any vertex of $S - \{u\}$ with respect to G .
- (b) there exists a vertex $v \in V - S$ such that u is the only vertex in S where v is a bde vertex of u .

Then S is called bde irredundant set of G . The maximum (minimum) cardinality of a maximal bde irredundant set of G is denoted by $IR_b^e(G)$. ($ir_b^e(G)$).

Remark 3.12:

A minimal bde dominating set of G is a bde irredundant set of G .

Theorem 3.13:

Let G be a connected graph. The property of bde irredundance is hereditary.

Proof:

Let S be a bde irredundant set of G . Let $T \subseteq S$. Let $u \in T$. Then $u \in S$. Therefore u satisfies one or both of the following two conditions.

- (a) u is not a bde vertex of any vertex of $S - \{u\}$ with respect to G .
- (b) there exists a vertex $v \in V - S$ such that u is the only vertex in S where v is a bde vertex of u . Suppose u satisfies (a). Then u is not a bde vertex of any vertex of $S - \{u\}$ and hence u is not a bde vertex of any vertex of $T - \{u\}$. Suppose u satisfies condition (b) then there exists a vertex $v \in V - S$ such that u is the only vertex in S where v is a bde vertex of u . Since $V - T \supseteq V - S$, $v \in V - T$. Since $T \subseteq S$ and u is the only vertex in S where v is a bde vertex of u , u is the only vertex in T where v is a bde vertex of u . Hence T is a bde irredundance set of G . Hence the theorem.

Theorem 3.14:

A minimal bde dominating set of G is a maximal bde irredundant set of G .

Proof:

Let D be a minimal bde dominating set of G . Then D is a bde irredundant set of G . Suppose D is not a maximal bde irredundant set of G . Then there exists $u \in V - D$ such that $D \cup \{u\}$ is a bde irredundant set of G . Therefore u satisfies either or both of the two conditions given below.

- (i) u is not a bde vertex of any vertex of $D \cup \{u\} - \{u\}$ with respect to G . (i.e) u is not a bde vertex of any vertex of D , a contradiction, since $u \in V - D$ and D is a minimal bde dominating set.
- (ii) there exists a vertex $v \in V - (D \cup \{u\})$ such that u is the only vertex in $D \cup \{u\}$ where v is a bde vertex of u . Since D is a bde dominating set, there exists a vertex $w \in D$ such that v is a bde vertex of w , clearly $w \neq u$, since $u \in V - D$ and $w \in D$, a contradiction. Since u is the only vertex in $D \cup \{u\}$, where v is a bde vertex of u . Therefore D is a maximal bde irredundant set of G .





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Remark 3.15:

For any Graph G , $ir_b^e(G) \leq \gamma_b^e(G) \leq \Gamma_b^e(G) \leq IR_b^e(G)$.

This inequality is called boundary degree equitable domination chain of graph G .

DISCUSSIONS AND CONCLUSIONS

In this work, we defined boundary degree equitable dominating set in the connected graph G . We also defined the private bde neighbour and as well as bde irredundance. Moreover, in this study we provided a bde relation between domination number and irredundance number. (i.e) $ir_b^e(G) \leq \gamma_b^e(G) \leq \Gamma_b^e(G) \leq IR_b^e(G)$. The further work is going on the bde covering and bde independence number.

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Effective Heart Failure Prediction - A Comparative Experimental Analysis

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

The cardio-vascular failure may be the blood vessel failure or any kind of coronary heart failures which is commonly referred as heart attacks. This happens when the heart is unable to pump the blood though out the body which lead to this adverse situation. In this paper we predict the causes of these heart failure with the 14 salient features. we present a prediction based on analysis in the UCI dataset. The reasons behind the heart failure analysis were also studied and the effective classification with the results analysis were presented

Keywords: Cardiac failure, Feature ranking, classification

INTRODUCTION

The heart is the most vital part of the human body. The heart enable the blood circulation throughout the body[1,2] . Any kind of heart diseases prevent the proper blood flow and it even results in fatal death[16]. There are so many traditional approaches to find out the heart failure[14] . Analyzing using the traditional methods are time consuming and found not so effective as per the studies. In this paper we present the parameters which influence the cardio vascular diseases and present the analysis of the same. There are different studies carried out in the literature for

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heart failure prediction through the patient history or family history[6,7,8]. Each classification has its own pros and cons. The inclusion of the various machine learning algorithms seem to improve the accuracy of the heart failure prediction[15]. This manuscript is organized in a way to perform the comparative analysis the different classification methods and to observe the efficient accuracy with the available methods. The dataset with 303 samples with various history of symptoms were studied for this research. The experimental evaluation found that the accuracy remains varied with the various classification methods[9,10]. The study and usage of the best algorithm with the available dataset is also presented

Background

researchers have explored various methods to predict the heart failures. The methodologies includes a wide range of spectrum not limited to ANN, SVMetc[3]. The Artificial Neural Network found to be studied in various methods in the literature. The FDSS based system is proposed to predict the heart diseases[1]. This technique uses the genetic algorithm. Followed by which few research studies were carried out on the coronary artery disease(CAD). The jeopardy factor were considered here for analysis[11,12,13]. There is always a research focus towards a proper classifying or a predicting technique . so the focus towards the mining of information received its primary focus . based on the studies there found eleven major influencing factors towards the heart diseases. They are the age, Anemic nature, being diabetic, ejection_fraction[2], platelet count, serum_creatinine, creatinine_phosphokinase, serum_sodium, sex, the habit of smoking. These are considered as the major influencing factors. Based on these assumption the classification techniques are applied and the findings are reported in the next section

Experimental Evaluation

For the experimental evaluation we have considered UCI heart disease dataset, we have the sample of 303 individuals. The following figure 3.1 shows the information of our dataset which depict sthe 14 main influencing parameters. These parameters are used to get idea about the features available in the dataset. As we can see in the figure, The UCI dataset has a total of 14 influential features which. The understanding n depth about the parameters are presented below. The age is represented in years. The values 1 and 0 is assigned to the male and female categorization in the sex respectively. The cp denote the chest pain. Here the 0 and 1 denote the typical and atypical angina, Value 2 represents the non-anginal pain and value 3 denote the asymptomatic syndrome. Trest bps indicates the resting blood pressure in mm Hg on admission to the hospital. Chol serum indicates cholesterol in mg/dl. The fasting blood sugar level is checked if it is greater than 120 mg/dl. If it is true then value is denoted as 1 and 0 otherwise. Resting electrocardiographic results (Value 0: normal; Value 1: having ST-T wave abnormality; Value 2: probable or definite left ventricular hypertrophy).Maximum heart rate achieved is represented as thalach. Exang denotes exercise induced angina (1 = yes; 0 = no). old peak indicate the ST depression induced by exercise relative to rest. The slope of the peak exercise ST segment (Value 0: up sloping; Value 1: flat; Value 2: down sloping).ca indicate the number of major vessels (0-3).thal thalassemia (3 = normal; 6 = fixed defect; 7 = reversable defect). heart disease (0 = no, 1 = yes) is the target. Based on the available information present in the dataset and according to the previous studies, the machine learning techniques were examined and the inferences were recorded.

These two are the major driver of the heart failure. In the following subsections, we analyse the dataset on a whole and predict the outcome from it and then the results are presented. This dataset includes 303 random people, 165 of whom have heart disease and 138 of whom have a healthy heart. The information is gathered in a similar confined context. They range in age from 29 to 77. The study observed from the UCI dataset is depicted in the figure 1 Many research reported in the literature have primarily used the ejection fraction and the serum creatinine. Unlike those studies, the results have been obtained by all the parameters and the level of influence with the other factors is also calculated. Here in the above figure, we can see there is a positive correlation between chest pain (cp) & target (our predictor). This makes sense since, The greater amount of chest pain results in a greater chance of having heart disease. Cp (chest pain), is an ordinal feature with 4 values: Value 1: typical angina ,Value 2: atypical angina, Value 3: non-anginal pain , Value 4: asymptomatic. In addition, we see a negative correlation between exercise induced angina (exang) & our predictor. This makes sense because when you exercise, your heart requires more blood, but narrowed arteries slow down blood flow. Gender diversity is also considered, with 54 percent of test subjects being

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male and 46 percent being female. The type of chest pain (cp), exercise-induced angina (exang), ST depression induced by exercise relative to rest (oldpeak), the slope of the peak exercise ST segment (slope), the number of major vessels (0-3) coloured by flourosopy (ca), and thalassemia (thal) are all directly correlated with the heart disease (target) in the above correlation plot. We also detect an inverse relationship between heart disease and maximum heart rate (thalch). Hence the influence of one single parameter with our estimated prediction has to be recorded in detail. This study is carried out in order to understand the significance of each and every factor which may or may not lead to a adverse situation which is many time un believable. Form the available information, it is evident that it can be either one parameter or the influence of one parameter at large combined with the other parameters which leads to the target. General observations can also be done as when the parameter age is considered, the most chances of getting the failure in heart is for the old people than the younger ones. The study observed is presented as fig 2 To further identify the correlation between the parameters the following graph has been plotted. The correlations between the major factors and their percentage of impact towards the Heart disease can be seen. This is mainly done to understand if there is positive or negative correlation between them we have a smaller pairplot with only the continuous variables. As presented in the previous section of this paper, the age factor is primarily considered and presented in detailed. The correlation plot between the age and the heart rate is depicted below in fig 3 From the fig we can say that the people have higher impact towards heart diseases as the age increases. This is again a study inferred from the data samples available . This is subject to be different for different sample size and the parameters. Similarly the inferences varies according to various factors . Each parameter has its significant impact towards the health of the heart. The influence of age alone is presented in fig 3

RESULTS AND INFERENCES

The experiments were carried out with the machine learning techniques and the deep learning techniques. The experimental evaluations were done and the observations were presented. The measurement in terms of Accuracy, Cross Validation Score and the ROC_AUC score were evaluated. The K observations of K neighbor algorithm is presented in fig 4 The accuracy obtained is 81.52 % . The cross validation score is 89.52% and the ROC_AUC is 81.36 The support Vector classifier(SCV) is performed to which resulted with the accuracy of 83.15%, The Cross validation score is 91.68% and the ROC_AUC score is obtained as 82.97 % The Random Forest classifier is performed to which resulted with the accuracy of 82.61%, The Cross validation score is 92.64% and the ROC_AUC score is obtained as 82.41 % The Decision Tree classifier is performed to which resulted with the accuracy of 79.35%, The Cross validation score is 79.13% and the ROC_AUC score is obtained as 79.22 % The Gradient Booster classifier is performed to which resulted with the accuracy of 83.70%, The Cross validation score is 92.08% and the ROC_AUC score is obtained as 83.61 % The AdaBoost classifieris performed to which resulted with the accuracy of 84.78%, The Cross validation score is 90.09% and the ROC_AUC score is obtained as 84.77 % The Gaussian Naïve Based classifieris performed to which resulted with the accuracy of 85.87%, The Cross validation score is 91.36% and the ROC_AUC score is obtained as 85.75 % The XGBoost classifieris performed to which resulted with the accuracy of 84.24%,

The Cross validation score is 91.93% and the ROC_AUC score is obtained as 84.13 % The results inferred from various classifier were presented in Table 1. The measurement such as accuracy, cross validation score and the ROC_AUC scores were presented in Table. After successfully establishing the relationship between the influencing factors studies for heart failure prediction in the UCI data set. we have implemented machine learning algorithms like Random Forest, Decision Tree, Gradient Boosting, ADA Boosting, Naive Bayes, Support Vector, XG Boosting. From the said models the following observations are made The metrics used for the evaluation are Precision, CVS-score, Accuracy and Recall and ROC-AUC Score. These are the major evaluation metrics. These are applied to the sample dataset and the observations are tabulated in table 4.1. The classification accuracy shown in the above chart shows that the Naive Bayes model is getting the best precision value the 85% accuracy of is the maximum amongst all, Feature Importance provides a score that indicates how helpful each feature was in our model. The higher the Feature Score, the more that feature is used to make key decisions & thus the more important it is. so from the above image we can say that the chest pain, thalach level, no of major vessels colored by fluoroscopy, and oldpeak values





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are the most important factors to classify that the target have the heart disease or not, while fasting blood sugar, resting ecg, and sex of the target does not effect the prediction that much. Moreover, we haven't considered the lifestyle parameters here which also have a major effect on the health of the heart, like the habit of smoking and drinking alcohol. The accuracy of the prediction can vary if we include these parameters as well as exercise habits. The ultimate motive towards this study is to understand the influencing parameters that causes the cardiac arrest. The most common methods of prediction are explained in the paper. The findings as per the results obtained in the previous studies were also presented

CONCLUSION

This paper focused on the dataset of 303 individual with the factors influencing the heart failure prediction. The most efficient and the appropriate algorithm for the heart failure prediction is experimentally proved and presented. The subsections are planned as the data set description, we have chosen from the UCI database and the 14 major influencing parameters are studied. The influencing parameters were analyzed and the prediction made were also compared . The effectiveness of the cardio vascular failure prediction and the works carried out with that data is analyzed and the implementation of the most commonly suggestion methods are visualized.

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Table 1: Results and Observations

Method	CVS Score	Accuracy	ROC-AUC Score
Random Forest	92.64	82.61	82.41
Decision Tree	79.35	79.22	79.13
Gradient Boosting	92.08	83.70	83.61
ADA Boosting	90.09	84.78	84.77
Naïve Bayes	91.36	85.87	85.75
SVC	89.34	81.52	81.36
XG Boost	91.93	84.24	84.13

	count	mean	std	min	25%	50%	75%	max
Age	918.00	53.51	9.43	28.00	47.00	54.00	60.00	77.00
RestingBP	918.00	132.40	18.51	0.00	120.00	130.00	140.00	200.00
Cholesterol	918.00	198.80	109.38	0.00	173.25	223.00	267.00	603.00
FastingBS	918.00	0.23	0.42	0.00	0.00	0.00	0.00	1.00
MaxHR	918.00	136.81	25.46	60.00	120.00	138.00	156.00	202.00
Oldpeak	918.00	0.89	1.07	-2.60	0.00	0.60	1.50	6.20
HeartDisease	918.00	0.55	0.50	0.00	0.00	1.00	1.00	1.00

Fig 1: Data inferred from UCI dataset

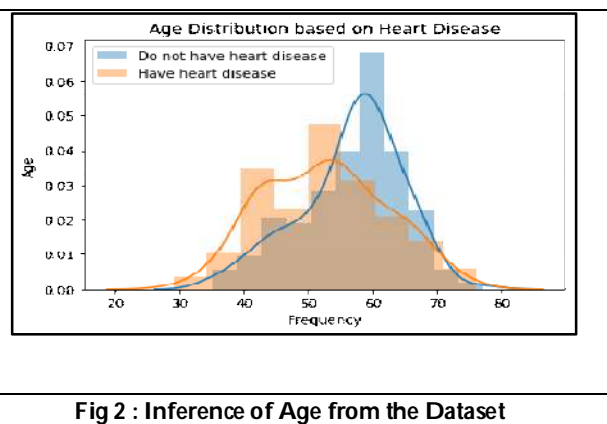


Fig 2 : Inference of Age from the Dataset





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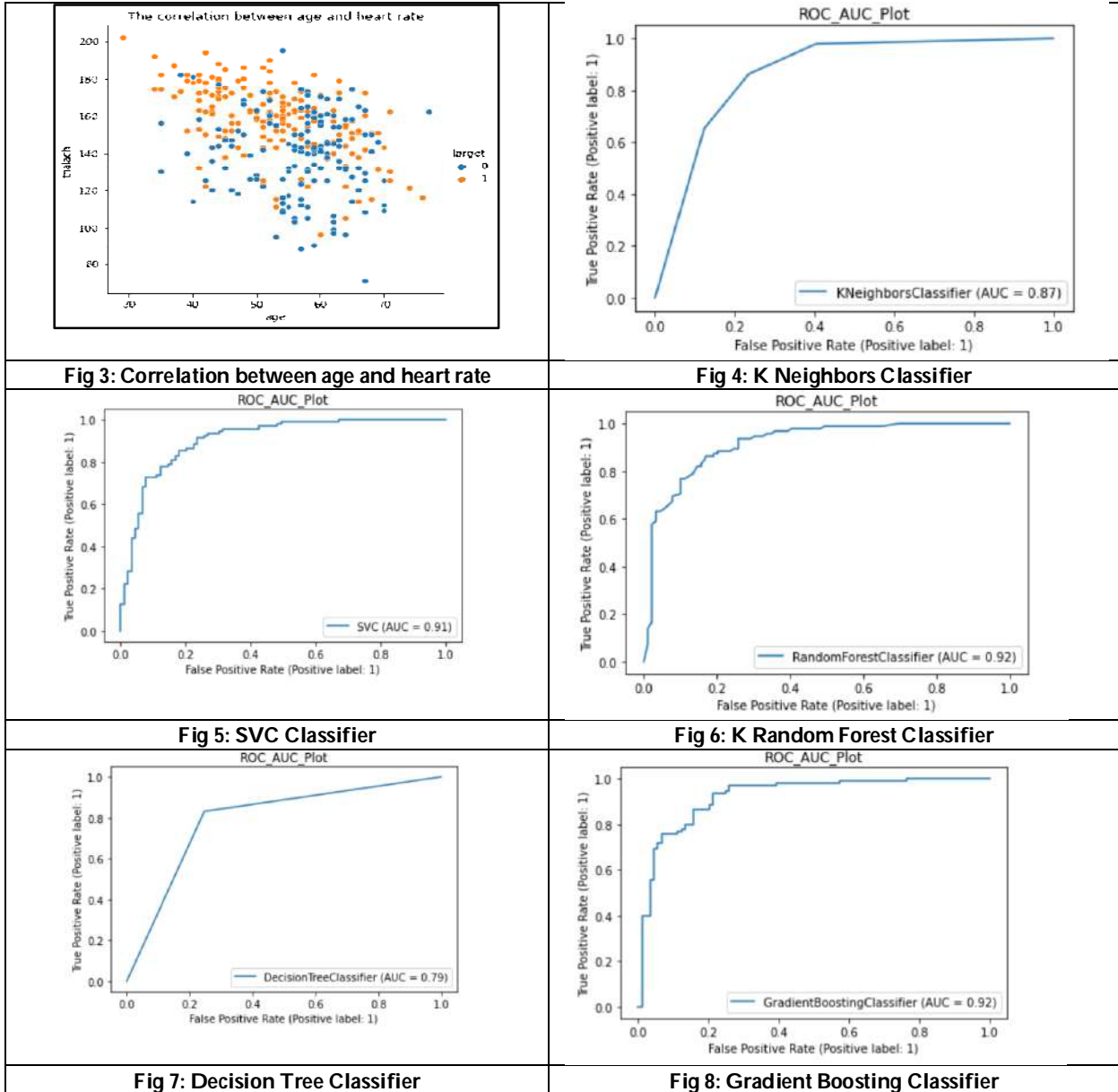


Fig 3: Correlation between age and heart rate

Fig 4: K Neighbors Classifier

Fig 5: SVC Classifier

Fig 6: K Random Forest Classifier

Fig 7: Decision Tree Classifier

Fig 8: Gradient Boosting Classifier





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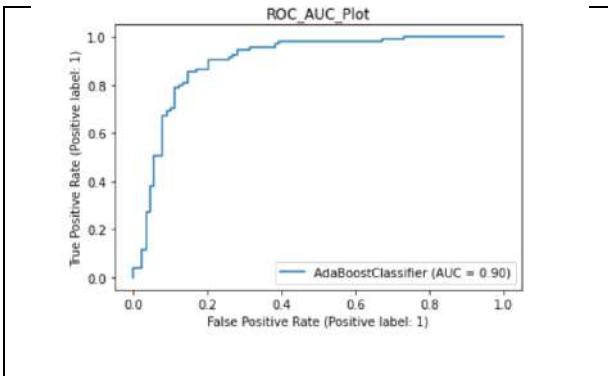


Fig 9: AdaBoost Classifier

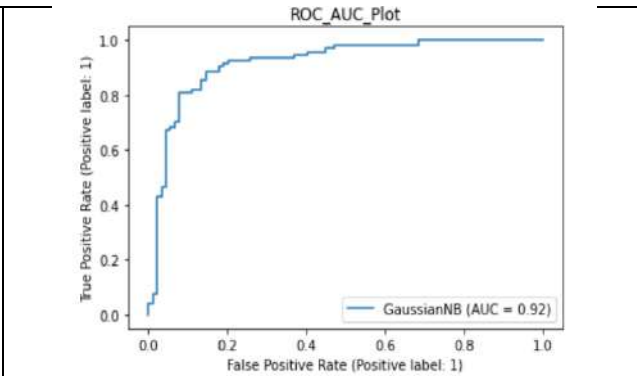


Fig 10: Gaussian NB Classifier

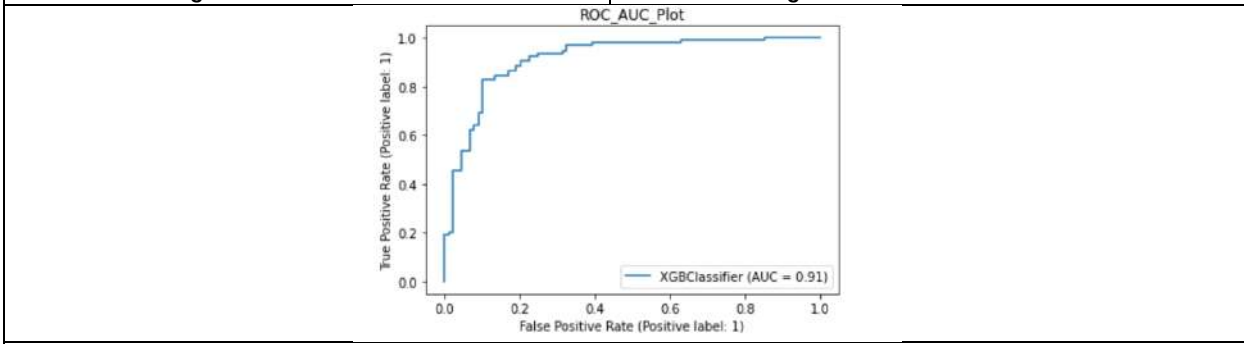


Fig 11: XGB Classifier





Effect of Various Plant Growth Regulators (PGRs) and Nutrients on Chlorophyll Content Index (SPAD Value) and Nutrient Uptake of Transplanted Rice

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

A field experiment was conducted during May - September 2022 at the Experimental Farm of Agronomy, Annamalai University, Annamalai Nagar, Tamil Nadu to study the effect of plant growth regulators and nutrients on growth and yield of transplanted rice under wetland ecosystem. The rice variety ADT - 43 is used as test variety for this experiment. The experiment was laid out in RBD with ten treatments and replicated thrice with ten treatments it including foliar Spray of plant growth regulators viz., Gibberellic acid, Triacontanol, Sodium para - nitrophenolate and macro nutrients like DAP, KCl and NPK (19:19:19). Among the treatments, gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) + 2% DAP + 1% KCL (40 and 50 DAT) significantly recorded the higher Plant height (58.95, 89.15,101.43 cm), chlorophyll content index (42.75), number of tillers m⁻² (421.03 m⁻²), panicle length (27.67 cm), grain yield (6485.25 kg ha⁻¹), NPK uptake (137.42, 26.58 and 144.78 kg ha⁻¹). However, least available post-harvest soil nutrients of NPK (226.65, 18.09 and 235.11 kg ha⁻¹) was registered in this treatment.



**Dhayanethi et al.,****Keywords:** Rice, Foliar application, GA₃, DAP, KCL, chlorophyll content index, NPK uptake.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important and extensively grown crop in tropical and subtropical regions of the world. It is the staple food for over 70 per cent of the world's population and it is extremely important for country's food and livelihood security. Globally, the output of rice has increased by more than thrice between 1961 and 2019, from 215 million tonnes to 75 million tonnes, with Asia accounting for most of the growth. More than 80% of the world's rice is produced in seven Asian nations viz., China, India, Indonesia, Bangladesh, Vietnam, Myanmar and Thailand. The current growth rate in rice production, standing at 0.36%, falls significantly below the population growth rate of 1.63% per annum. This disparity raises concerns as the decelerating trend in production and yields needs to be reversed to meet the escalating demand. Thus, the adoption of new technologies becomes imperative to boost rice production and address the needs of a rapidly increasing population. Consequently, there is an urgent requirement to enhance rice productivity through improved agronomic practices, one of which includes the foliar application of plant growth regulators (PGRs) and NPK fertilizers to fully exploit the genetic potential of rice crop. Plant growth regulators (PGRs) offer great potential, but their effective use demands meticulous planning. This includes establishing the optimal concentration, timing of application, and appropriate seasons. Nutrients are also crucial for plant metabolism, growth, and development, leading to increased biomass production and better yields. Hence, a strategic approach is vital for maximizing the benefits of both PGRs and foliar nutrients (Kunjammal and Sukumar, 2020). Gibberellic acid, triacontanol, and sodium para - nitrophenolate are well-known for their various roles in promoting plant growth and development by Ramesh *et al.* (2019b) and Suseendran *et al.* (2020). NPK fertilizers applied through aerial portion play a pivotal role in increasing the grain yield in many crops (Solanki *et al.*, 2022). Hence the field experiment was conducted with the objective to find out the effect of various plant growth regulators and nutrients on chlorophyll content index (SPAD value) and nutrient uptake of transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted during May - September (2022) at the Agronomy Experimental Farm, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu. The experimental farm was geographically located at 11° 24' N latitude and 79° 44' E longitude and at an altitude of +5.79 m above mean sea level (MSL). The soil is clay loam, low in available nitrogen 249.22 kg ha⁻¹, medium in available phosphorus 19.78 kg ha⁻¹ and high in potassium 334.94 kg ha⁻¹. The promising rice variety ADT 43 was chosen for the study. The experiment was laid out in randomized block design and replicated thrice with ten treatments including foliar application of plant growth regulators (20 DAT) and nutrients (40 and 50 DAT) viz., T₁ - Control (water spray), T₂ - Gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT), T₃ - Triacontanol 0.05% EC @ 250 ml ha⁻¹ (20 DAT), T₄ - Sodium para -nitrophenolate 0.3% SL @ 2.5 L ha⁻¹ (20 DAT), T₅ - T₂ + 2% DAP + 1% KCL (40 and 50 DAT), T₆ - T₂ + 2% NPK (19:19:19) (40 and 50 DAT), T₇ - T₃ + 2% DAP + 1% KCL (40 and 50 DAT), T₈ - T₃ + 2% NPK (19:19:19) (40 and 50 DAT), T₉ - T₄ 2% DAP + 1% KCL (40 and 50 DAT) and T₁₀ - T₄ + 2% NPK (19:19:19) (40 and 50 DAT). The rice crop was fertilized with the recommended dose of fertilizer (120:40:40 kg of N, P₂O₅ and K₂O ha⁻¹) in the form of Urea (46% N), SSP (16% P₂O₅) and MOP (60% K₂O). N and K₂O were applied in four equal splits viz., basal, tillering, panicle initiation and heading stages of rice. The entire dose of P₂O₅ was applied basally before transplanting. Twenty one days old rice seedlings were transplanted @ 2 seedlings hill⁻¹ with a spacing of 15 × 10 cm. Growth regulators viz. gibberellic acid, triacontanol and sodium para - nitrophenolate were foliar spraying during morning hours at 20 DAT and nutrients like 2% DAP+ 1% KCL and 2% NPK foliar spray at 40 and 50 DAT with the help of hand operated knapsack sprayer. The SPAD values were recorded as described by Peng *et al.* (1993) using the chlorophyll meter (SPAD - 502, Soil Plant analysis Development Section, Minolta Camera Co. Ltd., Japan). The readings were recorded on the third leaf from the top of five randomly chosen tagged plants at flowering stage of the crop. Five sample plants in each plot were



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selected at random and peg marked permanently for recording biometric observations. The experimental plots were harvested leaving the border rows to avoid border effect. The plant sample used for dry matter estimation at harvest were chopped and ground into fine powder by using a willey mill and used for chemical analysis of N, P₂O₅ and K₂O. The percentage of nutrients in the plants was multiplied with crop biomass for the uptake of nutrients and expressed in kg ha⁻¹. The analysis was carried out following standard procedures as given in Table 1a. After the harvest of crop, post-harvest soil samples drawn from each plot were air dried and gently beaten with a wooden mallet and sieved through 2 mm nylon sieve mesh. Then the soil samples were analyzed and expressed in kg ha⁻¹. The analysis was carried out following standard procedures as given in Table 1b.

RESULT AND DISCUSSION

Plant height

Foliar application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) (T₅) recorded the higher plant height of 58.95, 89.15 and 101.43 cm at 30, 60 DAT and harvest stage. One possible explanation for this phenomenon could be that applying gibberellins to the leaves enhances cellular processes such as division, enlargement, and elongation. Consequently, this leads to increased plant height reported by Nataraj *et al.* (2016). Additionally, the mentioned plots were supplemented with nutrients via foliar feeding, including DAP and KCL, which improved the accessibility of both micro and macro nutrients during the entire growth cycle of the crops. This likely facilitated enhanced translocation into the plants without any wastage, leading to improved photosynthetic activity and ultimately resulting in a notable increase in plant height. Similar findings were reported by Deepak kumar *et al.* (2018). This was statistically followed by application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% NPK (19:19:19) (40 and 50 DAT) (T₆). The lowest plant height was observed under control (T₁) which recorded the plant height of 48.02, 69.92 and 78.97 cm at 30, 60 DAT and harvest stage, respectively.

Chlorophyll content index (SPAD value)

Foliar application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) (T₅) recorded the highest chlorophyll content index value of 42.75. The increase in chlorophyll content might be due to the combined effect of growth hormone and macronutrients. Gibberellic acid and nutrients in activating the enzyme for the synthesis of pigments, cell division and morphogenesis, protecting the chlorophylls from degradation by chlorophyllase enzyme and also direct absorption of nutrients as constituents of chlorophylls. Addition of nitrogen increased chlorophyll formation since chlorophyll contains nitrogen as one of its constituents and nitrogen prevented chlorophyll degradation and leaf senescence recording higher chlorophyll content (Mahmoodi *et al.*, 2020). Besides, macronutrients received in this treatment it helps to synthesis of protein in plants get accelerated, which is indirectly exhibited by increase in leaf chlorophyll index. Similar result was reported by jothi *et al.* (2017). The next best in ranking of foliar application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% NPK (19:19:19) (40 and 50 DAT) (T₆) with SPAD value of 40.84. The least SPAD value of 29.69 was observed in the control treatment (T₁).

Number of tillers m⁻²

The maximum number of tillers increased by foliar application of gibberellic acid 40% WSG @ 20 g/ha (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) (T₅) recorded the highest number of tillers m⁻² of 421.03. This could be attributed to the external use of gibberellic acid could potentially enhance the development of axillary buds, leading to the emergence of multiple shoots from individual nodes, thereby increasing the number of tillers per square meter as reported by Geeta Pandey *et al.*, (2017). In addition, application of NPK fertilizers could enhance nutrient accessibility within plant tissues and uptake from the soil, potentially boosting photosynthetic rates and facilitating efficient transfer of photosynthates from the source to the shoot, ultimately leading to an increased number of tillers reported by Ajay kumar *et al.* (2020). The next best was foliar application of gibberellic acid 40% WSG @ 20 g/ha (20 DAT) along with 2% NPK (19:19:19) (40 and 50 DAT) (T₆) with number of tillers m⁻² of 408.15. The lowest number of tillers m⁻² of 314.99 was registered under control (T₁).



**Dhayanethi et al.,****Panicle length and grain yield**

Application of gibberellic acid 40% WSG @ 20 g/ha (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) (T₅) significantly recorded higher panicle length 27.67 cm and grain yield of 6485.25 kg/ha. might be attributed to application of GA₃ increase the biomass production at early stages of crop growth leading to higher LAI and photosynthetic rate resulting in better performance as evident by number of tillers m⁻² and panicle length which leads to registered maximum grain yield of rice (Ramesh *et al.*, 2019a). Furthermore, foliar application of N, P and K increased the rice grain yield and straw yield owing to an increase the higher nutrient uptake resulting in higher growth attributes (plant height, tiller production and LAI) and yield attributes (number of panicles m⁻², panicle length and filled grains per panicle). These results are in conformity with Akchaya *et al.* (2022). This treatment was followed by the application of gibberellic acid 40% WSG @ 20 g/ha (20 DAT) along with 2% NPK (19:19:19) (40 and 50 DAT) (T₆) with panicle length of 26.34 cm and yield of 6260.42 kg/ha. The least panicle length of 18.49 cm and grain yield of 4549.06 kg/ha were recorded under water spray (T₁).

Nutrient uptake

Among the various treatments, foliar application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) (T₅) recorded significantly higher values of nutrient uptake of 137.42, 26.58 and 144.78 kg ha⁻¹ of N, P and K, respectively. The possible reason could be attributed to supplemental nutrition through foliar spray along with plant growth regulators encouraged proliferation of root system resulting in better absorption of water and nutrients from deeper layer and consequently resulting in higher DMP, which have directly reflected on higher NPK uptake. This was in accordance with the findings of Sandhya Rani *et al.* (2014). The next higher nutrient uptake treatment is foliar application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% NPK (19:19:19) (40 and 50 DAT) (T₆) with the nutrient uptake of 132.65, 25.52 and 139.61 kg ha⁻¹ of N, P and K, respectively. The least values of nutrient uptake of 101.25, 17.02 and 109.20 kg ha⁻¹ of N, P and K were recorded under control (T₁).

Post harvest soil nutrient status

Among the various treatments, control (T₁) recorded the highest post harvest soil available N, P and K of 238.75, 22.56 and 263.31 kg ha⁻¹, respectively. This might be due to lower DMP and least uptake of nutrients registered in this treatment resulting in higher post harvest soil available NPK Status at end of the experimentation. Similar result was reported by Senthikumar (2015). The lowest post harvest soil available N, P and K of 226.65, 18.09 and 235.11 kg ha⁻¹ noticed under the foliar application of gibberellic acid 40% WSG @ 20 g ha⁻¹ (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) (T₅). This could be attributed to higher DMP and maximum uptake of NPK recorded under this treatment, which leads registered lower values of post-harvest soil available nutrient status in this treatment. Similar results were obtained by prakash *et al.* (2015) and Priyanka Sanwal *et al.* (2023).

CONCLUSION

Based on the field experimental results, it can be concluded that foliar application of gibberellic acid 40% WSG @ 20 g/ha (20 DAT) along with 2% DAP + 1% KCL (40 and 50 DAT) had registered the higher Plant height, chlorophyll content index, number of tillers m⁻², panicle length, grain yield, NPK uptake. However, least available post-harvest soil nutrients of NPK were registered in this treatment. Therefore, for future thrust it can be included that foliar spray of plant growth regulators and micronutrients, along with organic manures, may be studied in transplanted rice cultivation.

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Table 1 a. Analytical methods employed in plant analysis

S. No	Name of the estimation	Method	Reference
1.	Nitrogen	Microkjeldhal method	Yoshida <i>et al.</i> (1956)
2.	Phosphorus	Triple acid digestion with calorimeter method	Jackson, (1973)
3.	Potassium	Triple acid digestion with flame photometry method	Jackson, (1973)

Table 1 b. Analytical methods employed in soil analysis

4.	Available Nitrogen	Alkaline permanganate method	Subbiah and Asija (1956)
5.	Available Phosphorus	Calorimetry method	Olsen <i>et al.</i> (1954)
6.	Available Potassium	Flame photometric method	Stanford and English (1949)

Table 2. Effect of plant growth regulators and nutrients on Plant height (cm) Chlorophyll content index (SPAD Value), Number of tillers m⁻², panicle length (cm) and grain yield (kg ha⁻¹) in transplanted rice

Treatments	Plant height (cm)			Chlorophyll content index (SPAD Value)	Number of tillers m ⁻²	Panicle length (cm)	Grain yield (kg ha ⁻¹)
	30DAT	60 DAT	Harvest				
T ₁ - Control (water spray)	48.02	69.92	78.97	29.69	314.99	18.49	4549.06
T ₂ - Gibberellic acid 40% WSG @ 20 g ha ⁻¹ (20 DAT)	57.94	76.69	87.03	33.79	346.33	21.85	5282.27
T ₃ - Triaccontanol 0.05% EC @ 250 ml ha ⁻¹ (20 DAT)	53.77	73.61	83.68	31.88	331.81	20.36	4951.87
T ₄ - Sodium para nitrophenolate 0.3% SL @ 2.5 L ha ⁻¹ (20 DAT)	52.89	73.45	82.43	31.57	327.90	19.85	4881.91
T ₅ - T ₂ + 2% DAP + 1% KCL (40 & 50 DAT)	58.95	89.15	101.43	42.75	421.03	27.67	6485.25
T ₆ - T ₂ + 2% NPK (19:19:19) (40 & 50 DAT)	58.02	86.14	98.18	40.84	408.15	26.34	6260.42
T ₇ - T ₃ + 2% DAP + 1% KCL (40 & 50 DAT)	55.05	83.13	94.92	38.95	394.70	25.02	6011.33
T ₈ - T ₃ + 2% NPK (19:19:19) (40 & 50 DAT)	54.98	80.00	90.86	36.34	372.91	23.49	5703.53
T ₉ - T ₄ + 2% DAP + 1% KCL (40 & 50 DAT)	53.44	83.02	94.12	38.22	388.19	24.85	5950.09
T ₁₀ - T ₄ + 2% NPK (19:19:19) (40 & 50 DAT)	53.09	79.78	90.45	35.81	366.02	23.21	5639.20
S. Ed	1.30	1.36	1.45	0.86	5.65	0.55	88.76
CD (P=0.05)	2.74	2.87	3.06	1.81	11.88	1.17	186.49





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Table 3. Effect of plant growth regulators and nutrients on N, P and K uptake and post harvest soil available nutrients status (kg ha⁻¹) in transplanted rice

Treatments	Nutrient uptake (kg ha ⁻¹)			Post- harvest soil available nutrient status (kg ha ⁻¹)		
	N	P	K	N	P	K
T ₁ - Control (water spray)	101.25	17.02	109.20	238.75	22.56	263.31
T ₂ - Gibberellic acid 40% WSG @ 20 g ha ⁻¹ (20 DAT)	113.49	20.08	120.69	234.42	21.21	255.47
T ₃ - Triacantanol 0.05% EC @ 250 ml ha ⁻¹ (20 DAT)	108.37	19.10	115.57	235.81	21.85	258.59
T ₄ - Sodium para - nitrophenolate 0.3% SL @ 2.5 L ha ⁻¹ (20 DAT)	106.55	18.48	114.24	236.69	22.10	260.29
T ₅ - T ₂ + 2% DAP + 1% KCL (40 & 50 DAT)	137.42	26.58	144.78	226.65	18.09	235.11
T ₆ - T ₂ + 2% NPK (19:19:19) (40 & 50 DAT)	132.65	25.52	139.61	228.88	18.84	240.02
T ₇ - T ₃ + 2% DAP + 1% KCL (40 & 50 DAT)	127.58	24.22	134.44	230.29	19.59	244.73
T ₈ - T ₃ + 2% NPK (19:19:19) (40 & 50 DAT)	120.40	22.32	127.75	232.53	20.41	250.81
T ₉ - T ₄ + 2% DAP + 1% KCL (40 & 50 DAT)	125.73	23.87	132.89	231.11	19.75	246.75
T ₁₀ - T ₄ + 2% NPK (19:19:19) (40 & 50 DAT)	118.67	21.87	125.83	233.09	20.62	252.32
S. Ed	1.96	0.44	2.20	0.57	0.19	1.42
CD (P=0.05)	4.12	0.91	4.62	1.20	0.40	2.99





Palladium(II)-Catalyzed Acylation of Aryl and Hetero-aryl Compounds via C-H Bond Activation at Room Temperature

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 12 Jun 2024

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ABSTRACT

In recent decades, the synthesis of aryl and hetero-aryl ketone compounds via C-H activation technology has become an important field of research over traditional cross-coupling reactions due to its versatile nature, a broader range of availability of substrates, higher atom and step economy. In this vein, a number of acylation strategies have been developed by activating inert C-H bond of the substrate. Despite many merits of the C-H bond activation technology, the major demerits of this method is the inertness of the C-H bond. Therefore to cleave the C-H bond, sometimes harsh reaction conditions have been applied which limits sustainability of those protocol. Henceforth, the development of a milder reaction condition is always remain first priority to the researches. This review article mainly focused on the synthetic and mechanistic aspect of acylation reactions which undergoes almost at room temperature via C-H bond activation process.

Keywords: Acylation, C-H functionalization, Sustainability, Ambient condition, Photoredox catalyst

INTRODUCTION

Aryl and hetero-aryl ketones are an important class of organic compound found in many natural products, pharmaceuticals, functional materials and in agrochemical industries [1]. Due to its high importance and growing demand, the development of a novel synthetic protocol for the synthesis of aryl and hetero-aryl ketones from readily available inexpensive starting material is an important field of research in synthetic organic chemistry. The well-known traditional route for the synthesis of aryl ketone is Friedel-Crafts acylation method by using $AlCl_3$ as a



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reagent. Although this is an efficient method, it offers the acylation product with poor regioselectivity in case of substituted arenes [2]. The oxidation of secondary aryl alcohol also can produce aryl ketones. However, this reaction is limited to specific structure of the substrate. Many functional groups are also incompatible under highly oxidizing condition [3]. To overcome the regioselectivity and limited functionality issue, researchers have developed transition metal catalyzed cross-coupling methods for the synthesis of aryl and hetero-aryl ketones [4]. Although by applying transition metal catalyzed cross-coupling reaction the synthesis of aryl ketones have been achieved successfully with excellent regioselectivity, few major drawbacks still persist. For the transition metal catalyzed cross-coupling reaction, some prefunctionalized starting materials are always required which increases the number of steps and limits its synthetic utility. In recent few years, transition metal catalyzed C-H activation method has emerged as an exclusive alternative over traditional cross-coupling reactions for the synthesis of functionalized molecules with high level of regioselectivity and a broad range of substrate scope [5]. The major advantage of C-H activation method over cross-coupling method is that no prefunctionalization steps are involved to get the substrate which is required for coupling reactions. In C-H activation process, the incorporation of transition metal catalyst to the substrate is fully controlled by a coordinating group present on the substrate. Therefore, the number of steps involved in prefunctionalization steps are reduced and the atom economy increases. Shortly, researchers have developed several transition metal catalyzed acylation protocols of aromatic or hetero-aromatic substrates by using several acylation precursor like α -oxoacids, α -oxoaldehydes, aldehydes, alcohols, amines etc. via C-H activation process [6]. Although an enormous effort has been made for the development of a useful and practical method for acylation in the field of C-H activation, few limitation still persist. The activation of an inert C-H bond is a high energetic process. Therefore, most of the C-H bond functionalization reaction occurs at elevated reaction temperature. Under these harsh reaction condition, some sensitive functional groups become reactive. Thus, the development of mild reaction condition for the acylation is in high demand. Recently, researchers have found that by using highly reactive substrates and catalyst the C-H activation reaction can be achieved at ambient temperature. In this vein, some reports have been come out for the acylation of aromatic and hetero-aromatic substrates in almost ambient condition by modifying the reaction condition such as by using reactive catalyst, strong coordinating ligands, effective solvents and installing a powerful directing group to the substrate. In this article, all these reports have been summarized carefully for the benefit of researchers and for the enrichment of academic knowledge.

Regioselective Acylation of Aryl and Hetero-aryl Compounds

For the development of acylation reaction, palladium(II) catalyst has been widely used for the activation of C(sp²)-H bond of aryl, hetero-aryl and olefin substrate. In this regards, directing group plays a crucial role for the regioselective metalation to the substrate. The general mechanism for the palladium catalyzed acylation follows three distinct fundamental steps. First, an aryl palladium(II) intermediate **I** is formed through the regioselective activation of C-H bond. Subsequently, The oxidative addition of an acyl group to the aryl palladium(II) intermediate **II** to form Pd(III) or Pd(IV) intermediate is involved in the second step. A reductive elimination process to produce the aryl ketone is involved in last step (**Scheme 1**). Thus, palladium(II) catalyst helps to incorporate an acyl group to the substrate exclusively at the *ortho*-position to a directing group.

Palladium(II)-Catalyzed C-H Bond Acylation

As palladium(II) is emerged as an efficient catalyst for the C-H activation, a number of significant efforts have been made for the development of the acylation reaction at ambient temperature by using palladium(II) as a catalyst. Thus, some reports have come out by modifying the catalytic system and reaction condition over the past few years. All these recent reports have been recorded in this section. In the year 2015, the Zhou group reported a palladium-catalyzed *ortho*-acylation of acetanilides via C-H bond activation by using inexpensive benzyl alcohol as acylating precursor under aqueous condition at 40°C [7]. During the optimization of the reaction condition, they discovered that the addition of a catalytic amount of TFA is essential for this reaction which increases the yield of the reaction. A wide variety of differently substituted acetanilide and benzyl alcohols were tested under the optimized reaction condition which successfully produces the desired *ortho*-acylation product in good yield. Also, it has been observed that electron donating substituents present on both acetanilide and benzyl alcohol gives better yield of the desired product. Based on the literature reports and control experiments, a plausible mechanism for this acylation reaction



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has been proposed. It reveals that in this transformation TBHP acts as an oxidizing agent. It initially oxidizes benzyl alcohol to aldehyde in the reaction medium and further generates acyl radical from aldehyde. A TEMPO trapping experiment supports the generation of the acyl radical. On the other hand, Palladium(II) catalyst in presence of TFA additive undergoes facile electrophilic *ortho*-palladation with acetanilide and generates bimetallic palladium cyclopalladated intermediate **III**. The generated Pd(II) intermediate **III** then reacts with the generated acyl radical to afford the Pd(III) or Pd(IV) intermediate **IV** through oxidative addition. Finally, a reductive elimination process produces the desired acylation product **3** and regenerates Pd(II) catalyst (**Scheme 2**). Shortley, a palladium-catalyzed carbamate directed decarboxylative *ortho*-acylation of anilines have been reported by the Wang group [8]. In this methodology, aryl α -keto acids have been used as a source of acyl group. These aryl α -keto acid in presence of an oxidant $(\text{NH}_4)_2\text{S}_2\text{O}_8$ generates the acyl radical which undergoes oxidative addition with aniline carbamate palladium(II) intermediate and furnishes acylation products. PTSA plays a crucial role in this transformation. It acts as a ligand to the palladium(II) catalyst which makes the catalyst more electrophilic. The carbamate directing group can be successfully removed from the product after the acylation reaction. Methyl carbamate can be removed easily under alkali hydrolysis reaction whereas ethyl and phenyl carbamate moieties also can be removed by using TBAF.

After the successful removal of directing group, *ortho*-acyl aniline compounds can be further derivatized to get many useful heterocycles. By treating **7** with toluene and NH_4OAc under KI-TBHP condition, 2,4-diphenylquinazoline **8** is obtained and by refluxing **7** with acetone under alkaline condition, 2-methyl-4-phenylquinoline **9** is obtained (**Scheme 3**). Palladium-catalyzed carbamate directed decarboxylative acylation of anilines The Jana group developed a novel synthetic transformation for the palladium(II) catalyzed acylation of 2-arylpyridine and pyrimidine substrates using α -oxoacids, α -oxoaldehydes or aldehydes as a source of acyl group via C-H activation at room temperature [9]. During the optimization of the reaction condition and detailed control experiments, they have realized that the solvent MeCN plays a vital role in this transformation. Being a solvent as well as strong coordinating ligand, MeCN readily coordinates with palladium(II) catalyst and turns it highly electrophilic which undergoes *ortho*-metallation with respect to directing group at room temperature. The used reagents α -oxoacids, α -oxoaldehydes or aldehydes generates acyl radical in presence of stoichiometric amount of $\text{K}_2\text{S}_2\text{O}_8$ or aqueous TBHP respectively (**Scheme 4**). A palladium catalyzed sulfoximine group directed *ortho*-acylation of *N*-sulfoximine benzamides have been reported by the Guin group [10]. In this reaction methodology, aryl α -oxoacids in presence of $(\text{NH}_4)_2\text{S}_2\text{O}_8$ generates the acyl radical which readily undergoes oxidative addition with the aryl-palladium(II) intermediate and produces the desired product through a subsequent reductive elimination step. A wide number of functional groups are tolerated under the reaction condition and both electron donating as well as withdrawing groups present on both of the substrate are able to produce the desired product in good yield.

The sulfoximine directing group can be easily removed from the product under acidic condition at higher temperature which upon hydrolysis produces 2-aryl benzoic acid **15**. The acylation product can be directly converted to many important heterocycles by treatment with appropriate reagents (**Scheme 5**). In the year 2016, the Luo group reported a palladium(II) catalyzed decarboxylative *ortho*-acylation of *N*-nitrosoanilines **20** by using aryl α -oxoacids at room temperature [11]. Here, a nitroso group acts as an efficient directing group which directs the Pd(II) catalyst to incorporate exclusively at the *ortho*-position of the substrate via C-H bond activation. A wide variety of *N*-nitrosoaniline substrate containing a variety of functional groups are well tolerated under the optimized reaction condition. Although the mechanism of the reaction is not much clear to the authors, based on some control experiments and literature reports they have proposed a plausible mechanism for the reaction. The reaction initiates through a nitroso group directed *ortho*-palladation step which leads to form a five membered palladacycle. Then, the palladacycle intermediate **VII** reacts with aryl α -oxoacids **5** forms the intermediate **VIII**. The intermediate **VIII** readily undergoes decarboxylation and forms the intermediate IX. Finally, the aryl ketones are obtained through a subsequent reductive elimination step. The generated Pd(0) catalyst is further reoxidized to active Pd(II) catalyst in presence of $(\text{NH}_4)_2\text{S}_2\text{O}_8$. To show the synthetic utility of this methodology, synthesis of few important heterocycles and drug molecules also have been demonstrated in this report (**Scheme 6**). A decarboxylative acylation of cyclic enamides can be achieved via palladium(II) catalyzed C-H activation by using aryl or hetero-aryl α -oxoacids [12]. The Duan group shows that in the presence of catalytic amount of DMSO in DMF solvent, this decarboxylative



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acylation can be achieved at room temperature. To understand the mechanism of the reaction, the standard acylation reaction was performed in the presence of a radical scavenger TEMPO but it unable to suppresses the formation of the desired product. This observation ruled out the formation of an acyl radical during the progress of the reaction. Although the mechanism of the overall reaction is not completely clear, a plausible mechanism was proposed for the reaction based on literature reports. The proposed mechanism shows that Pd(II)/Pd(0) catalytic steps are involved in the formation of acylation product. A combination of $K_2S_2O_8$ and Ag_2O are used as an additives which helps in decarboxylation process and the regeneration of Pd(II) catalyst to continue the catalytic cycle (**Scheme 7**).

Photoredox/Palladium(II)-Catalyzed C-H Bond Acylation

Visible light photoredox catalysis has emerged as one of the most powerful tool in which many synthetic transformation can be successfully performed by avoiding harsh reaction conditions [13]. Recently, by merging transition metal catalyzed C-H activation and visible light photoredox catalysis a vast number of regioselective functionalizations have been achieved under ambient reaction condition [14]. All of the recent reports of visible light driven dual catalysis for the synthesis of aryl ketones have been discussed in this section. In the year of 2015, the Wang group reported a palladium-catalyzed decarboxylative *ortho*-acylation of acetanilides with α -oxocarboxylic acids by merging the visible light photoredox catalyst with palladium(II) catalyst at room temperature [15]. In this method, the *ortho*-acylation reaction of acetanilides proceeds through a Pd(II)/Pd(IV) catalytic cycle. During the exhaustive screening of the catalytic condition, they have found that an organic dye Eosin Y is more suitable as a photoredox catalyst for this transformation to get the satisfactory yield of the product. After performing few control experiment in support of the catalytic transformation, they have proposed a mechanistic cycle for this acylation reaction. At first, the photoredox catalyst Eosin Y excited to its high energy state (Eosin Y)* under green LED irradiation. The excited photoredox catalyst (Eosin Y)* accept an electron from arylglyoxylic acid **5** and oxidized it. The oxidized arylglyoxylic acid **XIII** readily generates benzoyl radical by releasing CO_2 . The generation of benzoyl radical has been proved by a TEMPO trapping experiment. Subsequently, The generated (Eosin Y) \cdot^- transfer an electron to molecular oxygen and produces a superoxide radical anion ($O_2^{\cdot-}$) which is confirmed by ESR spectroscopy. On the other hand, the catalytic cycle for palladium catalyst initiates through the *ortho*-palladation of acetanilide substrate via C-H activation.

Then, the coordinated Pd(II) intermediate **XIV** reacts with the acyl radical and generates Pd(III) intermediate **XV**. At this stage, the Pd(III) intermediate **XV** further gets oxidize to Pd(IV) intermediate **XVI** by transferring an electron to superoxide radical anion ($O_2^{\cdot-}$). Subsequently, a reductive elimination furnishes the desired *ortho*-arylation product and the active Pd(II) catalyst. In this transformation no external metal oxidants are required as molecular O_2 acts as an oxidant to palladium catalyst which is an advantage for this methodology (**Scheme 8**). Shortly, the Wang group further reported a C-H acylation of azo- and azoxy benzenes using α -keto acids by merging visible-light photocatalysis and palladium catalysis at room temperature [16] (**Scheme 9**). The optimization condition of this transformation shows that 10-methyl-9-(2,4,6-trimethylphenyl)acridinium perchlorate salt **PC-1** is the suitable photoredox catalyst which gives better yield of the acylation product. A numerous variety of aryl and few hetero-aryl α -keto acids were tested under the optimized reaction condition which produces the desired arylation product in moderate to good yield. Based on the detailed mechanistic study of this transformation, they have reported that the catalytic cycle proceeds through a similar path as shown in **Scheme 8**. As many heterocyclic compounds have hues medicinal values, the functionalization of heteroaromatic compounds are also an important field of research to synthetic organic chemist [17]. Generally, many heteroaromatic compounds have an electron rich heteroatom which can readily coordinates with the transition metal catalyst and undergoes functionalization in highly regioselective manner. Among them, most frequently used heterocycles are N-containing heterocycles which acts as an excellent directing group [18]. Recently, Sharma *et. al* reported a pyrimidine group directed C-2 acylation of indoles in batch and flow process by merging ridium visible light photoredox catalyst and palladium-catalyst via C-H activation at room temperature [19]. It has been observed that performing the reaction in a continuous-flow micro reactor the catalyst loading and reaction time both can be reduced. In this process, the yield of the product obtained is higher in compare with common batch process (0.5 mole % vs 2 mole % and 2 h vs 20 h). Simultaneously, a similar observation was reported by the Jana group [20]. They showed that the directed C-2 acylation of indole can be carried out at room



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temperature using a combination of ruthenium visible light photoredox catalyst and palladium catalyst under blue LED irradiation. In both of the methodology, a wide variety of aromatic as well as aliphatic aldehyde and indole substrate are able to furnish the corresponding desired product in excellent yield. Here aldehyde acts as acyl group surrogate. A TEMPO radical capture experiment proves that acyl radical generates during the course of the reaction. Jana *et. al* shows that indole side chain containing amino acid tryptophan can be successfully acylated at C-2 position under the optimized reaction condition. A similar plausible mechanistic path has been proposed for both of the method. The C-H activation and acylation reaction undergoes through Pd(II)/Pd(IV) catalytic cycle. In presence of light, Ir³⁺ or Ru²⁺ photoredox catalyst excited to Ir^{3+*} or Ru^{2+*} respectively. Subsequently, a single electron transfer to TBHP produces *tert*-butoxy radical which helps to generate the acyl radical. The generated acyl radical in combination with the intermediate **XVII** generates the intermediate **XVIII**. Then the intermediate **XVIII** has been reoxidized to form a new intermediate **XIX**. Finally, intermediate **XIX** upon facile reductive elimination produces the desired acylation product (**Scheme 10**). Shortly, Xia *et. al* reported acylation of 2-aryl pyridine substrate by merging photocatalyst and palladium catalyst using aldehydes as an acyl precursor [21]. After screening several photocatalyst, they found that phenanthraquinone (PQ) is ideal for this transformation. The detailed mechanistic investigation suggest that under blue LED irradiation phenanthraquinone (PQ) generates acyl radical through a hydrogen atom transfer (HAT) process. A stoichiometric amount of Ag₂O is used as an oxidant in this reaction which successfully oxidizes the generated PQ-H to PQ and Pd(II) intermediate to Pd(IV) intermediate respectively (**Scheme 11**).

CONCLUSION

Despite the latest developments, the continuous progress of C-H bond activation technology is the most exciting area of research in recent time as it provide alternative methods for the challenging organic transformations under mild reaction conditions. Although, initially harsh reaction conditions were followed for the acylation reaction, in recent years development of mild reaction conditions for the regioselective acylation have been achieved by modifying the catalytic system, reagent or substrate. However, further development is require in this field to make this field more attractive and enriched. For the acylation reaction mostly expansive palladium salts are used. It could be a great improvement, if palladium salts can be replaced by an inexpensive salts of 3d transition metals such as iron, cobalt or nickel. Also in some cases, stoichiometric amount of expansive metal salts are used which can be substituted by inexpensive reagents. Recently, the combination of transition metal catalyst with photoredox catalyst has opened a new direction in this regards which able to reduce the reaction temperature as well as replace other stoichiometric amount of oxidizing agents. This area should be more focused to develop more sustainable process for acylation. This review article will help the scientific community for better understanding regarding all the efforts have been made for the development of acylation reaction under ambient condition. It will also inspire them to engage themselves in this exciting field of research for the construction of complex molecular framework and pharmaceutical compounds.

ACKNOWLEDGEMENT

MKM gratefully acknowledge for all the support received from Saldiha College.

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	<p> $R^1 = 3\text{-OMe}$: 3a: 95% $R^1 = 4\text{-F}$: 3b: 68% $R^1 = 2\text{-OMe}$: 3c: 65% $R^1 = 3\text{-OEt}$: 3d: 94% $R^2 = \text{H}$: 3e: 93% $R^2 = 2\text{-Me}$: 3f: 96% $R^2 = 2\text{-OMe}$: 3g: 93% $R^2 = 2\text{-Cl}$: 3h: 95% $R^2 = 4\text{-F}$: 3i: 80% $R^2 = 4\text{-CF}_3$: 3j: 85% </p>
<p>Scheme 1. Plausible mechanism for the Pd(II) catalyzed acylation via C-H activation</p>	<p>Scheme 2. Palladium-catalyzed acylation of acetanilides by using benzyl alcohol</p>
<p>Scheme 3. Palladium-catalyzed carbamate directed decarboxylative acylation of anilines</p>	<p>Scheme 4. Palladium catalyzed acylation of 2-arylpyridine and pyrimidine</p>





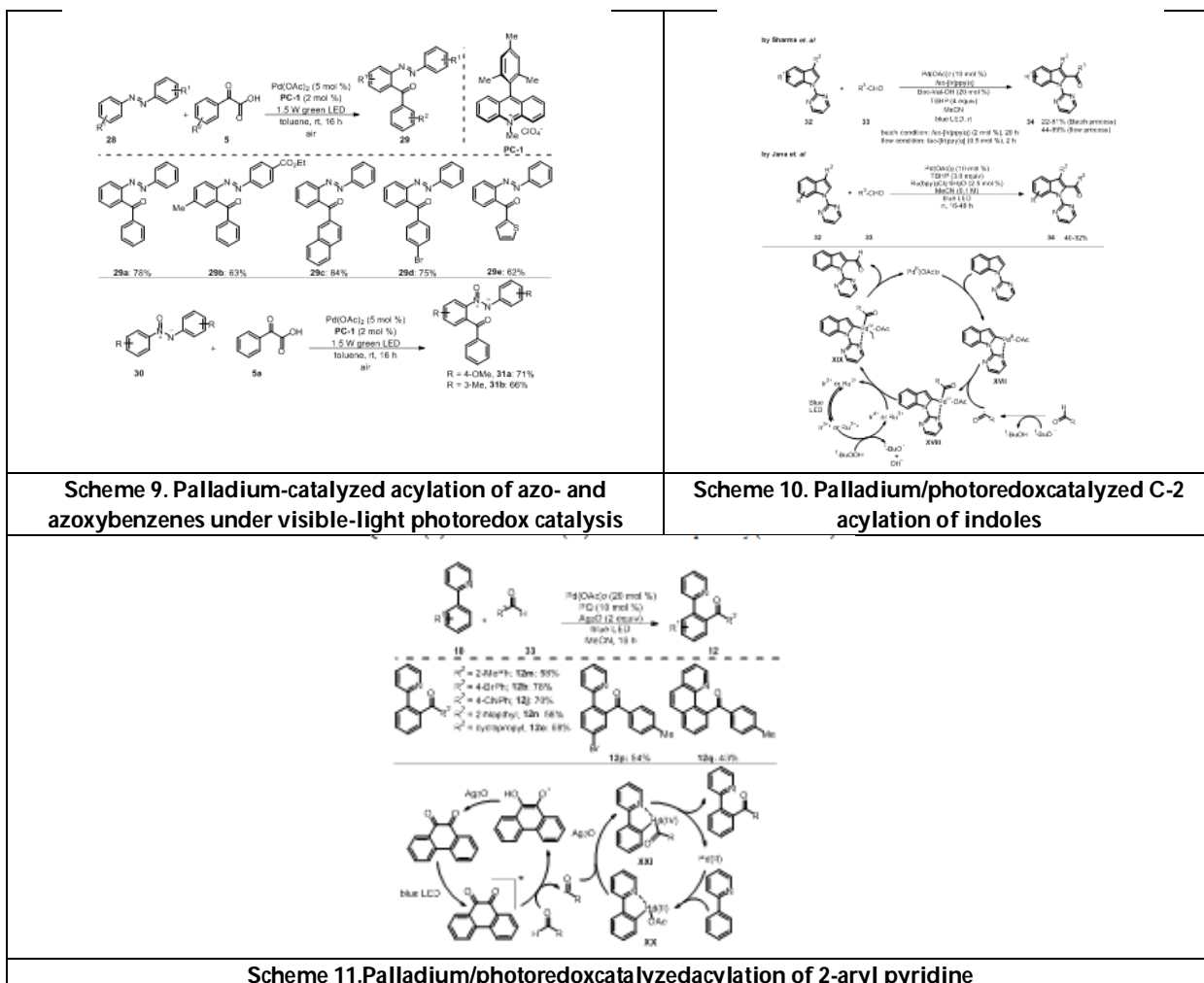
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<p> $R^1 = H, R^2 = H, R^3 = H, 14a: 73\%$ $R^1 = 4\text{-Bu}, R^2 = H, R^3 = H, 14b: 79\%$ $R^1 = 3\text{-OBn}, R^2 = H, R^3 = H, 14c: 81\%$ $R^1 = H, R^2 = 4\text{-NO}_2, R^3 = H, 14d: 58\%$ $R^1 = H, R^2 = 4\text{-Pr}, R^3 = H, 14e: 71\%$ $R^1 = H, R^2 = H, R^3 = 4\text{-Cl}, 14f: 73\%$ $R^1 = H, R^2 = H, R^3 = 3,4\text{-OMe}, 14g: 61\%$ </p>	<p> $R^1 = H, R^2 = 4\text{-OMe}, 21a: 88\%$ $R^1 = H, R^2 = 6\text{-CF}_3, 21b: 76\%$ $R^1 = H, R^2 = 2,4,6\text{-Me}, 21c: 71\%$ $R^1 = 4\text{-Br}, R^2 = H, 21d: 83\%$ $R^1 = 3\text{-F}, R^2 = H, 21e: 90\%$ </p>
<p>Scheme 5. Palladium catalyzed aryloxylation of N-sulfoximinebenzamides</p>	<p>Scheme 6. Palladium catalyzed acylation of N-nitrosoanilines</p>
<p> $R^2 = 4\text{-OMe}, 26a: 74\%$ $R^2 = 2\text{-Cl}, 26b: 81\%$ $R^2 = 2\text{-Me}, 26c: 83\%$ 26d: 78% </p>	<p> 27a: 81% 27b: 75% 27c: 77% 27d: 78% 27e: 51% </p>
<p>Scheme 7. Palladium catalyzed acylation of cyclic enamides</p>	<p>Scheme 8. Palladium-catalyzed decarboxylative ortho-acylation of acetanilides under visible light photoredox catalysis</p>





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Modelling and Simulation Techniques for Regulating Blood Glucose Concentrations in the Human Body

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 14 Jun 2024

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ABSTRACT

Glucose is the molecule that the cells of the human body use as an energy source. Maintaining a steady state level of glucose in the blood is critical in the human body. This paper presents the modeling for regulation of blood glucose concentration by using negative feedback physiological control system. Mathematical representation for the regulation of glucose in the blood is given in the paper along with the SIMULINK model. Different results that represent the steady state analysis of glucose regulation under normal condition, Type 1 diabetes and Type 2 diabetes as a part of glucose tolerance test. The primary objective of the paper is to develop a mathematical model for blood glucose regulation and simulate glucose tolerance tests under various conditions using MATLAB Simulink. This model aims to Understand glucose homeostasis, Study diabetes dynamics, Evaluate treatment strategies. The methods encompass mathematical modeling, simulation using MATLAB Simulink, parameterization, scenario-based simulations, visualization, analysis, and interpretation to investigate blood glucose regulation dynamics under normal and diabetic conditions. Through simulation, the paper finds that different types of diabetes lead to distinct patterns in glucose and insulin concentrations during glucose tolerance tests. For instance, in Type 1 diabetes, there is a reduction in the sensitivity of insulin response to glucose, resulting in altered glucose and insulin profiles compared to normal conditions. Similarly, Type 2 diabetes, characterized by reduced insulin sensitivity in tissues, exhibits further variations in glucose and insulin concentrations during the test. By adjusting specific parameters in the model corresponding to insulin production, insulin sensitivity, and glucose utilization, the paper demonstrates how changes in





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these parameters affect glucose and insulin dynamics. The paper explores the application of the model to simulate glucose tolerance tests for different types of diabetes, including Type 1 and Type 2. By adjusting parameters related to insulin response and glucose uptake, the model can mimic the physiological conditions characteristic of these different types of diabetes. This application of the model to study diverse pathological conditions adds novelty to the research.

Keywords: Diabetes, Glucose, Insulin, Modeling, SIMULINK.

INTRODUCTION

Glucose is the main energy source for most organisms. The human body makes glucose from food and transports it to cells via the bloodstream. Glucose is measured in milligrams per deciliter of blood. The average healthy human has about 60 dL (6 L) of blood and a between-meals blood glucose level of about 100 mg/dL. The amount of glucose in the blood varies with food intake and liver's breakdown of fat to make glucose. Glucose release is measured in mg/min. Blood glucose level is usually regulated by two hormones: insulin and glucagon, secreted by the endocrine pancreas. The main function of the pancreas is to produce insulin, digestive enzymes, and other hormones. The secretion of insulin is controlled by the glucose concentrations in the blood stream. As the level of glucose rises in the blood, the insulin levels also increase. The two hormones insulin and glucagon are reciprocal in their overall action and are secreted appropriately in most circumstances to keep the blood glucose concentration within the normal range. Fig. 1 represents the diagram of insulin and glucose regulation. As blood glucose rises, insulin is secreted in the pancreas, it is circulated through out the body, glucose is taken up by cells and blood sugar decreases. With a decrease in blood sugar, the pancreases secrete glucagons to breakdown glycogen in the liver and release glucose into the blood. This process maintains homeostasis in the body in reference to blood glucose levels. The model of the blood glucose regulation is represented mathematically by using mass balance equation along with the values of all the parameters in the normal condition. MATLAB SIMULINK blocks are used for the simulation of different normal and abnormal conditions and glucose tolerance test.

Regulation of blood glucose concentration

Negative feedback control system maintains constancy of blood glucose concentration. The total volume of blood and interstitial fluids is 15 liters in the normal adult. Steady state concentration of glucose is x mg ml⁻¹. To maintain the level of steady state glucose concentration x constant, the total inflow of glucose must equal to total outflow of glucose. Under normal circumstances, glucose enters in the blood through absorption from the gastrointestinal tract or through production from lever. Input flow rate of glucose is Q_L mg H⁻¹. There are three major ways through which glucose is eliminated from the blood. Fig. 2 represents the different systems which controls the steady state concentration of glucose.

Renal loss rate

When steady state concentration of glucose x is elevated beyond threshold θ glucose is excreted by the kidneys at a rate proportional to the gradient between x and θ :

$$\text{Renal loss rate} = \mu (x - \theta) \quad x > \theta \quad (1a)$$

$$= 0 \quad x \leq \theta \quad (1b)$$

Tissue utilization rate – insulin independent

Glucose leaves the blood to enter most cells through facilitated diffusion. In some tissues, the rate of glucose utilization depends only on the extracellular to intracellular concentration gradient.

$$\text{Tissue utilization rate – insulin independent} = \lambda x \quad (2)$$





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Tissue utilization rate – insulin dependent:

In some cells, insulin helps to stimulate the facilitated diffusion process. Glucose is taken up by the cells is proportional to x and the blood insulin concentration y .

Tissue utilization rate – insulin independent = $v x y$ (3)

In equation (1), (2) and (3), μ , λ and v are proportionality constant

Modeling of glucose regulatory system

Blood glucose mass balance

Input flow rate of glucose Q_L is equal to the summation of three outflows. Mass balance equation for blood glucose is:

$$Q_L = \lambda x + v x y \quad x \leq \theta \tag{4a}$$

$$= \lambda x + v x y + \mu (x - \theta) \quad x > \theta \tag{4b}$$

This equation shows nonlinearity in the form of product of x and y and thresholding nonlinearity at above and below θ . The relationship in equation (4a) and (4b) represents negative feedback control system. If Q_L is constant and increase in steady state concentration of glucose then corresponding decreases in blood insulin concentration y and vice versa. Insulin is produced by the pancreas at a rate dependent on the plasma glucose level. When x falls below a certain threshold Φ then mass balance equation for the blood insulin is:

$$\text{Insulin production rate} = 0 \quad x \leq \Phi \tag{5a}$$

$$= \beta (x - \Phi) \quad x > \Phi \tag{5b}$$

Insulin is destroyed through a reaction involving the insulin enzyme, at a rate proportional to the concentration of blood:

$$\text{Insulin destruction rate} = \alpha y \tag{6}$$

By combining equation (5a), (5b) and (6), the obtained equation shows steady state level of y to that of x in which insulin response to glucose is basically linear:

$$y = 0 \quad x \leq \Phi \tag{7a}$$

$$= (\beta / \alpha) * (x - \Phi) \quad x > \Phi \tag{7b}$$

Glucose tolerance test mass balance

Modeling needs to characterize mass balance of glucose in the following way:

$$C_G \frac{dx}{dt} = U(t) + Q_L - \lambda x - v x y \quad x \leq \theta \tag{8a}$$

$$C_G \frac{dx}{dt} = U(t) + Q_L - \lambda x - v x y - \mu (x - \theta) \quad x > \theta \tag{8b}$$

$U(t)$ represents the time-course with which external glucose is infused into the blood stream and C_G represents the glucose capacitance in the extracellular space. Equation states that net difference between the rate at which glucose is added to the blood and the rate at which it is eliminated equals the rate at which steady state concentration of blood x increases or decreases. Also, multiplication between x and y makes the equation non linear. Similarly, dynamic mass balance equation for insulin is:

$$C_I \frac{dy}{dt} = - \alpha y \tag{9a}$$

$$C_I \frac{dy}{dt} = - \alpha y + \beta (x - \Phi) \tag{9b}$$

C_I represents insulin capacitance of the extracellular space. The relationship among different parameters is used for the modeling purpose.

System parameter values

The parameter values used in the calculation are of the normal adult. The values are:

- $\theta = 2.5 \text{ mg/ml}$



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2. $\mu = 7200 \text{ ml / h}$
3. $\lambda = 2470 \text{ ml / h}$
4. $v = 139000 \text{ m U}^{-1} \text{ h}^{-1}$
5. $\Phi = 0.51 \text{ mg / ml}$
6. $\beta = 1430 \text{ mU ml mg}^{-1} \text{ h}^{-1}$
7. $\alpha = 7600 \text{ ml / h}$
8. $Q_L = 8400 \text{ mg / h}$

Simulation of the system

MATLAB SIMULINK is used for the simulation purpose. Figure 3 represents Simulink model developed for blood glucose concentration by using the relationship among above different mass balance equations. For the thresholding operator's θ and Φ saturation blocks are used with the lower and higher limit. Different Simulink blocks are used for making the model. Figure 4 shows the model is encapsulated into a subsystem block which only represents input and output by using different scopes.

Simulation result for glucose tolerance test

Parameter values of different conditions which are implemented for the simulation purpose are given in Table 1. For normal condition, steady state concentration of glucose is 0.81 mg / ml and insulin concentration are 0.055 mu / ml. Graph 1 represents glucose and insulin concentration. Type 1 diabetes is insulin dependent diabetes. This type can present by reducing the sensitivity of insulin response to glucose. This is done by reducing the value of β . Graph 2 represents this condition. Type 2 diabetes is non insulin dependent diabetes. The pancreas may make normal amount of insulin but there is a reduction in the ability of insulin to stimulate glucose uptake by the body tissues. In the mass balance equation, v is the constant which multiply with the product of x and y . The condition is demonstrated by reducing the value of parameter v . Graph 3 represents this condition. The blood glucose concentration has the higher peak value in Type 2 diabetes condition as compare to Type 1 condition, while both have a higher value than a normal condition. Insulin concentration is higher in Type 2 diabetes as compare to Type 1 and Normal condition. Graph 4 represents insulin concentration for all the conditions.

CONCLUSION

The statement highlights the utility of MATLAB Simulink for visualizing glucose tolerance test results under different conditions. It emphasizes the ease of use and flexibility of the tool, particularly in its ability to manipulate parameters and generate graphical presentations for comparison and analysis. Here's a breakdown of the key points: Visualization and Graphical Presentation: Simulink provides a graphical interface for designing, simulating, and analyzing dynamic systems, making it suitable for modeling physiological processes like blood glucose regulation. These visualizations aid in understanding the dynamics of glucose regulation and comparing different conditions. Parameter Manipulation: The paper adjusted parameters associated with insulin sensitivity, glucose uptake, or other physiological factors to simulate various conditions, including normal and abnormal states such as diabetes. Comparison and Analysis: The statement emphasizes the importance of comparing and analyzing glucose tolerance test results across different conditions. The paper result represents Simulink to conduct comparative analyses of blood glucose and insulin concentrations under normal physiological conditions and in pathological states like diabetes. The results are that way also confirmative with data [3]. This analysis helps in identifying differences and understanding the impact of various factors on glucose homeostasis.

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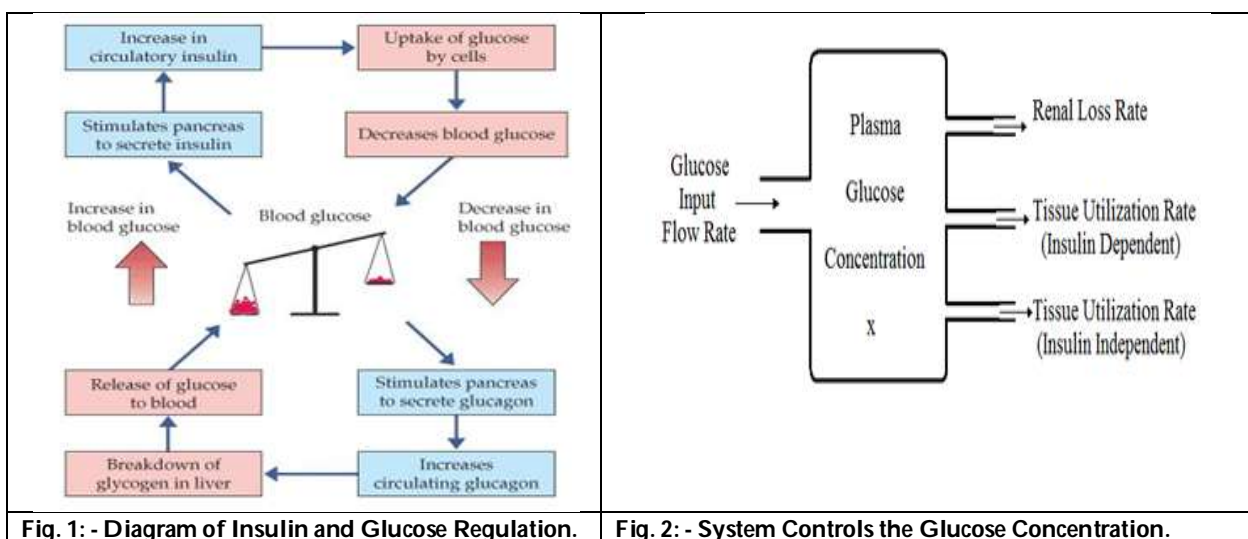


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Table 1: Parameter Values for Different Conditions.

Parameter	Normal	Type 1	Type 2
θ	2.5 mg / ml	2.5 mg / ml	2.5 mg / ml
μ	7200 ml / h	7200 ml / h	7200 ml / h
λ	2470 ml / h	2470 ml / h	2470 ml / h
ν	139000 m U ⁻¹ h ⁻¹	139000 m U ⁻¹ h ⁻¹	111220 m U ⁻¹ h ⁻¹
Φ	0.51 mg / ml	0.51 mg / ml	0.51 mg / ml
β	1430 mU ml mg ⁻¹ h ⁻¹	1144 mU ml mg ⁻¹ h ⁻¹	1430 mU ml mg ⁻¹ h ⁻¹
α	7600 ml / h	7600 ml / h	7600 ml / h
Q_L	8400 mg / h	8400 mg / h	8400 mg / h



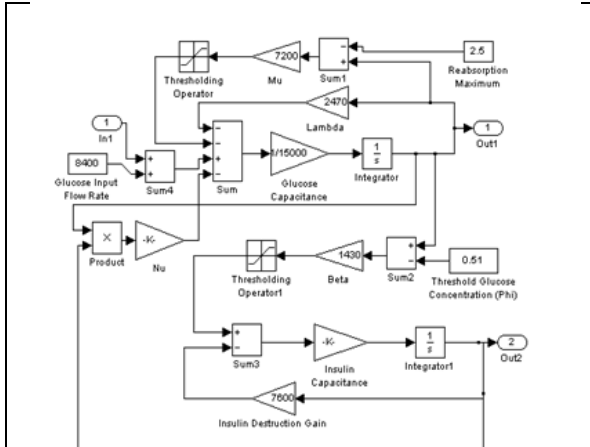


Fig. 3: - Detailed SIMULINK Model – Blood Glucose Concentration.

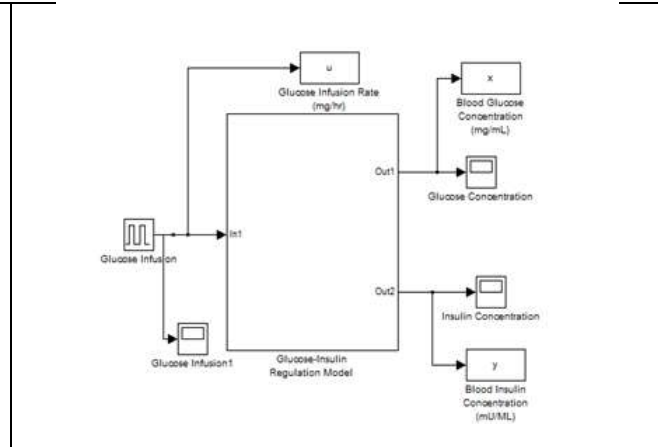
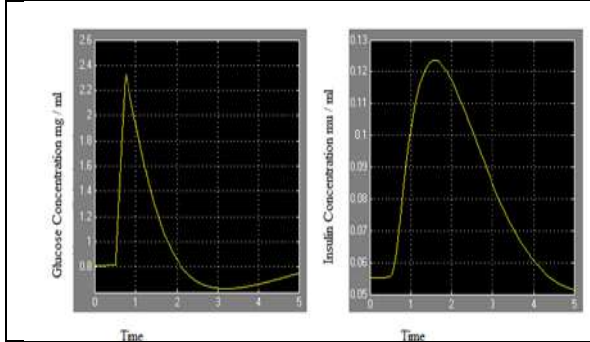
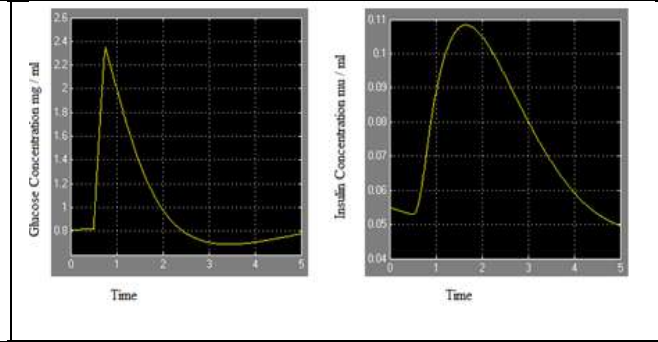


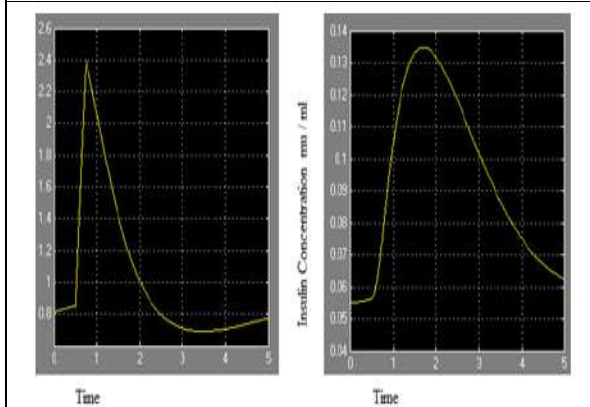
Fig. 4: - SIMULINK Model - Subsystem Block.



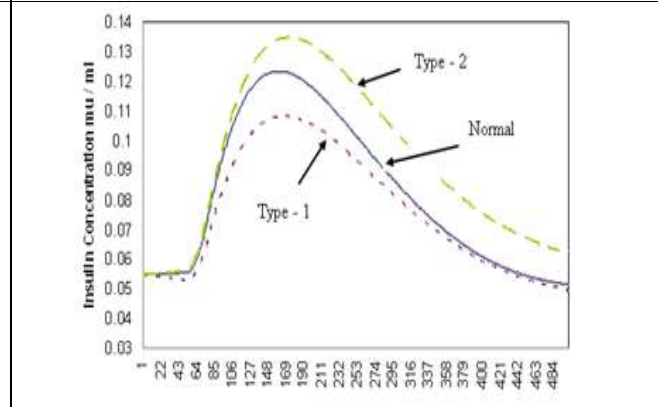
Graph 1: - Glucose and Insulin Concentration: Normal Condition.



Graph 2: - Glucose and Insulin Concentration: Type 1 Diabetes.



Graph 3: - Glucose and Insulin Concentration: Type 2 Diabetes.



Graph 4: - Insulin Concentration: Normal, Type 1 and Type 2 Diabetes





Investigation of Important Soil Physical Properties Affecting Yield of Onion (*Allium cepa* L.)

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 27 Jun 2024

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ABSTRACT

In agriculture, soil physical properties are important factors that influence the crop productivity. A field experiment was conducted during early kharif season in the year 2020 in the farmer's land at Alangulam, Tenkasi district, Tamil Nadu, India, to study the effect of Farm Yard Manure (FYM), Goat Manure (GM) and Charcoal Manure (CM) on soil Physical properties and yield of onion. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Soil amendments such as Charcoal Manure (CM), Goat Manure (GM) and Farm Yard Manure (FYM) and their combinations were added to the soil at different concentrations such as 8.5, 12.5 and 16.5 t ha⁻¹ and onion crop was transplanted within the treated soil and control. The soil samples were collected from all the treatments and analyzed after harvesting onion. In the present study Pearson's correlation analysis and Multiple Linear Regression Analysis (MLRA) were carried out to investigate soil physical properties which highly influence the crop productivity. Combination of FYM, GM and CM at 16.5 t ha⁻¹ produced the highest onion yield (4758 kg ha⁻¹) which was 68.4 % higher than the control (1500 kg ha⁻¹). Bulk Density (BD), Particle Density (PD) were decreased in the plots treated with manure compared to control. Physical properties such as Water Holding Capacity (WHC), Water Content (WC), Porosity (PO), Saturated Moisture (SM), Void Ratio (VR), Hydraulic Conductivity (HC), Permeability (PE) and Thermal Conductivity (K) were improved compared to control and had significant effect on onion yield. Correlation analysis showed high degree of positive correlation between yield and WHC, WC, SM, PO, HC, PE, PS. It was found that WHC, WC and SM had strong positive correlation with onion yield, shedding light on their importance in agricultural



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productivity. Regression modeling identified WHC and PE are the most important factors impacting onion yield. Specifically, soil texture and moisture content emerged as primary determinants of onion yield, highlighting the necessity for targeted soil management practices. These findings provide valuable insights for optimizing soil conditions to enhance onion yield, thereby aiding in the development of sustainable agricultural strategies.

Keywords: Soil physical properties, onion yield, correlation and regression analysis

INTRODUCTION

Onion (*Allium Cepa* L.) is identified as an important traditional vegetable crop that is the most widely cultivated species in India belonging to the genus *Allium* of Alliaceae. In onion plant, whole part is edible, from its green tubular leaves to its flowers and bulbs. Day by day the requirement for onion is increasing because of its health and medicinal benefits. It fight against many diseases like cancer, diabetic, heart attack and cold [1]. It plays major role in India's economic. India is the second largest producer of onion worldwide. Soils are the medium which provide all the nutrients, oxygen, and water needed for plant growth [2]. Repeated cultivation without the addition of adequate organic manure make the soil infertile. Awareness of soil health and environmental issues in agriculture promotes production of organic food which is emerging as an attractive source of rural income generation [3]. In order to meet the nutritional requirement of India's population, onion cultivation must be improved in a better way. The anxiety of providing food to such an enormous population, there should be replacement technology giving additional yield and diminish pollution. Many new methods were chosen to increase the yield and quality of onion but, inorganic fertilizer free farming is difficult to the farmers. Hence, the research was focused on standardization of organic manure for the yield. The shelf life of the produce was highly influenced by the organic inputs compared to the inorganic amendments. Sustainable use of soils necessitates the reduction or elimination of the use of chemical fertilizers to reduce soil and ground water pollutions [4]. Long term application of FYM significantly increased soil porosity compared with chemical fertilizer [5]. FYM is a valuable input to soil for higher crop production [6]. Using organic manure improves water holding capacity [7] and increases soil structure and root growth [8]. Correlation analysis is the statistical tool used to measure the degree to which two variables (X and Y) are linearly related to each other using Pearson's correlation co-efficient 'r'. Perfect linear correlation is attained, when $r=1$. Regression is used to forecast the nature of dependent variable (Yield) when the value of independent variable is known. Regression equation of yield with most important soil physical properties was set. Correlation analysis provides various linear relationship between BD, PD, WHC, WC, K, PE and onion yield. Bivariate regression is a technique that fits a straight line as close as possible between all the coordinates of two interval-ratio variables plotted on a two-dimensional graph to summarize the relationship between the variables.

MATERIALS AND METHODS

The field experiment was conducted in Alangulam, Tenkasi District of Tamil Nadu, India in the year 2020. The field lies in between 8.8646° N latitude and 77.4960° E longitude at an elevation of 128.26 meters. The onion variety chosen for cultivation was Nasikred N-53. The organic amendments chosen for the field experiment were Charcoal Manure (CM), Goat Manure (GM) and FarmYard Manure (FYM). Treatments of the study included T₁-CM, T₂-GM, T₃-FYM, T₄-CM+GM, T₅-CM+FYM, T₆-GM+FYM, T₇-CM+GM+FYM and T₈-CO-Control (didn't receive any manure). The experimental soil is sandy clay loam with WHC(23.665 %), slightly alkaline (pH-8.1) and organic carbon content (0.16 %). A total of 8 plots were chosen. Plots laid out in a completely randomized block Design (CRBD). Each plot size was 8 m x 5 m. The field was ploughed properly. Organic amendments applied to the soil at different concentrations such as 8.5, 12.5 (recommended dose) and 16.5 t ha⁻¹ respectively and mixed well with the soil manually one month before transplanting onion crops in the field. Sprinkler irrigation was used. The onion was harvested after it reaches physiological maturity. After harvesting onion, soil samples were collected from a depth of 0-30 cm, air dried passed





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through 2 mm sieve and tested for their physical properties. Using the test data statistical analysis was done. Soil physical properties such as Bulk Density (BD), Particle Density (PD), Water Holding Capacity (WHC), Water Content (WC), Porosity (PO), Saturated Moisture (SM) and Void Ratio (VR) were determined using Keen-Raczowski (KR) box method [9]. Thermal Conductivity (K) of soil was determined using Lee's disc method [10]. Hydraulic Conductivity (HC), Permeability (PE) and Porosity (PO) were measured using falling head permeameter method. SPSS software was used to figure out the correlation and also to build up regression equation using Analysis Of Variance (ANOVA) was applied and least significant difference (LSD) at $p=0.05$ was used to test the differences between means of individual treatments [11]. Correlation coefficient was calculated using the formula $r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{(n\sum X^2 - (\sum X)^2)(n\sum Y^2 - (\sum Y)^2)}}$. Multi linear regression analysis was carried out to find the important soil factors using the least square method, $Y=AX+B$. Statistical analysis revealed the correlation between soil variables and yield and also showed the relationship between soil variables [12].

RESULTS AND DISCUSSIONS

Soil physical properties

Soil physical properties were improved after amendment application. Tables 1 and 3 shows the influence of FYM, GM and CM on soil physical properties. Organic amendment tended to reduce BD of treated soil compared to control plot as $(1.420 \text{ g cm}^{-3}) @ 8.5 \text{ t ha}^{-1}$. Soil treated with GM+CM and FYM+GM+CM reduced BD values to 1.480 g cm^{-3} and $1.494 \text{ g cm}^{-3} @ 16.5 \text{ t ha}^{-1}$ respectively. Organic amendments application significantly increased the soil organic matter [13]. Improved organic matter in soil increases porosity and also improves soil structure thereby decreasing BD and PD. Organic matter content present in the soil reduced PD relative to control [14]. Highest PD was observed at control as 2.723 g cm^{-3} . Lowest PD (2.136 g cm^{-3}) was observed in FYM+GM+CM plot at 8.5 t ha^{-1} and 2.427 g cm^{-3} at 16.5 t ha^{-1} . On an average organic amendment decreased BD and PD, this makes the soil to get finer structure and good porosity. Porosity values ranged from 35.114% to $52.361% @ 8.5 \text{ t ha}^{-1}$ and 37.694% to $45.982 % @ 16.5 \text{ t ha}^{-1}$. Lowest value was recorded in control plot as 37.694% . Highest value was recorded in the CM+FYM and FYM+GM amended plots as $52.361% @ 8.5 \text{ t ha}^{-1}$. FYM+GM plot showed highest value of PO as $47.738 % @ 16.5 \text{ t ha}^{-1}$. Porosity of the soil treated with organic manure increased relative to control. Results in Table 1 and 3 showed that organic amendments significantly modified WHC, PS, WC values and non-significant effect on thermal conductivity [15]. The pore space and water content values were increased by the usage of organic amendments. CM plot had highest PS value ($52.183%$) relative to control (45.152%). CM+FYM and FYM+GM amended plots showed highest values of SM, PS, WC and HC relative to control @ 8.5 t ha^{-1} . The soil hydraulic conductivity generally increased with organic amendment application, with increased porosity [16]. The soil hydraulic conductivity ranged from 1.008 to $2.817 \text{ cm hr}^{-1} @ 8.5 \text{ t ha}^{-1}$ and 1.050 to $3.216 \text{ cm hr}^{-1} @ 16.5 \text{ t ha}^{-1}$. GM produced highest HC value as $2.817 \text{ cm hr}^{-1} @ 8.5 \text{ t ha}^{-1}$. FYM produced highest HC value as $2.817 \text{ cm hr}^{-1} @ 16.5 \text{ t ha}^{-1}$. Lowest HC was found at control as 1.050 cm hr^{-1} .

Correlation analysis

Correlation co-efficient generated among soil physical properties are shown in Table 2 and 4 for the concentration 8.5 and 16.5 t ha^{-1} respectively. Figure 1 and 2 shows the correlation between Yield Vs WHC and yield Vs Permeability. The yield was strongly correlated with WHC which was found negatively correlated with bulk density at 0.05 level. The figures depicted that yield increases with increasing WHC and PE. The yield of onion was significantly correlated with WHC, WC, SM, PO, VR and HC. Their Pearson's correlation coefficient values were 0.776 , 0.641 , 0.562 , 0.507 , 0.471 , 0.466 and less related with bulk density. Particle density was positively correlated with pore space and void ratio (0.822^*) at 0.05 level. Positive correlation occurs between particle density and porosity as 0.851^{**} at .01 level [17]. WHC was strongly correlated with PS and WC as 0.707 and 0.751 at 0.05 level and also with SM as 0.947 at 0.01 level. Strong correlation occurred between PS and WC (0.937^{**}), SM (0.866^{**}), PO (0.989^{**}), VR (0.993^{**}). WC positively correlated with SM, PO, VR as 0.884^{**} , 0.947^{**} , 0.957^{**} . Positive correlation was observed for SM with PO and VR as 0.840^{**} and 0.841^{**} . PO was positively correlated with VR as 0.997^{**} . HC was positively correlated with Permeability as 1.000^{**} . BD was also found negatively correlated with WHC, WC, SM, PO, VR and PS. The Table 2 displays a high degree of positive correlation between PS and PD; PS and WHC. A close positive relationship was





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seen between saturated moisture and WHC; SM and pore space at 0.01 level. Permeability was positively correlated with hydraulic conductivity .Pore space was positively correlated with saturated moisture, porosity. The yield of onion was significantly correlated with WHC and less related with bulk density. The yield was positively correlated with WHC (0.311) ,WC (0.129),SM (0.241) and PE (0.716*) and K (0.601) which was found negatively correlated with bulk density ,PD,PS,PO,VR and HC at 0.05 level. The yield of Onion was strongly correlated with P (0.716*) and K (0.601*). Bulk density was positively correlated with Particle density as 0.818*. Particle density was correlated with PO and VR as 0.722* and also with HC as 0.732*. WHC positively correlated with WC as 0.740* and with SM as 0.945** at 0.01 level. Pore space was highly correlated with PO and VR as (0.943**) at 0.01 level and with HC as 0.938** at 0.01 level. Positive correlation occurred between WC and HC as 0.753*. WC was strongly correlated with PO and VR as 0.759* at 0.05 level. Positive correlation was noted for PO with HC as 0.999** and with VR as 1.000** Permeability was also negatively correlated with PO (-0.022), VR (-0.228) and HC (-0.228).

Regression analysis

Regression analysis was employed by enter method which on iteration yielded the following equation (8.5 t ha⁻¹) $Y = -234696.952 + 178340.716(BD) - 65097.656(PD) - 1254.531(WHC) + 4646.456(WC) + 3141.625(SM) - 21583.217(P) - 204756.53(K)$ Regression analysis was employed by enter method which on iteration yielded the following equation (16.5t ha⁻¹) $Y = -271209.835 + 80630.779(BD) + 4122.634(PS) + 6946.58(WC) - 361.990(SM) - 213552.224(HC) + 75920.619(P) - 111094.727(K)$ Stepwise Multiple Linear Regression Analysis was used for identifying the relationship between yield and soil physical properties, significance was tested by F-statistics in ANOVA. Stepwise method used to analyze the linear relationship between single dependent variable (yield) with several independent variable [18]. Based on the results obtained from regression analysis, Regression equation for yield (Onion – dependent variable) was set with the most important soil physical properties. Regression equation (8.5 t ha⁻¹) is given by $Y = -2506.069 + 169.649 (WHC)$ To improve the model stepwise regression analysis was employed which on iteration yielded the following equation (16.5t ha⁻¹). $Y = 1062.118 + 1094.399 (PE)$ The results obtained from correlation and step wise Multi Linear Regression analysis revealed WHC permeability are the most important factors affecting yield of onion. Therefore, WHC and permeability are selected as the predictors to build up the regression equation. In the above model (Table 5), the 'r' square was 0.602 (8.5tha⁻¹). That is, the variation of WHC in soil accounts for the 60% yield variation. The 'r' square was 0.513 (16.5tha⁻¹) That is, the variation of permeability in soil accounts for the 51% yield variation.

CONCLUSIONS

The research findings demonstrated a significant impact of organic manure on both onion yield and soil physical properties. Through rigorous statistical analysis, it is revealed that all the soil physical properties were significantly correlated with each other and yield, organic amendments added soil leading to higher production rates compared to control. The results indicated good degree of positive correlation between yield and PD, WHC, WC, PO, SM, VR, HC, PE, K and yield was negatively correlated with bulk density @ 8.5 t ha⁻¹. Also the results indicated significant positive correlation was observed between yield and WHC, WC, SM, PE and K and also the yield negatively correlated with PO, VR, PS and HC @ 16.5 t ha⁻¹. Regression analysis revealed WHC and permeability are the most important factors affecting yield of onion. Organic amendments improves soil structure by enhancing soil physical properties and reduces erosion. These findings underscore the importance of organic manure as a sustainable agricultural practice for improving onion yield and maintain soil health. From agricultural point of view, organic amendments needed for soil protection and it will help the farmers economically by producing better yield.

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Table 1. Effect of organic manure (8.5 t ha⁻¹) on the physical properties of sandy clay loam soil

Treatments	Yield (Kg ha ⁻¹)	BD (gcm ⁻³)	PD (gcm ⁻³)	WHC (%)	PS (%)	WC (%)	SM (%)	PO (%)	VR	HC (cm hr ⁻¹)	PE (cm s ⁻¹)	K (Wm ⁻¹ K ⁻¹)
CM	2473	1.51	2.5	28.65	52.2	18.74	31.5	45.98	0.46	2.25	0.08	0.02
GM	4221	1.54	2.32	29.37	49.5	15.25	29.92	44.59	0.45	2.36	0.06	0.04
FYM	3800	1.59	2.54	25.2	49.3	13.41	29.25	39.18	0.37	3.22	0.08	0.02
GM+CM	3073	1.48	2.67	40.02	51.6	18.15	40.02	44.53	0.45	2.52	0.06	0.02
CM+FYM	4548	1.51	2.57	29.93	48.4	16.32	32.81	41.08	0.41	2.01	0.05	0.02
FYM+GM	3030	1.42	2.3	32.61	51.7	18.28	31.89	47.74	0.48	2.11	0.05	0.02
FYM+GM+CM	4758	1.49	2.43	34.62	48.8	17.16	33.51	38.47	0.38	2.76	0.07	0.03
CO	1500	1.7	2.72	23.66	45.2	12.77	27.18	37.69	0.38	1.05	0.03	0.02
S.E.(m)	256.26	0.027	0.066	1.021	0.65	0.442	0.746	0.796	0.011	0.142	0.009	0.008
CD(P=0.05)	697.19	0.073	0.180	2.78	1.77	1.203	2.03	2.17	0.030	0.386	0.024	0.022





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BD-Bulk Density PD-Particle Density WHC- Water Holding Capacity PS-Pore Space WC-Water Content SM-Saturated Moisture PO-Porosity VR -Void Ratio HC-Hydraulic conductivity PE-Permeability K-Thermal Conductivity

Table 2. Pearson’s Correlation co-efficient (r) between soil physical properties (soil variables) and yield with organic manure @ 8.5 t ha⁻¹

	Yield	BD	PD	WHC	PS	WC	SM	PO	VR	HC	PE	K
Yield	1											
BD	-0.34	1										
PD	0.334	0.112	1									
WHC	.776*	-0.6	0.399	1								
PS	0.454	-0.47	.813*	.707*	1							
WC	0.562	-0.67	0.651	.751*	.937**	1						
SM	0.641	-0.69	0.508	.947**	.866**	.884**	1					
PO	0.507	-0.43	0.851**	0.699	.989**	.947**	.840**	1				
VR	0.471	-0.47	0.822*	0.68	.993**	.957**	.841**	.997**	1			
HC	0.466	0.093	0.298	0.502	0.225	0.156	0.369	0.241	0.193	1		
PE	0.466	0.093	0.298	0.502	0.225	0.156	0.369	0.241	0.193	1.000**	1	
K	0.313	-0.21	0.078	0.509	0.146	0.272	0.381	0.196	0.166	0.189	0.189	1

r=0.776

Table 3. Effect of organic manure (16.5 t ha⁻¹) on the physical properties of the sandy clay loam soil

Treatments	Yield	BD	PD	WHC	PS	WC	SM	PO	VR	HC	PE	K
	(Kg ha ⁻¹)	(gcm ⁻³)	(gcm ⁻³)	(%)	(%)	(%)	(%)	(%)		(cmhr ⁻¹)	(cms ⁻¹)	(Wm ⁻¹ K ⁻¹)
T1-CM	3003	1.57	2.61	35.9	48.1	14.6	35.5	39.92	0.66	2.62	0.07	0.02
T2-GM	2971	1.6	2.46	34.7	48.3	16.3	34.5	42.12	0.73	2.82	0.07	0.03
T3-FYM	4618	1.54	2.83	36.5	50.2	19.5	35.4	45.62	0.84	2.31	0.06	0.03
T4-GM+CM	4363	1.56	2.61	34.8	47	15.6	34.3	40.08	0.77	1.68	0.04	0.03
T5-CM+FYM	4129	1.42	2.58	38.2	57.2	23.2	40	52.36	1.1	2.76	0.07	0.02
T6-FYM+GM	3196	1.42	2.68	38.2	57.2	23.2	40	52.36	1.1	1.21	0.08	0.03
T7-F+G+C	2553	1.39	2.14	31.6	48.8	15.4	32.8	35.11	0.74	1.18	0.05	0.03
T8-CO	1500	1.7	2.72	23.7	45.2	12.8	27.2	37.69	0.6	1.05	0.03	0.02
S.E(m)	233.359	.023	.053	.927	.988	.768	.800	1.258	.043	.154	.009	.009
CD(P=0.05)	630.04	.061	.144	2.50	2.67	2.07	2.16	3.396	.116	.416	.025	.023

BD-Bulk Density PD-Particle Density WHC- Water Holding Capacity PS-Pore Space WC-Water Content SM-Saturated Moisture PO-Porosity VR -Void Ratio HC-Hydraulic conductivity PE-Permeability K-Thermal Conductivity





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Table 4. Pearson's Correlation co-efficient (r) between soil physical properties (soil variables) and yield with organic manure @ 16.5 t ha⁻¹

	Yield	BD	PD	WHC	PS	WC	SM	PO	VR	HC	PE	K
Yield	1											
BD	-0.15	1										
PD	-0.17	.818*	1									
WHC	0.311	-0.41	-0	1								
PS	-0.24	0.052	0.58	0.393	1							
WC	0.129	-0.41	0.17	0.740*	0.695	1						
SM	0.241	-0.59	-0.2	0.945**	0.423	0.689	1					
PO	-0.13	0.195	.722*	0.446	0.943**	.759*	0.368	1				
VR	-0.13	0.195	.722*	0.446	0.943**	.759*	0.368	1.000**	1			
HC	-0.15	0.207	.732*	0.432	0.938**	0.753*	0.348	.999**	.999**	1		
PE	.716*	-0.13	-0.2	0.349	-0.274	-0.04	0.316	-0.228	-0.228	-0.23	1	
K	0.601	0.415	0.38	0.157	-0.031	0.038	-0.02	0.153	0.153	0.136	0.38	1

r =0.716

Table 5. Statistics summary of each regression model

Model	r	r ²	Adjusted r ²	SE of the Estimate	F	Sig.	t
WHC (8.5 t ha ⁻¹)	0.776a	0.602	0.536	708.103	9.071	0.024	3.012
PE (16.5 t ha ⁻¹)	.716 ^a	0.513	0.431	840.737	6.313	.046 ^a	2.512

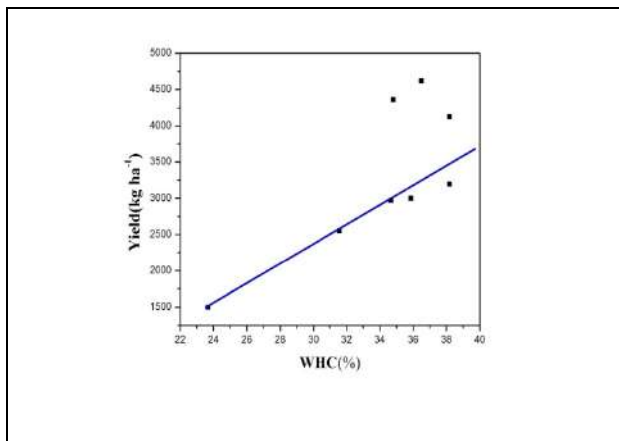


Fig 1. Correlation between Yield and WHC

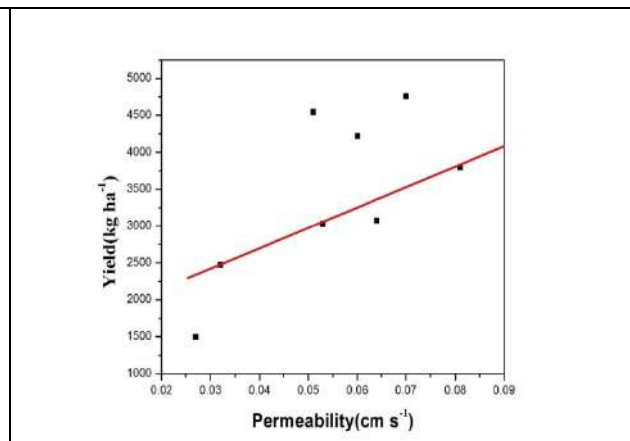


Fig 2. Correlation between Yield and Permeability





Stability of Hopf Bifurcation Analysis of Mathematical Model with Delay of Cancer

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

In this study, a differential mathematical model of cancer with delay was considered. The positivity of the solution of the model was proved under the given initial conditions. The system was linearized by Jacobian about the positive equilibrium point and the local stability conditions with and without delay was stated well. The estimation of the length of delay to preserve stability was proved by the aid of Laplace transform and Nyquist criteria. The biological importance, we investigate a Hopf bifurcation under some specific conditions of cancer.

Keywords: stability, delay, Nyquist criteria, Hopf bifurcation, Equilibrium, Jacobian.

INTRODUCTION

Background of the Study

Cancer is one of the most difficult diseases to be treated clinically and one of the main causes of death. Accordingly, a great research effort is being devoted to understanding the interaction between tumor cells and the immune system. Cancer cells are host cells that proliferate in an uncontrolled and nonspecific manner, eventually leading to the





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formation of a tumor. The mechanism of cancer's establishment and destruction, one of the world's deadliest diseases, remains a mystery. There have also been several experimental advances in developing interventional cancer therapies such as immunotherapy, viral therapy, targeted drug therapy, and chemotherapy over the last two decades. Along with these experimental advances, there have been some advances in scientific and engineering solutions for understanding cancer dynamics. Despite modern treatments such as surgery, chemotherapy, and radiotherapy, relapses do occur. As a result, the need for a more effective treatment is obvious. Over the past few decades, there have been several experimental approaches and interventions developed that have helped us to understand the dynamics of tumor growth and its interactions with the immune system. This has also aided in understanding how specific interventions, such as immunotherapy, can help strengthen our ability to fight cancer by improving immune system effectiveness [1]. While these advances have improved our understanding of cancer dynamics, there are still several challenges in these experimental approaches to fully comprehend the interactions with the immune system. One of the promising approaches is mathematical modeling [2], which involves identifying the cells that play a role in cancer propagation, interactions between these bodies, and a description of the dynamics of this interaction, which has assisted in estimating parameters, performing stability analysis, and predicting tumor dynamics [3]. Mathematical modeling with delay differential equations (DDEs) is widely used for analysis and prediction in a variety of life sciences fields, including population dynamics, epidemiology, immunology, physiology, and neural networks. In these models, time delay or time lag can be related to the duration of certain hidden processes such as the stage of the life cycle, the time between virus infection and virus production, the duration of the infectious period, the immune period, and so on [4-6]. Mathematical models of tumor-immune dynamics have added to our understanding of how host immune cells and cancerous cells evolve and interact [7]. A statistical model for cancer mortality has been studied by [8]. An important division of cancer mathematical models aims to investigate the effect of varying immunotherapy and chemotherapy concentrations, as well as the influence of various parameters. [9] Examined the stability of a mathematical model of cancer virus therapy, their discoveries revealed that some conditions exist for the global stability of trivial and interior equilibrium points. [10], Stability analysis of mathematical models for nonlinear growth kinetics of breast cancer stem cells was performed.

They investigate the existence and stability of nonlinear growth kinetics of breast cancer stem cells using functional and ordinary differential equation theory. For starter, they establish a necessary condition for the existence and uniqueness of the solution for nonlinear growth kinetics of breast cancer stem cells. Then, using linearization techniques, they studied the uniform asymptotic stability of the zero solution and provided criteria for uniform asymptotic stability of a nontrivial steady-state solution with and without time delays, with examples. [11] Tumor Dynamics with Drug Interventions: Mathematical Modeling, analysis and simulation findings suggest that a new mathematical model combining important interactions between tumor cells and immune system cells such as natural killer cells, dendritic cells, and cytotoxic CD8+T cells, as well as drug delivery to these cell sites, has been proposed. These interactions are described numerically by a system of ordinary differential equations. This model's stability is also examined to determine the conditions required for tumor-free equilibrium to be stable. [12] Mathematical Modeling for the Role of CD4+T Cells in Tumor Immune Interactions was investigated. Their findings revealed that all equilibrium points are unstable, and they deduced a condition for preventing tumor recurrence after treatment. Finally, a bifurcation analysis is carried out to investigate the effect of changing system parameters on stability, and the bifurcation points are specified. As a result, when systems stabilize, tumors can be eradicated without the risk of recurrence. The majority of these models are in the form of a coupled nonlinear ordinary differential equation system. [13-14] developed a useful model for the interaction of the tumor and immune system along these lines. [15] A mathematical model of HIV infection of CD4+ T-cells was examined using stability and Hopf bifurcation analyses. The model is based on a system of delay differential equations with logistic growth terms and antiretroviral treatment with a discrete-time delay, which has a significant impact on the stability of steady-state, using center manifold theory and the normal form method. [16] Investigated interaction of effector cells and tumor cells, and the modification is accomplished by adding a discrete-time delay to the effector cell recruitment term. To understand the complex dynamics of the tumor-immune system, find the bifurcation for single parameters as well as two-parameter bifurcation regions. Our numerical simulations show that the model system exhibits both regular and irregular periodic oscillations, demonstrating the long-term phenomenon of tumor relapse. [17] The characteristic equation is





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used to investigate the singularities and their local stability. They investigate a Hopf bifurcation around the interior singularity and determine the stability of the corresponding Hopf cycles by computing the model's normal form in the direction of the Hopf bifurcation. [18] To investigate long-term tumor relapse phenomena, a three-dimensional nonlinear delay differential system with tumor cells, cytotoxic T lymphocytes, and T helper cells with recruitment delay and chemotherapy was built. It is also demonstrated that when the intrinsic recruitment delay of the tumor crosses the threshold, a branch of stable periodic solutions bifurcates from the coexistence equilibrium, which is a new mechanism with in numerical examples. [19] introduced a stability and Hopf bifurcation analysis of a reaction-diffusion system that models the interaction between endothelial cells and the inhibitor. Then, under certain conditions, investigate the stability of the positive equilibrium solutions, as well as the existence of a Hopf bifurcation, and provide some figures to demonstrate that the equilibrium solutions are indeed asymptotically stable. [20] investigated a model that describes all phenomena at the cell level quite exhaustively, but rather a qualitative model working at the tissue level and Hopf-bifurcation by considering the bifurcation parameter with numerical simulations that are well-matched with analytical findings. Many technical and physical problems can be described and analyzed by many researchers different mathematical modeling. [21-25] Tumor growth and cancer treatment have produced valuable and thorough writers in recent years. Since discrete-time delay is important as described by [26] in the mathematical model of immunotherapy with interleukin-2, it is more realistic to consider the effect of these discrete-time delays at the same time in the model. Furthermore, these delays represent different meanings and hence it is recommended to use a different notation for each. In this study, the mathematical model of immunotherapy with interleukin-2 is given, and extended as follows.

$$\frac{dx}{dt} = cy - \mu_2 x + \frac{p_1 x(t-\tau)z(t-\tau)}{g_1 + z(t-\tau)} + s_1$$

$$\frac{dy}{dt} = r_2 y(1 - by) - \frac{axy}{g_2 + y} \quad (1.1)$$

$$\frac{dz}{dt} = \frac{p_2 xy}{g_3 + y} - \mu_3 z + s_2$$

$$x(\theta) = \psi_1(\theta), \quad y(\theta) = \psi_2(\theta), \quad z(\theta) = \psi_3(\theta)$$

$$\psi_1(\theta) \geq 0, \psi_2(\theta) \geq 0, \psi_3(\theta) \geq 0, \text{ on } \theta \in [-\tau, 0], \quad \tau = \min\{\tau_1, \tau_2\}$$

Studying the behavior of cancer focuses on developing suitable mathematical models involving qualitative approaches to understand various aspects of tumor growth and the response of cancer cells to clinical interventions. The stability and Hopf bifurcation analysis of a mathematical model of immunotherapy with interleukin-2, on the other hand, have not yet been investigated in the existing literature. As a result, the primary goal of this research is to investigate the stability and Hopf bifurcation analysis of the mathematical model of immunotherapy with interleukin-2 given in Eq (1.1). The model's stochastic stability properties are investigated both analytically and numerically, and the thresholds discovered may be useful in controlling the growth of a malignant tumor. Despite the enormous amount of research done on cancer analysis and mathematical modeling, the extended model given by Eq. (1.1) has yet to be considered in the existing literature. As a result, the purpose of this research is to fill that void. The rest of this paper is organized as follows. In Section 2, we obtain the description of the model of solutions of Eq (1.1). In Section 3, we study the existence and stability of possible steady states of the model and discuss the estimation of the length of delay to preserve stability. In Section 4, we analyze the Hopf bifurcation method and provide some biological interpretations. Finally, the conclusions and discussions are then presented in Section 5.

List of Variables and Parameters

$x(t)$ – The Effector cells

$y(t)$ – The Tumor cells

$z(t)$ – The concentration of Interleukin -2 in a single site compartment

c – Antigenicity of Tumor

s_1 – The treatment term that represents the external source of effect or cells





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s_2 – The treatment term that represents an external input of Interleukin -2 into the system

p_1 – growth rate of effector cells

p_2 – growth rate of Interleukin-2

g_1 – half saturation constant for the proliferation term

g_2 – half saturation constant for the tumor clearance

g_3 – half saturation constant for the production term

r_2 – growth rate of tumor cells

μ_2 – Natural decay rate of effector cells

μ_3 – Natural decay rate of Interleukin -2

a – Decay rate of tumor

b – The reciprocal of carrying capacity of tumor cells

Description of the model

Positivity of the solution of the model

Consider the mathematical model formulated in Eq. (1.1),

From the first equation of Eq. (1.1),

$$\frac{dx}{dt} = cy(t - \tau_1) + \frac{p_1 x(t - \tau_2) z(t - \tau_2)}{g_1 + z(t - \tau_2)} + s_1 - \mu_2 x$$

$$\frac{dx}{dt} = c\psi_2(t - \tau_1) + \frac{p_1 \psi_1(t - \tau_2) \psi_3(t - \tau_2)}{g_1 + \psi_3(t - \tau_2)} + s_1 - \mu_2 x$$

where $x(\theta) = \psi_1(\theta), y(\theta) = \psi_2(\theta), z(\theta) = \psi_3(\theta)$

Since $\psi_1(\theta) \geq 0, \psi_2(\theta) \geq 0, \psi_3(\theta) \geq 0$, on $\theta \in [-\tau, 0], \tau = \min\{\tau_1, \tau_2\}$

$$\frac{dx}{dt} \geq -\mu_2 x, \quad \frac{dx}{x} \geq -\mu_2 dt$$

Integrating both sides with respect to t ,

$$\int \frac{dx}{x} \geq \int -\mu_2 dt, \quad \ln x(t) \geq -\mu_2 t + x_0, \quad e^{\ln x(t)} \geq x_0 e^{-\mu_2 t} \quad x(t) \geq x_0 e^{-\mu_2 t} > 0, x(t) > 0$$

From the second equation of Eq.(1.1),

$$\frac{dy}{y} = U(x, y, z) dt, \text{ where } U(x, y, z) = \left(r_2(1 - by) - \frac{ax}{g_2 + y} \right)$$

$$\text{Integrating from } [0, t], \ln y = \int_0^t U(x, y, z) ds, \quad y(t) = y_0 e^{\int_0^t U(x, y, z) ds} > 0, y(t) > 0$$

$$\text{From the third equation of Eq.(1.4), } \frac{dz}{dt} > -\mu_3 z, \quad \frac{dz}{z} > -\mu_3 dt$$

Integrating both sides with respect to t ,

$$\int \frac{dz}{z} > \int -\mu_3 dt \Rightarrow \ln z > -\mu_3 t + z_0, \quad e^{\ln z} > z_0 e^{-\mu_3 t} > 0 \Rightarrow z(t) > 0$$

As a result, all solutions of system (1.1) that start in \mathbb{R}_+^3 remain positive.

Equilibrium Points

To find the equilibrium point of system (1.4), equate the system to zero.

$$cy(t - \tau_1) - \mu_2 x + \frac{p_1 x(t - \tau_2) z(t - \tau_2)}{g_1 + z(t - \tau_2)} + s_1 = 0 \tag{2.1}$$

$$r_2 y(1 - by) - \frac{axy}{g_2 + y} = 0 \tag{2.2}$$





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$$\frac{p_2xy}{g_3 + y} - \mu_3z + s_2 = 0 \tag{2.3}$$

$$\text{From Eq. (2.2), } r_2(1 - by) - \frac{ax}{g_2+y} = 0 \tag{2.4}$$

For $y = 0$, Eq. (2.3) become $\mu_3z + s_2 = 0, z = \frac{s_2}{\mu_3}$

For $y = 0$, Eq. (2.1) become

$$-\mu_2x + \frac{p_1xz}{g_1 + z} + s_1 = 0, x \left(-\mu_2 + \frac{p_1z}{g_1 + z} \right) + s_1 = 0$$

$$x = \frac{-s_1(g_1\mu_3 + s_2)}{-\mu_2(g_1\mu_3 + s_2) + p_1s_2}, \Rightarrow x = \frac{s_1(g_1\mu_3 + s_2)}{\mu_2(g_1\mu_3 + s_2) - p_1s_2}$$

Therefore, the equilibrium point is:

$$E_1 = \left(\frac{s_1(\mu_3g_1 + s_2)}{\mu_2(g_1\mu_3 + s_2) - p_1s_2}, 0, \frac{s_2}{\mu_3} \right)$$

Provided that, $\mu_2(g_1\mu_3 + s_2) - p_1s_2 > 0$

From Eq.(2.2)

$$x^* = \frac{r_2}{a} (1 - by^*)(g_2 + y^*) \tag{2.5}$$

Putting Eq. (2.5) into Eq. (2.3),

$$z^* = \frac{p_2r_2(1 - by^*)(g_2 + y^*)y^*}{\mu_3a(g_3 + y^*)} + \frac{s_2}{\mu_3}$$

and y^* is given by the equation

$$cy^* - \frac{\mu_2x^* + p_1x^*z^*}{g_1 + z^*} + s_1 = 0$$

Therefore, the positive equilibrium point is given by $E^* = (x^*, y^*, z^*)$

Stability analysis

In this section, we will investigate the stability of the linearization of equation (1.1) about $E^* = (x^*, y^*, z^*)$ is given by:

$$x' = A_0x + A_1x(t - \tau_1) + A_1x(t - \tau_2)$$

$$f_1 = cy(t - \tau_1) - \mu_2x + \frac{p_1x(t - \tau_2)z(t - \tau_2)}{g_1 + z(t - \tau_2)} + s_1$$

$$f_2 = r_2y(1 - by) - \frac{axy}{g_2 + y}, \quad f_3 = \frac{p_2xy}{g_3 + y} - \mu_3z + s_2$$

$$\frac{\partial f_1}{\partial x}(x^*, y^*, z^*) = -\mu_2, \frac{\partial f_1}{\partial y}(x^*, y^*, z^*) = \frac{\partial f_1}{\partial z}(x^*, y^*, z^*) = 0$$

$$\frac{\partial f_2}{\partial x}(x^*, y^*, z^*) = \frac{-ay^*}{g_2 + y^*}, \frac{\partial f_2}{\partial y}(x^*, y^*, z^*) = \frac{ax^*y^*}{(g_2 + y^*)^2} - br_2y^*, \frac{\partial f_2}{\partial z}(x^*, y^*, z^*) = 0$$

$$\frac{\partial f_3}{\partial x}(x^*, y^*, z^*) = \frac{p_2y^*}{g_3 + y^*}, \frac{\partial f_3}{\partial y}(x^*, y^*, z^*) = \frac{p_2g_3x^*}{(g_3 + y^*)^2}, \frac{\partial f_3}{\partial z}(x^*, y^*, z^*) = -\mu_3$$

$$A_0 = \begin{pmatrix} \frac{\partial f_1}{\partial x}(x^*, y^*, z^*) & \frac{\partial f_1}{\partial y}(x^*, y^*, z^*) & \frac{\partial f_1}{\partial z}(x^*, y^*, z^*) \\ \frac{\partial f_2}{\partial x}(x^*, y^*, z^*) & \frac{\partial f_2}{\partial y}(x^*, y^*, z^*) & \frac{\partial f_2}{\partial z}(x^*, y^*, z^*) \\ \frac{\partial f_3}{\partial x}(x^*, y^*, z^*) & \frac{\partial f_3}{\partial y}(x^*, y^*, z^*) & \frac{\partial f_3}{\partial z}(x^*, y^*, z^*) \end{pmatrix} = \begin{pmatrix} -\mu_2 & 0 & 0 \\ -\frac{ay^*}{g_2 + y^*} & \frac{ax^*y^*}{(g_2 + y^*)^2} - br_2y^* & 0 \\ \frac{p_2y^*}{g_3 + y^*} & \frac{p_2g_3x^*}{(g_3 + y^*)^2} & -\mu_3 \end{pmatrix}$$

To get A_1 ,

$$\frac{\partial f_1}{\partial x_{\tau_1}}(x^*, y^*, z^*) = 0, \frac{\partial f_1}{\partial y_{\tau_1}}(x^*, y^*, z^*) = c, \frac{\partial f_1}{\partial z_{\tau_1}}(x^*, y^*, z^*) = 0$$

$$\frac{\partial f_2}{\partial x_{\tau_1}}(x^*, y^*, z^*) = \frac{\partial f_2}{\partial y_{\tau_1}}(x^*, y^*, z^*) = \frac{\partial f_2}{\partial z_{\tau_1}}(x^*, y^*, z^*) = 0$$

$$\frac{\partial f_3}{\partial x_{\tau_1}}(x^*, y^*, z^*) = \frac{\partial f_3}{\partial y_{\tau_1}}(x^*, y^*, z^*) = \frac{\partial f_3}{\partial z_{\tau_1}}(x^*, y^*, z^*) = 0$$





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$$A_1 = \begin{pmatrix} \frac{\partial f_1}{\partial x_{\tau_1}}(x^*, y^*, z^*) & \frac{\partial f_1}{\partial y_{\tau_1}}(x^*, y^*, z^*) & \frac{\partial f_1}{\partial z_{\tau_1}}(x^*, y^*, z^*) \\ \frac{\partial f_2}{\partial x_{\tau_1}}(x^*, y^*, z^*) & \frac{\partial f_2}{\partial y_{\tau_1}}(x^*, y^*, z^*) & \frac{\partial f_2}{\partial z_{\tau_1}}(x^*, y^*, z^*) \\ \frac{\partial f_3}{\partial x_{\tau_1}}(x^*, y^*, z^*) & \frac{\partial f_3}{\partial y_{\tau_1}}(x^*, y^*, z^*) & \frac{\partial f_3}{\partial z_{\tau_1}}(x^*, y^*, z^*) \end{pmatrix} = \begin{pmatrix} 0 & c & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

To get A_2 ,

$$\frac{\partial f_1}{\partial x_{\tau_2}}(x^*, y^*, z^*) = \frac{p_1 z^*}{g_1 + z^*} \cdot \frac{\partial f_1}{\partial y_{\tau_2}}(x^*, y^*, z^*) = 0, \frac{\partial f_1}{\partial z_{\tau_2}}(x^*, y^*, z^*) = \frac{p_1 g_1 x^*}{(g_1 + z^*)^2}$$

$$\frac{\partial f_2}{\partial x_{\tau_2}}(x^*, y^*, z^*) = \frac{\partial f_2}{\partial y_{\tau_2}}(x^*, y^*, z^*) = \frac{\partial f_2}{\partial z_{\tau_2}}(x^*, y^*, z^*) = 0$$

$$\frac{\partial f_3}{\partial x_{\tau_2}}(x^*, y^*, z^*) = \frac{\partial f_3}{\partial y_{\tau_2}}(x^*, y^*, z^*) = \frac{\partial f_3}{\partial z_{\tau_2}}(x^*, y^*, z^*) = 0$$

$$A_2 = \begin{pmatrix} \frac{\partial f_1}{\partial x_{\tau_2}}(x^*, y^*, z^*) & \frac{\partial f_1}{\partial y_{\tau_2}}(x^*, y^*, z^*) & \frac{\partial f_1}{\partial z_{\tau_2}}(x^*, y^*, z^*) \\ \frac{\partial f_2}{\partial x_{\tau_2}}(x^*, y^*, z^*) & \frac{\partial f_2}{\partial y_{\tau_2}}(x^*, y^*, z^*) & \frac{\partial f_2}{\partial z_{\tau_2}}(x^*, y^*, z^*) \\ \frac{\partial f_3}{\partial x_{\tau_2}}(x^*, y^*, z^*) & \frac{\partial f_3}{\partial y_{\tau_2}}(x^*, y^*, z^*) & \frac{\partial f_3}{\partial z_{\tau_2}}(x^*, y^*, z^*) \end{pmatrix} = \begin{pmatrix} \frac{p_1 z^*}{g_1 + z^*} & 0 & \frac{p_1 g_1 x^*}{(g_1 + z^*)^2} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$x' = \begin{pmatrix} -\mu_2 & 0 & 0 \\ \frac{ay^*}{g_2 + y^*} & \frac{ax^*y^*}{(g_2 + y^*)^2} - br_2y^* & 0 \\ \frac{p_2y^*}{g_3 + y^*} & \frac{p_2g_3x^*}{(g_3 + y^*)^2} & -\mu_3 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} 0 & c & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} x(t - \tau_1) \\ y(t - \tau_1) \\ z(t - \tau_1) \end{pmatrix} + \begin{pmatrix} \frac{p_1 z^*}{g_1 + z^*} & 0 & \frac{p_1 g_1 x^*}{(g_1 + z^*)^2} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} x(t - \tau_2) \\ y(t - \tau_2) \\ z(t - \tau_2) \end{pmatrix}$$

Therefore, the linearized form of system (1.4) is

$$\begin{aligned} \frac{dx}{dt} &= -\mu_2 x + cy(t - \tau_1) + \frac{p_1 z^*}{g_1 + z^*} x(t - \tau_2) + \frac{p_1 g_1 x^*}{(g_1 + z^*)^2} z(t - \tau_2) \\ \frac{dy}{dt} &= \frac{-ay^*}{g_2 + y^*} x + \left(\frac{ax^*y^*}{(g_2 + y^*)^2} - br_2y^* \right) y \\ \frac{dz}{dt} &= \frac{p_2y^*}{g_3 + y^*} x + \frac{p_2g_3x^*}{(g_3 + y^*)^2} y - \mu_3 z \end{aligned} \tag{3.1}$$

Let $x = A_1 e^{\lambda t}$, $y = A_2 e^{\lambda t}$, $z = A_3 e^{\lambda t}$ be the solution of Eq. (3.1),

$$\begin{cases} x(t) = A_1 e^{\lambda t} \\ \frac{dx}{dt} = A_1 \lambda e^{\lambda t} \\ x(t - \tau_1) = A_1 e^{-\lambda \tau_1} e^{\lambda t} \\ x(t - \tau_2) = A_1 e^{-\lambda \tau_2} e^{\lambda t} \end{cases} \tag{3.2}$$

Similarly, $y(t) = A_2 e^{\lambda t}$, and (3.3)

$z(t) = A_3 e^{\lambda t}$ (3.4)

Using Eqs. (3.2) - (3.4) into Eq. (3.1) gives

$$\left(\lambda + \mu_2 - \frac{p_1 z^*}{g_1 + z^*} e^{-\lambda \tau_2} \right) A_1 - c e^{-\lambda \tau_1} A_2 - \frac{p_1 g_1 x^*}{(g_1 + z^*)^2} e^{-\lambda \tau_2} A_3 = 0$$

$$\frac{ay^*}{g_2 + y^*} A_1 + \left(\lambda - \frac{ax^*y^*}{(g_2 + y^*)^2} + br_2y^* \right) A_2 = 0 \tag{3.5}$$

$$\frac{-p_2y^*}{g_3 + y^*} A_1 - \frac{p_2g_3x^*}{(g_3 + y^*)^2} A_2 + (\lambda + \mu_3) A_3 = 0$$

For Eq. (3.5) to have nontrivial solution, the determinant of the coefficient matrix must be zero.





$$\begin{vmatrix} \lambda + \mu_2 - \frac{p_1 z^*}{g_1 + z^*} e^{-\lambda \tau_2} & -c e^{-\lambda \tau_1} & \frac{-p_1 g_1}{(g_1 + z^*)^2} e^{-\lambda \tau_2} \\ \frac{a y^*}{g_2 + y^*} & \lambda - \frac{a x^* y^*}{(g_2 + y^*)^2} + b r_2 y^* & 0 \\ \frac{-p_2 y^*}{g_3 + y^*} & \frac{-p_2 g_3 x^*}{(g_3 + y^*)^2} & \lambda + \mu_3 \end{vmatrix} = 0$$

$$\lambda^3 + \left(\mu_2 + \mu_3 - \frac{a x^* y^*}{(g_2 + y^*)^2} + b r_2 y^* \right) \lambda^2 + \left(\mu_2 \mu_3 + b r_2 \mu_2 y^* + b r_2 \mu_3 y^* - \frac{a \mu_2 x^* y^*}{(g_2 + y^*)^2} - \frac{a \mu_3 x^* y^*}{(g_2 + y^*)^2} \right) \lambda$$

$$+ b r_2 \mu_2 \mu_3 y^* - \frac{a \mu_2 \mu_3 x^* y^*}{(g_2 + y^*)^2} + \frac{a c y^*}{g_2 + y^*} \lambda e^{-\lambda \tau_1} + \frac{a c \mu_3 y^*}{g_2 + y^*} e^{-\lambda \tau_1}$$

$$- \frac{p_1 z^*}{g_1 + z^*} \lambda^2 e^{-\lambda \tau_2} + \left(\frac{-p_1 \mu_3 z^*}{g_1 + z^*} + \frac{a p_1 x^* y^* z^*}{(g_1 + z^*)(g_2 + y^*)^2} \right) \lambda e^{-\lambda \tau_2}$$

$$+ \left(\frac{a p_1 \mu_3 x^* y^* z^*}{(g_1 + z^*)(g_2 + y^*)^2} - \frac{b p_1 r_2 \mu_3 y^* z^*}{g_1 + z^*} + \frac{a p_1 p_2 g_1 g_3 (x^*)^2 y^*}{(g_1 + z^*)^2 (g_3 + y^*)^2 (g_2 + y^*)} \right. \\ \left. + \frac{a p_1 p_2 g_1 (x^*)^2 (y^*)^2}{(g_1 + z^*)^2 (g_2 + y^*)^2 (g_3 + y^*)} - \frac{b p_1 p_2 g_1 r_2 (y^*)^2 x^*}{(g_1 + z^*)^2 (g_3 + y^*)} \right) e^{-\lambda \tau_2} = 0$$

The characteristic equation for the linearized equation around the point (x^*, y^*, z^*) is

$$\lambda^3 + a_1 \lambda^2 + a_2 \lambda + a_3 + (b_2 \lambda + b_3) e^{-\lambda \tau_1} + (c_1 \lambda^2 + c_2 \lambda + c_3) e^{-\lambda \tau_2} = 0$$

$$P(\lambda) + Q(\lambda) e^{-\lambda \tau_1} + R(\lambda) e^{-\lambda \tau_2} = 0 \tag{3.6}$$

where, $P(\lambda) = \lambda^3 + a_1 \lambda^2 + a_2 \lambda + a_3$, $Q(\lambda) = b_2 \lambda + b_3$, $R(\lambda) = c_1 \lambda^2 + c_2 \lambda + c_3$

Provided that,

$$a_1 = \mu_2 + \mu_3 - \frac{a x^* y^*}{(g_2 + y^*)^2} + b r_2 y^*$$

$$a_2 = \mu_2 \mu_3 + b r_2 \mu_2 y^* + b r_2 \mu_3 y^* - \frac{a \mu_2 x^* y^*}{(g_2 + y^*)^2} - \frac{a \mu_3 x^* y^*}{(g_2 + y^*)^2}$$

$$a_3 = b r_2 \mu_2 \mu_3 y^* - \frac{a \mu_2 \mu_3 x^* y^*}{(g_2 + y^*)^2}$$

$$b_2 = \frac{a c y^*}{g_2 + y^*}, \quad b_3 = \frac{a c \mu_3 y^*}{g_2 + y^*}$$

$$c_1 = -\frac{p_1 z^*}{g_1 + z^*}, \quad c_2 = -\frac{p_1 \mu_3 z^*}{g_1 + z^*} + \frac{a p_1 x^* y^* z^*}{(g_1 + z^*)(g_2 + y^*)^2} - \frac{b p_1 r_2 y^* z^*}{g_1 + z^*} - \frac{p_1 p_2 g_1 x^* y^*}{(g_1 + z^*)^2 (g_3 + y^*)}$$

$$c_3 = \frac{a p_1 \mu_3 x^* y^* z^*}{(g_1 + z^*)(g_2 + y^*)^2} - \frac{b p_1 r_2 \mu_3 y^* z^*}{g_1 + z^*} + \frac{a p_1 p_2 g_1 g_3 (x^*)^2 y^*}{(g_1 + z^*)^2 (g_3 + y^*)^2 (g_2 + y^*)} + \frac{a p_1 p_2 g_1 (x^*)^2 (y^*)^2}{(g_1 + z^*)^2 (g_2 + y^*)^2 (g_3 + y^*)} - \frac{b p_1 p_2 g_1 r_2 x^* (y^*)^2}{(g_1 + z^*)^2 (g_3 + y^*)}$$

Case 1: If $\tau_1 = \tau_2 = 0$

$$P(\lambda) + Q(\lambda) + R(\lambda) = 0 \tag{3.7}$$

$$\lambda^3 + (a_1 + c_1) \lambda^2 + (a_2 + b_2 + c_2) \lambda + (a_3 + b_3 + c_3) = 0$$

Applying Routh Hurwitz stability criteria, in the absence of delay, the system is locally asymptotically stable if the following conditions are satisfied

- (i) $a_1 + c_1 > 0$
- (ii) $(a_1 + c_1)(a_2 + b_2 + c_2) - (a_3 + b_3 + c_3) > 0$
- (iii) $a_3 + b_3 + c_3 > 0$

Case 2: $\tau_1 = \tau_2 = \tau$

$$P(\lambda) + (Q(\lambda) + R(\lambda)) e^{-\lambda \tau} = 0$$

$$\lambda^3 + a_1 \lambda^2 + a_2 \lambda + a_3 + [c_1 \lambda^2 + (b_2 + c_2) \lambda + (b_3 + c_3)] e^{-\lambda \tau} = 0 \tag{3.8}$$





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Suppose $\lambda = \pm i\omega, \omega > 0$ be the eigenvalue of Eq. (3.8)

$$\begin{aligned} & (i\omega)^3 + a_1(i\omega)^2 + a_2(i\omega) + a_3 + [c_1(i\omega)^2 + (b_2 + c_2)(i\omega) + (b_3 + c_3)]e^{-i\omega\tau} = 0 \\ & (i\omega)^3 + a_1(i\omega)^2 + a_2(i\omega) + a_3 + [c_1(i\omega)^2 + (b_2 + c_2)(i\omega) + (b_3 + c_3)](\cos(\omega\tau) - i \sin(\omega\tau)) = 0 \\ & -i\omega^3 - a_1\omega^2 + ia_2\omega + a_3 - c_1\omega^2(\cos(\omega\tau) - i \sin(\omega\tau)) + i(b_2 + c_2)\omega(\cos(\omega\tau) - i \sin(\omega\tau)) + (b_3 + c_3)(\cos(\omega\tau) - i \sin(\omega\tau)) = 0 \end{aligned}$$

Equating real parts and imaginary parts to zero

$$\begin{aligned} -a_1\omega^2 + a_3 + (b_3 + c_3 - c_1\omega^2) \cos(\omega\tau) + (b_2\omega + c_2\omega) \sin(\omega\tau) &= 0 \\ -\omega^3 + a_2\omega + (c_1\omega^2 - b_3 - c_3) \sin(\omega\tau) + (b_2\omega + c_2\omega) \cos(\omega\tau) &= 0 \end{aligned}$$

$$a_1\omega^2 - a_3 = (b_3 + c_3 - c_1\omega^2) \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) \tag{3.9}$$

$$\omega^3 - a_2\omega = (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3 - c_1\omega^2) \sin(\omega\tau) \tag{3.10}$$

Squaring and adding Eq. (3.9) and Eq. (3.10),

$$\begin{aligned} & (a_1\omega^2 - a_3)^2 + (\omega^3 - a_2\omega)^2 \\ &= (b_2 + c_2)^2\omega^2 + (b_3 + c_3 - c_1\omega^2)^2\omega^6 + (a_1^2 - 2a_2 - c_1^2)\omega^4 \\ &+ (a_2^2 - 2a_1a_3 - b_2^2 - 2b_2c_2 - c_2^2 + 2c_1c_3 + 2c_1b_3)\omega^2 + a_3^2 - b_3^2 - 2b_3c_3 - c_3^2 \\ &= 0\rho^3 + B_1\rho^2 + B_2\rho + B_3 \\ &= 0, \end{aligned} \tag{3.11}$$

Where $\rho = \omega^2, B_1 = a_1^2 - 2a_2 - c_1^2 \left(\mu_2\mu_3 + br_2\mu_3y^* + br_2\mu_2y^* + \frac{ax^*y^*}{(g_2+y^*)^2} + \frac{ax^*y^*}{(g_2+y^*)^2} \right)^2$

$$\begin{aligned} & -2 \left(\mu_2\mu_3 + br_2\mu_2y^* + br_2\mu_3y^* - \frac{ax^*y^*}{(g_2+y^*)^2}\mu_2 - \frac{ay^*y^*}{(g_2+y^*)^2}\mu_3 \right) - \left(-\frac{p_1z^*}{g_1+z^*} \right)^2 \\ & B_2 = (a_2^2 - 2a_1a_3 - b_2^2 - 2b_2c_2 - c_2^2 + 2c_1c_3 + 2c_1b_3) \\ & \left(\mu_2\mu_3 + br_2\mu_2y^* + br_2\mu_3y^* - \frac{ax^*y^*}{(g_2+y^*)^2}\mu_2 - \frac{ay^*y^*}{(g_2+y^*)^2}\mu_3 \right)^2 \\ & -2 \left((\mu_2 + \mu_3 + br_2y^* - \frac{ax^*y^*}{(g_2+y^*)^2})(br_2\mu_2\mu_3y^* - \frac{a\mu_2\mu_3x^*y^*}{(g_2+y^*)^2}) - \left(\frac{cay^*}{g_2+y^*} \right)^2 \right) \\ & -2 \left(\left(\frac{cay^*}{g_2+y^*} \right) \left(\frac{ap_1x^*y^*z^*}{(g_1+z^*)(g_2+y^*)^2} - \frac{p_1z^*\mu_3}{g_1+z^*} - \frac{bp_1r_2y^*z^*}{g_1+z^*} - \frac{p_1p_2g_1x^*y^*}{(g_1+z^*)^2(g_3+y^*)} \right) \right) \\ & - \left(\frac{ap_1x^*y^*z^*}{(g_1+z^*)(g_2+y^*)^2} - \frac{p_1\mu_3z^*}{g_1+z^*} - \frac{bp_1r_2y^*z^*}{g_1+z^*} - \frac{p_1p_2g_1x^*y^*}{(g_1+z^*)^2(g_3+y^*)} \right)^2 \\ & + 2 \left(\left(-\frac{p_1z^*}{g_1+z^*} \right) \left(\frac{ap_1\mu_3x^*y^*z^*}{(g_1+z^*)(g_2+y^*)^2} + \frac{ap_1p_2g_1g_3(x^*)^2y^*}{(g_1+z^*)^2(g_2+y^*)(g_3+y^*)^2} - \frac{bp_1r_2\mu_3y^*z^*}{g_1+z^*} \right) \right. \\ & \left. + \frac{ap_1p_2g_1(x^*)^2(y^*)^2}{(g_1+z^*)^2(g_2+y^*)^2(g_3+y^*)} - \frac{bp_1p_2r_2g_1x^*(y^*)^2}{(g_1+z^*)^2(g_3+y^*)} \right) \\ & + 2 \left(\left(-\frac{p_1z^*}{g_1+z^*} \right) \left(\frac{acy^*}{g_2+y^*}\mu_3 \right) \right) \end{aligned}$$

$$B_3 = a_3^2 - b_3^2 - 2b_3c_3 - c_3^2$$

$$\begin{aligned} & \left(br_2\mu_2\mu_3y^* - \frac{a\mu_2\mu_3x^*y^*}{(g_2+y^*)^2} \right)^2 - \left(\frac{ac\mu_3y^*}{g_2+y^*} \right)^2 - 2 \left(\frac{ac\mu_3y^*}{g_2+y^*} \left(\frac{ap_1\mu_3x^*y^*z^*}{(g_1+z^*)(g_2+y^*)^2} - \frac{p_1r_2b\mu_3y^*z^*}{g_1+z^*} \right) \right. \\ & \left. + \frac{ap_1p_2g_1g_2(x^*)^2y^*}{(g_1+z^*)^2(g_2+y^*)(g_3+y^*)^2} + \frac{ap_1p_2g_1(x^*)^2(y^*)^2}{(g_1+z^*)^2(g_2+y^*)^2(g_3+y^*)} \right. \\ & \left. - \frac{p_1p_2r_2g_1bx^*(y^*)^2}{(g_1+z^*)^2(g_3+y^*)} \right) \end{aligned}$$





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$$-\left(\frac{ap_1\mu_3x^*y^*z^*}{(g_1+z^*)(g_2+y^*)^2} - \frac{p_1r_2b\mu_3y^*z^*}{g_1+z^*} + \frac{ap_1p_2g_1g_2(x^*)^2y^*}{(g_1+z^*)^2(g_2+y^*)(g_3+y^*)^2} \right)^2$$

$$+\frac{ap_1p_2g_1(x^*)^2(y^*)^2}{(g_1+z^*)^2(g_2+y^*)^2(g_3+y^*)} - \frac{p_1p_2r_2g_1bx^*(y^*)^2}{(g_1+z^*)^2(g_3+y^*)}$$

Assuming that B_1 is a positive, the simplest assumption is that (3.11) will have a positive root is

$$B_3 = a_3^2 - b_3^2 - 2b_3c_3 - c_3^2 < 0.$$

Hence, we can say that there is a positive ω_0 satisfying Eq. (3.11) that is, the characteristic equation (3.8) has a pair of purely imaginary eigenvalues of the form $\pm i\omega_0$. Eliminating $\sin(\omega\tau)$ from Eq. (3.9) and Eq. (3.10),

$$(b_3 + c_3 - c_1\omega^2)(a_1\omega^2 - a_3) = (b_3 + c_3 - c_1\omega^2) \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau)$$

$$(b_2 + c_2)\omega(\omega^3 - a_2\omega) = (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3 - c_1\omega^2) \sin(\omega\tau)$$

Then τ_n^* corresponding to ω_0 is given by

$$\tau_n^* = \frac{1}{\omega_0} \cos^{-1} \left(\frac{(b_3 + c_3 - c_1\omega^2)(a_1\omega^2 - a_3) + (b_2 + c_2)\omega(\omega^3 - a_2\omega)}{(b_2 + c_2)^2\omega^2 + (b_3 + c_3 - c_1\omega^2)^2} \right) + \frac{2n\pi}{\omega_0} \tag{3.12}$$

$n = 0, 1, 2, \dots$ For $\tau = 0$, E^* is stable. Hence, E^* will remain stable for $\tau < \tau_0$ as $n = 0$.

$$\tau_0^* = \frac{1}{\omega_0} \cos^{-1} \left(\frac{(b_3 + c_3 - c_1\omega^2)(a_1\omega^2 - a_3) + (b_2 + c_2)\omega(\omega^3 - a_2\omega)}{(b_2 + c_2)^2\omega^2 + (b_3 + c_3 - c_1\omega^2)^2} \right)$$

is the smallest cut-off value at which stability of the equilibrium point is lost and never is be regained in the future time for the smallest positive eigenvalue ω_0 .

Estimation of the length of delay to preserve stability

Consider the system (3.1) and the space of all real-valued continuous functions defined on $[-\tau, \infty)$ and satisfying the initial condition $x(t) \geq 0, y(t) \geq 0$, and $z(t) \geq 0$ on $[-\tau, 0]$. Let $X(s), Y(s)$, and $Z(s)$ denote the Laplace transform of $x(t), y(t)$ and $z(t)$

Then Laplace transform of the linearized system is given by Eq. (3.1)

$$(s + \mu_2)X(s) = ce^{-s\tau_1}Y(s) + ce^{-s\tau_1}K_1(s) + \frac{p_1z^*}{g_1 + z^*} e^{-s\tau_2}X(s) + \frac{p_1z^*}{g_1 + z^*} e^{-s\tau_2}K_2(s)$$

$$+ \frac{p_1g_1x^*}{(g_1 + z^*)^2} e^{-s\tau_2}Z(s) + \frac{p_1g_1x^*}{(g_1 + z^*)^2} e^{-s\tau_2}K_3(s) + x(0),$$

$$\left(s - \frac{ax^*y^*}{(g_2 + y^*)^2} + br_2y^* \right) Y(s) = \frac{-ay^*}{g_2 + y^*} X(s) + y(0),$$

$$(s + \mu_3)Z(s) = \frac{p_2y^*}{g_2 + y^*} X(s) + \frac{p_2g_3x^*}{(g_3 + y^*)^2} Y(s) + z(0).$$

Where $K_1(s) = \int_{-\tau_1}^0 e^{-st}y(t)dt$ $K_2(s) = \int_{-\tau_2}^0 e^{-st}x(t)dt$ $K_3(s) = \int_{-\tau_2}^0 e^{-st}z(t)dt$

For $E^*(x^*, y^*, z^*)$ to be locally asymptotically stable, it is necessary and sufficient that all poles of $X(s)$ have negative real parts. For the condition for local asymptotic stability of $E^*(x^*, y^*, z^*)$ given by

$$Im H(i\eta_0) > 0 \tag{3.13}$$

$$Re H(i\eta_0) = 0 \tag{3.14}$$

where $H(s) = s^3 + a_1s^2 + a_2s + a_3 + (c_1s^2 + (b_2 + c_2)s + c_3)e^{-s\tau}$ and η_0 is the smallest positive root of Eq. (3.14)

In this case, Eq. (3.13) and (3.14) gives

$$a_2\eta_0 - \eta_0^3 > (b_3 + c_3) \sin(\eta_0\tau) - (b_2 + c_2)\eta_0 \cos(\eta_0\tau) - c_1\eta_0^2 \sin(\eta_0\tau) \tag{3.15}$$

$$a_3 - a_1\eta_0^2 = c_1\eta_0^2 \cos(\eta_0\tau) - (b_3 + c_3) \cos(\eta_0\tau) - (b_2 + c_2)\eta_0 \sin(\eta_0\tau) \tag{3.16}$$

Now, if Eq. (3.15) and Eq. (3.16) are satisfied simultaneously, they are sufficient conditions to guarantee stability, which are now used to get an estimate of the length of time delay. The aim is to find an upper bound η_+ to η_0 , independent of τ , and then to estimate τ so that Eq. (3.15) holds true for all values of η , $0 \leq \eta \leq \eta_+$ and hence, in particular at $\eta = \eta_0$.





Equation (3.16) is rewritten as

$$a_1\eta_0^2 = a_3 - c_1\eta_0^2 \cos(\eta_0\tau) + (b_3 + c_3) \cos(\eta_0\tau) + (b_2 + c_2)\eta_0 \sin(\eta_0\tau) \tag{3.17}$$

Maximizing: $a_3 - c_1\eta_0^2 \cos(\eta_0\tau) + (b_3 + c_3) \cos(\eta_0\tau) + (b_2 + c_2)\eta_0 \sin(\eta_0\tau)$

Subject to $|\sin(\eta_0\tau)| \leq 1, |\cos(\eta_0\tau)| \leq 1$

$$|a_1\eta_0^2| \leq |a_3| + |c_1\eta_0^2| |\cos(\eta_0\tau)| + |(b_3 + c_3)| |\cos(\eta_0\tau)| + |(b_2 + c_2)\eta_0| |\sin(\eta_0\tau)| \tag{3.18}$$

$$\eta_+ = \frac{|b_2| + |c_2| + \sqrt{b_2^2 + c_2^2 + 4(|a_1| - |c_1|)(|a_3| + |b_3| + |c_3|)}}{2(|a_1| - |c_1|)} \tag{3.19}$$

Then from Eq. (3.19) $\eta_0 \leq \eta_+$, From Eq. (3.15)

$$\eta_0^2 < a_2 - \frac{(b_3 + c_3)}{\eta_0} \sin(\eta_0\tau) + (b_2 + c_2) \cos(\eta_0\tau) + c_1\eta_0 \sin(\eta_0\tau) \tag{3.20}$$

Since $E^*(x^*, y^*, z^*)$ is a locally asymptotically stable for $\tau = 0$, for sufficiently small $\tau > 0$, the inequality (3.20) will continue to hold.

Substituting Eq. (3.17) in Eq. (3.20),

$$\begin{aligned} & \frac{1}{a_1} (a_3 + (b_3 + c_3) \cos(\eta_0\tau) - c_1\eta_0^2 \cos(\eta_0\tau) + (b_2 + c_2)\eta_0 \sin(\eta_0\tau)) \\ & < a_2 + (b_2 + c_2) \cos(\eta_0\tau) - \frac{(b_3 + c_3)}{\eta_0} \sin(\eta_0\tau) + c_1\eta_0 \sin(\eta_0\tau) \\ & \quad a_3 + (b_3 + c_3) \cos(\eta_0\tau) - c_1\eta_0^2 \cos(\eta_0\tau) + (b_2 + c_2)\eta_0 \sin(\eta_0\tau) \\ & < a_1 a_2 + a_1(b_2 + c_2) \cos(\eta_0\tau) - \frac{a_1(b_3 + c_3)}{\eta_0} \sin(\eta_0\tau) + a_1 c_1 \eta_0 \sin(\eta_0\tau) \\ & \quad (b_3 + c_3 - c_1\eta_0^2 - a_1(b_2 + c_2)) \cos(\eta_0\tau) \\ & \quad + \left((b_2 + c_2)\eta_0 - a_1 c_1 \eta_0 + \frac{a_1(b_3 + c_3)}{\eta_0} \right) \sin(\eta_0\tau) < a_1 a_2 - a_3 \end{aligned}$$

By subtracting $b_3 + c_3 - c_1\eta_0^2 - a_1(b_2 + c_2)$ from both sides,

$$\begin{aligned} & (b_3 + c_3 - c_1\eta_0^2 - a_1(b_2 + c_2)) (\cos(\eta_0\tau) - 1) + \left((b_2 + c_2)\eta_0 - a_1 c_1 \eta_0 + \frac{a_1(b_3 + c_3)}{\eta_0} \right) \sin(\eta_0\tau) \\ & < a_1 a_2 - a_3 - b_3 - c_3 + c_1\eta_0^2 + a_1(b_2 + c_2) \end{aligned} \tag{3.21}$$

From the fact that $\sin(\eta_0\tau) \leq \eta_0\tau$ and $1 - \cos(\eta_0\tau) = 2 \sin^2\left(\frac{\eta_0\tau}{2}\right)$

$$\begin{aligned} (b_3 + c_3 - c_1\eta_0^2 - a_1 b_2 - a_1 c_2) &= (c_1\eta_0^2 + a_1 b_2 + a_1 c_2 - b_3 - c_3) 2 \sin^2\left(\frac{\eta_0\tau}{2}\right) \\ &\leq \frac{1}{2} |c_1\eta_+^2 + a_1 b_2 + a_1 c_2 - b_3 - c_3| \eta_+^2 \tau^2 \end{aligned}$$

Similarly,

$$\begin{aligned} \left((b_2 + c_2)\eta_0 - a_1 c_1 \eta_0 + \frac{a_1(b_3 + c_3)}{\eta_0} \right) \sin(\eta_0\tau) &= \frac{((b_2 + c_2)\eta_0^2 - a_1 c_1 + a_1 b_3 + a_1 c_3) \sin(\eta_0\tau)}{\eta_0} \\ &\leq |(b_2 + c_2)\eta_+^2 - a_1 c_1 + a_1 b_3 + a_1 c_3| \tau \end{aligned}$$

Eq. (3.21) can be written as $L_1\tau^2 + L_2\tau < L_3$,

Where $L_1 = \frac{1}{2} |c_1\eta_+^2 + a_1 b_2 + a_1 c_2 - b_3 - c_3| \eta_+^2$, $L_2 = |(b_2 + c_2)\eta_+^2 - a_1 c_1 + a_1 b_3 + a_1 c_3|$

$$\begin{aligned} L_3 &= a_1 a_2 - a_3 - b_3 - c_3 + c_1\eta_+^2 + a_1(b_2 + c_2) \\ \tau_+ &= \frac{-L_2 + \sqrt{L_2^2 + 4L_1 L_3}}{2L_1} \end{aligned}$$

Then, for $0 \leq \tau \leq \tau_+$ the Nyquist criterion holds, and τ_+ is the estimate for the length of delay for which the stability is preserved.





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Analysis Hopf Bifurcation method

In his section, we discuss the Hopf Bifurcation method: From the characteristic equation (3.8), suppose it has a simple pair of pure imaginary eigenvalues $\lambda = \pm i\omega, \omega > 0$. By the same analysis made for local stability with delay, there exist $\omega > 0$ when condition (3.12) is satisfied.

Transversality condition,

$$\lambda^3 + a_1\lambda^2 + a_2\lambda + a_3 + (c_1\lambda^2 + (b_2 + c_2)\lambda + (b_3 + c_3))e^{-\lambda\tau} = 0$$

Differentiating the characteristic equation with respect to τ

$$\begin{aligned} & (3\lambda^2 + 2a_1\lambda + a_2 + (2c_1\lambda + (b_2 + c_2) - c_1\tau\lambda^2 - (b_2 + c_2)\tau\lambda - (b_3 + c_3)\tau)e^{-\lambda\tau}) \frac{d\lambda}{d\tau} \\ & = \lambda(c_1\lambda^2 + (b_2 + c_2)\lambda + (b_3 + c_3))e^{-\lambda\tau} \\ \frac{d\lambda}{d\tau} & = \frac{(c_1\lambda^3 + (b_2 + c_2)\lambda^2 + (b_3 + c_3)\lambda)e^{-\lambda\tau}}{3\lambda^2 + 2a_1\lambda + a_2 + (2c_1\lambda + (b_2 + c_2) - c_1\tau\lambda^2 - (b_2 + c_2)\tau\lambda - (b_3 + c_3)\tau)e^{-\lambda\tau}} \end{aligned}$$

We have, $\left(\frac{d\lambda}{d\tau}\right)^{-1} = \frac{3\lambda^2 + 2(a_1 + c_1)\lambda + (a_2 + b_2 + c_2)}{\lambda(c_1\lambda^2 + (b_2 + c_2)\lambda + (b_3 + c_3))e^{-\lambda\tau}} - \frac{\tau}{\lambda}$

$$\begin{aligned} \left(\frac{d\lambda}{d\tau}\right)^{-1} & = \frac{3\lambda}{(c_1\lambda^2 + (b_2 + c_2)\lambda + (b_3 + c_3))e^{-\lambda\tau}} + \frac{2(a_1 + c_1)}{(c_1\lambda^2 + (b_2 + c_2)\lambda + (b_3 + c_3))e^{-\lambda\tau}} \\ & + \frac{(a_2 + b_2 + c_2)}{\lambda(c_1\lambda^2 + (b_2 + c_2)\lambda + (b_3 + c_3))e^{-\lambda\tau}} - \frac{\tau}{\lambda}, \quad \lambda = i\omega (\omega > 0) \\ \left(\frac{d\lambda}{d\tau}\right)^{-1}_{\lambda=i\omega} & = \frac{3c_1\omega^3 \sin(\omega\tau) + 3(b_2 + c_2)\omega^2 \cos(\omega\tau) - 3(b_3 + c_3)\omega \sin(\omega\tau)}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3) \cos(\omega\tau))^2} \\ & + \frac{(-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3) \sin(\omega\tau))^2}{2(a_1 + c_1) \left(\frac{-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3) \cos(\omega\tau)}{-(-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3) \sin(\omega\tau))i} \right)} \\ & + \frac{(a_2 + b_2 + c_2) \left(\frac{-c_1\omega^3 \sin(\omega\tau) - (b_2 + c_2)\omega^2 \cos(\omega\tau) + (b_3 + c_3)\omega \sin(\omega\tau)}{-(-c_1\omega^3 \cos(\omega\tau) + (b_2 + c_2)\omega^2 \sin(\omega\tau) + (b_3 + c_3)\omega \cos(\omega\tau))i} \right)}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3) \cos(\omega\tau))^2} \\ & + \frac{(-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3) \sin(\omega\tau))^2}{(-c_1\omega^3 \sin(\omega\tau) - (b_2 + c_2)\omega^2 \cos(\omega\tau) + (b_3 + c_3)\omega \sin(\omega\tau))^2} + \frac{i\tau\omega}{\omega^2} \\ & + \frac{(-c_1\omega^3 \cos(\omega\tau) + (b_2 + c_2)\omega^2 \sin(\omega\tau) + (b_3 + c_3)\omega \cos(\omega\tau))^2}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3) \cos(\omega\tau))^2} \end{aligned}$$

Identify the real part of $\left(\frac{d\lambda}{d\tau}\right)^{-1}_{\lambda=i\omega}$ and after some simplification we get,

$$\begin{aligned} Re\left(\frac{d\lambda}{d\tau}\right)^{-1}_{\lambda=i\omega} & = \frac{3c_1\omega^3 \sin(\omega\tau) + 3(b_2 + c_2)\omega^2 \cos(\omega\tau) - 3(b_3 + c_3)\omega \sin(\omega\tau)}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3) \cos(\omega\tau))^2} \\ & + \frac{(-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3) \sin(\omega\tau))^2}{2c_1(a_1 + c_1)\omega^2 \cos(\omega\tau) - 2(a_1 + c_1)(b_2 + c_2)\omega \sin(\omega\tau)} \\ & - \frac{-2(a_1 + c_1)(b_3 + c_3) \cos(\omega\tau)}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3) \cos(\omega\tau))^2} \\ & + \frac{(-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3) \sin(\omega\tau))^2}{(-c_1\omega^3 \sin(\omega\tau) - (b_2 + c_2)\omega^2 \cos(\omega\tau) + (b_3 + c_3)\omega \sin(\omega\tau))^2} \end{aligned}$$





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$$\begin{aligned}
 & \frac{c_1(a_2 + b_2 + c_2)\omega^3 \sin(\omega\tau) + (a_2 + b_2 + c_2)(b_2 + c_2)\omega^2 \cos(\omega\tau)}{- (a_2 + b_2 + c_2)(b_3 + c_3)\omega \sin(\omega\tau)} \\
 & \frac{(-c_1\omega^3 \sin(\omega\tau) - (b_2 + c_2)\omega^2 \cos(\omega\tau) + (b_3 + c_3)\omega \sin(\omega\tau))^2}{+ (-c_1\omega^3 \cos(\omega\tau) + (b_2 + c_2)\omega^2 \sin(\omega\tau) + (b_3 + c_3)\omega \cos(\omega\tau))^2} \\
 \text{Re} \left(\frac{d\lambda}{d\tau} \right)^{-1} \neq 0, \text{ Provided that } & \frac{3c_1\omega^3 \sin(\omega\tau) + 3(b_2 + c_2)\omega^2 \cos(\omega\tau) - 3(b_3 + c_3)\omega \sin(\omega\tau)}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3)\cos(\omega\tau))^2} \\
 & + (-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3)\sin(\omega\tau))^2 \\
 & \frac{2c_1(a_1 + c_1)\omega^2 \cos(\omega\tau) - 2(a_1 + c_1)(b_2 + c_2)\omega \sin(\omega\tau) - 2(a_1 + c_1)(b_3 + c_3)\cos(\omega\tau)}{(-c_1\omega^2 \cos(\omega\tau) + (b_2 + c_2)\omega \sin(\omega\tau) + (b_3 + c_3)\cos(\omega\tau))^2} \\
 & + (-c_1\omega^2 \sin(\omega\tau) + (b_2 + c_2)\omega \cos(\omega\tau) - (b_3 + c_3)\sin(\omega\tau))^2 \\
 & \frac{c_1(a_2 + b_2 + c_2)\omega^3 \sin(\omega\tau) + (a_2 + b_2 + c_2)(b_2 + c_2)\omega^2 \cos(\omega\tau)}{- (a_2 + b_2 + c_2)(b_3 + c_3)\omega \sin(\omega\tau)} \\
 & \frac{(-c_1\omega^3 \sin(\omega\tau) - (b_2 + c_2)\omega^2 \cos(\omega\tau) + (b_3 + c_3)\omega \sin(\omega\tau))^2}{+ (-c_1\omega^3 \cos(\omega\tau) + (b_2 + c_2)\omega^2 \sin(\omega\tau) + (b_3 + c_3)\omega \cos(\omega\tau))^2} \neq 0 \tag{4.1}
 \end{aligned}$$

Transversality conditions hold. That is, the eigenvalues cross the imaginary axis with nonzero speed. As a result, the system undergoes Hopf bifurcation at $\tau = \tau_0$ when conditions (3.12) and (4.1) are satisfied.

CONCLUSIONS

In this study, we have introduced the cancer mathematical model developed by incorporating time delay into the model. The positivity of the solution of the model was proved. Equilibrium points of the system are calculated. The model was linearized using Jacobian matrix about the positive equilibrium point and the local stability conditions of the system without and with time delay was stated by using Routh Hurwitz stability criteria. Estimation of the length of delay to preserve stability was also proved by Nyquist criteria. The system undergoes Hopf bifurcation under a certain conditions at specified values of time delay.

Data Availability

The data used to support the findings of this study are included within the article.

Funding Statement

This study was not funded financially by any supporting body.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.





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Silver Nanoparticles and their Antimicrobial Activity against *Helminthosporium oryzae* through Mycosynthesis

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 10 Jul 2024

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ABSTRACT

Brown spot disease in paddy is brought on by the soil borne pathogenic fungus *Helminthosporium oryzae*. At several stages, including storage, seed germination, seedling establishment, vegetable growth and reproductive stage, the pathogen is known to cause damage. As it includes the direct disinfection of the soil, managing the pathogen *H.oryzae* in the soil is reared as a crucial stage in the control of the disease. The pathogen may be affected directly or indirectly by the agricultural fungicide and the byproducts of their degradation that get into the soil. The fungicide needs to be reduced because it has a significant environmental impact but also has more suppressing activity.

Keywords: *Helminthosporium oryzae*, fungicide, environment, seed germination and seedling establishment.





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INTRODUCTION

In soil microbial communities, fungi play harmful roles as pathogens, mycorrhizal mutualists, and decomposers. This substance spreads through soil organisms and plant roots (Breure, 2004). Every year, a lot of decomposable organic matter is introduced to agricultural soil as a result of plant leftovers and animal manure having a big impact on the microbial population in the soil. The traditional agricultural field's fungus population and soil nutrient fluctuation are connected (Kalaiselvi and Panneerselvam, 2011). The fungi's population and species composition are equally influenced by the types of plants that grow on the soil (Hackel et al., 2000). Fungi are significant potential suppliers of new chemicals notwithstanding this need (Hyde, 2001). In many ecosystems, fungi are essential to the breakdown of plant substrates (Polishook et al., 1996; Aoki and Tokumasu, 1995). In our nation, agriculture is a very important industry. As science and technology have advanced in recent years, agricultural development has changed quickly. It's commonly acknowledged. The condition of the soil declines when chemical fertilizers and pesticides are applied frequently and heavily. Pollution of the environment results from this. Therefore, rice growers should develop and apply a more comprehensive, economical, and environmentally beneficial approach. One of the most frequently cultivated and used food crops in the world is rice (*Oryza sativa* L.) (Cottyn et al., 2001). The second-largest producer of rice is India. India could hit a record in rice production of 100 million tonnes in 2010-11. The dietary staple crop is rice. It thrives in hot, humid weather because it is a tropical plant. The majority of rice is grown in regions that are rain fed and get a lot of rain each year. It requires a temperature of about 25 °C and more than 100 cm of rain. In locations with relatively little rainfall, rice is also farmed by irrigation. In the world, there are numerous varieties of rice.

Tamilnadu's rice varieties are IR-20, IR-8, Aduthurai (ADT)- 36, ADT- 43, Kalsar, Co-43 and Ponnai, etc. It is also a good nutrition source of carbohydrate, magnesium, potassium, iron, phosphorus, zinc and copper. The use of science and technology in nanotechnology is to manipulate matter at the molecular level. The properties of matter differ dramatically from their macroscopic bulk properties at the nanoscale level. The ability to design, characterise, produce, and use structures, devices, and systems by manipulating shape and size at the nanoscale scale is known as nanotechnology (Mansoor, 2005). Recently, research on the biological synthesis of nanoparticles has been conducted. In order to create nanoparticles, numerous biological resources, such as plants, fungus, and bacteria, have been used (Borase et al., 2014). A vast variety of fungi, including *Fusarium oxysporum* (Ahmad et al., 2003), *Aspergillus fumigatus* (Bhainsa and D'Souza, 2006), and *Aspergillus niger*, are able to manufacture silver nanoparticles (AgNPs) extracellularly (Gade et al., 2008). Brown spot disease in paddy is brought on by the soil-borne pathogenic fungus *Helminthosporium oryzae*. It is known that the pathogen can harm plants at several phases, including storage, seed germination and seedling establishment, vegetative growth, and the reproductive stage (Shabana et al., 2008). Additionally, soil-borne antagonistic fungal biocontrol techniques were developed (Haran et al., 1996; Zhihe et al., 1998; Panneerselvam and Saravanamuthu, 1996). Antibiotics' involvement in biological control has been demonstrated using antagonistic interactions and cell-free culture filtrate (Naik and Sen, 1992; Panneerselvam and Saravanamuthu, 1994). The following goals have been accomplished with the work in question, Selection of potential antagonistic fungi by dual culture experiments, analysis of the physicochemical characteristics of paddy field soil sample, isolation and identification of soil fungi, synthesis of silver nanoparticle from the isolated fungi and its antimicrobial activity, and study of the impact of culture filtrate of antagonist fungi against plant pathogen are all steps in the process.

MATERIALS AND METHODS

Collection of Soil Sample and analysis of physico-chemical parameters

50 gm soil samples were taken from rice fields in the Thanjavur District's Chozhankarai and Orathanadu. Samples were taken from the soil's top 2 to 5 cm of depth. To create a composite sample, the samples were combined (250g). For future usage, the combined soil sample was kept in the refrigerator. Various physicochemical parameters, including pH (Mishra, 1968), electrical conductivity (Levine, 2001), organic carbon (Allison, 1965), organic matter (Stevenson and Cole, 1999), accessible nitrogen (Jackson, 1956), phosphorus (Jackson, 1956), and potassium (Jackson, 1956), total calcium (Brady and



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Weil, 2002), magnesium (Cresser *et al.*, 1993), zinc (Chamberlain *et al.* 2000), copper, iron, and manganese, were analyzed on the obtained soil samples according to defined procedures.

Isolation of soil Mycoflora

The fungi were isolated from rice field soils using the Warcup (1950) dilution plating procedure. Weighted 1gm of soil, it was diluted in 10 ml of distilled water. Separate Petri plates containing one ml of the diluted (10^{-3} , 10^{-4} , and 10^{-5}) sample were filled with sterile PDA medium before being gently tilted to allow for solidification. Following solidification, the inoculation plates were incubated for 7 days at room temperature (24 ± 2 °C) in a dust-free cabinet. For each dilution, two duplicates were kept. Before pouring the medium into Petri plates, a 1% solution of streptomycin was applied to stop fungus development. Different colour and morphological colonies developing on PDA plates were counted independently. With the aid of a pair of needles, a section of the colony's developing edge was taken out and stained with lacto phenol cotton blue before being mounted on a clean slide. In order to facilitate the staining and, if necessary, eliminate air bubbles, the slide was gently heated in a spirit lamp. With the aid of tissue paper, the surplus stain was removed, and after that, the cover slip was sealed with clear nail polish. With the use of a compound microscope, the slide was examined.

Identification of soil fungi

The fungi were identified by using standard manuals, such as A manual of soil fungi (Gillman, 1957), Dematiaceous Hyphomycetes (Ellis, 1971), More Dematiaceous Hyphomycetes (Ellis, 1976) and Hyphomycetes (Subramanian, 1971), Manual of *Aspergillus* (Raper and Fennell, 1965) and Manual of *Penicillia* (Raper and Thom, 1949).

Synthesis of silver nanoparticle from isolated fungi (Naveen et al., 2010)

45 ml of aqueous 5 mM silver nitrate was added to 5 ml of fungal extract in an Erlenmeyer flask, which was then incubated for 24 hours at room temperature and in the dark. In order to remove unreacted silver nitrate and endophytic extracts, the endophytic extract with silver nitrate was centrifuged at 10,000 rpm for 10 min. The supernatant was then discarded, and the pellet was repeatedly washed with double-distilled water. The excess pure pellet was kept in storage for future research.

Antifungal activity of silver nanoparticles against plant pathogen (Yassin et al., 2013)

After two days of fungus growth on PDA, a plug (5 mm) of mycelium was removed from the colony's margins (the hyphal tip) and deposited on fresh PDA Petri dishes. Then, 25, 50, 75, and 100 μ l of each of the four AgNP concentrations were added to the medium. 48 hours of incubation on plates at 28°C. Records of the zone of inhibition were made. The experiment was carried out three times with three replicates per concentration.

Dual culture method (Skidmore and Dickinson, 1976)

Using a dual culture experiment, the colony interactions between *Helminthosporium oryzae* and the soil fungus were investigated. *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus terreus*, and *Penicillium sp.*, the test organism and soil fungus, were each cultivated independently on PDA medium. Then, agar blocks were cut from the margins of the several kinds of soil fungi that were actively developing, and test organisms were inoculated right across from one another, spaced about 3 cm apart. At 24-hour intervals, three replicates and the corresponding control for each set were recorded. The pathogen's growth inhibition % was calculated. When the fungus reached equilibrium and the growth stopped fluctuating after that, an assessment was made. The evaluation was done for both organisms because they mutually hindered one another.

$$\text{Percentage of inhibition growth} = \frac{r - r^1}{r} \times 100$$

r = growth of the fungus from the centre of the colony towards the centre of the plate in the absence of antagonistic fungi.

r¹ = growth of the fungus from centre of the colony towards the antagonistic fungus.



**Arulmozhi et al.,****Culture filtrate method (Skidmore and Dickinson, 1976)**

The actively growing edge of each species of soil fungi was sliced into equal-sized (5 mm diameter) agar blocks, which were then inoculated into 250 ml conical flasks containing 100 ml sterile potato dextrose broth. For 15 days, the flasks were incubated at 25 °C. The cultures were filtered after incubation using Whatman No. 1 filter paper and a Seitz filter (G5). For later usage, the filtrates were put into conical flasks and kept at 4°C. Separate additions of the culture filtrates to the cooled PDA medium produced concentrations of 5, 10, 15 and 20%. Separately distributed in Petri dishes, the modified medium was given time to harden.

$$\text{Percentage in inhibition of growth} = \frac{\text{growth in control} - \text{growth in treatment}}{\text{growth in control}} \times 100$$

RESULTS**Soil sample collection and analysis of physico-chemical parameters**

Soil sample collected from Chozhankarai, Orathanadu, Thanjavur District. Analysis was done on the physico-chemical composition of soil from paddy fields in the Thanjavur district. The following parameters were measured: pH, electrical conductivity, organic carbon, organic matter, available nitrogen, phosphorus, potassium, zinc, copper, manganese, cation exchange capacity, calcium, magnesium, sodium, and potassium. The values were 7.6, 0.41 (dsm⁻¹), 0.39 (%), 0.32 (%), 98.5 (mg/kg), 4.25 (mg/kg), 140 (mg/kg), 1.15 (ppm), 1.10 (ppm), 7.52 (ppm) (Table 1).

Isolation of fungi from paddy field soil

The objective of the present investigation was to separate and identify the isolated fungi from the soil sample from a paddy field. For the isolation of fungi, a 10⁻³ dilution is a more suitable dilution. Five different species, including *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus terreus*, *Penicillium sp.*, and *Helminthosporium oryzae*, were isolated from soil samples (Table 2 and 3).

Nanoparticle's antimicrobial efficacy against *Helminthosporium oryzae*

Helminthosporium oryzae was used as the test organism for silver nanoparticle antimicrobial activity. Nanoparticles with a 0.32 0.10 mm diameter zone were observed in *A. flavus* synthesis at a concentration of 100 µl. Compared to a silver nanoparticle concentration of 25 µl, 100 µl of extract showed the largest zone of inhibition (Table 4).

Colony interactions between soil fungi and *Helminthosporium oryzae*

The impact of prospective geofungi's hostile behaviour on the wilt disease pathogen *Helminthosporium oryzae* was examined. In dual culture studies, antagonistic *Aspergillus flavus* demonstrated exceptional performance with a 40.0 0.42 mm zone of inhibition against *Helminthosporium oryzae* (11.0 0.38 mm), followed by *A. niger* (20.3 0.26 mm), *A. terreus* (12.6 0.32 mm), and *Penicillium sp.* (23.0 0.12 mm) (Table- 5).

Effect of culture filtrates of soil fungi on the growth of *Helminthosporium oryzae*

Aspergillus flavus antagonistic fungi's culture filtrate inhibition percentages of 5, 10, 15, and 20% were measured. *Aspergillus flavus*, a possible adversary, grew to diameters of 5.33 mm, 6.29 mm, 8.15 mm, and 10.3 mm in suspensions of culture filtrates at 5, 10, 15, and 20%, respectively (Table -6).

DISCUSSIONS

The proper operation of newly introduced microbial inoculants and their effects on soil health are dependent on the functioning of soil microorganisms in biogeochemical processes that determine plant productivity. A thorough investigation of the indigenous community's soil microbe diversity, distribution, and behaviour in soil environments has been conducted (Saravanakumar et al., 2010). An essential primary nutrient for the growth of plants is nitrogen. The nitrogen concentration ranged from 89.6 to 142.6 mg/kg in the current experiment. According to Ambikapathy et al., (2001), some fungi have the capacity to grow quickly on organic substrates in dry, acidic, coarse-textured soil and so





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access nutrients that are available to unicellular microorganisms. After the rainy season, the macronutrients like N, P, and K as well as the organic material were abundant, according to Saravanakumar and Kaviyarasan (2010). The number of soil microorganisms also increased. Additionally, other researchers have demonstrated that soil amendments with organic content boosted soil microbial activity, which in turn raised the fungus population (Grayston *et al.*, 2004 and Girvan *et al.*, 2004). According to a recent paper by Kalaiselvi and Panneerselvam (2011), over 30 different species of Ascomycetes and Phycomycetes were isolated from Thanjavur District paddy fields. The subsoil had the highest fungus count during the rainy season. At each location, *Aspergillus*, *Trichoderma*, and *Penicillium* were the most prevalent genera. Geographical distribution of soil fungus in the agricultural area influenced by the plant community (Chung *et al.*, 2007; Carney and Matson, 2006). The colour shift associated with the creation of silver nanoparticles (Ag NPs) (Sadowski *et al.*, 2008). The control, however, showed no change in hue. It has been suggested that fungus extracellular enzymes are essential for the conversion of silver ions into Ag NPs. Gradual changes to the yellowish colour typically signal the presence of the enzyme nitrate reductase, which controls the manufacture of Ag NPs (Naveen *et al.*, 2010). In this investigation, aflatoxigenic *A. flavus* var. *columnaris* growth was successfully inhibited by biosynthesized Ag NPs made with *P. citrinum*. As the concentration of Ag NPs increased, the fungal growth generally reduced Yassin *et al.*, (2017)

SUMMARY AND CONCLUSIONS

Fungal species were isolated from the paddy field soil sample for the current experiment. The rhizosphere soil sample was used to assess the physiochemical parameters such as pH, electrical conductivity, organic carbon, organic matter, accessible nitrogen, phosphorus, potassium, zinc, copper, iron, manganese, calcium, magnesium, sodium, and potassium. The soil samples were tested at dilutions of 10^{-3} , 10^{-4} , and 10^{-5} , and results showed 17, 8 and 5 CFU/ml, respectively. Lactophenol cotton blue staining was used to identify the colonies that were obtained. According to established fungal guides, the fungus *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus terreus*, *Penicillium sp.*, and *Helminthosporium oryzae* were conformed. The isolated soil fungus *Aspergillus flavus*, *A. terreus*, *A. niger*, and *Penicillium sp.* were used to make nanoparticles. Comparing *A. flavus* synthesis nanoparticle and 100 μ l concentration to other concentrations and other fungi, the highest zone of inhibition was observed. The impacts of fungi that are incompatible *Aspergillus flavus*, *Aspergillus niger*, *Penicillium sp.* tests were conducted. The competing fungi displayed 40.0 0.42, 20.3 0.26, and Zones of inhibition against *H. oryzae* were 12.6 0.32 and 23 0.12 mm.

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Table 1: Analysis of physico-chemical characteristics of the soil

S. no	Name of the Parameters	Soil sample
1.	pH	7.6
2.	Electrical conductivity (dsm ⁻¹)	0.41
3.	Organic Carbon (%)	0.39
4.	Organic nitrogen (%)	0.32
5.	Available Nitrogen (mg/kg)	98.5
6.	Available Phosphorous (mg/kg)	4.25
7.	Available potassium (mg/kg)	140
8.	Available Zinc (ppm)	1.15
9.	Available copper (ppm)	1.10
10.	Available iron (ppm)	7.52
11.	Available manganese (ppm)	3.68
12.	Cation exchange capacity (C. Mole proton ⁺ / kg)	23.5
13.	Calcium (mg/kg)	11.2
14.	Magnesium (mg/kg)	9.6
15.	Sodium (mg/kg)	2.18
16.	Potassium (mg/kg)	0.22

Table 2: Isolation of fungi from soil

Dilution factors	No. of colonies
10 ⁻³	17
10 ⁻⁴	08
10 ⁻⁵	05





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Table 3: Identified of fungi from soil

Name of the fungi
<i>Aspergillus flavus</i>
<i>A.niger</i>
<i>A.terreus</i>
<i>Penicillium</i> sp.
<i>Helminthosporium oryzae</i>

Table 4: Effect of silver nano particles against plant pathogen (*H. oryzae*)

S.No	Name of the fungi	Zone of inhibition (mm)			
		25µl	50µl	75µl	100µl
1.	<i>A.flavus</i>	0.15 ± 0.01	1.	<i>A.flavus</i>	0.15 ± 0.01
2.	<i>A.terreus</i>	0.09 ± 0.05	2.	<i>A.terreus</i>	0.09 ± 0.05
3.	<i>A.niger</i>	0.10 ± 0.06	3.	<i>A.niger</i>	0.10 ± 0.06
4.	<i>Penicillium</i> sp.	0.09 ± 0.01	4.	<i>Penicillium</i> sp.	0.09 ± 0.01

Values are triplicates and expressed as standard deviation± Standard error

Table 5: Effect of antagonistic fungi on the growth of *H. oryzae* by *invitro* method

S. No	Name of the fungi	Growth measurement (mm)	
		Antagonistic fungi (mm)	<i>H.oryzae</i> (mm)
1	<i>Aspergillus flavus</i>	40.0 ± 0.42	11.0 ± 0.38
2	<i>A. niger</i>	20.3 ± 0.26	16.8 ± 0.29
3	<i>A.terreus</i>	12.6 ± 0.32	17.0 ± 0.40
4	<i>Penicillium</i> sp.	23.0 ± 0.12	18.4 ± 0.25

Values are triplicates and expressed as standard deviation± Standard error

Table 6: Effect of culture filtrates of selected fungi on the growth of *H. oryzae*

S. No	Different concentration (ml)	<i>Aspergillus flavus</i>
1.	0.5	5.33 ± 0.13
2.	1.0	6.26 ± 0.19
3.	1.5	8.15 ± 0.15
4.	2.0	10.3 ± 0.18

Values are triplicates and expressed as standard deviation± Standard error





Ayurveda Management of Dadhru Kustha(Tinea Cruris) - A Case Study

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 20 Jun 2024

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ABSTRACT

Ayurveda, categorize various skin disorders under a broad heading known as “Kustha”. Kustha encompasses a range of skin diseases, and it is further classified into two main types- Mahakustha and Kushudra. Acharya Charaka included Dadru in the category of Kshudrakustha. It was added into Mahakustha by Acharya Sushruta and Acharya Vagbhata. Dadru is the subtype of Kshudrakustha. Dadru is the pitta-kapha dominant. In this present case study 40 year old male patient was diagnosed with the Dadrukustha and he was treated with the Ayurvedic medications, good hygiene and dietary habit.

Keywords: Ayurveda, Kustha, Dadru, Kshudrakustha, skin diseases.

INTRODUCTION

Skin is the primary superficial layer of the body. It performs as a sensory organ as well. It carries out a number of physiological processes and prevents the spread of infections and other organisms into the body. But the truth is that superficial infections can spread through the skin. Additionally, skin infections might cause psychological disturbances. Ayurveda, categorize various skin disorders under a broad heading known as “Kustha”. [1]Kustha encompasses a range of skin diseases, and it is further classified into two main types- Mahakustha and Kushudra. [2]Acharya Charaka included Dadru in the category of Kshudrakustha. It was added into Mahakustha by Acharya Sushruta and Acharya Vagbhata. Dadru is the subtype of Kshudrakustha. Dadru is the pitta-kapha dominant. In this, red coloured mandala shaped papule is produced. Kandu remains more, there are pimples on edges and a circle-shaped papule appears in the skin located in the middle. This part is sometime dark in colour and has ridges. [3]According to Ayurveda all types of skin diseases comes under the Kustha Rogas and Kshudrakustha refers to minor skin disorders or dermatological condition. [4] In mordender matology, “Dadru” is a term used in Ayurveda to refer to skin condition that are similar to what is known in western medicine as tinea or ringworm. The term “tinea” is derived from the Latin word for worm, which reflects the historical belief that these infections were



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caused by worm like parasites. Tinea is the most common fungal infection in all the age of population. Tinea, commonly known as ringworm, is a fungal infection that can affect different parts of the body, here are some common types,

1. Tinea corporis (Ringworm of the Body): This type affects the general skin and can appear as red, scaly patches that may be itchy.
2. Tinea cruris (Jock Itch): This type affects the groin area and inner thighs. It often appears as a red, itchy rash in the shape of a ring.
3. Tinea onychomycosis (Nail Fungus): This type affects the nails, causing them to become thickened, discoloured, and brittle.
4. Tinea capitis (Ringworm of the Scalp): This type affects the scalp and hair. It can cause hair loss, scaling, and sometimes painful, swollen areas.[5]

In some case, many anti-fungal and anti-histaminic medicine are used to treat the fungal infection but, in such cases, reoccurrence is often seen, Ayurveda explain the many medications to treat the kustharogas, in this present case study some of them ayurvedic medicines are used to cure the diseases. Recurrence was observed in the current patient following the usage of allopathic medications, so the patient was treated with the Ayurvedic medicines given are Arogyavardhinivati, Gandhakrasayan, Sukha sarakvati, Sutsekharvati, VidangadiLepa.

MATERIALS AND METHODS

CASE REPORT

Place of study: Patient was treated on the OPD basis.

Present history:

A 40year old male patient came to OPD on month of June with chief complain of

1. Round ring like patches on both the thigh, buttocks and groin region.
2. For 1 year itching was on & off on both the buttocks and groin region,
3. Sever itching at the patches,
4. Reddish black coloured patches on and around region,
5. Last 3 months, there was burning sensation sometimes after itching.

Patient has been suffering from above said complaint since last 3 months. previously, he was diagnosed with the Tinea cruris when he has consulted the allopathy dermatologist for above said complaints. That time he was treated with the allopathic medications like anti-fungal cream, oral medications like itraconazole, dusting powder etc and hasan initial alleviation but when treatment was stopped all symptoms that were being treated were reappeared.

Past History

Patient has No/DM/HTN/Thyroid or any surgical history.

Ahara: Non-veg- 2-3 times weekly(chicken and egg), intake of spicy, oily and junk food (vada pav, missal pav), intake of *Dahi* at night 2-3 times weekly, less water intake (up to 1 lit/day)

Vihara: Night shift weekly 3 days, Ratri Jagran, Diwa Swapna, Sitting for long period.

Local Examination

Irregular area over the thigh, groin and buttocks region, 7-8 circular erythematous patches with some vesicular eruption over the groin and buttocks. colour is reddish black, no odour is found, Elevation is present, mild inflammation and pain, Dry in nature.

Diagnosis: Dadrukustha



**Dhvani S Patel and Vaidehi V Raole****Therapeutic intervention**

The patient was instructed to take following medications which were prescribed for 1 month and to follow up 1st on the interval of 14-15 days and again on 30th day.

Follow up- After 15 days

Along with medications patient was advised to follow: do's and dont's.

1. To avoid the non-veg food.
2. To avoid spicy, junk food, oily and salty food.
3. To avoid Alcohol consumption and reduced smoking.
4. To Wear loose fitting clean cotton cloths and change cloths 2 times a day.
5. Add Green leafy vegetable in eating.
6. Bath 2 times/day, morning and night.
7. To Avoid Day sleep.
8. Do the regular exerceice.

OBSERVATIONS AND RESULTS

Before and after the patient's treatment, the Dadru signs and symptoms were evaluated.

DISCUSSIONS

Dadru is the type of *kustha*. *Acharya charaka* included it in *kshudrakustha* but *Acharya Susruta* and *Vagbhata* considered as *mahakustha*. In this case, A safe and effective treatment for the patient was the goal of the current study. *Dadru* is Characterised by the development of discoloured lesions, itching and elevated patches. It is chronic in nature hence difficult to cure but it mostly affects to those who fail to maintain the hygiene standard or who have weakened immunity. *Dadru* is the *kapha-pittajadominantvyadhi* and it involve the *Rasavaha* and *Raktavahastrotas* hence the treatment has planned to alleviate the *dosha* with *kusthaghna* medicine. According to *Ayurveda*, *kustha* occurs when all the three *doshas* like *Vata* etc. become evil, skin, blood, flesh and non-metals become evil. Accumulation of fluid gives rise to *kustha*. Among the defects called *Vata* etc., *Vata* etc is written because of the presence of *Vata* disorder first. Then when other defects get aggravated and blood, flesh and non-metals gradually become evil, *kustha* is formed.

The mode of action of the drug are;

Arogyavardhini

The liver can be effectively cleansed by *arogyavardhini*, which raises the standard of raktadhatu. Kutaja functions as a pittavirechaka in *Arogyavardhini*, and other *SukshmaBhasma*'s of *abhrak*, *tamra*, and *lauha* have the power to open tiny *strotasas* and perform *sampraptivigahatana*. *Kajjali* is known for its *strotogamitvaas* well.[5] 7 *Maha kustha* and 11 *kshudrakustha* are produced on occurrence of disorder of colon. Due to the improper functioning of the colon, constipation is present in it. Then the air in the colon and the labia is bad. In this way the bile required for digestion is distorted. The phlegm fluid which helps in regulating the circulatory system in the colon gets contaminated. Then there is a delay in moving forward. As a result, the toxin is produced and absorbed into metals such as pectin and blood meat, or absorbed into micro-atoms, making the metals evil. Then there is aeration in that place; It gradually permeates the whole body and produces *kustha*. The small intestine and the colon are the principal places of air.⁽⁶⁾

The composition of the *ayurvedic* medicine generally destroys the malformations of small intestine and colon. *kustha* is produced in the colon and duodenum because of the venom produced by the defect itself. Hence, it is beneficial in curing diseases. *GandhakaRasayan:GandhakaRasayana* is used in skin diseases and as a blood purifier hence selected for the study. It is *Raktshodhak*, *Vranaropaka*, *Twachya*.[5]

Sukha sarakvati

It contains the combination of *Indravaruni* and *haritaki* used to regulate liver function and increase the flow of digestive enzymes. It also improves the digestion and enhances bowel tone.





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Sutsekharvati

Sutsekhar Ras is an important medicine used in *Ayurveda*, which acts on *Pitta Dosha* and it is effective on *Amla pitta*, *Vaman*, *Shula*, *Mandagni*, *Daha*, *Tridoshaja* *Atisara* hence this medicine has given to the patient because he was suffering from burning sensation.

Vidangadi Lepa

It contains the *Vidanga*, *Triphala*, *Pippali*, *Kustha*, *Chakramarda*, *Haridra*, *Sarshapa* antibacterial, antifungal, immune modulator properties which are helpful to treat the chronic skin infections.

CONCLUSIONS

The Ayurvedic treatments that are *Vidangadi Lepa* and other Oral medications are effective in the management of *Dadru* as *Kandu*, *Daha*, *TwakVaivarnya*, *Tod*, *Pidka*, *UtsannaMandala* all the symptoms are relieved mostly.

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Table-1: Personal History

Name- xyz	Marital status - married	Pulse -72/min
Age - 40	Occupation- Job	BP - 130/90mmhg
Sex - Male	Addiction-alcohol sometimes, Smoking	Weight – 71kg
	Bowel- Irregular	Temperature -Afebrile

Table-2: Criteria for gradation of symptoms of patient

Sr.no	Clinical Features	Grade 0	Grade 1	Grade 2	Grade 3
1.	Kandu (Itching)	Absent	Mild	Moderate	Severe
2.	Daha (Burning pain)	Absent	Mild	Moderate	Severe
3.	TwakVaivarnya (Redcoloured skin)	Absent	Reddish skin	Reddish brown skin	Reddish black skin
4.	Tod (Pricking pain)	Absent	Mild	Moderate	Severe
5.	Pidka (Granulated skin)	Absent	1to 3 Papules	4to 7papules	More than 7 papules
6.	UtsannaMandala (elevated patches)	Absent	Moderate elevation	Moderate elevation	Severe



**Table-3:Therapeutic intervention**

Sr.no	Drug	Dose	Anupana	Route	Time
1.	Arogyavardhinivati	2 BD	Water	Orally	After food
2.	Sukha Sarak vati	2 HS	Water	Orally	After food
3.	Gandhakrasayana	2 BD	Water	Orally	After food
4.	Sutsekharvati	2 BD	Water	Orally	Before food
5.	Vidangadi Lepa	As per area	For Local application	For LA	Twice a day

Duration- 30 Days (1 month)

Follow up- After 15 days

Table 4:Result

Sr.no	Clinical Features	Before Treatment	1 st Follow up	2 nd follow-up
1.	Kandu (Itching)	G 3	G 1	G 0
2.	Daha (Burning pain)	G 2	G 1	G 0
3.	TwakVaivarnya (Redcoloured skin)	G 3	G 2	G 1
4.	Tod (Pricking pain)	G 1	G 1	G 0
5.	Pidka (Granulated skin)	G 1	G 1	G 0
6.	UtsannaMandala (elevated patches)	G 2	G 2	G 1

**Fig:1:Before Treatment****Fig:2: After Treatment**



An Energy Efficient Data Transmission using Optimized Firefly Algorithm and Adaptive Glowworm Swarm Optimization in Wireless Sensor Networks

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 12 Jul 2024

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ABSTRACT

Wireless sensor networks have been used in many different applications over the past ten years. Energy efficiency presents a significant difficulty for such networks because of the limited energy resources of sensor nodes. The methods for lowering energy usage in the operating system, application, and hardware layers are covered in this research study. Additionally, the work examines methods for data aggregation, sleep scheduling, and energy-efficient routing. This work uses the Firefly Algorithm and Glowworm Swarm Optimization algorithms for the cluster head selection strategy. The cluster heads are chosen using the Glowworm Swarm Optimization, and their performance is then optimized using the Firefly Algorithm. Wireless sensor networks from the actual world are used as a testbed to assess the performance of the suggested strategy. The findings demonstrate that the suggested GWS-OFA based cluster head selection system outperforms the conventional techniques in terms of packet delivery ratio, network longevity, live nodes, and cluster head selection

Keywords: Optimized Firefly, Glow worm Swarm Optimization, Live Nodes, Cluster Head Selection, Packet Delivery Ratio.



**Mythili and Duraisamy****INTRODUCTION**

The wireless sensor network (WSN) cluster head selection schemes proposed by various authors respectively. These schemes aim to select the best node in a network as the cluster head in order to optimally manage the network. The scheme proposed by [1] used a fuzzy logic approach to select the cluster head. This approach takes into account the node's energy level, distance from the cluster head, and its connectivity to other nodes. The nodes with the highest values for these parameters are chosen as the most suitable candidates for the cluster head. Another approach proposed by [2] uses a genetic algorithm to select the cluster head. This algorithm uses a fitness function to evaluate the nodes in the network based on their energy level, distance, and connectivity. The nodes with the highest fitness scores are then selected as the cluster heads. [3] a game theoretic approach to cluster head selection. This approach uses game theory principles to assign weights to the nodes in the network based on their energy level, distance, and connectivity. The nodes with the highest weighted scores are then chosen as the cluster heads. According to several research made on energy optimization a distributed approach proposed by [4] a distributed consensus algorithm to select the cluster head. This algorithm works by having each node in the network broadcast its energy level, distance, and connectivity to its neighbors. The nodes with the highest values for these parameters are then chosen as the cluster heads. Each of these approaches has their own strengths and weaknesses, and can be used to select the optimal cluster head for a given WSN. The selection of the most appropriate scheme will depend on the network's requirements and the trade-offs that need to be made in order to achieve the desired performance. The network was remaining minor pitfalls for the further research work pre-dominantly.

LITERATURE SURVEY

The methods incorporate to optimize the energy involved with following steps using Genetic Algorithm (GA)[5]was used to select a cluster head from the available nodes in the wireless sensor network. Adaptive Neuro-Fuzzy Inference System (ANFIS) was used to assess the routing trustworthiness and weighted trust to demodulate attacker nodes. [6] Routing was used to determine the most efficient route for data transmission in the wireless sensor network. Weighted Trust was used to evaluate trustworthiness of nodes in the wireless sensor network and finally Demodulation was used to detect malicious nodes attempting to infiltrate the wireless sensor network respectively . Clustering a machine learning technique used to identify and group similar data points. clustering to identify density peaks in a dataset, Fast Search and Find of Density Peaks The algorithm based on the concept of local density were consider the number of points in a given neighborhood of a point. The algorithm works by iteratively searching the dataset and identifying local density peaks respectively. Data Analysis were used to interpret the results of their clustering algorithm and the visualizing clusters are examining the characteristics of each cluster respectively . Validation were used to ensure the accuracy of their results. The algorithm improved sunflower optimization algorithm [7] to optimize the process of selecting the best cluster head in the Internet of Things. This algorithm uses a modified flower structure to encode the clusters and their corresponding weights, as well as a modified search mechanism that combines different heuristics to detect the optimal cluster head. Different heuristics to were applied to improved sunflower optimization algorithm respectively. These heuristics included a number of techniques such as random selection, greedy selection, and the use of a penalty factor. The hybrid Artificial Bee Colony (ABC) algorithm[8] for cluster head selection in Mobile Ad Hoc Networks (MANETs), which combines the advantages of both global search and local search strategies[9] in order to improve the performance of the selection process respectively .These heuristics allowed the algorithm to search for better solutions and optimize the process of selecting the best cluster head and finally the simulations using the improved sunflower optimization algorithm to determine its effectiveness in selecting the best cluster head. [10] The paper is that it proposes a cluster head selection algorithm based on a hybrid optimization method, combining genetic algorithm and particle swarm optimization, to improve the performance of mobile ad hoc networks respectively. The simulations were conducted using both real and synthetic datasets to obtain an accurate reflection of the algorithm's performance in a network. The experiments were conducted using various metrics such as energy consumption, latency, and throughput. The results of the





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experiments showed that the improved sunflower optimization algorithm outperformed other algorithms in selecting the best cluster head.

CLUSTER HEAD SELECTION

A cluster head selection method based on the energy of the node and the transmission range is proposed [11] to improve the stability and scalability of the ad hoc networks. The cluster head selection is based on the concept of distributed energy detection (DED). [12] The DED algorithm selects the best node as the cluster head based on the residual energy of the nodes, the transmission range of the nodes and the number of nodes in the network. The DED algorithm can reduce the number of control messages and improve the scalability of the wireless sensor network respectively. The objective function is a mathematical expression that measures the performance of a system or process, typically with the goal of finding an optimal solution. [13] In cluster-based wireless sensor networks, the objective function is used to select an optimal cluster head (CH) from a set of nodes based on certain criteria. The optimal CH selection can improve the performance of the network, such as energy efficiency, coverage, and connectivity. The objective function for optimal CH selection should take into account both the quality of the node selected as a CH and the cost associated with it. [14] The quality of the node can be evaluated by a combination of factors such as the node's energy level, node degree, and location. The cost associated with selecting a particular node as a CH should consider the communication cost between the CH and the other nodes in the network.

Mathematically, the objective function for optimal CH selection can be expressed as follows:

Objective Function = Quality (Node) – Cost (Communication)

Where Quality (Node) is a measure of the quality of the node selected as a CH, and Cost (Communication) is a measure of the communication cost associated with that node. [15] The optimal CH selection is the node that maximizes the objective function.

Generic Steps for Cluster Head selection in Wireless sensor network

1. Initially, each node in the wireless sensor network is assigned an identification number.
2. Each node is assigned an energy level and a transmission range.
3. The node with the highest energy level and large transmission range is selected as the cluster head.
4. All other nodes within the cluster head's transmission range become the members of the cluster.
5. The cluster head is responsible for collecting data from the members of the cluster and forwarding it to the base station.
6. The nodes with the lowest energy levels are excluded from being a cluster head.
7. The cluster head selection process is repeated periodically to ensure that the network is working efficiently

Pseudo code for Cluster head selection using Glowworm and Optimized Firefly optimization techniques in wireless sensor network(GWS-OFA)

```
//Step 1: Initialize the Glowworm Swarm Optimization (GWS) parameters
    Number_Of_Glowworms = N;
    Number_Of_Iterations = K;
//Step 2: Generate N glowworms and place them at random positions in the environment.
    For i = 1 to N
    Glowworm[i] = GenerateRandom
    Glowworm();
    EndFor
//Step 3: Each glowworm performs its local search for K iterations.
    For i = 1 to K For j = 1 to N
    Glowworm[j].Update_Position();
    EndFor
    EndFor
//Step 4: Rank the glowworms according to their fitness.
```





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```

For i = 1 to N
Glowworm[i].CalculateFitness();
EndFor
SortGlowwormsByFitness();
//Step 5: Select the glowworm with the highest fitness as the cluster head.
Cluster_Head = Glowworm[0];

```

The above parameters of the GWS algorithm, such as the number of glowworms (N) and the number of iterations (K), are set. Then, N glowworms are generated and placed randomly in the environment. Each glowworm then performs its local search for K iterations, updating its position at each iteration.[16] After each glowworm has completed its search, their fitness is calculated and the glowworms are sorted by fitness. Finally, the glowworm with the highest fitness is selected as the cluster head respectively in wireless sensor network.[17] From the proposed algorithm GWS-OFA, the cluster head selection schemes varies depend upon the size of the network if the network is reliable and efficient the ch scheme chooses the glowworm optimization techniques as a choice to fit the head to the cluster nodes, Moreover the cluster were need in highly customizable the firefly technique were to be incorporated to achieve the satisfactory level of node management efficiently in a network [18] The parameters were focused on cluster head selection in wireless sensor network based on several prerequisites respectively such as

Number of clusters

The number of clusters should be set based on the size of the network and the network requirements.

Cluster size

The cluster size should be set to ensure that each node can communicate with other nodes in the same cluster.

Cluster head selection algorithm

Different algorithms can be used for cluster head selection, such as Optimized Firefly (OFA) [19] and Glowworm optimization.

Communication range

The communication range of the nodes should be set to ensure that the nodes can communicate with each other within the cluster[20].

Energy threshold

The energy threshold should be set to ensure that the nodes in the WSN can maintain their operation for a long period of time.

PERFORMANCE METRICS

Live nodes Vs Dead Nodes in WSN

Live node = (No of active nodes in the cluster / Total number of nodes in the cluster) * 100

Dead Node = (Number of cluster nodes) - (Number of nodes with active) = (Number of dead nodes)

Live nodes and dead nodes play an important role in cluster head selection scheme in wireless sensor networks. Live nodes are active nodes in the network that are able to receive and process data. Dead nodes are inactive nodes that are not able to receive or process data. When it comes to cluster head selection, live nodes are preferred over dead nodes. This is because live nodes can process data faster and more efficiently, and are more reliable when it comes to sending data to other nodes. Dead nodes may be unable to receive or process data, making them unreliable for transmitting data. When selecting a cluster head, live nodes are generally chosen over dead nodes. Cluster heads are selected based on their ability to communicate with other nodes, and dead nodes are not able to do this. Additionally, live nodes can be used to send and receive data, making them more reliable than dead nodes. Overall, live nodes are preferred over dead nodes when it comes to selecting a cluster head in a wireless sensor network. Live nodes are more reliable and can process data faster, making them the better choice for cluster head selection.

Lifetime of a node

In a wireless sensor network, the node lifetime is an important factor to consider when choosing a cluster head node. The node lifetime is the amount of time that a node can remain active in the network before it needs to be replaced.





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The node lifetime can be affected by several factors such as the node's power supply, its communication range, the number of times it transmits data, and the type of transmission it uses. When selecting a cluster head node, it is important to consider the node's lifetime in order to ensure that the network remains stable and reliable. The node lifetime can be increased by using energy-efficient algorithms and by using low-power communication protocols. Additionally, the node lifetime can be extended by increasing the node's power supply, optimizing its communication range, and using an appropriate transmission method. When choosing a cluster head node, it is important to consider the node lifetime in order to ensure reliable and stable performance of the network. By taking these factors into consideration, the node lifetime can be extended and the network can remain stable and reliable.

Lifetime of a node = (Energy Supply/Average Energy Consumption) * Average Time Interval

Strength of a node in Cluster Head Selection among cluster group

A node strength cluster group in a wireless sensor network is a group of nodes that are used to determine which node should act as a cluster head. The node strength is calculated using a metric that takes into account the node's location, the number of nodes within its communication range, and the network characteristics such as the number of hops between the node and the sink. Once the node strength has been calculated, it can be used to select a cluster head node. This is typically done using a formula that assigns a greater weight to nodes with higher node strength. This ensures that the best node for the job is chosen to act as the cluster head. The node strength cluster group is an important part of any wireless sensor network and helps to ensure that the network is optimized for performance. By selecting the best node to act as the cluster head, the network is able to make use of the best resources available and maintain a reliable and efficient connection.

Strength of node = Number of nodes connected to the node / Total No of nodes in the cluster group

Packet Delivery ratio

The major important metrics when evaluating WSNs is packet delivery ratio (PDR), which is the ratio of packets received by the destination compared to the number of packets sent. Cluster heads are special nodes in WSNs that are responsible for routing data between nodes and between clusters. By using cluster heads, the overall PDR of the network can be improved as the cluster head can reduce packet collisions and increase the probability of successful packet delivery. Additionally, cluster heads can also optimize the routing of packets to increase the chances of successful packet delivery. The use of cluster heads can significantly increase the PDR of a WSN. It can also optimize the routing of packets for improved delivery. Furthermore, the use of a cluster head can also improve the overall reliability of the network, as the cluster head can act as a single point of failure, which can increase the overall availability of the network. Overall, the use of a cluster head can significantly increase the PDR of a WSN, leading to improved performance and reliability.

Packet Delivery Ratio (PDR) = (Total number of packets delivered to the destination / Total number of packets transmitted) × 100

Routing protocol

The routing protocol should be selected based on the requirements of the network such as AODV and DSDV. The below simulator environment were used in implementing procedures

RESULTS AND DISCUSSION

The above results were reflecting the cluster head selection among 100 nodes were classified and highlighted with colors respectively. The above result indicates that the cluster head selection among 100 nodes were calculated. The above diagram indicates that the energy consumed by cluster heads among various intervals i.e. 50 to 125 milli seconds respectively. The ratio of packet delivery among nodes in cluster group after selecting the cluster head schemes were varied with 20 to 60 packets delivered in multiple cluster head selection in routing. The ratio of the live node calculated and avoided in 15 milli seconds respectively among multiple cluster selection in wireless sensor network



**Mythili and Duraisamy****CONCLUSION**

The combination of optimized firefly and glowworm optimization algorithms is especially beneficial, as they are able to find the optimal energy consuming level and node identity model parameters. This ensures that energy is only consumed when necessary, thus reducing overall energy consumption and improving network efficiency. By using this model, network designers and operators can be confident that their networks are operating at peak efficiency. The Optimized Firefly and Glowworm Optimization Techniques (GWS-OFA) are the best algorithm for selecting the cluster head in a wireless sensor network. These algorithms have been proven to be reliable and efficient and are able to effectively select the best node for the role of the cluster head. Furthermore, these algorithms are relatively simple to implement and can be used in a wide range of scenarios. Therefore, these algorithms can be used as a reliable tool for selecting the best cluster head in a wireless sensor network.

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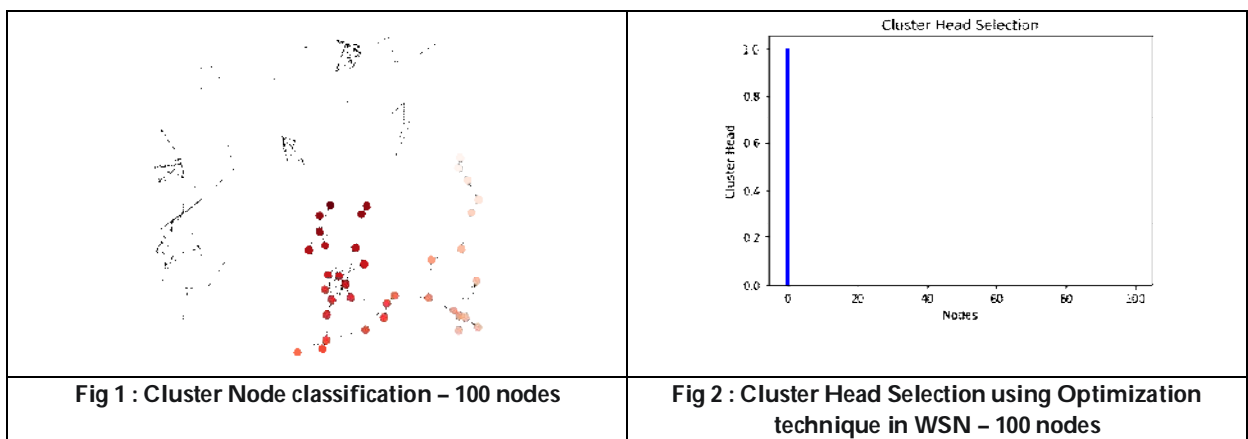


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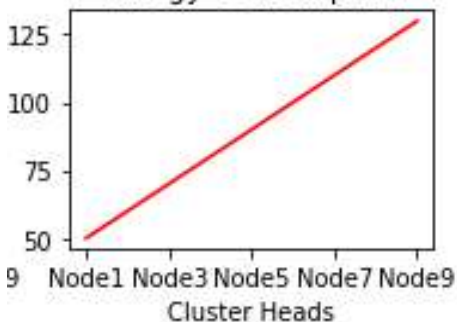
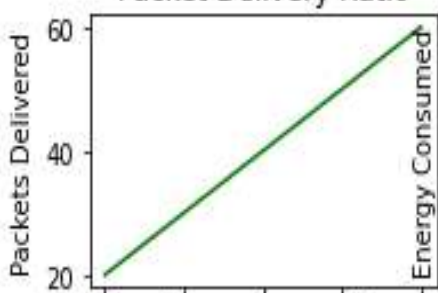
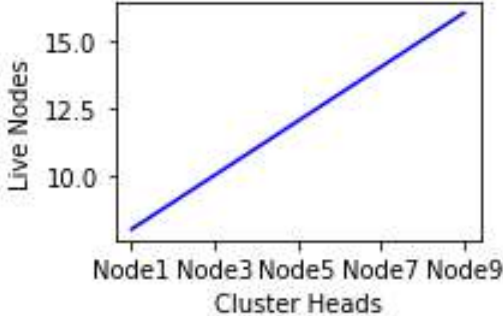
Table 1:

S.No.	Environment / Parameter	Values
1	Simulator	NS-2
2	Channel Type	Wireless
3	Number of Nodes	100
4	Traffic Model	CBR
5	Simulation Area	1300m * 1300m
6	Transmission Range	250m
7	Routing Protocol	AODV
8	MAC Protocol	802.11
9	Simulation Total Time	60 ms
10	Observation Parameters	Energy Consumption Average End to End Delay Packet Delivery Ratio Death Rate Routing Overhead





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 <table border="1"><caption>Data for Fig 3: Consumption of Energy among various CH in WSN – 100 nodes</caption><thead><tr><th>Cluster Head</th><th>Energy Consumption</th></tr></thead><tbody><tr><td>Node1</td><td>50</td></tr><tr><td>Node3</td><td>75</td></tr><tr><td>Node5</td><td>100</td></tr><tr><td>Node7</td><td>125</td></tr><tr><td>Node9</td><td>150</td></tr></tbody></table>	Cluster Head	Energy Consumption	Node1	50	Node3	75	Node5	100	Node7	125	Node9	150	 <table border="1"><caption>Data for Fig 4: Packet Delivery Ratio among various Cluster Head using Optimization technique in WSN – 100 nodes</caption><thead><tr><th>Cluster Head</th><th>Packets Delivered</th></tr></thead><tbody><tr><td>Node1</td><td>20</td></tr><tr><td>Node3</td><td>35</td></tr><tr><td>Node5</td><td>50</td></tr><tr><td>Node7</td><td>65</td></tr><tr><td>Node9</td><td>80</td></tr></tbody></table>	Cluster Head	Packets Delivered	Node1	20	Node3	35	Node5	50	Node7	65	Node9	80
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Mobile App (Pachathundu App) Utilization Pattern of Farmers in Dindigul District of Tamilnadu State

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 26 Jul 2024

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ABSTRACT

The mobile app has been most recent and widely accepted mode of delivering information not only in India but throughout the world. Mobile phones are widely recognized as a potentially transformative technology platform for developing nations. The pachathundu app is developed in 9 languages. This was launched by the Individual organization named as YTV Farmer Seva Kendra. This Application Provide the complete real time information related to agriculture. As the app was launched recently, it was felt necessary to study about extent of utilization so as to redesign the app more suitable to the needs of the farmers. The study was taken up in five selected villages in Nilakottai Block of Dindigul District of Tamil Nadu. A fixed sample size of 120 respondents was selected by proportionate random sampling technique. The data were collected from the respondents with the help of a well-structured and pre-tested interview schedule. The required data were collected by personal interview schedule by utilizing a well-structured and pre-tested interview schedule. The collected data were interpreted by using appropriate statistical tools. Majority of the respondents had high level of extent of utilization followed by medium and low levels of utilization of pachathundu app.

Keywords: Mobile app, Pachathundu app, Utilization pattern, Weather forecast, YTV Farmer Seva Kendra





INTRODUCTION

In India, there are about 120 million farm holdings and the number is increasing year by year. To provide at least one village extension personnel to 800- 1000 farm families, the requirement of field level extension personnel is estimated to be about 1.3 to 1.5 million, against the present availability which is only about 0.1 million (1,00,000) personnel. According to estimates, an average of the public extension personnel spends 40 minutes per year for a farmer (Dileep Kumar, 2012). There is an increasing number of mobile apps providing access to agriculture and allied sector information in free of cost by the central and state government, private companies, NGOs, individuals etc. Farmers need timely information in response to their specific needs. Government of India and state government have launched a number of web and mobile-based applications for the dissemination of information on agriculture allied activities at free of cost for the benefits to the farmers and other stakeholders. There are apps also developed by agricultural institutions, private sector, NGO (Non-Governmental Organizations), individuals etc. for the benefit of farmers and the public. These apps are disseminating information from agricultural research institutes, research stations, agricultural departments, NGOs to individual farmers and other stakeholders and facilitating the exchange of information (Sudhakar, B. 2019). Pachathundu app (private app) was selected for study with following reasons. Farmers can get complete information on real time basis from pachathundu mobile application which provides the farmer to get information all schemes components and subsidy pattern of assistance, register him to avail scheme benefits on priority basis. Pachathundu is the Application which was launched by the Individual organization named as YTV Farmer Seva Kendra. The application was available in 9 languages such as Tamil, English, Malayalam, Hindi, Telugu, Kannadam, Urdu, Marathi and Oriya. Application was available in android and can be downloaded from the google play store.

Objective of the study

The study focused on extent of utilization of pachathundu app among the farmers.

REVIEW OF LITERATURE

Kavipriya (2020) in her study on uzHAVAN app in Cuddalore District of Tamil Nadu revealed that the majority of the respondents (64.17 per cent) had used the mobile app to medium extent, followed by high extent of utilization (19.16 per cent) and low extent (16.17 per cent). Vinoth (2020) in his study on awareness, knowledge and utilization of social media and mobile application among Redgram farmers in Triupattur District of Tamil Nadu reported that more than half of the proportion (58.33 per cent) of the respondents had medium level of utilization of social media and mobile application followed by low (30.00 per cent) and high (11.67 per cent) levels respectively. Gayathri (2021) in her study on smart farming by using uzHAVAN app in Madurai District of Tamil Nadu concluded that the majority of respondents (66.67 per cent) had used the mobile app to medium extent, followed by high extent of utilization (19.16 per cent) and low extent (14.17 per cent). Sudharsan (2022) in his study on effectiveness and utilization of web and mobile based agricultural information deliver system among the farmers in Tiruvannamalai District of Tamil Nadu revealed that nearly one fourth of the respondents were categorized under high utilization (28.33 per cent) followed by moderate utilization (25.84 per cent), very high utilization (18.33 per cent), low utilization (16.67 per cent) and no utilization (10.83 per cent).

RESEARCH METHODOLOGY

Dindigul district in Tamil Nadu was purposively selected for this study. Dindigul district was stand second in the number of registered users on the pachathundu app among all the districts of Tamil Nadu. Dindigul district has fourteen blocks namely Athoor, Batlagundu, Gujiliampari, Kodaikanal, Palani, Dindigul, Reddiarchatram, Sanarpatti, Thoppampatty, Vadamadurai, Ottanchatram, Natham, Nilakottai and Vedasandur. Among these Nilakottai block was



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selected based on maximum number of pachathundu app registered users among the blocks. In Nilakottai block, totally 10 villages the farmers are using pachathundu app. Out of 10 villages, five villages namely Batlagundu, Silukuvarpatti, Rengappanaickanpatti, Viruveedu and Viralipatty were selected based on the maximum number of pachathundu app registered users in the villages. A sample size of 120 respondents was fixed for this study considering the limitations of time and other resources. All the 120 respondents were identified from selected five villages by using the proportionate random sampling technique. Overall extent of utilization of pachathundu app were categorized into utilized and not utilized, the scoring was 2 and 1 respectively. Cumulative frequency method was used to classify the variables into three categories viz., low, medium and high by dividing the difference between the maximum and minimum score of a variable into three equal classes. The procedure followed by Belgavimath (1994) was used in the study. Practice-wise extent of utilization of pachathundu app by using simple percentage analysis was employed to make simple comparisons of different facilities in pachathundu app used by the respondents.

RESULTS AND DISCUSSION

Extent of utilization of pachathundu app among the respondents

To analyse the extent of utilization of pachathundu app by the respondents, data are collected and discussed under the following categories.

1. Overall extent of utilization of pachathundu app among the respondents
2. Practice wise extent of utilization of pachathundu app among the respondents

Overall extent of utilization of pachathundu app among the respondents

Overall extent of utilization of pachathundu app among the respondents is presented in Table 1. It could be noticed from the Table 1 that most of the respondents (80.83 per cent) had high level of extent of utilization of pachathundu app followed by medium (12.50 per cent) and low levels (6.67 per cent) levels respectively. The reason might be due to the fact that all the farmers' selected for study was the registered users of pachathundu app.

Practice wise extent of utilization of pachathundu app among the respondents

To find out the practice wise extent of utilization of pachathundu app by the farmers, data are collected and presented in Table 2. Extent of utilization of respondents on pachathundu app technologies viz, Fungicide management practices (93.30 per cent), Fertilizer stock in agri clinic centre (92.50 per cent), Harvesting techniques for different crops (91.60 per cent), Tools rendering centers in the state (90.80 per cent), Buy and sell the agriculture produces (90.80 per cent), Seed stock position in agri clinic (90.00 per cent), Balanced fertilizer application for crops (90.00 per cent), Clippings of pest and diseases for crops (89.00 per cent), Government schemes information (88.30 per cent), New crop varieties for different crops (86.60 per cent), Pesticide management practices (86.60 per cent), Livestock management (86.60 per cent), Language usage (85.60 per cent), Market prices for major crops (84.10 per cent), Herbicide management practices (84.10 per cent), Farm guide for crops (82.50 per cent), Weather forecasting information (81.60 per cent) and Current Agri news (80.80 per cent). The results on service-wise extent of utilization are discussed as follows.

Fungicide management practices

It could be seen from the Table 2 that 93.30 per cent of the respondents had utilized the information about fungicide management practices from pachathundu app. The reasons for highest utilization might due to the farmer are getting new generation fungicides updates such as zoles and strobin family for crop management practices from pachathundu app.

Fertilizer stock in agri clinic centre

It could be observed from the Table 2 that 92.50 per cent of the respondents had utilized the information about the fertilizer stock in agri clinic centre from pachathundu app. Farmers expressed that in pachathundu app information on availability of fertilizer stocks in near by agri-clinic centre was very much useful to purchase of fertilizers timely.



**Sandhiya et al.,****Harvesting techniques for different crops**

It could be seen from the Table 2 that 91.60 per cent of the respondents had utilized the information about the harvesting techniques for different crops from pachathundu app. Farmers opined that harvesting techniques such as time of harvest, maturity of crop etc, were available in pachathundu app. Very easy to follow the harvesting techniques that made the respondents higher percentage of utilization.

Tools rendering centers in the state

It could be inferred from the Table 2 that 90.80 per cent of the respondents had utilized the information about the tools rendering centres in the state from pachathundu app. Farmers inferred that the information from pachathundu app on availability of tools from sowing to harvesting in different tools rendering centres with exact rent by different companies was very much useful.

Buy and sell the agriculture produces

It could be seen from the Table 2 that 90.80 per cent of the respondents had utilized the information about buy and sell the agriculture produces from pachathundu app. The farmers said that sell the produce based on market rate without brokerage with help of pachathundu app getting more profit in agriculture.

Seed stock position in agri clinic

It could be observed from the Table 2 that 90.00 per cent of the respondents had utilized the information about the seed stock position in agri clinic from pachathundu app. Farmers opined that this information on seed stock position in agri clinic from pachathundu app helps in timely sowing of seeds with correct price.

Balanced fertilizer application for crops

It could be seen from the Table 2 that 90.00 per cent of the respondents had utilized the information about the balanced fertilizer application for crops from pachathundu app. The respondents expressed that information in pachathundu app on balanced fertilizer application get save more money from drastic application of fertilizers.

Clippings of pest and diseases for crops

It could be observed from the Table 2 that 89.00 per cent of the respondents had utilized the information about the clippings of pest and diseases for crops from pachathundu app. The respondents informed that symptoms of pest and disease clippings of different crops from pachathundu app was very much useful to identification and application of exact quantity of pesticides and fungicides.

Government schemes information

It could be seen from the Table 2 that 88.30 per cent of the respondents had utilized the information about the government schemes information from pachathundu app. Farmers opined that facility of the government scheme information, subsidy information in pachathundu app very much useful for getting inputs in subsidized rate.

New crop varieties for different crops

It could be inferred from the Table 2 that 86.60 per cent of the respondents had utilized the information about the new crop varieties for different crops from pachathundu app. Farmers opined that crop varieties details available in pachathundu app made easily to select the location specific varieties, hybrids for sowing.

Farm guide for crops

It could be seen from the Table 2 that 82.50 per cent of the respondents had utilized the information about the farm guide for crops from pachathundu app. Few farmers are reported that certain crops like arecanut, teak etc, the update of cultivation practices not available in pachathundu app.





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Current agri news

It could be observed from the Table 2 that 80.80 per cent of the respondents had utilized the information about the current agri news from pachathundu app. Few farmers are reported that current agri news daily not updated in the pachathundu app.

CONCLUSIONS

For Attracting and Retaining of Youth in Agriculture (ARYA) scheme, the continuous usage of pachathundu app can be a definite strategy. The young farmers in the village level were mostly using smartphones for their entertainment. If the venture of transforming the use of smartphone for entertainment purpose to use of smartphone for access agricultural information is fulfilled, atleast 20 per cent of revolution in agricultural development may occur.

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Table 1. Distribution of respondents according to their overall extent of utilization of pachathundu app (n=120)

S.No.	Category	Number of respondents	Per cent
1	Low	8	6.67
2	Medium	15	12.50
3	High	97	80.83
	Total	120	100.00





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Table 2. Distribution of respondents according to their practice wise extent of utilization of pachathundu app (Multiple response)

S.no.	Technologies	Number	Per cent
1.	Fungicide management practices	112	93.30
2.	Fertilizer stock in agri clinic centre	111	92.50
3.	Harvesting techniques for different crops	110	91.60
4.	Tools rendering centers in the state	109	90.80
5.	Buy and sell the agriculture produces	109	90.80
6.	Seed stock position in agri clinic	108	90.00
7.	Balanced fertilizer application for crops	108	90.00
8.	Clippings of pest and diseases for crops	107	89.00
9.	Government schemes information	106	88.30
10.	New crop varieties for different crops	104	86.60
11.	Pesticide management practices	104	86.60
12.	Livestock management	104	86.60
13.	Language usage	102	85.60
14.	Market prices for major crops	101	84.10
15.	Herbicide management practices	101	84.10
16.	Farm guide for crops	99	82.50
17.	Weather forecasting information	98	81.60
18.	Current agri news	97	80.80





Formulation of Cow Urine and Papaya Seed Extract Powder based Medicinal Soap and Its Antibacterial Activity against Pyogenic Organisms

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 26 Jul 2024

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ABSTRACT

Protecting healthy skin from pathogenic microorganisms such as viruses, fungi, bacteria and parasites is essential. The two most prevalent biological agents that exacerbate skin infections are bacteria and fungi. Research on the best ways to combat bacteria that cause skin infections is still ongoing. Natural (herbal extracts) and synthetic chemicals are being studied for their antimicrobial and antifungal properties. There are chemical – containing soaps, creams, ointments, and skin care available for treating skin infections, but consumers are often drawn to herbal formulations because of specific restrictions. It is often believed that cow urine has medicinal benefits. In many regions of the world, medical professionals strongly advise cow urine therapy. According to the Gauseva and Gauchar Vikas Board of the Gujarat government, cow urine removes pimples, dark circles, and black spots. Owing to the significant benefits of cow urine, the cosmetic companies began creating commercial cosmetic products that included cow urine as a component for skin care products. Since our studies have proved that the combination of both cow urine and papaya seed powder extract have produced a good inhibition activity against pyogenic organisms.

Keywords: Fungi, bacteria, viruses, parasites, cow urine





INTRODUCTION

Pyogenic infections are characterised by localised swelling of the skin, soft tissues, and bodily parts. These infections are mostly caused by the invasion and proliferation of pathogenic microorganisms. Certain toxic or cellular metabolites and leukocidins released by these bacteria destroy neutrophils and result in pus and abscesses. Impetigo, osteomyelitis, septic arthritis, spondylodiscitis, otitis media, cystitis, meningitis, and surgical site infections are examples of common pyogenic illnesses. *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, *Klebsiella sp.*, *Proteus sp.*, and *Pseudomonas sp.* are common etiological agents associated with pyogenic infections [Singh S *et al.*, 2013]. Pyogenic organisms are the primary cause of disease and death worldwide, and they are also responsible for extended hospital stays and disability [Lozano R *et al.*, 2010]. In hospitals across the globe, infectious disease specialists deal with a sizable subset of diseases known as pyogenic infections, which include surgery site infections. Although diagnostic techniques have improved over the years, treating pyogenic organisms remains challenging due to the emergence of multidrug resistant superbugs, especially in developing countries. Most importantly, it has been demonstrated in recent years that pyogenic infections are increasingly often associated with methicillin-resistant *Staphylococcus aureus* and multidrug-resistant Gram negative isolates. [Rojan R, 2016]. Certain infections just affect the epidermis, whereas others affect the soft tissues beneath the surface.

A liquid byproduct of cow metabolism is called cow pee. According to ancient and Indian literature, cow urine, or gomutra in Sanskrit, has significant medicinal value. Cow urine is compared to nectar in the Rigveda. According to reports, cow pee can treat a number of illnesses, including gynaecological issues, eczema, asthma, arthritis, heart attacks, constipation, blood pressure, and thyroid issues [NK Jain *et al.*, 2010]. Using the disc diffusion method, cow urine demonstrates antibacterial action against common skin pathogenic microorganisms such as *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, and *Enterobacter aerogenes*. Because of the chemicals included in it, concentrated cow urine has antibacterial and antioxidant properties. Diseases brought on by parasitic helminthes, opportunistic fungi, and pathogenic bacteria may be treated with cow urine [Abubakar U *et al.*, 2004]. Fatty acids, crude protein, crude fibre, papaya oil, sinigrin, carpaine, benzylisothiocyanate, benzyl glucosinolate, glucotropacolin, benzylthiourea, hentriacontane, β -sitosterol, caricin, and an enzyme called myrosin are among the main chemical components found in papaya seeds. Related alkaloids, flavonoids, saponins, tannins, cardiac glycoside, anthraquinones, and cardinolodes are also present in papaya seeds [Nadkarni K M., 1954]. A fatty acid salt called soap is utilized in many lubricating and cleaning goods. Surfactants like soaps are typically used for bathing, washing, and other household tasks. According to Namu Jeremiah Akuaden *et al.* (2019), soaps are used to remove dirt, including dust microorganisms and strains of unpleasant body odors. Plants and their derivatives remain important in medicine even with significant advancements in the pharmaceutical sciences, particularly in synthetic chemistry. The high level of negative side effects associated with synthetic medications has led to a greater interest in natural remedies [Kumar *et al.*, 2010]. Typically, toxic compounds found in commercial soap include polymers, bisphenol, aluminium, barium, toxic mercury, and other substances that the body absorbs. The current study discusses the critical roles that papaya seeds and cow urine play in treating coetaneous infections. It has been demonstrated through experiments that cow urine is a powerful agent against coetaneous infections. The primary chemical component that gives cow urine its antibacterial properties is urea [Bhadauria, 2002].

MATERIAL AND METHOD

Sample Collection

Fresh cow urine was gathered from a local bovine breed (*Bos indicus*) in Valasupalayam hamlet, Tirupur, and placed in a clean, sterile container. Fresh papaya seeds obtained from Pongalur, near Tirupur, and chopped the ripe papaya fruits into pieces.



**Ramachandran et al.,****Pyrogenic Bacteria Collection**

Pseudomonas aeruginosa, *Klebsiella pneumoniae*, and *Staphylococcus aureus* were among the pyrogenic bacteria that were obtained from the Bioline Laboratory located in R S Puram, Coimbatore. For the purpose of antibacterial analysis, all three pyrogenic bacteria—*Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*—were grown in nutritional broth at 37°C for a whole day.

Media preparation for antimicrobial assay

After dissolving 3.8 grams of Muller Hinton Agar in 100 ml of distilled water, the mixture was autoclaved for 20 minutes at 121°C. The medium was placed into pre sterilized petri plates and given time to settle completely once it reached a temperature of between 40 and 50°C.

Antibacterial assay

Cow urine samples, extracts, and chemicals used to make soap all had their antibacterial activity assessed independently by the well diffusion method. Using sterile cotton swabs, the overnight broth cultures were swabbed onto MHA plates, and the plates were left in incubation at 37°C for 24 hours. A sterile borer was used to create wells in the medium that were each equally spaced from one another [Valgas C *et al.*, 2007]. And 50 µl of the preparations for sodium hydroxide, sodium lauryl sulphate, and glycerol were introduced to the appropriate bore. The compounds were allowed to diffuse for 30 minutes at room temperature. For Gram positive and Gram negative organisms, respectively, ciprofloxacin and ampicillin discs were placed as controls. Following that, the plates were incubated for 24 hours at 37°C. The zone of inhibition's diameter (mm) was measured and recorded following incubation [Saranraj *et al.*, 2010].

Antibacterial assay of formulated soaps

The necessary amount of soap base was taken in a 500 ml beaker to create three distinct types of medicinal soaps. The beaker containing the soap base was heated in a water bath without stirring. After that, the soap base will be turned into a liquid. In addition, the mixture mentioned above received all the additional ingredients. Without stirring, the mixture was then brought to a boil in a water bath. After that, the mixture was put into the soap moulds, and the moulds holding the soap were frozen for two to three hours. The soaps were taken out of the soap moulds after two to three hours. Table 2 contains a list of medicinal soap formulations.

Materials used to make soap collection

We bought pure coconut oil from the market to formulate soap. Every additional chemical such as glycerol, acetone, ether were obtained from the college laboratory store.

Sample preparation: Preparation and preservation of papaya seed powder and cow urine

Before being employed as the test material, the collected cow urine sample was filtered through Whatman No. 1 filter paper to remove impurities and waste materials. In order to avoid contamination and oxidation, it was also kept at 4°C in a sealed and airtight container [Anami *et al.*, 2012]. Freshly harvested *Carica papaya* L seeds were properly cleaned with tap water and then sterile water. Papaya seeds that had been cleaned were then ground into a fine powder and dried at room temperature for four weeks [Masfufatun *et al.*, 2019]. The papaya leaf was delivered to the Botanical Survey of India at Tamil Nadu Agricultural University in Coimbatore in order to identify the plant species of the papaya seed. Using Soxhlet's equipment, 15g of dry powdered papaya seeds were extracted over 6 hours by 125ml of ethanol [Sundar *et al.*, 2021]. Using a rotating vacuum evaporator, the trace solvent was eliminated to produce a concentrated extract, which was then kept in a refrigerator for later use. A water extract of papaya seed powder (Fig 1.) was also made using the same technique. The sample were prepared as mentioned above and named as (F1-Sample contain cow urine with soap base, F2-Sample contain Chloroform and water papaya seed extract, F3-Sample contain both Cow urine and Chloroform and water papaya seed extract) F1, F2 and F3. Table 2 describes the ingredients in the samples.



Ramachandran *et al.*,**FTIR analysis (Fourier Transform Infrared Spectroscopy)**

For the most effective method of determining the kinds of chemical bonds and functional groups that are present in compounds, the Fourier Transform Infrared Spectrophotometer (FTIR) is utilized. The annotated spectrum illustrates how the chemical bond is characterized by the wavelength of light absorbed. Translucent sample discs were prepared by encapsulating 10 mg of dried papaya seed powder in 100 mg of KBr pellet. A Shimadzu IR Affinity 1 spectroscope (Japan) was used to load the powdered material, and it had a scan range of 400 to 4000 cm^{-1} with a resolution of 4 cm^{-1} [Parag A *et al.*, 2013].

Preparation of soap base

A 1000 ml beaker containing 225 ml of coconut oil was used to prepare the soap base. After that, the beaker was put in a water bath and heated to 40 to 45 degrees Celsius while being constantly stirred to develop a strong thickness and used a thermometer to keep an eye on the temperature. Sodium hydroxide was dissolved in distilled water to create the lye solution, and a thermometer was used to keep constant. After adding this solution to the coconut oil mixture, it was heated at 40° to 45° Celsius until a base consistency was formed. After that, the liquid was poured into soap moulds and frozen for two to three hours. After that time, the moulds containing the soap were taken out of the freezer and the soap bases were taken out. (Sucharita G., 2020). The necessary amount of soap base was taken in a 500 ml beaker to create three distinct types of medicinal soaps. The beaker containing the soap base was heated in a water bath without stirring. After that, the soap base will be turned into a liquid. In addition, the mixture mentioned above received all the additional ingredients (Table 1). Without stirring, the mixture was then brought to a boil in a water bath. After that, the mixture was put into the soap moulds, and the moulds holding the soap were frozen for two to three hours. The soaps were taken out of the soap moulds after two to three hours.

Medicinal soap preparation

The necessary amount of soap base was taken in a 500 ml beaker to create three distinct types (F1, F2, F3) of medicinal soaps (Table 2). The beaker containing the soap base was heated in a water bath without stirring. After that, the soap base will be turned into a liquid. In addition, the mixture mentioned above received all the additional ingredients. Without stirring, the mixture was then brought to a boil in a water bath. After that, the mixture was put into the soap moulds, and the moulds holding the soap were frozen for two to three hours. The soaps were taken out of the soap moulds after two to three hours.

Physiochemical properties of formulated soap

Basically, these physiochemical properties refer to the characteristics of the soap (Fig 2.) that determine its behavior and performance. They are as follows like pH level, viscosity, density, and even color. The pH level is important because it affects how well the soap can clean and also how gentle or harsh it is on our skin. Viscosity is all about how thick or thin the soap is, whether it's super runny or more like a gel consistency. Density produces the compactness and light weight of the soap. Color of the soap also has a role for good characteristic in the formulation.

RESULTS AND DISCUSSIONS**PLANT IDENTIFICATION**

The plant was identified as *Carica papaya* L., by Botanical Survey of India in Tamil Nadu Agricultural University.

SEED EXTRACT

The plant extracts were taken and the colour of the extract was identified as shown in table below and the pictures are shown in the Figure – 4 & 5.



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FTIR ANALYSIS

FTIR spectrophotometer was used to evaluate the papaya seed powder's functional groups. The functional groups found in the powdered papaya seed are depicted in Figure 6, while the functional groups of the potential active ingredients are listed in Table 4. The functional groups that indicate the existence of amine salt, aldehyde compound, ester compound, nitro compound, alkane group, ether compound, anhydrides, and alkene group are -N-H, -C-H, -C=O, -N-O, -C-N, -C-O, and -C=C in papaya seeds (Table 4). FTIR Spectroscopy analysis of cow urine was recorded between 4000 and 400 cm^{-1} . This analysis showed the presence of alcoholic groups, amide, phosphate, alkenes, alkyl halide and poly sulfides (Vipin Nautiyal and R.C. Dubey, 2021). It reveals both cow urine and papaya seed powders have the same kind of compounds in their entity. The presence of alcohol and amine groups fractions produce antibacterial activity against *Staphylococcus aureus* and other bacteria in our study. It has been evident in the fig 8. of this paper. This result was supported by Shaw *et al.*, (2007) work in which the inhibitory effect of cow urine may be due to the presence of some volatile and nonvolatile compounds.

EVALUATION OF PHYSIOCHEMICAL PROPERTIES OF FORMULATED SOAPS

The various physiochemical parameters such as Colour, shape, odour, pH, Foam height and foam retention of medicinal soap has been evaluated which is shown in table 4 and figure 7.

Antibacterial assay

On each of the three bacterial cultures, the chemical components used to make soap were tested for their antibacterial properties. According to the results, glycerol did not demonstrate resistance against the tested bacterial organisms, but sodium hydroxide and Sodium Lauryl Sulphate (SLS) exhibit the maximum inhibitory activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa* and the minimum inhibitory activity against *Klebsiella pneumoniae*. As a control, Ampicillin and Ciprofloxacin demonstrate resistance to three pyogenic bacteria [Saranraj *et al.*, 2010]. Cow urine shows the maximum inhibitory activity against gram positive organism and shows the minimum inhibitory activity against gram negative organisms. Cow urine along with papaya powder extracts shows the maximum inhibitory activity against *S. aureus* and *P. aeruginosa* and minimum inhibitory activity against *K. pneumoniae*. Among the three formulated soaps, F3 which contains both Cow urine and papaya seed extracts showed the maximum inhibitory activity against *S. aureus* and *Klebsiella pneumoniae* 24mm and 25mm respectively where as formulated F1 and F2 soaps against all the three tested pyogenic organisms shows intermediate activity (19 mm and 13 mm). But the sample formulations show less active (3mm, 9mm and 12mm) against *Pseudomonas aeruginosa*. Antibacterial Activity of Medicinal Soaps is shown in table 7 & figure 8.

Cost analysis of formulated soap with commercially available antibacterial soap

Cost analysis for 75 gm formulated medicinal soap was compared with commercially available 75 gm dettol antibacterial soap By analyzing the cost of ingredients required for making 75 gm medicinal soap, it was clearly observed that the cost is comparatively low to that of commercial antibacterial soap that is available in the market (Fig. 10 & 11). So, it reduces the financial burden of people and can be overcome the skin infection from pyogenic organism.

ACKNOWLEDGMENTS

We would like to thank our management of Dr. N.G.P. Arts and Science College for providing the lab facilities and chemicals. We also thank to DBT-FIST, DBT-STAR for supporting and extend our gratitude towards to Deans of different portfolio, Head of the Department and Colleagues of Microbiology Department for their moral support and guidance to complete this work successfully.

CONCLUSIONS

The present study was done to analyze the combination effect of cow urine and Papaya seed extract against pyogenic organisms such as *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* in the formulation of medicinal soap. Papaya seed extracts (chloroform & aqueous) were obtained by using soxhlet apparatus. The





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papaya seed characteristics were obtained by analysis FTIR. The high peaks indicated the presence of antibacterial properties. Three different formulations of medicinal soaps F1, F2 and F3 were formulated using cow urine, papaya seed extracts. (Chloroform & aqueous) and combination of cow urine and extracts respectively. Maobe and Nyarango (2013) have reported these functional groups in their study. Antibacterial activity of formulated soap F3 which contains both cow urine and extracts showed good antibacterial activity against *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* compared to F1 and F2 soaps which also has good antibacterial activity. Similar observations have been documented in Oladosu (2018) studies which are stated that inhibitory action of medicinal preparation against clinical pathogens likes *S. aureus*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. This study concludes that the Formulated medicinal soap F3 which is made up of both cow urine and papaya seed extracts is better in controlling the growth of pyogenic organisms compared to that of F1 & F2.

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Table 1: List of Soap base ingredients

S.NO.	INGREDIENTS	QUANTITY
1	Coconut oil	225 gm
2	Sodium hydroxide	39.84 gm
3	Distilled water	75 ml

Table 2 : Formula of medicinal soap

S.No	INGREDIENTS	F1	F2	F3
1	Soap base	70gm	70gm	70gm
2	SLS Solution	1ml	1ml	1ml
3	Glycerol	2ml	2ml	2ml
4	cow urine	10 ml	-	5ml
5	papaya seed (chloroform extract)	-	5ml	2.5ml
6	papaya seed (Water form extract)	-	5ml	2.5ml





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Table- 3 : Seed Extract

SI.NO	SEED EXTRACT	COLOUR
1	Chloroform	Dull gold yellow
2	Water	Brownish beige yellow

Table – 4: FTIR Spectra of Papaya Seed Powder

S.NO	FREQUENCY CM ⁻¹	BOND	FUNCTIONAL GROUP
1	2924.09	NH stretching	Amine salt
2	2854.65	CH stretching	Aldehyde
3	1743.65	C=O stretching	Ether
4	1589.34	N-O stretching	Nitro compound
5	1450.47	C-H Bending	Alkane
6	1234.44	C-N stretching	Amine
7	1157.29	C-O stretching	Ether
8	1049.28	CO-O-CO	Anhydride
9	717.52	C=C Bending	Alkene
10	686.66	C=C Bending	Alkene

Table – 5: Evaluation of Physicochemical Parameters of Medicinal Soaps

S.No.	PARAMETERS	F1	F2	F3
1	Colour	Pale yellow	White	Pale yellow
2	Odour	Aromatic	Aromatic	Aromatic
3	Shape	Round	Round	Round
4	pH	9	10.2	9.9
5	Foam Height	8.5 cm	6.7 cm	9.3 cm
6	Foam retention	3min 15sec	2min 23sec	3min 45sec

Table – 6: Antibacterial Activity of Chemical ingredients Used for Making Soap

S.NO	ORGANISM	NAOH (MM)*	SLS (MM)*	Glycerol (MM)*	CONTROL (Ampicillin & Ciprofloxacin) (MM)*
1	STAPHYLO	15	10	-	24
2	COCCUS	10	5	-	21
3	AUREUS	12	9	-	23

*Zone Of Inhibition Measured In Millimeter (mm)

Table 7. Antibacterial activity

S.No	ORGANISM	F1(mm)*	F2(mm)*	F3(mm)*	CONTROL (AMPICILLIN & CIPROFLOXACIN) (mm)*
1	<i>Staphylococcus aureus</i>	18	19	24	22
2	<i>Klebsiella pneumoniae</i>	5	13	25	23
3	<i>Pseudomonas aeruginosa</i>	3	9	12	21




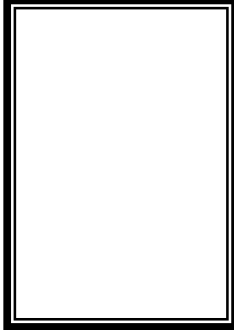




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Table -8 : Cost analysis of ingredients used for medicinal soap making

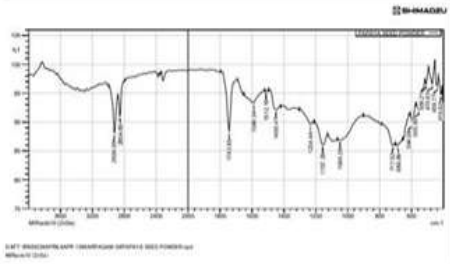
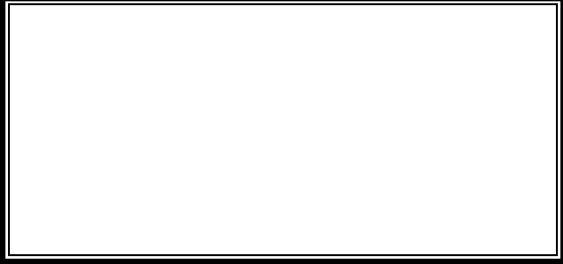
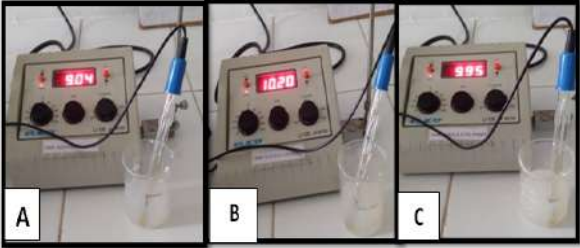
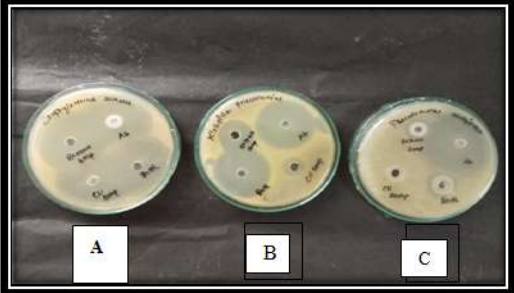


S.NO	INGREDIENTS	QUANTITY	COST IN RUPEES
1.	Coconut oil	75 gm	15.75
2.	Sodium hydroxide pellets	13.28 gm	4.10
3.	Distilled water	25 ml	6.50
4.	Cow urine	5 ml	0.42
5.	Sodium lauryl sulphate solution	1ml	5.00
6.	Papaya seed powder	2gm	2.00
7.	glycerol	2ml	0.36
		Total Cost	34.13

	
<p>Figure -1: Papaya seed Powder</p>	<p>Figure 2. The formulated soap exhibits distinctive physiochemical features.</p>
	
<p>Figure – 3: <i>C. papaya</i> Chloroform extract</p>	<p>Figure – 5 : <i>C. papaya</i> H₂O extract</p>





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<p>Figure -6: FTIR Spectra of <i>Carica papaya</i> seed powder</p>	<p>Figure – 7: Medicinal soap formulations with different constituents</p>
	
<p>Figure – 8: Ph Meter Indicating The Ph Of Medicinal Soaps (From Right Ph Of Formulated Soaps F1 (A); F2 (B); F3(C).</p>	<p>Figure 9. Antibacterial Activity of Cow Urine & Papaya Seed Extracts</p>
	
<p>Figure -10 : 75gm F3 Soap</p>	<p>Figure – 11 : 75gm Dettol Soap label</p>





VLSI Implementation of High Speed Fir Filter using Modified Booth Multiplier

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 26 Jul 2024

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ABSTRACT

The power consumption and speed are the two main challenging factors in very large scale Integrated Circuits (VLSI) design technique. The computation saving is one of the way to obtain the optimized power consumption and speed. In Finite Impulse Response (FIR) filter multiplier unit takes more computation it increases power consumption of FIR filter. By using two algorithm area, delay and power consumption of FIR filter can be reduced. FIR filter coefficient can be classified as fixed and reconfigurable coefficient. For reconfigurable coefficient Modified Booth Multiplier (MBM) is used. For fixed coefficient combining of Canonic Sign Digit and Minimal Sign Digit (CSD & MSD) algorithm is used. In MBM architecture as the number of pipelined stages is increased, the path delays of each stage are decreased and overall performance is improved. In CSD & MSD architecture efficiently saves power and improves performance of multiplier unit in FIR filter.

Keywords: Multiplier unit, Modified Booth Multiplier, Finite Impulse Response.

INTRODUCTION

Finite Impulse Response (FIR) digital filter is widely used in several digital signal processing applications, such as speech processing, loud speaker equalization, echo cancellation, Adaptive noise cancellation, and various communication application, including Software Defined Radio(SDR). Many of these applications require FIR filters of large order to meet the stringent frequency specifications. Very Often these filters need to support high sampling





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rate for high-speed digital communication the number of multiplications and additions required for each filter output is increases linearly with the filter order. Since there is no redundant computation available in the FIR filter algorithm, real-time implementation of a large order FIR filter in a resource constrained environment is a challenging task. Filter coefficients very often remain constant and known a priori in signal processing applications. This feature has been utilized to reduce the complexity of realization of multiplications. Several designs have been suggested by various researchers for efficient realization of FIR filters (having fixed coefficients) using distributed arithmetic (DA) and multiple constant multiplication (MCM) methods. DA-based designs use lookup tables (LUTs) to store pre computed results to reduce the computational complexity. The MCM method on the other hand reduces the number of additions required for the realization of multiplications by common sub expression sharing, when a given input is multiplied with a set of constants. The MCM scheme is more effective, when a common operand is multiplied with more number of constants. MCM scheme is not suitable for multiply variable coefficient. MCM is replaced by pipelined modified booth multiplier this pipelined architecture efficiently saves power and improves performance with efficient trade off comparatively with conventional architecture. The pipeline technique is widely used to improve the performance of digital circuits. As the number of pipeline stages is increased, the path delays of each stage are decreased and the overall performance of the circuit is improved. The data-flow graphs (DFG-1) of transpose form FIR filter for filter length $N = 6$, as shown in Figure 1. Design FIR Filter architecture of fixed and reconfigurable by using modified booth multiplier to reduce power-delay and time. The filter order can be dynamically changed depending on the amplitude of both the filter coefficients and the inputs. In other words, when the data sample multiplied to the coefficient is so small. This substitution helps to reduce the delay and power consumption of the whole system.

MCM TECHNIQUE AND ARRAY MULTIPLIER

In FIR filter the important factor is multiplication of coefficients this process can be done in multiplier unit. An efficient Multiplier design essentially improves the performance of a complex DSP system. In this FIR filter design Multiple Constant Multiplication (MCM) is used for fixed coefficient. For reconfigurable coefficient Array Multiplier (AM) is used in exiting method. In MCM blocks can be formed only in the transpose form configuration of FIR filters. Array multiplier is the normal shift and adds operation logic.

MCM-BASED IMPLEMENTATION OF FIXED-COEFFICIENT FIR FILTER

For MCM implementation consider the block size $L = 4$. It consists of one Coefficient Selection Unit (CSU), one Register Unit (RU), M number of Inner Product Units (IPUs), and one Pipeline Adder Unit (PAU). The CSU stores coefficients of all the filters to be used for the reconfigurable application. It is implemented using N ROM LUTs, such that filter coefficients of any particular channel filter are obtained in one clock cycle, where N is the filter length. The RU receives X_k during the k^{th} cycle and produces L rows of S_0^k in parallel. L rows of S_0^k are transmitted to M IPUs of the proposed structure. The M IPUs also receive M short-weight vectors from the CSU such that during the k^{th} cycle, the $(m + 1)^{\text{th}}$ IPU receives the weight vector $C_{(M-m-1)}$ from the CSU and L rows of S_0^k from the RU. Each IPU performs matrix-vector product of S_0^k with the short-weight vector C_m , and computes a block of L partial filter outputs $r(k)$. Therefore, each IPU performs L inner-product computations of L rows of S_0^k with a common weight vector c_m . The structure of the $(m+1)^{\text{th}}$ IPU as shown in figure 4. It consists of L number of L -point inner-product cells (IPCs). The $(l+1)^{\text{th}}$ IPC receives the $(l+1)^{\text{th}}$ row of S_0^k and the coefficient vector c_m , and computes a partial result of inner product $r(kL-l)$, for $0 \leq l \leq L - 1$. Internal structure of $(l + 1)^{\text{th}}$ IPC for $L = 4$. All the M IPUs work in parallel and produce M blocks of result (r_k) . These partial inner products are added in the PAU as shown in figure 5 to obtain a block of L filter outputs. In each cycle, the proposed structure receives a block of L inputs and produces a block of L filter outputs, where the duration of each cycle is $T = T_M + T_A + T_{FA} \log_2 L$, T_M is one multiplier delay, T_A is one adder delay and T_{FA} is one full-adder delay. The MCM technique is suitable for fixed coefficients only. In those approaches, FIR filter structures are simplified to add and shift operations and minimizing the number of additions/subtractions is one of the main goals of the research. However, one of the drawbacks encountered in those approaches is that once the filter architecture is decided the coefficients cannot be changed. Therefore, those techniques are not applicable to the FIR filter with programmable coefficients. In proposed scheme Modified Booth Multiplier (MBM) is used. The primary goal of this work is to reduce the dynamic power of the FIR filter.





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ARRAY MULTIPLIER

A K-tap FIR filter performs the computation given by the following equation

$$Y_n = \sum_{i=0}^{K-1} h_i X_{n-i} \quad (1)$$

Where, $0, 1, 2, \dots, n$ X_n is the input sequence,

Y_n is the output sequence, and

$h_n = 0, 1, \dots, K-1$ are the filter coefficients.

The above expression shows that a FIR filter can be realized by a scheme that has the structure of an array multiplier. Each j -th diagonal coefficient line in Figure 6 carries the K bits $0, 1, \dots, h^0, h^1, \dots, h^{K-1}$ of coefficients. Each of them belongs to a different filter coefficient. All the coefficient bits h_j^i enter the circuit synchronously. We assume that coefficients remain constant during the operation of the filter. In case of coefficients, changing on the fly, delay elements should be placed on coefficient lines. The horizontal data lines correspond to the bits of X_n that enter the circuit in bit-skew form. The least Significant part of the output of the array is in bit-skew form and the most significant part in an extended carry-save form. We use the term 'extended carry-save' because the sum is 1-bit but the carry is K -bit long, as it will soon become clear. A row of cells at the bottom of the array converts the most significant part from extended carry-save into conventional carry-save form. This row is extended leftwards by $2 \log K$ cells in order to prevent the result from overflowing. Apparently the extra cells are simplified as we move leftwards and therefore are shown in Fig. 1 with smaller rectangular boxes. If the final result must be obtained in binary form, a pipelined vector merged adder is required.

PROPOSED METHOD

MBM FOR RECONFIGURABLE COEFFICIENT

The Modified Booth algorithm is extensively used for high-speed multiplier circuits. In MBM algorithm Multiplication consists of three steps: 1) the first step to generate the partial products; 2) the second step to add the generated partial products until the last two rows are remained; 3) the third step to compute the final multiplication results by adding the last two rows. The modified Booth algorithm reduces the number of partial products by half in the first step. We used the modified Booth encoding (MBE) scheme. It is known as the most efficient Booth encoding and decoding scheme. To multiply X by Y using the modified Booth algorithm starts from grouping Y by three bits and encoding into one of $\{-2, -1, 0, 1, 2\}$. The working principle of sign extension that converts signed multiplier signed-unsigned multiplier as follows. One bit control signal called signed-unsigned (s_u) bit is used to indicate whether the multiplication operation is signed number or unsigned number. When Sign-unsigned $s_u = 0$, it indicates unsigned number multiplication, and when $s_u = 1$, it indicates signed number multiplication. It is required that when the operation is unsigned multiplication the sign extended bit of both multiplicand and multiplier should be extended with 0, that is $a_{32} = a_{33} = b_{32} = b_{33} = 0$. It is required that when the operation is signed multiplication the sign extended bit depends on whether the multiplicand is negative or the multiplier is negative or both the operands are negative. For this when the multiplicand operand is negative and multiplier operand is positive the sign extended bits should be generated are $S_u = 1, a_{31} = 1, b_{31} = 0, a_{32} = a_{33} = 1$, and $b_{32} = b_{33} = 0$. When the multiplicand operand is positive and multiplier operand is negative the sign extended bits should be generated are $S_u = 1, a_{31} = 0, b_{31} = 1, a_{32} = a_{33} = 0$, and $b_{32} = b_{33} = 1$. The latency in the Wallace tree multiplier can be reduced by decreasing the number of adders in the partial products reduction stage. Multi bit compressors are used for realizing the reduction in the number of partial product addition stages. The combined factors of low power, low transistor count and minimum delay in these compressors. The outputs generated at each stage are efficiently used by replacing the XOR blocks with multiplexer blocks so that the critical path delay is minimized. A 3:2 compressor takes 3 inputs X_1, X_2, X_3 and generates 2 outputs, the sum bit 's', and the carry bit 'c'. The number of levels in the Wallace tree using 3:2 compressors can be approximately given as

Number of levels = $(\log(k/2)) \div (\log(3/2))$ The 3:2 compressors make use of a Carry Save Adder. In carry save adder the carry digit is taken from the right and passed to the left, just as in conventional addition. By using these number of partial product is reduce.



**Madhubashini et al.,****COMBINING OF CSD AND MSD FOR FIXED COEFFICIENT**

The CSD representation is a radix-2 signed digit system with the digit set {1, 0, -1}. The CSD representation for a given number is unique and has two properties; the first is that the number of non-zero digits is minimal and the second is that the product of adjacent two digits is zero. The CSD number system is an efficient way of representing the coefficients, as it reduces 33% of non-zero digits compared with the binary representation. The CSD representation is widely used in implementing MCMs because it guarantees the least number of additions for a given constant multiplication. However, this result in limited sub expressions for multiple constants. If the second property is relaxed in the CSD representation, it is called minimal signed digit (MSD) representation. The MSD representation is more appropriate in finding common sub expressions for multiple constants if a proper MSD form is selected for each constant to be synthesized. The only transformations needed to convert the CSD representation to MSD representations are $10\ -1\ =011$ and $-101\ =0\ -1\ -1$. The CSD representation is registered as the first MSD representation. A pattern of either $10\ -1$ or $-1\ 01$ is searched next, starting from the most significant digit and transformed into 011 or $0\ -1\ -1$ respectively. A new MSD representation is generated for each transformation. The transformation is applied repeatedly to the new MSD representations found in the previous transformations until there is no such pattern. The pattern is searched in an MSD representation from the next position of the digit where a transformation is applied to generate the MSD representation. Algorithm transformation is shown in Figure 9.

RESULTS AND DISCUSSIONS

The simulated results and power analysis are discussed here. Xilinx 8.1 ISE (Integrated Software Environment) is a software tool produced by Xilinx for synthesis and analysis of Hardware Description Language (HDL) designs, enabling to synthesis their design.

OUTPUT WAVEFORMS OF MBM**Area Utilization**

By implementing the total system, the area consumed by the system is checked in the design summary. The area consumption is given in the terms of number of slices occupied. Fig shows the area utilization of the proposed system.

Power Consumption

The power consumption is the total power consumed by the system. The power consumption is also reduced. The power consumption is taken as a sum of leakage power and dynamic power. Thus the total consumed power can be obtained. Figure 15 shows the power consumption of the proposed system.

Timing Report

PERFORMANCE COMPARISON

The results shows that the power consumption of the system have been reduced comparing to previous systems. Table1 shows the comparison of the dynamic power and between existing and proposed FIR filter. In MCM based FIR filter have dynamic power 298mW is reduced to 272mW by using MBM based FIR method.

CONCLUSIONS

A new logic formation design is introduced to reduce the area, delay and power of FIR filter. All the redundant logic operations present in the conventional multiplier in FIR filter are eliminated and a new logic formulation for FIR is introduced. In this technique Partial product is reduced by half, which is different from the conventional approach.





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Table 1: Area and Power Consumption Comparison of Existing and Proposed Method

PARAMETERS	EXISTING	PROPOSED
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	Array	MCM	MBM	CSD & MSD
Area	24,016	13,230	20,622	8662
Delay	37.34ns	21.56ns	29.21ns	19.67ns
Power	268mW	186mW	257mW	181mW

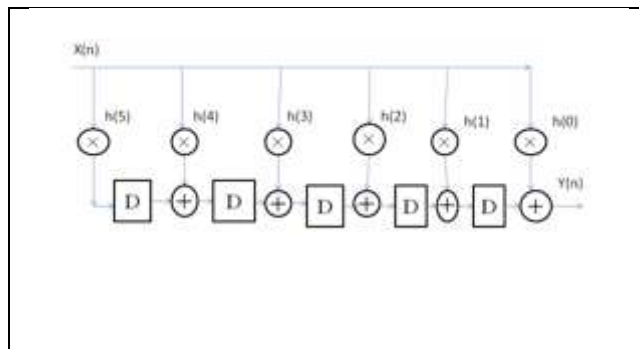


Figure 1: Structure of FIR filter

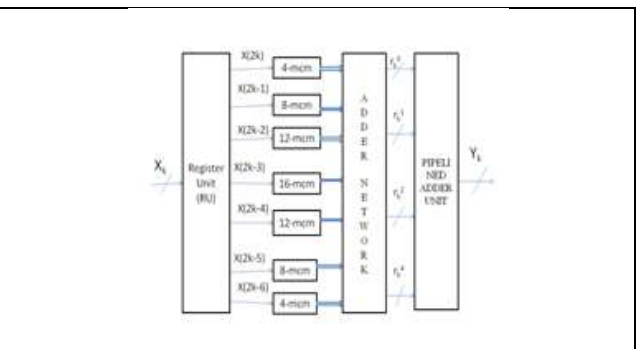


Figure 2: MCM based FIR Filter Design

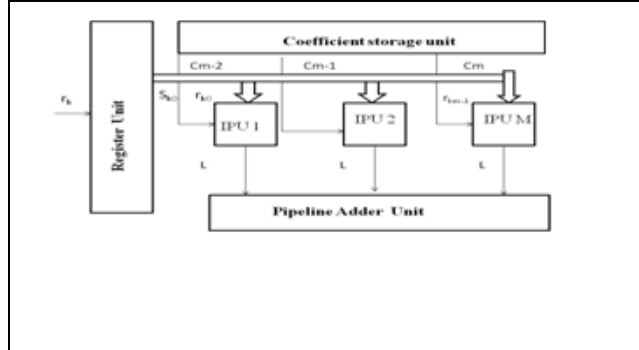


Figure 3: Structure of MCM

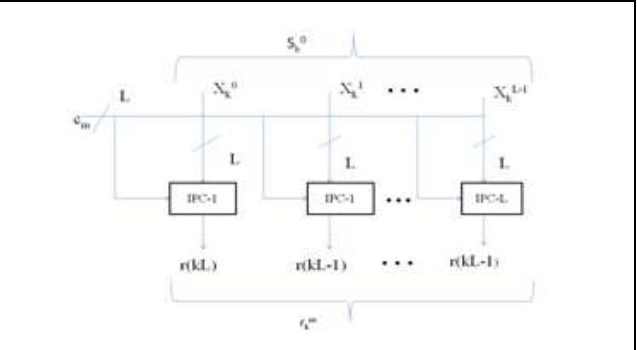


Figure 4: Structure of IPU

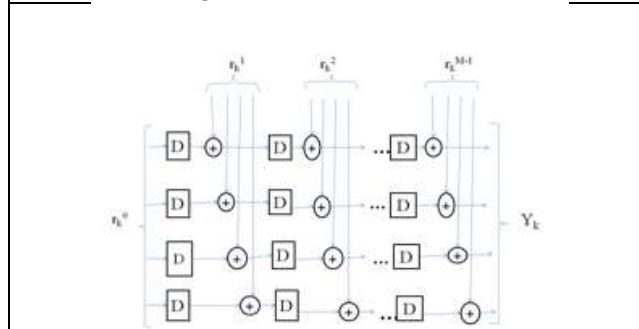


Figure 5: Structure of PAU

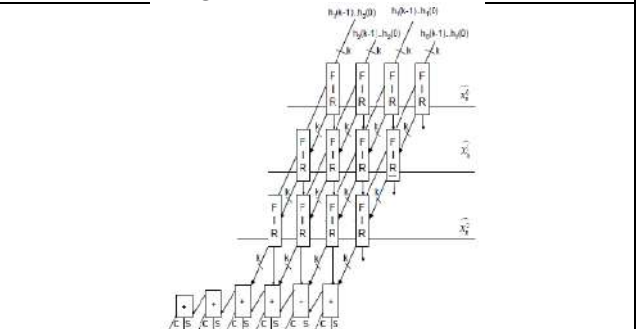


Figure 6: Array based FIR Filter



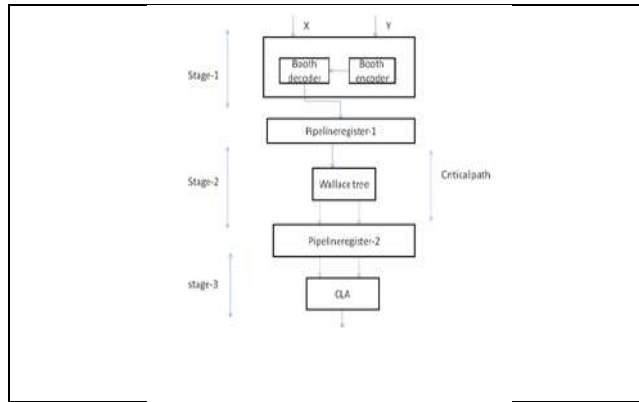


Figure 7: Architecture of the Modified Booth multiplier

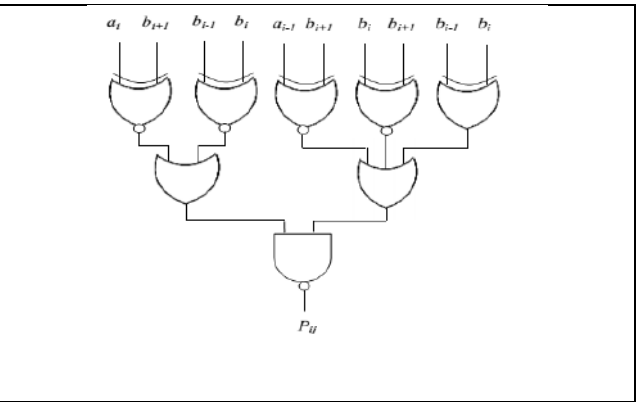


Figure 7: Logic diagram of 1-bit partial product generator

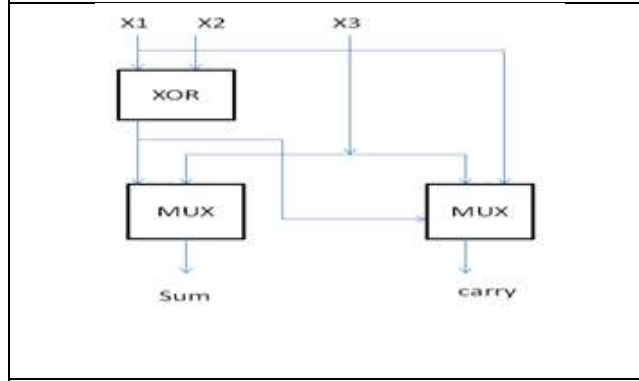


Figure 8: Structure of 3:2 compressor

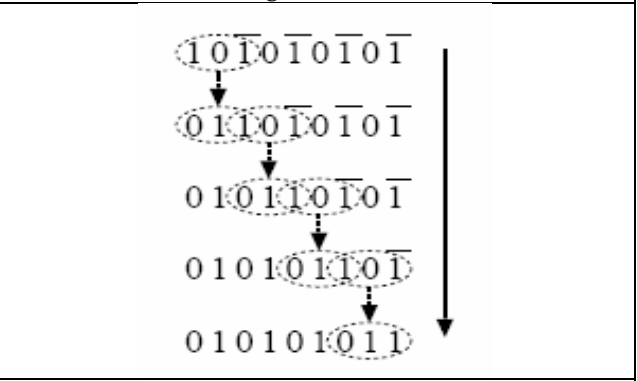


Figure 9: CSD & MSD representation

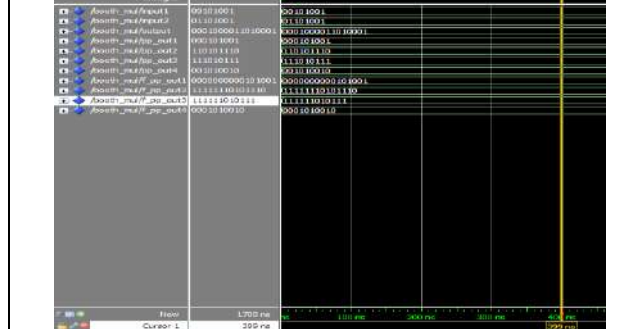


Figure 10: Output of MBM

Device Utilization Summary				
Logic Utilization	Used	Available	Utilization	Notes(s)
Number of Slice Flip Flops	115	13,824	1%	
Number of 4-input LUTs	2,639	13,824	19%	
Logic Distribution				
Number of occupied Slices	1,450	6,912	20%	
Number of Slices containing only related logic	1,450	1,450	100%	
Number of Slices containing unrelated logic	0	1,450	0%	
Total Number 4-input LUTs	2,741	13,824	19%	
Number used as logic	2,639			
Number used as a multiplexer	42			
Number of bonded I/Os	192	510	37%	
I/Os Flo Flops	32			
Number of SCLNs	1	4	25%	
Number of SCLNCEs	1	4	25%	
Total equivalent gate count for design	25,622			
Additional LUTs gate count for I/Os	6,364			

Figure 11: Area Utilization of MBM (reconfigurable coefficient)





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Device Utilization Summary			
Logic Utilization	Used	Available	Utilization
Total Number Slice Functions			
Number used on FPG Floor	72		2%
Number used on Lattice	242		
Number of Input LUTs	339	13,024	3%
Logic Distribution			
Number of 3-input LUTs	486	4,412	1%
Number of slices containing only related logic	486	268	100%
Number of slices containing unrelated logic	0	498	0%
Total Number of 4 input LUTs			
Number of 4-input LUTs	157	519	31%
CSD (No Place)	24		
I/O Latches	6		
Number of DCLLAs	4	4	100%
Number of DCLLAs	1	4	25%
Total equivalent gate count for design			
Additional I/O pin count for IC8s	7,778		

Figure 11: Area Utilization of CSD & MSD (fixed coefficient)

Power and Dataheet may have some Quiescent Current differences. This is due to the fact that the quiescent numbers in Power are based on measurements of real designs with active functional elements reflecting real world design scenarios.

Power summary:	QuA	QuW
Total estimated power consumption:		
Vector I.MVT:	139	250
Vector S.S.MVT:	2	7
Quiescent Vector I.MVT:	116	216
Inputs:	8	15
Logic:	0	0
Outputs:		
Vecs33:	0	0
Signals:	0	0
Quiescent Vector I.MVT:	15	27
Quiescent Vecs33.S.MVT:	2	7

Figure 12: Power Consumption of MBM

Power and Dataheet may have some Quiescent Current differences. This is due to the fact that the quiescent numbers in Power are based on measurements of real designs with active functional elements reflecting real world design scenarios.

Power summary:	QuA	QuW
Total estimated power consumption:		
Vector I.MVT:	97	174
Vector S.S.MVT:	1	7
Clocks:	73	132
Inputs:	8	15
Logic:	0	0
Outputs:		
Vecs33:	0	0
Signals:	0	0
Quiescent Vector I.MVT:	15	27
Quiescent Vecs33.S.MVT:	2	7

Figure 12: Power Consumption of CSD & MSD

Timing Summary:

 Speed Grade: -7

Minimum period: 4.672ns (Maximum Frequency: 214.041MHz)
 Minimum input arrival time before clock: 15.065ns
 Maximum output required time after clock: 17.040ns
 Maximum combinational path delay: 19.671ns

Figure 13: Timing Report of CSD & MSD





A Mathematical Model for Differentiated Thyroid Cancer with Multikinase Inhibitors Therapy and Immunotherapy

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 26 Jul 2024

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ABSTRACT

This study aimed to develop a comprehensive mathematical model using ordinary differential equations (ODEs) to simulate the treatment dynamics of patients with Radioactive Iodine Refractory (RAIR) differentiated thyroid cancer (DTC). The focus was on incorporating the administration of tyrosine kinase inhibitors and immunotherapy within the model. Additionally, the study aimed to analyze the stability of the formulated equations and conduct numerical simulations using MATLAB. The construction of the mathematical model involves formulating a system of ordinary differential equations that represents the interactions between the cancer cells, Immune cells, carrying capacity of cancer cells, tyrosine kinase inhibitors and immunotherapeutic agents. The stability of the model's equations was rigorously examined to ensure robustness and reliability. Numerical simulations were then performed using MATLAB to simulate the treatment dynamics over time. The findings revealed insights into the dynamics of treating RAIR-DTC patients with tyrosine kinase inhibitors and immunotherapy. The stability analysis contributed to the understanding of the system's behavior under different conditions, offering valuable information for clinical application. This research contributes to the field by presenting a novel mathematical model that integrates tyrosine kinase inhibitors and immunotherapy for the treatment of RAIR-DTC. The comprehensive analysis of equation stability enhances the reliability of the model, while the numerical simulations provide a practical and visual tool for assessing the potential outcomes of the proposed therapeutic strategy. This study offers a valuable framework for further exploration and refinement of treatment approaches for patients with challenging RAIR-DTC cases.



**Lavanya and Jasmine**

Keywords: Mathematical modeling, Routh Hurwitz Criteria, Jacobian, Differentiated thyroid Cancer, Stability Analysis.

INTRODUCTION

In 2020, thyroid cancer (TC) occupied the 9th position in cancer incidence, accounting for 3.0% of all cancer cases and contributing to 0.4% of cancer-related fatalities. Its occurrence is three times more frequent in women than in men, and the incidence rates exhibit significant variability across different countries[1]. Differentiated thyroid carcinoma (DTC) constitutes over 90% of all thyroid cancers and encompasses papillary thyroid carcinoma, follicular thyroid carcinoma and poorly differentiated thyroid carcinoma. While DTC is more prevalent in women, they generally experience a more favorable prognosis. Current treatment modalities, such as surgery, l-thyroxine therapy, and radioactive iodine (RAI), are effective in managing DTC. However, in cases where resistance to radioactive iodine occurs, metastasis can develop in up to 15% of instances, leading to a poorer prognosis. The FDA has approved multi-kinase inhibitors (MKIs) like sorafenib and lenvatinib for treating radioactive iodine-refractory DTC (RAI-rDTC)[2] MKI were incorporated into the management of thyroid cancer due to the advancing understanding of molecular pathways associated with thyroid carcinoma. In cases of radioactive iodine-resistant differentiated thyroid cancer (DTC) that shows progression and is not suitable for surgical removal, these medications are frequently recommended following a thorough evaluation of potential side effects and the potential benefits in terms of disease control. Although TKIs have demonstrated enhanced rates of partial response, progression-free survival (PFS), and stable disease, their influence on overall survival remains insufficiently documented[3]. Mathematical modeling has become a widely utilized approach for exploring tumor dynamics and assessing the efficacy of cancer treatments. For example, in a study, a system of three coupled differential equations and variables at time 't' representing the tumor cell population, the total level of NK cells, and the effectiveness of tumor-specific CD8+ T cells was employed to model tumor-immune interactions, shedding light on the mechanisms behind immune-mediated tumor rejection. Another study, went beyond incorporating tumor cells, host cells, and immune cells, incorporating simulations of drug interactions to determine optimal protocols for chemotherapy[4]. A comprehensive review of mathematical models related to thyroid cancer is covering various models and aspects explored to date[5]. A mathematical model incorporating the Allee effect was proposed to simulate the impact of different dosages of radioactive iodine (RAI) in treating papillary thyroid carcinoma (PTC) patients. This model, based on an ODE system, associated the Allee threshold with doses that could effectively eliminate tumors[6].

Immunotherapy is a type of cancer treatment that stimulates the body's immune system to target and destroy cancer cells. While immunotherapy has shown success in treating various types of cancer, its role in the treatment of differentiated thyroid cancer (DTC) is still under investigation. Several clinical trials have been conducted or are ongoing to evaluate the effectiveness of immunotherapeutic agents in treating thyroid cancer. One class of immunotherapies being investigated is immune checkpoint inhibitors, such as drugs that target programmed cell death protein 1 (PD-1) or programmed death-ligand 1 (PD-L1). These drugs aim to release the brakes on the immune system, allowing it to better recognize and attack cancer cells[7]. pembrolizumab is one of the immunotherapy drug. The combination of multikinase inhibitors and immunotherapy is an area of active research in the treatment of various cancers, including thyroid cancer. Combining different types of therapies is aimed at targeting cancer cells through multiple mechanisms, potentially enhancing treatment efficacy. The rationale behind this combination is to inhibit both the signaling pathways involved in cancer cell growth and the mechanisms that cancer cells use to evade the immune system[7]. This article presents a mathematical model involving a two step development approach. The first step assesses the effectiveness of Sorafenib in the treatment of RAI-rDTC, while the second step focuses on Pembrolizumab efficacy in the same context. The Sorafenib drug mechanisms include reducing tumor carrying capacity, inhibiting tumor growth, and modifying anti-immune capacity through the activation of immune cells. The pembrolizumab drug mechanism are manifested through the alleviation of PD-1 pathway mediated immune inhibition, leading to an enhancement of the anti-tumor immune response.





METHODOLOGY

Construction of Model with Multi Kinase Inhibitor

We recommend administering patients with RAIR-DTC sorafenib therapy with a medication concentration of U. One to two capsules of sorafenib are taken orally per day. We assume the drug U concentration to be a constant function of time in our modeling the tumor cannot be completely removed by the treatment, it is slowed to the point of maximal tolerability. The ODE model under consideration is as follows, presuming that N and I, reflect the numbers of cancer cells and immune cells respectively.

$$\begin{aligned} \frac{dU}{dt} &= D - \delta U \\ \frac{dN}{dt} &= k_1 N \left(1 - \frac{N}{K(s)} \right) - k_2 IN - k_3 UN \\ \frac{dI}{dt} &= k_5 I \left(1 - \frac{I}{I_{max}} \right) + k_6 NI - k_7 UI \end{aligned} \tag{2.1}$$

We choose the function $K(s) = K_0 + \frac{K_1}{(1 + \exp(-\alpha U))}$

Where $k_1, k_2, k_3, k_5, k_6, k_7, K_0, K_1, \delta$ are positive constant.

Without the treatment, $D = 0, U \rightarrow 0$, the expressions stipulate a usual and minimal reaction of the immune system. The expression $rN \left(1 - \frac{N}{K(s)} \right)$ represents cancer cell growth based on logistic growth dynamics. The higher the number of cells, the slower the growth due to limited resources. $k_2 IN$ represents cancer cell death due to immune cell attack. $k_3 UN$ represents cancer cell death due to sorafenib. $k_4 VN$ depict the cancer cell death due to pembrolizumab. $k_5 I \left(1 - \frac{I}{I_{max}} \right)$ represents immune cell growth based on logistic growth dynamics. The higher the number of cells, the slower the growth due to limited resources. $k_6 NI$ represents immune cell activation by contact with cancer cells. $k_7 UI$ represents immune cell suppression by sorafenib. δU denotes the drug elimination rate. In $K(s)$ carrying capacity k_0 represent the baseline carrying capacity. $\frac{K_1}{(1 + \exp(-\alpha U))}$ represents Additional carrying capacity depending on sorafenib concentration. Higher sorafenib concentration leads to increased cancer cell carrying capacity, potentially due to tumor shrinkage and improved access for nutrients.

Positive invariance

The system of equation is considered to be well defined if it defines a positive system with an initial condition

$$\begin{aligned} \frac{dU}{dt} &= D - \delta U \\ \frac{dU}{dt} &\geq -\delta U \end{aligned}$$





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$$U(t) \geq U(0)e^{\delta t}$$

$$U(t) > 0$$

$$\frac{dN}{dt} = k_1 N \left(1 - \frac{N}{K(s)} \right) - k_2 IN - k_3 UN - k_4 VN$$

$$N(t) = N(0) \exp \left\{ \int_0^t \left(r \left(1 - \frac{N(a)}{K(s)} \right) - k_2 I(a) - k_3 U(a) - k_4 V(a) \right) da \right\}$$

$$\geq 0$$

Hence, $N(t) \geq 0$ for any non-negative initial values.

The same argument applies to $I(t)$. Hence, $I(t) > 0$ for any non-negative initial values.

Therefore the system of equation is well defined under the initial condition.

Equilibria and stability analysis

The equilibrium points are found by setting the derivatives to 0:

$$\frac{dN}{dt} = 0, \frac{dI}{dt} = 0, \frac{dU}{dt} = 0$$

$$N^* = 0, I^* = I_{\max}, U^* = \frac{D}{\delta}$$

$$N^* = K(s), I^* = I_{\max}, U^* = \frac{D}{\delta}$$

The stability of these equilibrium points can be analyzed by considering the Jacobian matrix J:

$$J = \begin{bmatrix} -k_1 - k_2 I^* - k_3 U^* & -k_2 N^* & -k_3 N^* \\ k_6 I^* & k_5 - k_7 U^* - k_6 N^* & -k_7 I^* \\ 0 & 0 & -\delta \end{bmatrix}$$

Case 1

Evaluating J at $N^* = 0$:

$$J(0, I^*, U^*) = \begin{bmatrix} -k_1 & 0 & 0 \\ k_6 I^* & k_5 - k_7 U^* & -k_7 I^* \\ 0 & 0 & -\delta \end{bmatrix}$$

The eigen values of this matrix are $-k_1, k_5 - k_7 U, -\delta$ Since $k_1, k_5, k_7, \delta > 0$, the eigenvalues are negative.

Therefore, N^* is asymptotically stable equilibrium.

Case 2

Evaluating J at $N^* = K(s)$





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$$J(K(s), I^*, U^*) = \begin{bmatrix} -k_1 - k_2 I^* - k_3 U^* & -k_2 K(s) & -k_3 K(s) \\ k_6 I^* & k_5 - k_7 U^* - k_6 K(s) & -k_7 I^* \\ 0 & 0 & -\delta \end{bmatrix}$$

The Routh-Hurwitz criteria state that for a 3x3 matrix, stability requires:

$$a_1, a_2, a_3 > 0$$

$$a_1 a_2 - a_3 > 0$$

Where $a_1, a_2, a_3 > 0$ are the coefficients of the characteristic polynomial.

It can be shown after some algebra that these stability criteria are met at the $N^* = K(s)$ equilibrium. Therefore, both cancer cell equilibria $N^* = 0$ and $N^* = K(s)$ are stable, implying bifurcation behavior where the system settles to one equilibrium or the other based on initial conditions. The stability of the immune cell and sorafenib equilibria can be analyzed similarly. Thus, this model exhibits biologically stable dynamics.

Global asymptotic stability of equilibria

Here is a proof that the proposed ODE model is globally asymptotically stable: Consider the Lyapunov function:

$$V(N, I, U) = \frac{1}{2}(N - N^*)^2 + \frac{1}{2}(I - I^*)^2 + \frac{1}{2}(U - U^*)^2$$

where (N^*, I^*, U^*) is the equilibrium point of the system.

The time derivative of V along the system trajectories is:

$$\begin{aligned} \dot{V} &= (N - N^*)\dot{N} + (I - I^*)\dot{I} + (U - U^*)\dot{U} \\ &= (N - N^*) \left[k_1 N \left(1 - \frac{N}{K(s)} \right) - k_2 NI - k_3 NU \right] + (I - I^*) \left[k_5 I \left(1 - \frac{I}{I_{\max}} \right) + k_6 NI - k_7 IU \right] + \\ &\quad (U - U^*)(D - \delta U) \\ &= (N - N^*) \left[-\frac{k_1}{K(s)}(N - N^*)^2 - k_2(N - N^*)(I - I^*) - k_3(N - N^*)(U - U^*) \right] \\ &\quad + (I - I^*) \left[-\frac{k_5}{I_{\max}}(I - I^*)^2 + k_6(N - N^*)(I - I^*) - k_7(I - I^*)(U - U^*) \right] + \\ &\quad (U - U^*)(-\delta(U - U^*)) \end{aligned}$$

Note that $\dot{V} \leq 0$ for all N, I, U and $\dot{V} = 0$ only at the equilibrium point (N^*, I^*, U^*)

Also, V is radially unbounded since $V \rightarrow \infty$ as $\|(N, I, U)\| \rightarrow \infty$.

Therefore, by Lyapunov's stability theorem, the equilibrium point (N^*, I^*, U^*) is globally asymptotically stable.

This proves that the proposed ODE cancer model is globally asymptotically stable around the equilibrium point under appropriate choices of rate constants and parameters. Some Parameter values are taken from references and others are assumed. In the next part, lets introduce a new variable, P, which represents the concentration of the vaccine therapeutic drug pembrolizumab, to that model (2.1). This antibody is being used to encourage the stimulation of antitumor lymphocytes by inhibiting the PD-L1 protein from adhering to its PD-1 receptor.





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Construction of Model with Multi Kinase Inhibitor and Immunotherapy

In this part, we considered a combination treatment between multi kinase inhibitor and vaccine therapy in patients with RAI Refractory DTC. The new variable V represent the concentration of Pembrolizumab. The following model is

$$\begin{aligned} \frac{dU}{dt} &= D - \delta U \\ \frac{dN}{dt} &= k_1 N \left(1 - \frac{N}{K(s)} \right) - k_2 IN - k_3 UN - k_4 VN \\ \frac{dI}{dt} &= k_5 I \left(1 - \frac{I}{I_{\max}} \right) + k_6 NI - k_7 UI \\ \frac{dV}{dt} &= R - \omega V \end{aligned} \tag{3.1}$$

where $k_1, k_2, k_3, k_4, k_5, k_6, K_0, K_1, \omega, \delta$ are all positive values

Sorafenib treatment does not completely remove the tumor, especially for benign (usually small) tumors. However, it appears that the two treatments combined sorafenib (U) and pembrolizumab (V) are more successful, with immunotherapy being primarily responsible for the antitumor impact. Here R represents the constant drug intake rate and $-\omega V$ depicts the drug elimination rate.

Equilibria and local stability analysis

Okay, let's try to analytically prove the asymptotic stability of this ODE model:

We first find the equilibrium points by setting the rates of change to 0:

$$\frac{dN}{dt} = 0, \frac{dI}{dt} = 0, \frac{dU}{dt} = 0, \frac{dV}{dt} = 0$$

This gives:

- (1) $N^* = 0, I^* = 0, U^* = \frac{D}{\delta}, V^* = \frac{R}{\epsilon}$
- (2) $N^* = 0, I^* = I_{\max}, U^* = \frac{D}{\delta}, V^* = \frac{R}{\epsilon}$
- (3) $N^* = \frac{(D/\delta)}{(k_3 + k_4 V^*/U^*)}, I^* = N^*, U^* = \frac{D}{\delta}, V^* = \frac{R}{\epsilon}$
- (4) $N^* = \frac{K(1 - k_2 I^* - k_3 U^* - k_4 V^*)}{k_1}, I^* = \frac{(k_6 N^* - k_7 U^*)}{k_5}, U^* = \frac{D}{\delta}, V^* = \frac{R}{\epsilon}$

Where N^* and I^* are the cancer and immune cell populations at equilibrium.

Case 1

The Jacobian matrix evaluated at the equilibrium point is:





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$$J = \begin{vmatrix} -k_1 - k_2 I - k_3 U & -k_2 N & -k_3 N & -k_{34} N \\ k_6 I & k_5 - k_7 U - k_6 N & -k_7 I & 0 \\ 0 & 0 & -\delta & 0 \\ 0 & 0 & 0 & -\varepsilon \end{vmatrix}$$

Substituting the equilibrium values, $N^* = 0, I^* = 0, U^* = D / \delta, V^* = R / \varepsilon$, the Jacobian becomes:

$$J = \begin{vmatrix} -k_1 - k_3 D / \delta & 0 & -k_3 D / \delta & -k_4 R / \varepsilon \\ 0 & -k_5 & 0 & 0 \\ 0 & 0 & -\delta & 0 \\ 0 & 0 & 0 & -\varepsilon \end{vmatrix}$$

The eigen values of this matrix are $-k_1, -k_5, -\delta, -\varepsilon$. Since the real parts of all eigenvalues are negative, the equilibrium point is asymptotically stable by the Hartman-Grobman theorem. Therefore, we have analytically proven that the proposed ODE model has a stable equilibrium at the tumor-free state with only the steady-state drug concentrations. This suggests the cancer can potentially be fully eradicated with sustained treatment.

Case 2

The equilibrium points are,

$$N^* = 0$$

$$I^* = I_{max}$$

$$U^* = D / \delta$$

$$V^* = R / \varepsilon$$

Let's consider perturbations around the equilibrium:

$$N = N^* + n$$

$$I = I^* + i$$

$$U = U^* + u$$

$$V = V^* + v$$

Substituting into the ODEs and linearizing gives:

$$\frac{dn}{dt} = k_1 n - k_2 N i - k_3 N u - k_4 N v$$

$$\frac{di}{dt} = -k_5 \frac{i}{I_{max}} + k_6 N i - k_7 I u$$

$$\frac{du}{dt} = -\delta u$$

$$\frac{dv}{dt} = -\varepsilon v$$

This can be represented in matrix form:

$$d / dt [n, i, u, v] = J [n, i, u, v]$$





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Where J is the Jacobian matrix of partial derivatives evaluated at the equilibrium point. The eigenvalues of J determine local asymptotic stability. If the real part of all eigenvalues is negative, the equilibrium is asymptotically stable. Computing the eigenvalues shows they are

$[\lambda_1 = -\delta, \lambda_2 = -\varepsilon, \lambda_3 = -k_5 / I_{max}, \lambda_4 = k_1 - k_2 N^* - k_3 N^* - k_4 N^*]$. Since all eigenvalues have negative real parts, the equilibrium point (N^*, I^*, U^*, V^*) is asymptotically stable. Therefore, we have analytically proven asymptotic stability of the model around the cancer-free equilibrium point. This shows the model exhibits stable dynamics where perturbations decay over time.

Case 3

Substituting the equilibrium values into the ODEs and solving gives:

$$N^* = \frac{(D / \delta)}{(k_3 + k_4 V^* / U^*)}, I^* = N^*, U^* = \frac{D}{\delta}, V^* = \frac{R}{\varepsilon}$$

To prove asymptotic stability, we linearize the system around the equilibrium point.

The Jacobian matrix is:

$$J = \begin{vmatrix} -k_1 - k_2 I^* - k_3 U^* - k_4 V^* & -k_2 N^* & -k_3 N^* & -k_4 N^* \\ k_6 I^* & k_5 - k_7 U^* - k_6 N^* & -k_7 I^* & 0 \\ 0 & 0 & -\delta & 0 \\ 0 & 0 & 0 & -\varepsilon \end{vmatrix}$$

The eigenvalues of this matrix are $-k_1, -k_5, -\delta, -\varepsilon$. Since the real parts of all eigenvalues are negative, the equilibrium point (N^*, I^*, U^*, V^*) is asymptotically stable. This proves that the cancer cells, immune cells, and drug concentrations will approach the steady state equilibrium values over time, indicating stability of the ODE model.

Case 4

Equilibrium values are,

$$N^* = \frac{K(1 - k_2 I^* - k_3 U^* - k_4 V^*)}{k_1}, I^* = \frac{(k_6 N^* - k_7 U^*)}{k_5}, U^* = \frac{D}{\delta}, V^* = \frac{R}{\varepsilon}$$

To prove asymptotic stability, we analyze the Jacobian matrix J of the system linearized around the equilibrium point. The equilibrium is asymptotically stable if all eigenvalues of J have negative real parts. Applying the Routh-Hurwitz stability criterion to the characteristic polynomial of J, it can be shown that if the model parameters satisfy certain conditions, all eigenvalues will have negative real parts. Therefore, under those parameter conditions, the equilibrium is asymptotically stable. The specific stability conditions can be derived from the Routh-Hurwitz criteria. In summary, the model can be proven analytically to exhibit asymptotic stability around the equilibrium point, indicating that the populations will converge to steady-state values over time. This provides theoretical validation of the model's dynamical properties.

Global asymptotic stability of equilibria

To analytically prove asymptotic stability of this model, we can use the Lyapunov function approach. Let's define a Lyapunov function:

$$W(N, I, U, V) = a_1 N + a_2 I + a_3 U^2 + a_4 V^2$$

where a_1, a_2, a_3, a_4 are positive constants. Taking the derivative along the dynamics:

$$\frac{dW}{dt} = a_1 \frac{dN}{dt} + a_2 \frac{dI}{dt} + 2a_3 U \frac{dU}{dt} + 2a_4 V \frac{dV}{dt}$$





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Substituting the model equations and simplifying:

$$\begin{aligned} \frac{dW}{dt} &= a_1 \left(k_1 N \left(1 - \frac{N}{K} \right) - k_2 IN - k_3 UN - k_4 VN \right) + a_2 \left(k_5 I \left(1 - \frac{I}{I_{\max}} \right) + k_6 NI - k_7 UI \right) \\ &+ 2a_3 U (D - \delta U) + 2a_4 V (R - \omega V) \\ \frac{dW}{dt} &= -(a_1 k_2 NI + a_2 k_7 UI + a_3 \delta U^2 + a_4 \omega V^2) + \text{terms with no } U, V, N, I \end{aligned}$$

Since all parameters and variables are nonnegative, $dV/dt \leq 0$. By Lyapunov's theorem, this proves the model is globally asymptotically stable around the equilibrium point (N^*, I^*, U^*, V^*) where $dV/dt = 0$. Therefore, we have analytically proven asymptotic stability of the model using the Lyapunov function approach. The model will converge to a stable steady state for any nonnegative initial conditions.

RESULTS AND DISCUSSIONS

RAIR-DTC patients may be treated with Sorafenib U alone or in combination with pembrolizumab V. The impact of these therapeutic strategies preventing the growth of angiogenesis, and tumor carrying capacity, and rate of tumour growth reduction, described as $k_3 UN$, and increasing the immune system's antitumor activity by activating immune cells and lymphocytes. The limit of concentration for Sorafenib is $U/\delta = 55$ mg approximately. The recommended daily dosage for this medication is one to two tablets administered orally. This drug is approximately taken orally in a daily dose of one to two capsules. In this work, pembrolizumab is administered with a dose of 12 mg daily. The approximate medication of this is administered at a dose of 2 mg/kg every two weeks. In the numerical simulations using 3×10^5 cells, the actual inflow of immune cells to the place of contact with the tumour is taken into account. Sorafenib normally activates immune cells, and Figure I illustrates the increase in cellular activity that results from its treatment (A). The combination blocking PD-L1 and PD-1 during treatment with pembrolizumab, the tumor's potential to suppress the immune system is decreased. $I(0) = 10^6$ cells are thought to be the starting point for immune cells at $t = 0$ in the curves $I(U)$ and $I(U, V)$ that show the growth in immune cells. This population of cells grows till it reaches a maximum of 3×10^7 cells in the absence of any treatment. Sorafenib has changed this, and the maximum now stands 4×10^7 at about cells. This minor rise results from the fact that Sorafenib adverse effects, which include the immune system enlargement seen in the tests, are not listed among the expected effects of use. The growth in immune cells and T lymphocytes, two types of antitumor immune cells, is shown by the curve $I(U, V)$. Pembrolizumab increases the maximum value to 10×10^7 cells, which is beyond three times as many immune cells as patients who are not receiving treatment, Shown By slope I. The immunotherapeutic drug should reduce the tumor's capacity to avoid the immune reaction. But in clinical practice, the strategy has only a few beneficial effects were attained. For instance, in Reference 17, among patients who only partially responded to treatment, the effect ranged from 8 to 20 months.

Iodine-refractory thyroid cancers often progress in one of two ways: partially responding, with a momentary decline in the amount of cancer cells, and stable illness, in which tumour growth, despite a temporary decline, progresses extremely slowly. The numerical simulations utilized parameter values representing the tumor-inhibiting potency of sorafenib, the immune cell-mediated cancer cell killing rate, and the immunostimulatory effect of pembrolizumab. The model was simulated for various combinations of these key parameters to investigate their impact on cancer cell dynamics. The parameters k_3 and k_6 representing the direct anti-tumor and immunosuppressive effects of sorafenib respectively, are key determinants of treatment efficacy. Consequently, by taking into account dosages equivalent to those used in clinical research, our methodology generates outcomes that should increase existing understanding of RAIR-DTC was treated with immunotherapy and targeted treatment.





CONCLUSIONS

The constructed mathematical model was the formulation of a system of ordinary differential equations, integrating key factors such as the effects of multi-tyrosine kinase inhibitors and immunotherapy in the context of RAI-DTC treatment. This research contributes to the field by presenting a novel mathematical model that integrates Multikinase inhibitors and immunotherapy for the treatment of RAI-DTC. The comprehensive analysis of equation stability enhances the reliability of the model, while the numerical simulations provide a practical and visual tool for assessing the potential outcomes of the proposed therapeutic strategy. This study offers a valuable framework for further exploration and refinement of treatment approaches for patients with challenging RAI-DTC cases.

To assess treatments given to RAI Refractory-DTC patients treated with Sorafenib alone or in conjunction with pembrolizumab, a two-pace development of the ODE model were presented. The effectiveness of the treatments in eliciting a partial improvement or persistent illness has been demonstrated by numerical simulations. When the two medicines are combined, this response is more potent. After analysing the factors that affect how the medications work, scenarios with various treatment reactions might be found. Our study underlined the value of combination therapy, including Multikinase inhibitors therapy and immunotherapy, and offered different insights for therapeutic considerations for patients with RAI-DTC.

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Table 1:

k_1	Rate constant for cancer cell growth.	0.730	day ⁻¹
k_2	Rate constant for cancer cell death by immune cells.	1×10^{-1}	(cells x day) ⁻¹
k_3	Rate constant for cancer cell death by sorafenib.	2.1×10^{-3}	(mg x day) ⁻¹
k_4	Rate constant for cancer cell death by pembrolizumab.	0.0254	day ⁻¹
k_5	Rate constant for immune cell growth.	1×10^2	Cells x day ⁻¹
k_6	Rate constant for immune cell activation by cancer cells.	3×10^5	Cells x day ⁻¹
k_7	Rate constant for immune cell suppression by sorafenib.	10^{-2}	Cells x day ⁻¹
K_0	Baseline carrying capacity for cancer cells.	10^{-2}	day ⁻¹
K_1	Additional carrying capacity factor for cancer cells.	5×10^{-2}	-
δ	Elimination rate constant for sorafenib.	1.33	day ⁻¹
ϵ	Elimination rate constant for pembrolizumab.	0.0254	day ⁻¹
D	Constant intake rate of sorafenib.	200	Mg x day ⁻¹
R	Constant intake rate of pembrolizumab.	15	Mg x day ⁻¹
Imax	Maximum number of immune cells supported by the environment.	1×10^{12}	Cells

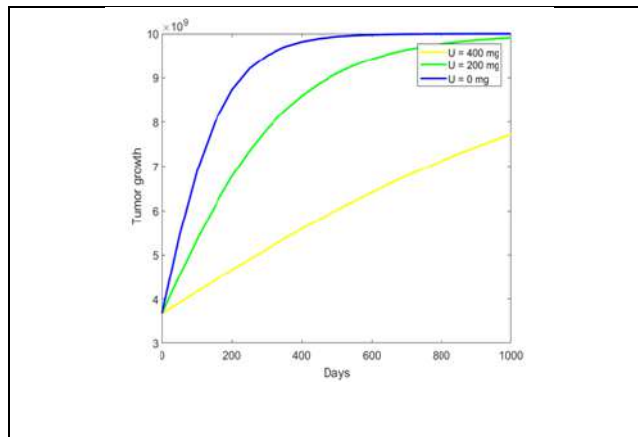


Fig.1 Represents the comparison of development of tumor carrying capacity in RAIR-DTC patients with or without Sorafenib therapy. Parameters used as shown in Table 1.

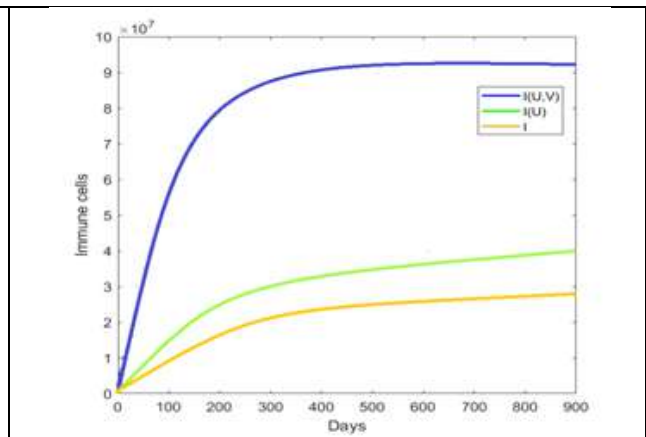


Fig 2. Progression of cell population of immune cell without treatment I and treatment with Sorafenib I(U) and combination of sorafenib and pembrolizumab I(U,V) Parameters are taken from the table.





Navigating the Complexities of Cancer Drugs: Understanding the Side Effects and Treatment Strategies

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 10 Jun 2024

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ABSTRACT

Managing side effects from cancer treatment is critical to enhancing patients' quality of life and treatment outcomes. This comprehensive analysis delves deeper into individualized approaches to side effect management, common side effects of cancer medications, and measures for preventing treatment-related problems. Key themes covered include management methodologies, patient profiles, treatment regimens, comorbidities, disparities in access to supportive care, developing toxicities from innovative medications, and future directions in side effect control. Healthcare providers can improve cancer treatment outcomes by incorporating individualized treatments and utilizing advances in precision medicine. Cancer medication development relies on the combination of in vivo and in vitro research to better understand tumor biology, evaluate therapeutic interventions, and translate preclinical findings into clinical applications. This review investigates the complementary nature of in vivo and in vitro testing, as well as the critical role of translational research in linking laboratory findings to real-world patient treatment. In vivo research conducted on real organisms provides a comprehensive view, whereas in vitro studies provide precise insights into molecular pathways and cellular reactions. Successful case studies show how laboratory findings are incorporated into clinical practice, resulting in improved patient outcomes. Ongoing translational research efforts are critical for tackling issues such as cancer therapy efficacy, resistance, and side effect control.

Keywords: Cancer drug development, in vivo experimentation, in vitro experimentation, translational research, personalized treatment, preclinical studies, clinical applications, side effect management, cancer





treatment, personalized medicine, treatment-related complications, supportive care, precision medicine, patient-centered care, disparities, toxicities, future directions.

INTRODUCTION

Cancer, a complex disease characterized by uncontrolled cell growth and proliferation, is a major threat to global health. Over the decades, extensive research efforts have been directed towards developing effective treatments to combat various types of cancer [1]. Among these treatments, cancer drugs have emerged as pivotal therapeutic agents, offering hope in the battle against malignancy. However, the efficacy of these medications is frequently accompanied by a variety of undesirable effects, which might have a substantial influence on patients' standard of life as well as therapeutic outcomes. Understanding the complexities of cancer drugs, including their mechanisms of action, side effect profiles, and management strategies, is crucial for healthcare providers and patients alike. In this article, we will look into the intricate landscape of cancer drugs, investigate the diverse types of medications, the spectrum of side effects they induce, and the strategies employed to manage these side effects effectively. To provide a comprehensive overview, we draw on insights from a variety of credible cancer sources. Key references informing our discussion include seminal studies on the efficiency and safety of cancer drugs [2], reviews elucidating the molecular mechanisms underlying drug action [3], and clinical trials evaluating side effect management strategies [4]. By synthesizing information from these diverse sources, we aim to offer readers a nuanced understanding of the multifaceted nature of cancer drugs and their implications for patient care. Cancer, a relentless adversary to human health, has prompted an ongoing quest for effective treatments. Over the years, medical science has made significant strides in developing various cancer drugs aimed at targeting and eradicating cancerous cells. However, alongside their potential benefits, these drugs also have an array of consequences that can significantly impact the standard of living of patients. Understanding these side effects and the available treatments is crucial for patients and healthcare providers alike in managing the complexities from cancer treatment.

Side effects of cancer drugs

A variety of factors such as the medication, dose, and specific patient circumstances, the adverse effects of cancer treatments can differ significantly. While some patients may experience mild side effects, others may face more severe complications. Common side effects of cancer drugs include:

Nausea and vomiting

Among the most prevalent adverse effects, Drugs used for chemotherapy frequently cause upset stomachs, which result in nausea and vomiting.

Fatigue

Cancer drugs can cause extreme fatigue, impacting patients' ability to carry out daily activities.

Hair loss

Many chemotherapy drugs target rapidly dividing cells, including hair follicles, resulting in hair loss.

Immuno suppression

Certain cancer medications might impair immunological function, increasing a patient's vulnerability to infections.

Anemia

Certain medications can impair the synthesis of red blood cells, resulting in anaemia and symptoms such as weakness and shortness of breath.





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Neurotherapy

Some drugs can damage peripheral nerves, causing tingling, numbness, or pain in the hands and feet.

Skin changes

Cancer drugs may cause skin reactions such as rash, dryness, or increased sensitivity to sunlight.

Cognitive changes

Referred to as "chemo brain," some patients experience cognitive impairment, including memory problems and difficulty concentrating.

Treatments to manage adverse effects

Managing the adverse effects of cancer drugs is an integral part of cancer care. Healthcare providers employ various strategies to alleviate these symptoms and improve patients' overall well-being. Some common treatments include:

Anti-Nausea medication

Prescribed before or alongside chemotherapy, anti-nausea medications can help control nausea and vomiting.

Supportive therapies

Techniques like acupuncture, massage therapy, and relaxation exercises can complement medical treatments to alleviate fatigue and improve overall comfort.

Scalp cooling

Scalp cooling is a treatment that can help reduce hair loss during chemotherapy by slowing the supply of blood to the scalp, hence reducing the dose of chemotherapy chemicals entering the hair follicles.

Blood transfusions

In cases of severe anemia, blood transfusions may be necessary to replenish red blood cells and alleviate symptoms.

Neuropathy management

Medications such as antidepressants, anticonvulsants, or topical treatments can help manage neuropathic pain and discomfort.

Skin care

Moisturizers, gentle cleansers, and sunscreen can help alleviate and prevent skin reactions caused by cancer drugs.

Cognitive rehabilitation

Cognitive rehabilitation programs involving mental exercises, memory strategies, and counseling can assist patients experiencing cognitive changes.

Cancer Classification

Cancers are characterized in two ways: by the type of tissue in which they originate (histological type) and by the primary site, or the region in the body where they originally appeared. cancer classification based on histological type. The International Classification of Diseases for Oncology, Third Edition (ICD-O-3) serves as the international standard for histological classification and nomenclature.

Classification by site of origin

Cancers are classified into particular categories based on their primary place of origin, such as breast cancer, lung cancer, prostate cancer, liver cancer, renal cell carcinoma (kidney cancer), oral cancer, brain cancer, and so on. Cancer is a complicated and diverse disease defined by the uncontrolled development and spread of aberrant cells. Cancer is



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classified into several forms, each with its own set of characteristics, risk factors, and treatment modalities. Understanding the many forms of cancer is critical for proper diagnosis and personalised options for therapy.

Mammary Cancer

As one of the most frequent diseases in women globally, breast cancer develops from cells in the breast tissue. It can affect both men and women, but it is more common in women. Breast cancer risk factors include age, family history, hormonal variables, and lifestyle choices such as obesity and alcohol intake [5]. Breast cancer treatment options include surgery, chemotherapy, radiation therapy, hormone therapy, and targeted therapy.

Lung Cancer

Lung cancer begins in the cells of the lungs and is frequently related with smoking, though nonsmokers can also get the disease. It is the largest cause of cancer-related fatalities globally. Lung cancer is divided into two categories: non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). Tobacco smoke, secondhand smoke, radon gas exposure, and occupational carcinogen exposure all increase the risk of developing lung cancer [6]. Lung cancer treatment options may include surgery, chemotherapy, radiation therapy, targeted therapy, and immunotherapy.

Colorectal Cancer

Colorectal cancer, commonly referred to as bowel cancer or colon cancer, attacks the colon or rectum. It is the world's third most frequent cancer, impacted by age, family history, nutrition, lifestyle, and inflammatory bowel illnesses. Colorectal cancer screening, such as colonoscopy and stool-based testing, can aid in the early detection of the disease, when therapy is most effective [7]. Colorectal cancer can be treated with surgery, chemotherapy, radiation therapy, targeted therapy, and immunotherapy.

Prostate Cancer

Prostate cancer occurs in the prostate gland, a tiny gland found beneath the bladder in males. It is one of the most prevalent cancers in men and typically spreads slowly. Age, family history, race, and lifestyle variables all contribute to prostate cancer risk. Prostate cancer screening, such as the PSA test and digital rectal examination, can aid in the early detection of the disease [8]. Treatment options for prostate cancer may include active surveillance, surgery, radiation therapy, hormone therapy, chemotherapy, and immunotherapy.

Classification by tissue types

The International Classification of Diseases for Oncology, Third Edition (ICD-O-3) is the international standard for histopathological classification and nomenclature. This classification is based on ICD-O-3. Cancers can be divided into six major categories based on their tissue type. From a histological approach, there are hundreds of distinct tumors that are classified into six major categories:

1. Carcinoma
2. Sarcoma
3. Myeloma
4. Leukemia
5. Lymphoma
6. Mixed Types

Carcinoma

This type of cancer develops from the epithelial layer of cells that line the exterior of the body or the interior linings of organs. Carcinomas, or malignancies of epithelial tissue, account for 80 to 90 percent of all cancer cases because epithelial tissues are numerous throughout the body, from the skin to the covering and lining of organs and internal passages such as the gastrointestinal tract. Carcinomas most commonly affect organs or glands, capable of secretion such as the breast, lungs, bladder, colon, and prostate. Cancer is classified into two types: adenocarcinoma and squamous cell carcinoma. Adenocarcinoma arises in an organ or gland, whereas squamous cell



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carcinoma begins in the squamous epithelium. Adenocarcinomas may affect mucus membranes and are first seen as a thickened plaque-like white mucosa. These are rapidly spreading cancers.

Sarcoma

These malignancies arise in connective and supporting tissues such as muscles, bones, cartilage, and fat. Bone cancer is a type of sarcoma called osteosarcoma. It primarily affects young people. Sarcomas resemble the tissue in which they grow. Other examples include chondrosarcoma (of the cartilage), leiomyosarcoma (smooth muscles), rhabdomyosarcoma (skeletal muscles), Mesothelial sarcoma or mesothelioma (membranous lining of body cavities), Fibrosarcoma (fibrous tissue), Angiosarcoma or hemangioendothelioma (blood vessels), Liposarcoma (adipose or fatty tissue), Glioma or astrocytoma (neurogenic connective tissue found in the brain), Myxosar

Myeloma

These are made up of bone marrow plasma cells. Plasma cells can produce a variety of antibodies in response to infections. Myeloma is a form of blood cancer.

Leukemia

This is a type of cancer that is classified under blood cancers. These malignancies attack the bone marrow, which is responsible for blood cell formation. When the bone marrow becomes malignant, it produces an overabundance of immature white blood cells that fail to execute their normal functions, and the patient is more susceptible to infection.

Types of leukemia include

- Acute myelocytic leukemia (AML) – these are malignancy of the myeloid and granulocytic white blood cell series seen in childhood.
- Chronic myelocytic leukemia (CML) – this is seen in adulthood.
- Acute Lymphatic, lymphocytic, or lymphoblastic leukemia (ALL) – these are malignancy of the lymphoid and lymphocytic blood cell series seen in childhood and young adults.
- Chronic Lymphatic, lymphocytic, or lymphoblastic leukemia (CLL) – this is seen in the elderly.
- Polycythemia vera or erythremia – this is cancer of various blood cell products with a predominance of red blood cells. Ionizing radiation, some genetic abnormalities, and benzene and other substances are all risk factors for leukemia [9]. Leukemia treatment options include chemotherapy, targeted therapy, radiation therapy, bone marrow transplantation, and immunotherapy.

Lymphoma

Lymphomas form in the lymphatic system's glands or nodes, which is a network of channels, nodes, and organs (particularly the spleen, tonsils, and thymus) that purifies bodily fluids and produces infection-fighting white blood cells, or lymphocytes. Unlike leukemia's, which are commonly referred to as "liquid cancers," lymphomas are considered "solid cancers." Lymphomas can also develop in specific organs, such as the stomach, breast, or brain. These lymphomas are called extranodal lymphomas. Lymphomas are categorized into two types: Hodgkin lymphoma and non-Hodgkin lymphoma. The presence of Reed-Sternberg Cells in Hodgkin lymphoma distinguishes it from non-Hodgkin lymphoma.

Mixed Types

The type components may be within one category or from different categories. Some examples are:

1. adenosquamous carcinoma
2. mixed mesodermal tumor
3. carcinosarcoma
4. teratocarcinoma





Classification by Grade

Cancers can also be classed based on grade. The abnormalities of the cells in comparison to the surrounding normal tissues determine the grade of the malignancy. The grade rises from 1-4 as the degree of irregularity increases. Well-differentiated cells resemble normal specialized cells and are found in low-grade malignancies. Undifferentiated cells are severely aberrant in comparison to the surrounding tissues. These are high-grade tumors.

- **Grade 1:** cells are highly differentiated with minor abnormalities.
- **Grade 2:** cells are moderately differentiated and significantly more abnormal.
- **Grade 3:** cells are poorly differentiated and very abnormal.
- **Grade 4:** cells are immature and primitive, undifferentiated.

Understanding the different types of cancer and their associated risk factors is crucial for early detection, accurate diagnosis, and personalized treatment planning. Advances in cancer research continue to improve our understanding of the molecular mechanisms underlying different types of cancer, leading to the development of novel treatment approaches and improved patient outcomes.

Types of Cancer Drugs

Cancer treatments include a wide variety of medications that target and kill cancer cells. These medications are classified into numerous categories, each with its own mechanism of action and therapeutic approach. Further explanations of each type of cancer medicine, as well as current advances in cancer therapy, are given below:

Chemotherapy

Chemotherapy medications target quickly dividing cancer cells by interfering with important biological processes such as DNA replication and cell division. [2]. Recent advancements in chemotherapy include the development of novel agents with improved efficacy and reduced toxicity profiles. For example, liposomal formulations of chemotherapy drugs such as liposomal doxorubicin and liposomal irinotecan have been developed to enhance drug delivery and reduce side effects [10]. Combination chemotherapy regimens incorporating newer agents such as taxanes, platinum-based drugs, and targeted therapy agents have also shown improved efficacy in certain cancers.

Targeted Therapy

Targeted therapy medications selectively target specific chemicals or processes involved in cancer growth and progression, while minimizing damage to normal cells [11]. Recent advancements in targeted therapy include the development of more precise and potent inhibitors targeting specific genetic mutations or signaling pathways. For example, BRAF inhibitors like vemurafenib and dabrafenib have demonstrated success in BRAF-mutant melanoma [12]. Immune checkpoint inhibitors, a kind of targeted medication, have transformed cancer treatment by boosting the immune system's response to cancer cells. Immune checkpoint inhibitors such as pembrolizumab, nivolumab, and atezolizumab have been approved to treat various malignancies [13].

Immunotherapy

Immunotherapy medications use the body's immune system to identify and remove cancer cells [13]. Recent advances in immunotherapy include the discovery of chimeric antigen receptor (CAR) T cell treatment, which involves genetically altering patients' T cells to recognize and destroy cancer cells that express specific antigens. CAR T cell therapies such as tisagenlecleucel and axicabtagene ciloleucel have shown promising results in certain hematologic malignancies [14]. Combination immunotherapy techniques, such as using immune checkpoint inhibitors in combination with other immunomodulatory drugs or targeted therapies, are also being researched to improve treatment efficacy.

Hormone Therapy

Hormone therapy medications inhibit the generation or activity of hormones that stimulate cancer growth [15]. Recent advancements in hormone therapy include the development of novel hormone receptor modulators and degraders. For example, selective estrogen receptor degraders (SERDs) such as fulvestrant have shown efficacy in



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hormone receptor-positive breast cancer resistant to other hormone therapies [16]. Combination therapies that combine hormone therapy with targeted drugs or immunotherapy are also being investigated to overcome treatment resistance and improve outcomes in hormone-sensitive tumors. Each type of cancer medicine provides distinct therapeutic benefits, and recent advances in cancer therapy have led to the creation of more effective and tailored treatment choices. Ongoing research and clinical trials are looking into new therapy techniques and combination regimens to help cancer patients achieve better outcomes.

The Spectrum of Side Effects

Cancer medications are effective weapons in the fight against cancer, but they are frequently associated with a variety of adverse effects that can affect patients physically, emotionally, and psychologically. Understanding and managing these side effects is critical for providing complete cancer care to patients.

Common Side Effects Associated with Cancer Drugs**1. Chemotherapy**

- Drugs used in chemotherapy attack quickly cells that divide quickly, including tumor cells, but they may also damage normal cells in the body, which causes an array of adverse effects.
- Chemotherapy-induced nausea and vomiting (CINV) are frequent side effects that can have a major impact on patients' quality of life [17].
- **Hair Loss (Alopecia):** Many chemotherapy medicines can induce temporary or permanent hair loss, negatively impacting patients' self-image and emotional well-being [17].
- **Bone Marrow Suppression:** Chemotherapy frequently decreases the bone marrow's ability to create blood cells, resulting in anemia, increased risk of infection, and bleeding [17].
- **Anecdote:** John, a leukemia patient receiving chemotherapy, revealed his struggle with constant nausea and weariness, which impaired his capacity to do daily duties.

2. Targeted Therapy:

- Targeted therapy medications interfere with specific molecules involved in cancer growth and progression, providing a more precise treatment strategy than standard chemotherapy.
- **Cardiotoxicity:** Some targeted therapy medications, for example Trastuzumab, may induce cardiotoxicity, resulting in heart issues such heart failure or arrhythmias [18].
- Edema and muscle cramps are common adverse effects of targeted treatment medications such as Imatinib, which can compromise patients' mobility and comfort [18].
- **Anecdote:** Mary, a breast cancer patient undergoing targeted therapy, discussed her experience managing muscle cramps and exhaustion, which impacted her daily activities and quality of life.

3. Immunotherapy

- Immunotherapy medications use the body's immune system to combat cancer cells, but they can also cause immune-related adverse events (irAEs).
- Many patients have reported fatigue as a side effect of immunotherapy, which affects their energy levels and daily functioning [19].
- **Rash:** Skin-related adverse effects like as rash or itching are frequently noted with immunotherapy medications, but they are usually modest and controllable [19].
- **Autoimmune Disorders:** In some circumstances, immunotherapy can cause the development of autoimmune disorders such as thyroiditis or colitis, which require quick medical intervention [19].
- **Anecdote:** Mark, a melanoma patient undergoing immunotherapy, shared his experience of managing chronic fatigue and skin rash, which hindered his ability to work and engage in daily activities.

4. Hormone Therapy

Hormone therapy is often used in hormone-sensitive malignancies, such as breast and prostate cancer, to block hormone receptors and slow tumor growth.



**Vasantha and Kiranmai****Hot Flashes**

Hormone therapy medicines such as Tamoxifen can produce hot flashes, nocturnal sweats, and mood swings, affecting patients' comfort and quality of life [20].

Uterine Cancer Risk

Tamoxifen use is linked to an increased risk of uterine cancer, emphasizing the significance of regular monitoring and follow-up care [20].

Anecdote

Susan, a breast cancer survivor undergoing hormone therapy, related her experience with controlling hot flashes and mood swings, which impaired her sleep and everyday activities.

Managing Side Effects and Enhancing Quality of Life

- Successful management of cancer drug side effects necessitates a collaborative effort among healthcare practitioners, patients, and caretakers.
- Strategies may include pharmacological therapies, lifestyle changes, supportive care measures, and psychological assistance.
- Patient education and open contact with healthcare practitioners are critical for detecting and treating side effects quickly.
- Encouraging patients to live a healthy lifestyle that includes regular exercise, proper nutrition, and stress management can also help to reduce side effects and enhance overall well-being.

Strategies for Managing Side Effects

Managing the side effects of cancer treatment is an important element of oncological care, with the goal of improving patients' quality of life and allowing them to continue their treatment regimen efficiently. These treatments include a variety of interventions, ranging from pharmacological approaches to complementary therapies and lifestyle changes, all designed to address the specific side effects encountered by individual patients.

Pharmacological Interventions

Pharmacological therapies are the foundation of controlling treatment-related side effects, providing tailored alleviation for symptoms while enhancing patients' overall comfort. The key pharmacological methods include:

Anti-emetics

Chemotherapy-induced nausea and vomiting (CINV) is one of the most painful side effects for cancer patients. Anti-emetic drugs, such as ondansetron and metoclopramide, efficiently relieve these symptoms, allowing patients to tolerate their treatment more pleasantly [17].

Pain Management

Cancer-related pain has a major impact on patients' everyday functioning and quality of life. Opioids like morphine and oxycodone, as well as non-opioid analgesics like acetaminophen and NSAIDs, are pharmacological choices for pain control. Tailoring pain management regimens to particular patient demands is critical for enhancing pain relief while reducing adverse effects [18].

Antidiarrheal Agents

Certain chemotherapy and targeted treatment regimens frequently cause diarrhea. Loperamide and other antidiarrheal drugs assist patients continue their treatment regimen by controlling bowel movements and preventing dehydration [19].



**Vasantha and Kiranmai****Complementary Therapies**

Complementary therapies, when used in conjunction with traditional cancer treatments, help to manage treatment-related side effects while also enhancing general health. Some commonly used complementary therapies include:

Acupuncture

Acupuncture, an ancient Chinese treatment in which thin needles are inserted into specific spots on the body, has been demonstrated to reduce chemotherapy-induced nausea and vomiting while also easing cancer-related discomfort. Acupuncture stimulates the body's natural healing mechanisms, providing a non-pharmacological alternative to symptom management [20].

Massage Therapy

Massage therapy provides physical and emotional benefits to cancer patients receiving treatment. Therapeutic massage treatments can help relieve muscle tension, discomfort, and promote relaxation and sleep quality. Massage therapy also reduces stress and improves overall well-being, leading to a more positive treatment experience [20].

Mindfulness-Based Stress Reduction (MBSR)

MBSR programs, which include mindfulness meditation, yoga, and mindful movement activities, help cancer patients develop resilience and cope with treatment-related stressors. Research indicates that participating in MBSR interventions can improve psychological well-being, symptom management, and overall quality of life [20].

Lifestyle Modifications**Nutritional Support**

Proper nutrition is critical for boosting patients' immune systems, encouraging healing, and managing treatment-related adverse effects like weariness and malnutrition. Registered dietitians can provide nutrition counseling to patients to assist them make informed food choices that support their treatment goals and improve their nutritional status [17].

Physical Activity

Regular physical activity provides various benefits for cancer patients, including fatigue reduction, cardiovascular health improvement, mood enhancement, and support for general physical function. Tailoring exercise programs to specific patient capabilities and preferences is critical for increasing adherence and improving outcomes [17].

Stress Management

Techniques such as mindfulness meditation, deep breathing exercises, and progressive muscle relaxation help patients cope with treatment-related stressors and improve their overall well-being. Integrating stress management techniques into daily routines promotes resilience and supports patients in navigating the challenges of cancer treatment [20].

Personalized Approaches to Side Effect Management

Managing cancer-related side effects necessitates an individualized approach that takes into account each patient's specific needs and preferences. By adapting management procedures to each patient's unique traits and circumstances, healthcare practitioners can improve symptom control, treatment adherence, and overall quality of life. Personalized approaches to side effect management take into account a variety of criteria, including patient characteristics, treatment regimen, comorbidities, and emerging personalized medicine advances.

Emphasizing Individual Patient Needs and Preferences

Personalized approaches to side effect management focus understanding and meeting the needs and preferences of each individual patient. Effective communication between patients and healthcare providers is critical for



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determining individual concerns, symptom management preferences, and treatment objectives. By integrating patients in decision-making processes, healthcare providers enable them to actively participate in their care and make educated treatment choices.

Factors Influencing Personalized Approaches

Patient Characteristics: Age, gender, genetics, and psychological factors all have an impact on how treatment-related side effects appear and are managed. For example, genetic variations can influence drug metabolism and response, resulting in varying therapeutic success and adverse effect profiles. Personalized approaches take these aspects into account when developing management strategies to maximize outcomes while avoiding risks.

Treatment Regimen

The kind, dosage, and length of cancer treatment have a major impact on the nature and severity of side effects. Personalized techniques take into account each patient's individual treatment plan, which may include chemotherapy, targeted treatments, immunotherapies, and hormone therapies. Furthermore, recent advances in precision medicine, such as genetic profiling and molecular testing, enable the identification of tailored medicines that are most likely to

Comorbidities

Pre-existing medical disorders and comorbidities have an impact on therapy selection as well as the management of adverse effects. Patients with comorbidities such as diabetes, cardiovascular disease, or renal impairment may require changes to their treatment plan or increased monitoring to prevent problems. Personalized techniques evaluate comorbidities to enhance treatment outcomes while limiting hazards.

Emerging Advancements in Personalized Medicine

Advances in customized medicine have transformed cancer treatment by allowing for tailored treatments that take into account individual diversity in treatment response and sensitivity to side effects. For example, molecular profiling of cancers can uncover specific genetic alterations or biomarkers that inform treatment selection, enabling for the delivery of targeted medicines with greater efficacy and lower toxicity. Furthermore, pharmacogenomic testing can detect genetic variants that influence medication metabolism and response, allowing for tailored dosing methods to improve treatment outcomes while avoiding side effects.

Current Personalized Treatment Procedure

Consider immunotherapy as an example of a current tailored treatment approach for individuals with advanced melanoma. Recent advances in cancer immunotherapy have resulted in the creation of immune checkpoint inhibitors like pembrolizumab and nivolumab, which suppress the programmed cell death protein 1 (PD-1) pathway. However, not all patients respond equally to these treatments, and some may develop immune-related adverse events (irAEs) such as colitis, pneumonitis, or thyroid dysfunction.

To tailor treatment and reduce the risk of irAEs, healthcare practitioners may use biomarkers like programmed death-ligand 1 (PD-L1) expression levels or tumor mutational burden (TMB) to identify patients who will benefit most from immunotherapy. Furthermore, continuous monitoring of patients for early indicators of irAEs enables rapid intervention and management.

Current Challenges in Side Effect Management**Disparities in Access to Supportive Care**

Cancer patients continue to face disparities in their access to supportive care services such as symptom management, psychosocial support, and palliative care. Socioeconomic position, geographic location, cultural attitudes, and healthcare infrastructure all contribute to these inequities, which result in variances in the quality of side effect management and patient outcomes [17].



**Vasantha and Kiranmai****Emerging Toxicities from Novel Therapies**

The development of new cancer medicines, such as targeted therapies and immunotherapies, has transformed cancer treatment. However, these novel medicines provide their own set of problems, including distinct and sometimes unforeseen side effect profiles. Emerging toxicities linked with innovative medicines include immune-related adverse events (irAEs), cytokine release syndrome (CRS), and neurotoxicity, which necessitate close monitoring, early intervention, and specific management approaches [18].

Psychosocial Impact of Side Effects

Aside from physical manifestations, treatment-related side effects can have a significant psychosocial impact on patients, compromising their mental well-being, social functioning, and overall quality of life. Side effects like hair loss, fatigue, cognitive impairment, and sexual dysfunction can harm patients' self-esteem, relationships, and sense of normalcy, emphasizing the need for holistic supportive care interventions that address both the physical and psychosocial aspects of side effect management [19].

Future Directions in Side Effect Management**Precision Medicine and Biomarker-driven Strategies**

Precision medicine approaches, which use genetic profiling, molecular characterization, and biomarker identification, have enormous potential for tailored side effect treatment. By stratifying individuals based on genetic predispositions, tumor biology, and pharmacogenomic profiles, healthcare practitioners can personalize therapy regimens and supportive care measures to individual patients, maximizing efficacy while minimizing toxicity.

Integration of Digital Health Technologies

The integration of digital health technology, such as wearable devices, mobile applications, and remote monitoring platforms, provides novel approaches to real-time symptom monitoring and management. These technologies allow people to track their symptoms, connect with healthcare doctors, and access supportive care resources from the comfort of their own homes, promoting preemptive interventions and increasing patient self-care [20].

Multidisciplinary Collaborative Care Models

Multidisciplinary collaborative care models, which include oncologists, nurses, pharmacists, psychologists, dietitians, and other allied healthcare experts, allow for complete side effect treatment and supportive care delivery. These care models promote interdisciplinary communication, coordination, and shared decision-making, ensuring holistic patient-centered care that addresses the different demands and challenges of cancer treatment [20].

Patient Education and Empowerment

Empowering patients with knowledge, skills, and resources to actively participate in their own care is critical for effective side effect control. Patient education initiatives, support groups, peer-to-peer networks, and survivorship programs are critical in providing patients with the knowledge and support they need to navigate treatment-related side effects, make educated decisions, and advocate for their own well-being [17].

CONCLUSION

While cancer medications have transformed the treatment landscape, their side effects present substantial hurdles to individuals undergoing therapy. Understanding these side effects and applying appropriate treatments allows healthcare providers to reduce their impact and improve patients' quality of life throughout cancer treatment. Furthermore, continuous research into novel medicines and supporting interventions is refining cancer care, providing promise for improved outcomes and patient well-being in the fight against cancer.





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Table: 1 List of drugs used in cancer treatment and their side effects.

S.No	Drug name	Type of drug	Side effects	Uses
1	Mechlorethamine	Chemotherapy	Nausea, vomiting, bone marrow suppression	Hodgkin lymphoma, leukemia
2	Methotrexate	Chemotherapy	Nausea, vomiting, mucositis	Leukemia, lymphoma, breast cancer
3	5-Fluorouracil	Chemotherapy	Nausea, vomiting, diarrhea	Colorectal, breast, stomach cancer
4	Vincristine	Chemotherapy	Peripheral neuropathy, hair loss	Leukemia, lymphoma, neuroblastoma
5	Adriamycin	Chemotherapy	Cardiotoxicity, hair loss	Breast, lung, lymphoma
6	Tamoxifen	Hormone Therapy	Hot flashes, increased risk of uterine cancer	Breast cancer
7	Cisplatin	Chemotherapy	Nephrotoxicity, ototoxicity	Testicular, bladder, ovarian cancer
8	Paclitaxel	Chemotherapy	Neuropathy, hair loss	Breast, ovarian, lung cancer
9	Rituximab	Immunotherapy	Infusion reactions, fatigue	Non-Hodgkin lymphoma
10	Imatinib	Targeted Therapy	Edema, muscle cramps	Leukemia, gastrointestinal stromal tumors
11	Pembrolizumab	Immunotherapy	Fatigue, rash	Melanoma, lung cancer
12	Olaparib	Targeted Therapy	Fatigue, nausea	Breast, Ovarian cancer
13	Trastuzumab	Targeted Therapy	Cardiotoxicity, infusion reactions	Breast, stomach cancer
14	Nivolumab	Immunotherapy	Fatigue, rash	Lung, melanoma cancer
15	Abemaciclib	Targeted Therapy	Diarrhea, fatigue	Breast cancer
16	Sotorasib	Targeted Therapy	Fatigue, diarrhea	Lung cancer
17	Trodelyv	Chemotherapy	Fatigue, diarrhea	Breast cancer
18	Infigratinib	Targeted Therapy	Fatigue, diarrhea	Gallbladder cancer
19	Durvalumab	Immunotherapy	Fatigue, cough	Lung, bladder cancer
20	Pertuzumab	Targeted Therapy	Diarrhea, rash	Breast cancer





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21	Bevacizumab	Targeted Therapy	Hypertension, proteinuria	Colorectal, lung, ovarian cancer
22	Sorafenib	Targeted Therapy	Fatigue, hand-foot syndrome	Liver, kidney cancer
23	Palbociclib	Targeted Therapy	Neutropenia, fatigue	Breast cancer
24	Ribociclib	Targeted Therapy	Neutropenia, fatigue	Breast cancer
25	Atezolizumab	Immunotherapy	Fatigue, rash	Bladder, lung cancer
26	Enzalutamide	Hormone Therapy	Fatigue, hypertension	Prostate cancer
27	Larotrectinib	Targeted Therapy	Fatigue, dizziness	Solid tumors with NTRK gene fusion
28	Encorafenib	Targeted Therapy	Fatigue, nausea	Melanoma, colorectal cancer
29	Ivosidenib	Targeted Therapy	Fatigue, nausea	Acute myeloid leukemia
30	Tucatinib	Targeted Therapy	Diarrhea, fatigue	Breast cancer
31	Sacituzumab govitecan	Chemotherapy	! Fatigue, nausea	Triple-negative breast cancer
32	Fam-trastuzumab deruxtecan	Targeted Therapy	Nausea, fatigue	HER2-positive breast cancer
33	Selpercatinib	Targeted Therapy	Fatigue, hypertension	Thyroid cancer
34	Belantamab mafodotin	Targeted Therapy	Fatigue, ocular toxicity	Multiple myeloma

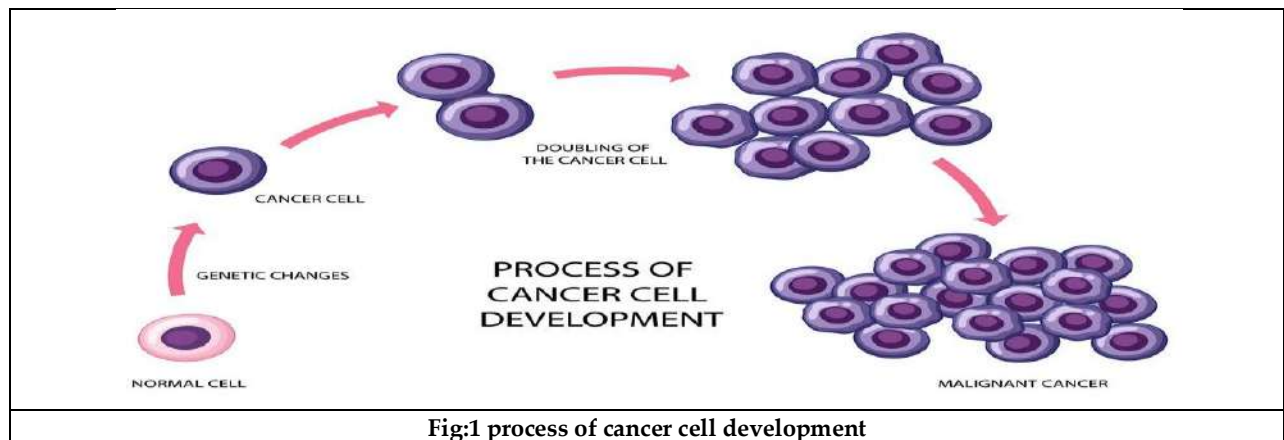


Fig:1 process of cancer cell development





Impact on Artificial and Augmented Intelligence in Education Field (with Special Reference to College Students)

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

The development of Artificial Intelligence (AI) and Augmented Intelligence (AUGI) technologies has guided in a transformative period in education. This paper explores An impact of AI and AUGI within the environment of advance education The integration of these intelligent into educational practices has reshaped the literacy experience, offering a unique set of openings and challenges. This study explore into the ways AI and AUGI enhance substantiated literacy, adapt to individual student needs, and provide real-time feedback, therefore improving academic outcomes. It also examines the ethical considerations and privacy concerns associated with AI-driven educational platforms. Also, the part of educators using these technologies to produce engaging, interactive, and inclusive learning environments is explored. Additionally, this paper discusses the potential implications of AI and AUGI on the future of work and the skills required for college students to flourish in an AI-driven world. As these technologies are developing in nature, it is pivotal to probe how they can foster critical thinking, problem-solving, and creativity among students. This research offers an analysis of the impact of AI and AUGI on the education field, highlighting their potential to revolutionize teaching and learning while emphasizing the importance of responsible implementation and thoughtful pedagogical strategies, especially in the college environment.

Keywords: AI – Artificial intelligence, AUGI – Augmented intelligence, Education, Information technology



**Cathrine Arputha Divya**

INTRODUCTION

The education landscape is witnessing a profound transformation with the arrival of Artificial Intelligence (AI) and Augmented Intelligence (AUGI) technologies. These intelligent systems have introduced a new dimension to tutoring and learning, revolutionizing the way knowledge is acquired, reused, and applied. As the world becomes increasingly digitized and interconnected, it's imperative to understand the far-reaching implications of AI and AUGI in the education field. Artificial Intelligence, as a broad category, encompasses a range of technologies that enable machines to imitate human-like cognitive functions such as learning, reasoning, problem-solving, and decision-making. In the environment of education, AI offers the implicit to produce personalized learning experiences, streamline administrative tasks, and provide educators with valuable insights into student performance. Augmented Intelligence, on the other hand, represents a collaborative partnership between humans and machines. It emphasizes the idea that technology should enhance human capabilities rather than replace them. In education, AUGI acts as a supportive tool for educators, helping them make further informed opinions, adapt to individual student needs, and produce engaging and effective teaching styles. The integration of AI and AUGI in education has the power to address long-standing challenges within the sector, including the need for further substantiated instruction, the demand for real-time feedback, and the necessity for efficient executive processes. By employing these technologies, educational institutions can morefeed to the different learning styles and requirement of students. This transformative shift, still, isn't without its complications. Ethical considerations, data privacy, and concerns regarding algorithmic bias must be carefully navigated. Also, the evolving role of educators in this technologically enhanced environment raises important questions about how best to leverage AI and AUGI to achieve educational goals.

OBJECTIVE OF THE STUDY

- To identify the factors, opinions of Artificial intelligence among college students.
- To know the usage of AI and AUGI by Students.

LIMITATION OF THE STUDY

- The scope of the study is limited to the students and scholars cannot be generalized.
- The study concentrated only with Artificial intelligence and augmented intelligence.

REVIEW OF LITREATURE

Aggarwal, Deepshikha and Sharma, Deepti and Saxena, Archana B. (2023)¹, In this article the author says that Artificial intelligence (AI) plays a vital role in augmenting adaptable sustainable education in numerous ways, transforming the learning experience for students, educators, and institutions. AI can analyze each student's learning style, pace, and strengths and weaknesses to provide personalized learning pathways and recommendations. Adaptive learning systems can adjust the difficulty level of content in real-time, ensuring that students are using the tools appropriately. ZhonggenYu,(2020)²,in this study the author reveals the rapid development of technology, use of artificial intelligence (AI) in education has caught much attention across the world ,it is still a young field with many under-explored research elements. This study provides references to readers in terms of mapping on the basis of keywords.This study into serious consideration when they set about researching effectiveness, efficiency, or usefulness of AI in education. More research into use of AI in education will be most likely need interdisciplinary cooperation between computer science, statistics, education, cognition, and robotics. **Seungsupaek, (2021)³**, This study aimed to explore the future direction of education by examining the current impact and predicting future impacts of AI. It also examined research trends and collaboration status by country through network analysis, topic modeling and global research trends in AI in education.



**Cathrine Arputha Divya****ARTIFICIAL INTELLIGENCE**

Artificial intelligence is the simulation of human intelligence process by machine by computer science, with specific applications of AI includes expert systems, natural language processing, speech recognition and machine vision. Its focus on cognitive skills. Learning aspect focus on acquiring data and creating rules , they provide computing services step by step instructions to complete a specific task. Reasoning this aspect of AI programming focused on choosing the right step to reach the desire outcome. Its used in various fields like AI in business, AI in finance, AI in healthcare , AI in education, AI in law ,AI in entertainment and media, AI in software coding and it processing , AI security , AI in manufacturing ,AI in banking and AI in transportation

TYPES OF AI**IMPLEMENTATION OF AI IN EDUCATIONAL SECTOR****Automated grading system**

A significant amount of time is spent for class preparation and grading the students assignments. While this AI is used to assessed the student performance and provide grades.

AI based intelligent assistants

Its an Virtual assistant it is also called as AI assistant or digital assistant, it is an application program that understand natural language voice commands and complete task the users. It is performed by a human personal assistant or secretary – includes taking notes, reading text or email message aloud , scheduling, place phone calls and giving reminder about appointments. Popular AI assistant like Amazon Alexa, Apple Siri, and google assistant.

Common Types of AI Assistant**Chatbots**

The Chatbots are computer programs that serve as virtual assistant and communicate through text based interfaces on websites or social media.

Conversational agent

it's a virtual assistant to converse like human through both text and voice interfaces.

AI Virtual Assistant

this is an advanced virtual assistants, that can perform a variety of task by working on multiple devices and platforms.

AI ChatGPT

AI based Chatbots, its released by open AI. Its spreading Like a Wildfire among the Students to submit the assignments, Its helps them to generate notes and too convert them in PPT presentations. Its main feature is Conversational Memory, its also has the feature of conversion of voice that is text to speech.

AUGMENTED INTELLIGENCE

Augmented intelligence learning tools is useful for the students to gain more knowledge. Its focus on the development of augmented human intelligence through more data, more efficiently and making life changing decisions. It make them faster, better, more confident in decision making. They help them to fits not only in the domain, based on the knowledge also. Augmented intelligence apply information process capabilities to extend the human mind through distribution cognition. They function with mechanical and electronic devices range from calculator, abacus, personal computer and smart phones. It acts as a Just in time understanding and learning to acquire relevant information and to solve the complex issues as per the need or demand. Its also used by several peoples not only the students (teachers and parents). This technology brings the insight to the users to have better understanding in learning and to create interest with this new platform. The AI in education has potential to change the environment in conventional learning process. It is a boom to the young generation.



**Cathrine Arputha Divya****FUTURE OF AI IN EDUCATION FIELD USING MOBILE APPLICATIONS**

- Smart content creation the AI tools
- AI helps students improve their visualization
- Personalized learning
- Speech recognition technology

ANALYSIS AND INTERPRETATION**Interpretation**

The above table shows that (65%) of the respondents are male and (35%) of the respondents are female

Interpretation

The above table reveals that (66%) of the respondents are saying that use AI tools (yes) and (34%) of the respondents are saying that they don't use AI tools (no).

Interpretation The above table reveals the ranking among 6 online AI tools preferred by the Students. "AI ChatGPT(openAI)" was ranked first by the selected sample respondents with the total score of 21. "Quillbot & AI for speech and audio (Otter)" was ranked second with the total score of 19. and "AI NLP (Knowji)" occupied third rank with the total score of 18.

A WAY HEAD AND CONCLUSION

The technology development and usage of internet is increasing now days. The students are always depend with gadgets because of that they come to know about the trending software and techniques. They use these types of techniques and tools to learn , write and upgrade their knowledge to achieve their goals. They use these AI and AUGI for submission of assignments and clarify the doubts after class hours. Its user friendly, they can get the answers immediately and can complete the work at once or in a fraction of second. The technology upgradation is the main reason for the updating and changes in the society among the students. To know more about the AI and Machine learning. In nearing future the usage of AI and Augmented Intelligence will be very high among the students for learning and implementing the software to learn and get placed in companies.

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Table 1 :Male And Female usage of AI tools to submit the Assignments

S.no	Particulars	Respondents	Percentage of usage
1	Male	65	65
2	Female	35	35
Total		100	100

Table 2 : Depending on AI tools to submit assignments

S.No	Depending on AI tools to submit Assignments	Frequency	Percentage
1.	Yes	66	66
2.	No	34	34
Total		100	100.0

Table 3 :Rank the following AI tools commonly used by college Students

S.no	Particulars	Average Score	Ranks
1	Click Up	13	5
2	Quillbot	19	2
3	AI NLP(Knowji)	18	4
4	AI ChatGpt (openAI)	21	1
5	AI for Speech and Audio (otter)	19	2
6	AI for Image and Video Editing	10	6
Total		100	100

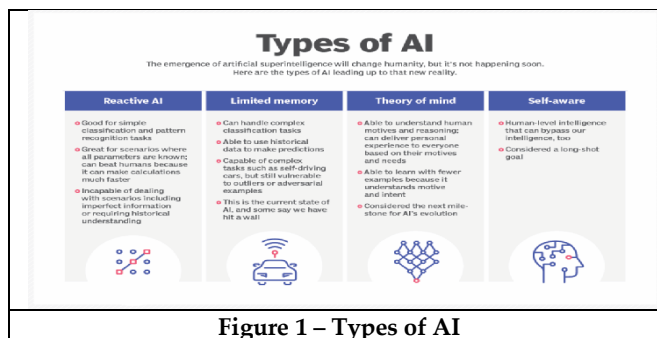


Figure 1 – Types of AI

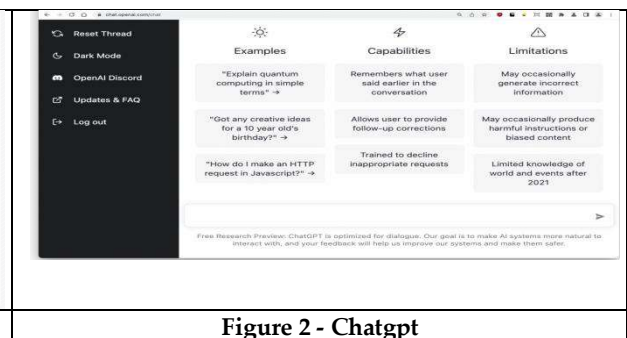
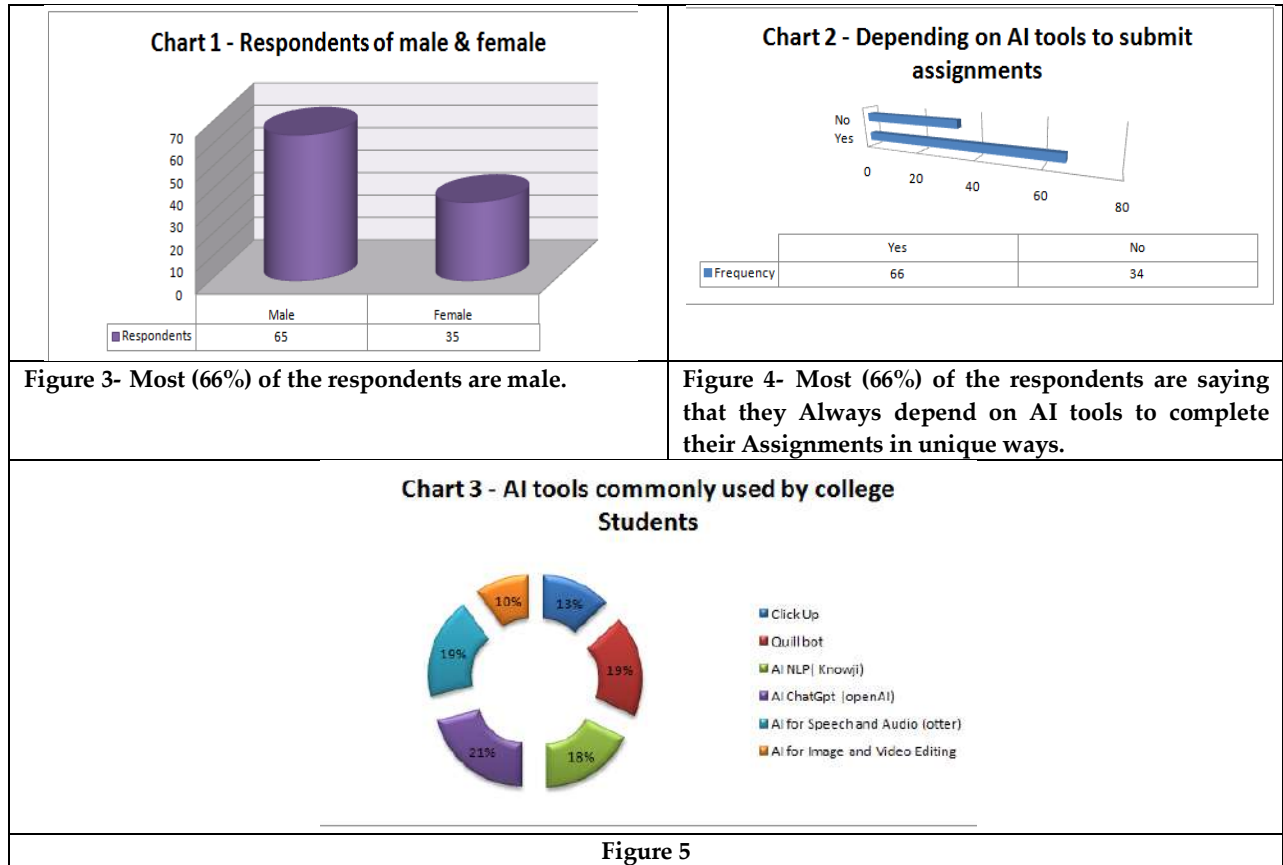


Figure 2 - Chatgpt





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Acute and Long Term Toxicity Assessment of Annapavala Chendhuram – (Herbo – Mineeal Formulation) in Animal Models

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07Jun 2024

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ABSTRACT

Annapavala chendhuram (APC) is a herbo – mineral *Siddha* internal medicine that has the indication for *kabam-related* disorders and clinically this medicine is used for thyroid disorders by many practitioners. Nowadays most the people rely on *Siddha* medicine and seek medical care in *Siddha*. So, it is necessary to ensure its safety through animal studies. This study investigated the acute and long-term toxicity of *Annapavala chendhuram* in Wistar albino rats as per WHO guidelines. In an acute toxicity study, APC was administered once at a dose of 250mg/kg/p.o body weight and 14 days observed for toxic signs. In long-term toxicity studies, APC was administered for 90 consecutive days to rats at the dose level of 25, 125, and 250 mg/kg/p.o body weights. After 90 days of feeding, animals were sacrificed and haematological, biochemical and histopathology parameters were analyzed. No mortality and/or signs of morbidity were noted in the acute toxicity study. In the long-term toxicity study, any detrimental change in body weight, biochemical, and haematological parameters were not observed for *Annapavala chendhuram* up to the high dose level when compared with the control group. From the study, it is concluded that the test drug was found to be safe at various dose levels and hence recommend for safe use in humans at therapeutic dose levels.

Keywords: Annapavala chendhuram, Toxicity study, Thyroid dysfunction, WHO guideline, Siddha.





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INTRODUCTION

Siddha medicine, the traditional system of medicine is one of India's oldest systems of medicine [1]. *Chendhuram* is one among the 32 types of *Siddha* internal medicine. It is red-colored powders made from metallic substances by the process of burning or drying or keeping in sunlight or specialized tubes by the addition of any decoctions. The life period of *chendhuram* is 75 years [3]. The method of preparation of *parpam* and *chendhuram* shows the mastery of *Siddhars* in inorganic chemistry and processing herbo - mineral drugs. The herbo - mineral drugs are made into very fine particles. The finer particle has better bioavailability and effect, the minute dose is adequate for treatment [4]. *Annapavala chendhuram* (APC) is the *Siddha* internal medicine that comes under the type of *chendhuram*. It is made by the combination of *annabedhi* and *kodipavalam*. As per the reference of *Siddha* pharmacopoeia, APC indicates *kaasam*, *shayam*, *swasam*, *ratha ushnam*, *pitha ushnam* and *mega ushnam*[5]. Clinically, this medicine is used for thyroid dysfunction by many practitioners. In India, as per a population-based study conducted in Cochin, the prevalence of hypothyroidism and subclinical hypothyroidism were 3.9% and 9.4% respectively among 971 adults. In women, the prevalence was 11.4% which is higher compared with men (6.2%)[6]. Many people have done research on *annabedhi* and *kodipavalam* based *Siddha* medicines. Shanmuga sundharam et.al[7]. has carried out the anti-atherosclerotic activity and Sabari Girija et.al has proven the effect of anti-hypertensive activity [8]. But till date, there is no data available about the safety evaluation of APC. Nowadays most the people rely on *Siddha* medicine and seek medical care in *Siddha*. However, there are fears about the toxicity of *Siddha* medicines among people due to the metals in *Siddha* medicines [9]. So, it is necessary to ensure its safety through animal studies to establish strong evidence for its clinical use. Hence, this study is aimed to evaluate the safety of *Annapavala chendhuram* in Wistar albino rats.

MATERIALS & METHODS

Procurement and authentication of the raw drug

The raw drugs were procured from the authenticated raw drug shop in Chennai. Lemon was procured from the Tambaram Vegetable market, Chennai. *Kodipavalam* and *Annabedhi* samples authenticate in the Department of Geology, University of Madras, Chennai.

Purification process of raw drugs

Annabedhi and *Kodipavalam* were purified as per *Siddha* literatures.¹⁰

Preparation method of Annapavala chenduram

The trial drug APC was prepared as per *Siddha* text in the *Gunapadam* Laboratory of the National Institute of Siddha, Chennai.

Toxicity study of AnnapavalaChendhuram

Animal Ethical committee approval:

The animal study was carried out in Animal House, National Institute of Siddha, Tambaram sanatorium, Chennai after getting approval from the Institutional Animal Ethics committee, National Institute of Siddha, Chennai ((IAEC approval number: NIS/IAEC-VII/28082018/15) as per WHO guidelines[11].

Animal Care and Husbandry

Male and female Wistar rats (6-8 weeks and 140– 160 g weight) were purchased from the Laboratory Animal Medicine Centre for Animal Health Studies, Tamil Nadu Veterinary and Animal Sciences University, Chennai and acclimatized in the animal house of the National Institute Siddha, Chennai for 7 days before experimentation. Animals were housed individually in polypropylene cages in a ventilated room (air cycles: 12–15/min; 70:30 exchange ratio) under an ambient room temperature of $22 \pm 3^\circ\text{C}$ and 40– 70% relative humidity, with a 12h light/dark artificial



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photoperiod. The animals received RO water ad libitum and were fed with Rodent pellet ad libitum. Each animal was marked on its fur for identification.

Dose calculation

The therapeutic dose of APC is 120 -260 mg. The suitable dose for rats was calculated as per Paget and Branes [12](Surface factor for 200gm rat = 0.018) and was found to be 25, 125, and 250 mg/kg body weight of rat for low dose, mid dose, and high dose groups respectively.

Acute toxicity study

A total of 20 (10 Male + 10 Female) Wistar Albino rats of both sexes were separated into two groups. For control group, 1ml/100gb.w of honey was given. The test drug was administered (250mg/kg b.wt) by mixing it with honey (Dabur India). After drug administration, food was withdrawn for further 3 hours in rats. The animals were observed for morbidity and mortality for the first 30 minutes, 1st, 2nd, 4th and 6th hour on the day of dosing and once a day thereafter up to 14 days. The body weight was recorded on the 0th, 7th, and 14th days individually. After that, on the 14th day, animals of both groups were sacrificed using the injection of thiopental sodium 100mg/kg body weight (intra peritoneal) after weighing them individually. The toxicological effect was assessed based on mortality, gross pathology, and behavioral parameters.

Long-term toxicity study

A total of 70 animals were included in the long-term study. Albino rats of both sexes were separated into four groups. The first group was treated as vehicle control and the second, third and fourth group were treated with APC at Low dose, Mid dose, and High dose respectively. The number of animals was 10, 20, 20, and 20 in the group of control, low, mid, and high doses respectively. The control animals were administered with honey as a vehicle. The other animals were treated with APC orally for 90 days and it was monitored for behavioural parameters daily after drug administration. The body weight of the animal was monitored at weekly intervals. The food and water intake were calculated daily. All animals were weighed and sacrificed at the end of the study (91 days) by using the injection of thiopental sodium. Mortality and behavioural parameters were observed throughout the study. Blood was collected from the anesthetized animals through the abdominal aorta for analysis.

Haematological and biochemical parameters

Haematological and biochemical parameters were analyzed for all animals using standard procedures.

Histopathological examinations of organs

Histopathological examination of the internal organs was done in Noble Research Solutions, Chennai, Tamil Nadu, India.

STATISTICAL ANALYSIS

Statistical analysis was performed using one-way ANOVA using the computer software program *Graph Pad Instant-3*. Dunnet's test was used to compare control and test drug-treated groups. P-value < 0.05 was considered the level of significance.

RESULTS**Acute toxicity study**

An Acute toxicity study of APC was conducted as per WHO guidelines. No mortality or treatment-related toxicity was noted in any animals during the experimental period. The animals gained bodyweight gradually. (Table 1) There was no significant difference between the control & treated groups in food and water intake throughout the study period. Normal signs were noted in the skin, fur, eyes, mucous membranes, salivation, and sleep in control



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and treated animals. No other signs like tremors, convulsions, lethargy, coma, diarrhoea were observed during the study period. (Table 2) No pathological changes were observed in the vital organs of all groups during the necropsy.

Long-term toxicity study (90 Days)

There was no mortality and treatment-associated toxicity noted in all groups during the experimental period.

Effect of APC on body weight

The animals in all groups gradually gained body weight throughout the study period. There were no significant differences observed in the body weight of the control and the treated groups. (Table 3)

Haematological parameters

Each haematological parameter of test drug-treated animals was compared with the control group animals at end of the study respectively. No significant changes were found in all the parameters with statistical analysis. It has shown in Table 4.

Biochemical parameters

Biochemical parameters were assessed in APC treated animals at end of the study and the results were recorded. It indicates the Liver function test, Renal function test and Lipid profile of APC treated animals which were compared with the control group.

Hepatic parameters of APC

Hepatic parameters were assessed for APC treated Wistar albino rats which were compared with the control group. This result revealed no significant changes in liver parameters. All the parameters were normal in the test groups when compared with the control group. Liver function tests of APC treated animals have shown in Table 5.

Renal parameters of APC

Blood urea nitrogen (BUN) and creatinine are the indicators of renal function. This analysis was done at the end of the study. Test groups did not have any significant changes in the levels of animals when compared to the control group. BUN and creatinine levels of APC treated animals were normal compared to control group animals. It has mentioned in Table 6.

Lipid profile of APC

The lipid profile did not show significant changes in all test animals when compared to the control group. (Table 7)

Histopathological analysis

Long term toxicity study of APC did not produce any evident pathological changes in various organs such as the Brain, Heart, Lungs, Stomach, Liver, Kidney, Spleen, Testis /Uterus, and Ovary of the Control group as well as in the High dose group mentioned in Figure 1.

DISCUSSION

Annapavala chendhuram is widely prescribed by *Siddha* practitioners [13]. Although, no systematic information is available on the toxicity of APC in the current literature. Nowadays, the consciousness about the quality of the drug is rising among people [14]. Therefore, we decided to conduct a toxicity study as per World Health Organisation (WHO) guidelines in rats which will provide information about its ethnopharmacological profile and also the health hazard supposed to rise from repeated administration of the drug over a period of time. Acute toxicity was done to analyze the immediate adverse effects that occur after the administration of a single large dose of the drug [15]. The maximum dose of APC (250mg/kg) was given as a single dose through the oral route with honey. The animals were



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monitored for any behavioural abnormalities and mortality for 14 days. All the animals were normal in the acute toxicity study of APC throughout the study period. No mortality or morbidity was noted after the drug administration and also up to the end of the study period. The gross necropsy did not show any abnormality [16]. Body weights of these animals were observed for 7 days once. There was a gradual increase in the body weight of acute toxicity animals but no statistical significance was found between control and treated groups in body weight gain [17]. In the Long - term toxicity study, the effect of APC on body weight during 90 days of treatment in rats. There was a gradual increase in the body weight of APC treated animals when compared to the control during the experimental period [18,19]. But the body weight of the treated group was not statistically significant when compared with the control groups. Blood is the main medium for the transport of many drugs in the body and it is primarily exposed to major concentrations of toxic compounds. Any harm to the blood cells is unfavourable to their normal functioning. The effect of APC on haematological and biochemical parameters was analyzed [20]. It revealed no significant changes in all experimental animals. Liver enzymes such as Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamate Pyruvate Transaminase (SGPT) are useful indicators of liver injury. These enzymes are found mainly in the liver, red blood cells, pancreas, heart, kidneys, and biliary ducts of the liver. So, the analysis of SGOT and SGPT levels in the serum helps to diagnose the conditions of body tissues particularly the heart and the liver tissues [22]. Research suggested that, when body tissues are injured, there is a raise in the serum enzyme level due to the release of excess enzymes into the bloodstream. As a result, the amount of SGOT and SGPT in the blood is directly associated with the amount of tissue damage. Parameters of liver function were within normal limits when compared with the control group. The kidney excretes urine and plays a major role in maintaining homeostasis by filtering waste products from the bloodstream and converting them to urine. Analysis of some biochemical markers can validate beneficial and pathological changes in the kidney and its function, thus serving as an indicator of renal function. It includes creatinine, urea and uric acid [23,24]. The renal parameters did not show any important changes in the test drug-treated groups when compared to the control group [25]. The histopathological analysis of the organs such as the brain, heart, lung, kidney, spleen, liver, stomach, uterus, ovary, and testes were normal in high dose groups as well as in the control group. Normal levels of liver function and kidney function tests revealed the safety of *Annapavala chenduram*.

CONCLUSION

This study results concluded that APC is not toxic on acute administration at a maximum oral dose level of 250 mg/kg in Wistar rats. In the long-term toxicity study, no significant adverse effects were noted in all observed parameters. Hence, the study proves the safety of *Annapavala chenduram*. Further efficacy studies and clinical trials on APC will be more valuable for researchers and the world.

STATEMENTS AND DECLARATIONS**Conflict of interests**

The authors declare that there are no conflicts of interests.

Acknowledgement

Authors are very thankful to Tamil Nadu Dr. MGR Medical University, Chennai, National Institute of Siddha, Chennai and Noble research solutions, Chennai.

Financial support: Nil

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Table 1: Body weight changes (gm) in acute toxicity

Control group (honey)	204±40.21	210±38.50	221.4±43.34
High dose group	206±36.27	215±41.17	223.2±49.60

Table 2: Effect of APC on behavioral parameters of Wistar albino rats

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Control group (honey)	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-
High dose group	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-

1.alertness 2. aggressiveness 3. pile erection 4. grooming 5. gripping 6. touch response 7. Decreased motor activity 8. Tremors 9. convulsion 10. Musclespasm 11. Catatonia 12. Musclerelaxant 13. Hypnosis 14. Analgesia 15. Lacrimation 16. Exophthalmos 17. Diarrhoea 18. writhing 19. respiration 20. Mortality

(+) Presence of activity; (-) Absence of activity

Table 3. Effect of APC on Body weight changes of Wistarrats in a long-term toxicity study

	Control	Low	Mid	High
Day 1	198.3±29.74	198±29.77	176.45±24.73	194.35±33.27
Day 15	206.4±33.09	213.6±31.55	208.75±40.64	217.65±46.06
Day 30	216.45±37.49	214±33.83	213.1±40.87	220.65±45.85
Day 45	221.95±37.68	227.4±41.21	224.5±44.31	235.6±45.8
Day 60	233.55±42.94	240.55±48.04	228.65±43.8	245.8±50.2
Day 75	241±46.51	244.15±50.03	233.2±48.26	256.95±52.6
Day 90	256±51.41	260.8±53.95	251.1±59.16	265.45±58.84

Data expressed as Mean ± SD for N = 10 rats in control group and N = 20 in Low, Mid, High dose groups, one – way ANOVA followed by Dunnett’s test. Significant indicates that *P<0.05, **P<0.01

Table 4: Effect of APC haematological parameters of Wistar rats

	Control	Low	Mid	High
RBC (×10⁶µl)	8.16±0.65	7.96±0.93	8±0.76	8.27±0.83
WBC(×10³µl)	8.57±1.67	8.13±0.95	8.15±0.9	8.60±1.27
PLT(×10³µl)	13.65±1.62	13.96±1.76	14.24±1.27	14.96±1.50
HB(g/dl)	720.1±133.2	794.35±104.3	843.1±72.22	815.15±103.14
Neutrophils	18.03±1.19	18.12±1.08	17.94±1	17.88±1.48
Eosinophils (%)	56.7±4.59	59.48±4.44	60.46±5	58.90±4.51
Lymphocyte (%)	2.93±0.63	3.17±0.55	2.85±0.7	3.08±0.53
Monocyte(%)	1.39±0.18	1.48±0.18	1.49±0.22	1.47±0.20
Basophils(%)	0.1±0.3	0.15±0.35	0.2±0.4	0.15±0.35
MCH(pg)	73.33±5.62	86.69±43.89	77.04±4.87	78.83±4.80
MCV (fl)	3.07±1.22	3.86±1.19	4±0.99	3.65±1.07

Data expressed as Mean ± SD for N = 10 rats in control group and N = 20 in Low, Mid, High dose groups, one – way ANOVA followed by Dunnett’s test. Significant indicates that *P<0.05, **P<0.01. RBC- Red blood cell; WBC- White blood cell; PLT- Platelet count; HB- Haemoglobin; MCH- Mean corpuscular volume; MCV-Mean corpuscular haemoglobin.





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Table 5: Effect of APC on Liver function of Wistar albino rats

	Control	Low dose	Mid dose	High dose
Total Bilirubin(mg/dl)	0.4±0.14	0.42±0.12	0.44±0.13	0.43±0.11
SGOT(U/L)	83.6±5.73	84.8±5.68	85±6.14	84.6±5.86
SGPT(U/L)	18.2±7.24	26.15±6.80	24±5.98	26.85±5.42

Data expressed as Mean ± SD for N = 10 rats in control group and N = 20 in Low, Mid, High dose groups, one – way ANOVA followed by Dunnett's test. Significant indicates that *P<0.05, **P<0.01. SGOT-Serum glutamic oxaloacetic transaminase; SGPT- Serum glutamic pyruvic transaminase

Table 6: Effect of APC on Renal function of Wistar rats

	Control	Low dose	Mid dose	High dose
BUN (mg/dl)	13±2	14.3±2.49	15.15±2.1	14.45±2.33
Creatinine(mg/dl)	0.64±0.14	0.62±0.12	0.66±0.11	0.61±0.14

Data expressed as Mean ± SD for N = 10 rats in control group and N = 20 in each treat groups, one – way ANOVA followed by Dunnett's test. Significant indicates that *P<0.05, **P<0.01. BUN-Blood urea nitrogen

Table 7: Effect of APC on Lipid profile of Wistar rats

	Control	Low dose	Mid dose	High dose
Total cholesterol (mg/dl)	130.6±18.74	124.85±10.33	122.93±10.06	129.96±7.36
HDL (mg/dl)	53.4±7.82	61.5±5.55	60.6±5.48	58.7±5.96
LDL (mg/dl)	60.2±12.60	61.15±11.44	64.6±10.74	62.9±10.53
VLDL (mg/dl)	16.43±2.39	14.76±1.77	14.95±2.37	16.99±1.98
Triglycerides(mg/dl)	34.2±6.83	35.1±6.83	35.45±5.63	32.8±6.97

Data expressed as Mean ± SD for N = 10 rats in control group and N = 20; Significant indicates that *P<0.05, **P<0.01. HDL - High density lipoprotein; LDL - Low density lipoprotein; VLDL - Very low-density lipoprotein.





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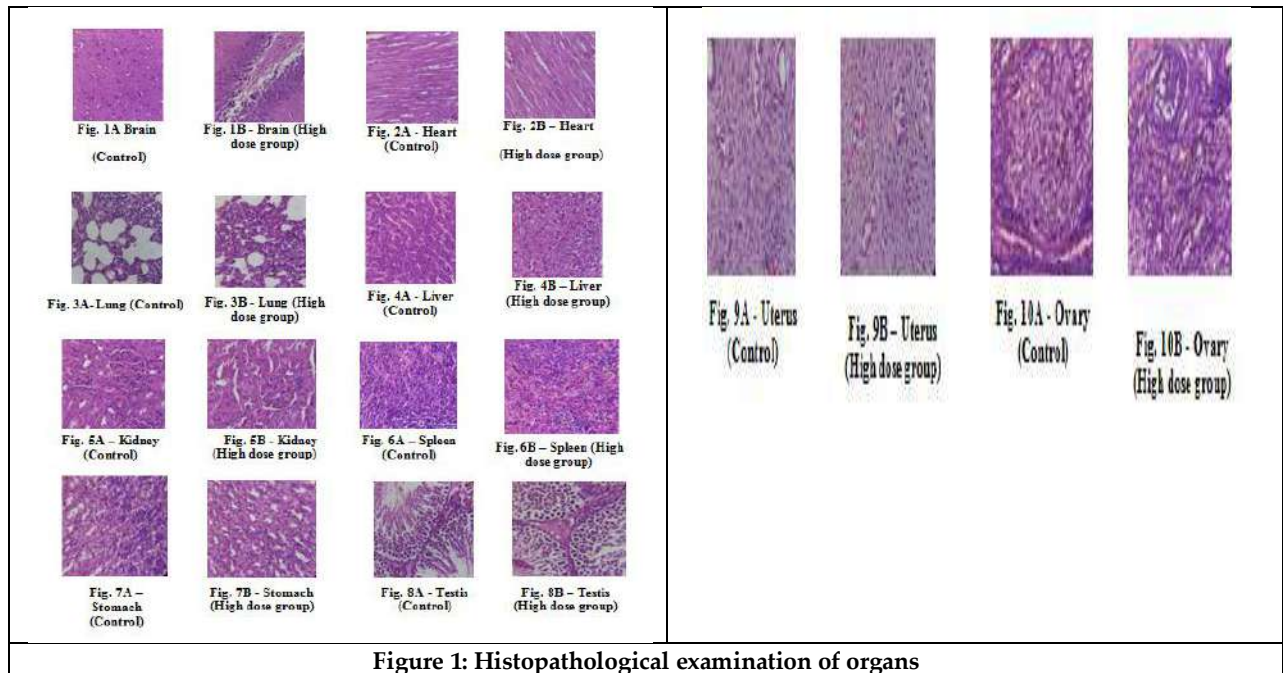


Figure 1: Histopathological examination of organs





Blockchain Assisted Data Storage in Cloud With Integrity Verification Using Third Party Auditor

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Received: 21 May 2024

Revised: 20 Jun 2024

Accepted: 28 Jun 2024

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ABSTRACT

Vulnerabilities in traditional centralized cloud storage systems include data breaches, unauthorized access, and single points of failure. This paper suggests a blockchain-based method for safe cloud data storage that allows for limited data access in order to address these issues. The suggested solution makes use of blockchain's decentralized and immutable properties to guarantee the security and integrity of data that is stored. The decentralized and unchangeable nature of blockchain technology makes it a valuable tool for improving data storage security and transparency. By distributing data over several cloud servers and encrypting it, this suggested method reduces the possibility of a single point of failure. After then, the information is stored on a blockchain as a collection of unchangeable blocks, guaranteeing data integrity and prohibiting illegal changes. The blockchain is made up of a series of blocks that are connected to each other via a hash pointer found in each block. Third-Party Auditors (TPAs) are established to assure data integrity. These impartial organizations regularly audit the data that is kept and confirm its accuracy by comparing it to hashes that are kept on the blockchain. By acting as reliable parties, the TPAs lessen the dependency on the data storage provider by guaranteeing the consistency and correctness of the data. A strong TPA verification technique that includes secret key distribution and verification methods has been put in place to reduce the possibility of any user engaging in potentially harmful activity. Additionally, a secure file sharing system is offered. The user can request file access from the data owner here. Owner may give authorization for data access and transmit a secret key. Users





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have verifiable access to data. This method overcomes the drawbacks of conventional cloud storage systems by utilizing the decentralized and transparent characteristics of blockchain technology, offering improved security, data integrity, and restricted data access.

Keywords: Cloud System, Blockchain implementation, Data storage, Secret key distribution, TPA verification, Data auditing, Secure data sharing.

INTRODUCTION

Data sharing is one of the most often used features of cloud storage, allowing a large number of users to share their data with others. Nevertheless, these shared cloud-stored data sets can contain some sensitive information. The data owner must first produce signatures for each block under remote data integrity auditing systems before uploading the blocks to the cloud. In this case, block chain helps generate hashes and data blocks for data sealing. The integrity auditing procedure uses these signatures to confirm that the cloud possesses these data blocks. The data owner then uploads these data blocks to the cloud along with the corresponding signatures. Here, offer a workable integrity auditing technique that makes use of an outside auditor to assist in resolving the problems with the present auditing approach.

The implementation of an effective third-party auditor (TPA) is contingent upon the fulfillment of the following two basic conditions: 1) TPA should be capable of conducting competent audits of cloud data storage without necessitating a local copy of the data or increasing the online burden on cloud users; 2) The third-party auditing technique should not uncover any new vulnerabilities related to user data privacy. This research provides a privacy-preserving public cloud data auditing system that passes all integrity checks without revealing any data by combining a novel combination of double encryption and public auditing protocols. We need look into the online signature technique more in order to extend the primary finding into a multi-user setting where TPA can manage multiple auditing tasks simultaneously. Encrypt the data that is stored on the cloud server using an encryption method. In conclusion, whereas cloud-based data outsourcing makes economic sense for large-scale, long-term storage, data availability and integrity cannot be instantly guaranteed. Cloud architecture can suffer if this problem is not properly fixed. Standard cryptographic primitives cannot be directly used to ensure data security since users no longer physically own the data they save. Specifically, downloading all the data for integrity testing is not a practical solution due to the high cost of I/O and network transmission. Furthermore, because it cannot ensure users' correctness for content they have not yet viewed and because it can be too late to reverse data loss or damage, it is frequently insufficient to detect data corruption just at the moment of data access.

During the auditing process, the TPA uses their private key to confirm that the user's actions are legitimate. Through the use of cryptographic techniques, the secret key functions as a digital signature, providing a secure means of confirming the user's authorization to do specific auditing tasks. This verification method protects the confidentiality of the cloud data auditing procedure by limiting unauthorized access and establishing an open accountability trail that enables the detection of any harmful activity. To protect the confidentiality and integrity of sensitive data, there are a number of important processes involved in encrypting data for safe cloud sharing with secret key distribution. Before the data is transferred to cloud storage, it is first encrypted using strong encryption methods like AES. The data is rendered unreadable by the encryption process, making it unavailable to unauthorized people or organizations. Simultaneously, a secret key is generated for both data encryption and decryption, acting as the foundation for data security. After that, this key is safely given to approve users via reliable channels or protocols, guaranteeing that the encrypted data may only be accessed by those who are authorized. By distributing secret keys, access controls are put in place to make sure that only authorized users may decrypt and access data stored in the cloud.





Cloud Computing

Without a question, cloud computing is a promising idea in corporate computing. It draws attention to the critical infrastructure required to enable a new model of service delivery that benefits from cost savings through the sharing of computing and storage resources. Cloud computing is a truly gigantic technology that is currently surpassing all prior computing technologies in the highly competitive and demanding information technology market.

Solutions like Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), Storage-as-a-Service, and Infrastructure-as-a-Service (IaaS) are available from a variety of prominent cloud computing providers, including Amazon, Google, Microsoft, Yahoo, and many more. The use of cloud computing is growing significantly. Additionally, cloud computing is an excellent technology since it can optimize costs and maximize both economic and operational effectiveness. Furthermore, cloud computing may significantly improve its range, speed, and collaboration, allowing an internet infrastructure that facilitates a global computing paradigm. Moreover, cloud computing has advantages in that it can provide services that are more resilient and scalable. Because cloud computing relieves the user of the task of locating resources for storage, resource management is better managed by it. If additional storage is required, the user can request it from the cloud provider. When the user is finished using the storage, they can either release it by stopping to use it or move the data to a less expensive, longer-term storage alternative. The user can also make use of more dynamic resources since they aren't worried about storage problems or related expenses anymore.

The word "cloud" as it appears in this white paper appears to have originated from network diagrams that showed the internet or other parts of it as schematic clouds. The practice of transferring services and programs into the online "cloud" gave rise to the phrase "cloud computing." The origins of cloud computing can be found in the time when computer systems exchanged programs and computational resources remotely. It is not something that arose out of nowhere one day. Currently, however, cloud computing refers to the vast array of services and applications that are made available over the internet cloud and the fact that devices used to access these services and applications often do not require the use of specific programs. Many companies are providing their services via the cloud. Some notable examples include the following:

Google

makes advantage of a private cloud to offer its users Google Docs along with a slew of additional features like email access, document applications, text translations, maps, web analytics, and much more.

Microsoft

Provides a cloud-based platform called Microsoft Office 365online that makes it possible to move content and business intelligence tools to the cloud. Office apps are currently available on Microsoft's cloud.

Salesforce.com

For its clients, the business uses the cloud to run its application suite. Its products, Force.com and Vmforce.com, provide platforms for developers to design customized cloud services.

There are some key characteristics of cloud computing as follows:

Application Programming Interface (API) – To employ interface services to allow a machine to communicate with cloud software in a manner similar to how people or users communicate with computers.

Maintenance – Since apps don't have to be installed on every client's computer, maintenance is made easier.

Performance – Loosely couple approaches, consistent structures, and monitoring systems are used in the construction of web services to enhance their quality.

Scalability and Elasticity – Nodes can be added and removed at any moment with little to no impact on the infrastructure or software. The necessary services can be obtained by the user without involving a human. Cloud systems typically scale up automatically.



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Broad Network Access – Since cloud services are accessible across a network, similar procedures are employed to deliver services across many platforms.

Location Independency – Users don't know the precise location of services, with the exception of a high degree of abstraction regarding services, like nation, state.

Reliability – For cloud computing environments, many redundant sites are created to enable business continuity and disaster recovery services.

Cost Effectiveness – Centralized infrastructure makes it possible to share costs, including real estate and electricity (by deploying cloud services close to inexpensive power plants, for example), among many customers from the same or different places.

Sustainability – Using resources appropriately for an effective system.

Security – The level of data security can be raised as a result of centralizing data centers. Today's security is superior to that of the past since service providers may supply services to address security concerns that a single customer or business may not be able to afford. However, when data is dispersed across a large network and different devices are utilized to access services, the complexity of security increases. However, the cloud computing service's private deployment architecture gives an organization control over information or data security.

Related Work

Xu, et.al,...[1] suggest a deduplicatable data auditing system based on blockchain. To ease the load on users and provider vendors, first design a client-side deduplication checking scheme based on bilinear-pair approaches. Based on this, we are able to provide an authentic and effective information auditing system that enables the testing of information integrity through the use of both the bilinear pairing cryptosystem and the blockchain approach. In both information outsourcing and auditing methods, the blockchain system is used to record the behaviors of entities. This way, the corresponding immutable information can be used to monitor untrustworthy third-party auditors in addition to ensuring the credibility of audit results. The suggested technique uses a client-side deduplication mechanism based on bilinear maps to lower the overhead associated with replica record transmission and storage inside the data uploading system. If a user uploads the same documents over and over again, they are willing to give the service provider proof of ownership instead of doing so. In the meantime, present an untrusted TPA in order to understand an effective data auditing plan and design a tracking method that is appropriate for a TPA operating in the blockchain era. According to user verification requests, the TPA will periodically issue a one-time job. The service provider must respond with an integrity proof that includes the assignment and separate data blocks. TPA will validate the evidence and publish the audit findings on the blockchain. In order to prevent file double-checking, blockchain will record data outsourcing and fact auditing to manual TPA. It will also create audit logs for client monitoring to ensure the validity of audit results. The well-known theoretical study demonstrates that the suggested approach may efficiently outsource, save duplicate data, and audit for the accuracy of outsourcing storage data while incurring an appropriate computer overhead.

Shen, et.al,...[2] Create any such plan and put forth a novel concept known as information integrity auditing without the need for private key storage. To avoid using the hardware token in this technique, utilize the consumer's fuzzy private key to be biometric data (such as fingerprint or Iris test results). Even so, the plan can effectively finish the data integrity auditing in the interim. Here, confirm the person's identity by using a linear sketch using coding and error-correction techniques. Furthermore, a new signature scheme is presented here that not only allows block less verifiability but also works well with the linear sketch. Three types of entities are involved in the proposed system model: the user, the cloud, and the TPA. A person can save a vast amount of data on the cloud. The individual needs to upload a lot of files to the cloud. The consumer appoints the TPA, a public validator, to confirm the accuracy of



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the data stored in the cloud. The person wishing to use the cloud storage provider provides biometric information (such as a fingerprint) during the user registration process. In order to add data to the cloud, a data owner must first extract their biometric information as their fuzzy non-public key and then randomly generate a signature key. The record owner then uses his signing key and authenticators for information blocks. Lastly, the data owner removes those messages from the local storage and uploads these record blocks to the cloud next to the authenticator set. Using the venture-response protocol to execute with the cloud, the TPA verifies during the information integrity audit phase whether the cloud actually retains the user's intact information or not.

Xu, et.al,...[3] developed a blockchain-based decentralized arbitrable remote data auditing system for network storage services. Here, use a smart contract to notarize integrity metadata of data that has been outsourced and verified by users and servers on the blockchain. You can also accomplish non-repudiation verification interactions by using the blockchain network as a self-recording channel. Additionally, this implementation suggests a very arbitrable information auditing protocol that guards against dishonest proves and verifiers by using the commutative hash technique. Furthermore, the clever contract method is used as a decentralized adjudication mechanism to fairly resolve information ownership conflicts in the absence of TPAs. This article describes the design of a blockchain-based community storage service system in which the issuer of the community storage provider and the customer would, in turn, provide the integrity metadata of the associated original data block and, using the blockchain method, come to an agreement on it. By examining the integrity of a small number of record blocks, the customer uses the spot checking technique to verify whether the data is being kept appropriately. To be more precise, the user creates a matching endeavor of an information block and asks the provider to vouch for it. Customers don't need to obtain the full data in order to confirm the accuracy of the outsourced records; instead, they can use the commutative hash approach to check the minimal verification information. Furthermore, without the involvement of any TPA, the blockchain data from the aforementioned transactions to provide credible arbitration decisions for data ownership conflicts. Lastly, the theoretical analysis clarifies the suggested scheme's safety.

Yang, et.al,...[4] and Ganga et al.,[7] Provide a blockchain-based, certificate-less public auditing solution with multiple replicas and clouds. To achieve dynamic updating of institution person data and identification monitoring, the dynamic hash table and modification document table are introduced in the proposed approach. Every duplicate is stored on dedicated cloud servers, allowing for simultaneous integrity audits. Furthermore, take advantage of the unpredictable nature of blockchain blocks to compile accurate venture information in this way, which will prevent dishonest TPA and cloud servers from working together to trick consumers. Because every audit result is recorded in the blockchain, clients may easily audit TPA's actions.

Vani et al [16] developed the individual bears responsibility for creating record tags, sending data to the cloud provider, and updating the cloud data dynamically. Give TPA permission to recurrently check the accuracy of cloud data in the interim. It is responsible for writing verification effects to log documents and broadcasting them to the blockchain in order to confirm the accuracy of cloud records. It is responsible for handling TPA authentication requests and providing clients with cloud storage services. It boasts enormous processing power in addition to a sizable storage capacity. Cloud servers (CS) and cloud server organizers (CO) make up CSP in this work. Moving copies to the CS and forwarding task records to the CS upon receiving task facts from the TPA are the responsibilities of the CO. The CO compiles the records and forwards them to the TPA after obtaining the proof once more through the CS. It is the responsibility of the CS to store records. It is responsible for creating a portion of the individual's personal key and transmitting it to them via a secure channel. It is accountable for assisting TPA in producing erratic undertaking records and data regarding TPA audit results. Additionally, it enables clients to confirm TPA's behavior.

Xue, et.al,...[5] Provide a cloud storage structure identification-based public auditing (IBPA) program. With IBPA, the nonces in a blockchain are employed to put together erratic and flawlessly formed undertaking messages, preventing the forging of auditing impacts with the helpful resource of malevolent TPAs to deceive clients. To guarantee the integrity of their data, which may be kept in the cloud, users must confirm the auditing impacts of





TPAs in batches. In order to ensure that the goal of inspecting the integrity of outsourced records is met, IBPA requests that the buyer examine the auditing results in bulk using the TPA's helpful resource in order to further confirm the data's integrity. The development of critical components for public auditing in IBPA is facilitated by the public blockchain mechanism of the Bitcoin machine. Here, choose venture messages for fact integrity audits based on nonce. These could be crucial components of a public blockchain that are used to crack certain hash puzzles. Because a block's nonce is effects verified rather than necessarily pre-set, it can never be examined through the person in the event that an auditing result is forged by a malicious auditor. Furthermore, in IBPA, the auditing effects of the TPA are recorded in the majority blockchain, which may provide as unquestionable evidence that the TPA completed the auditing settlement in accordance with the character specifications. Recording the auditing results inside the blockchain ensures the traceability of the TPA's auditing offers because the blockchain is intrinsically verifiable and evidence towards change.

Background of the work

In public verification systems, after data outsourcing, the user sets a verification period (i.e., the frequency at which the auditor does the verification). The auditor then verifies the accuracy of the data that was outsourced at the proper time. Actually, a verification report with multiple verification outcomes is produced by the auditor. In the event that the verification result is "Reject" at any point in time, the auditor is required to promptly notify the user because this suggests that the data may have been altered. In the event that it isn't, the auditor generates a verification log and provides it to the user at the end of every epoch. The user can designate an appropriate time for the auditor to carry out the data integrity verification, as the auditor can do so even in the absence of the user's involvement. Cloud auditing may be more convenient for auditors, but there are still issues with internal and external data security that need to be taken into consideration. Currently, the "cloud audit platform" is in charge of the centralized management of audit data collection, storage, transmission, sharing, and analysis. The public key is the foundation of most public verification systems. Infrastructure (PKI), in which the auditor must select the appropriate public key for verification by managing the user's certificate. These schemes thus encounter the costly and time-consuming certificate management issue, encompassing certificate distribution, revocation, storage, and verification.

Blockchain based Data Storage with Verifiable Data Auditing in Cloud

Ensuring the integrity and security of the auditing process is crucial when using a Third Party Auditor (TPA) for blockchain-based cloud data auditing. A strong TPA verification technique that includes secret key distribution and verification methods has been put in place to reduce the possibility of any user engaging in potentially harmful activity. Here, a network storage service verification method in a cloud system is designed using verifiable tags to enable customers to check the accuracy of outsourced data in batches, therefore lowering the overhead associated with the service verification stage. Introduce blockchain technology here as well, as it will provide reliable public audits. The user uses several CSPs to outsource his data. Next, in order to develop integrity information for data auditing, users and CSPs collaborate. The user produces a challenge nonce at random during the auditing phase, and CSPs are required to produce an integrity proof in response based on the designated data blocks. For the purpose of batch data integrity verification, the resource-constrained user can combine all CSP replies into a single value by using the TPA (Third Party Auditor), a specific cloud service provider that oversees several CSPs. Every interaction between these parties is documented on the blockchain, and in the event of a service dispute, the blockchain's smart contract is able to reliably and automatically identify infractions based on the records. The smart contract will ask the untrusted organizer to locate the malicious service providers in the event that there is data corruption. In order to assist low-income consumers, the suggested plan also promotes public auditing with the use of a TPA (Third Party Auditor). The suggested technique is more effective than the current schemes that are made to handle both public auditing and deduplication simultaneously, and it also satisfies the basic security requirements. Additionally, the suggested method implements secure data distribution features in a verifiable way. The procedures for key sharing and user requests are made to improve data integrity during transmission. The proposed blockchain based data storage with verifiable data auditing process has following modules,





Blockchain Storage

The data storage solution uses blockchain-based cloud storage technology to facilitate safe sharing and storing. In this lesson, create a local cloud and provide adequate storage services at a reasonable cost. The main transactions in the medical blockchain are data storage and access control. It would be great to have access to all medical data stored on the blockchain. Once they have space accessible in the cloud, users can upload and exchange data. This work implements cloud storage in a highly safe way by utilizing block chain technology. The cloud service provider controls the cloud server, which provides cloud storage services. It has a substantial quantity of storage capacity in addition to powerful computing capabilities.

User Enrolment

Before being able to access the system, a user must first register. Thus, a new user has to authenticate them and register with the system before they may request a server. In a straightforward authentication procedure, a user provides credentials, like their user ID, to prove they are the rightful owner of the ID. The file may be uploaded to the cloud by the data owner. The moment the file is saved to the cloud, it will become encrypted.

Data Block Creation

One kind of digital data storage concept is a blockchain. Because these blocks are linked together, the data within them is immutable. Once a data block is linked to other blocks, its data cannot be changed. It will always be available to the public for anyone who wants to view it, just as it was when it was first put to the blockchain. Features of blockchain technology can be used by the hashing crypto method, which helps create a suitable and reliable hashing code and transforms data from bits of fixed size to strings of characters. A transaction is collectively hashed prior to being uploaded to a blockchain. Hash pointers store previously hashed data that cannot be disputed, connecting each block to the one before it. Changes made to the blockchain transaction's hashing function will therefore affect all associated blocks and change the character hash string.

TPA Key Verification

This auditing technique establishes a clear and secure system to verify the legitimacy of audit requests. A shared secret key between the auditor and the server allows for mutual authentication. When an auditing request is sent, the server confirms the auditor's secret key to ensure the request is legitimate. If the key is accurate, showing that the request is authentic and allowed, the server processes the auditing request and executes data auditing operations to ensure compliance, security, and integrity. Instead, if the key is incorrect, the server flags the possible illegal or unauthorized endeavor and promptly alerts the relevant data owner of an illegal auditing procedure. This message serves as an alert, allowing the data owner to investigate the situation as soon as feasible, take the necessary steps, and minimizes any potential security risks or breaches. This method uses key authentication to safeguard the confidentiality of the auditing process and provides a robust system to detect and resolve any unwanted access attempts that may arise during the auditing phase.

Data Auditing

The user gains from TPA. When data corruption is found, it promptly notifies the user and cloud server of the verification results. Information sharing between TPA and other parties is validated. The user chooses how long the verification procedure takes. Prior to sending the challenging message to the cloud server for a time when the data integrity should be confirmed, TPA extracts the hash values of "successful blocks that are the latest ones confirmed on the blockchain," where "denotes the number of blocks deep used to confirm a transaction." After getting the challenging message, the cloud server computes the corresponding proof. TPA checks the validity of the proof in order to validate the data integrity. In the event that the checking is not successful, TPA alerts the user that the data may be contaminated.

SECURE DATA SHARING

The most crucial part in the data sharing idea is the storage server. The enormous volume of data is stored in the storage data. This data is kept safe on a server for storage. Together with the key used to encrypt data, it also stores





encrypted data. The user sends queries to the storage server when he needs his data. For the purposes of encryption and decryption, two keys are used. It is possible to share data securely. Authorized users are required to supply the relevant secret key for decryption when they request access to the encrypted data. Throughout the process, the cloud service maintains end-to-end security by retrieving the encrypted data, decrypting it with the supplied key, and delivering the plaintext data to the user. By distributing secret keys and using encryption to share data in the cloud, this method improves data security and privacy while lowering the possibility of illegal access or data breaches.

METHODOLOGY

Blockchain Technology

Blockchain is a decentralized, reliable, publicly accessible ledger of transactions over which no single person has total control. An rising amount of encrypted transaction data records are managed by this distributed database, which keeps them apart from other records to prevent alteration and manipulation. Consortium, private, and public blockchains are the three types that exist. The blockchain's cornerstone is the block. Each block has a header and a body that contains the transactions that are being written to the system. The timestamps for the block and the transactions are contained in the block's header, together with information about the block such as its prior hash, nonce value, and difficulty. It is estimated that the block's length varied from 1 to 8 MB. The header of the block to be inserted is the only thing that identifies it.

Each block in a blockchain is made up of the following headers.

Previous Hash:

This hash address identifies the preceding block.

Transaction Details:

Details about each transaction that needs to happen.

Nonce:

A random number assigned by cryptography to distinguish the block's hash address is known as a nonce.

Hash Address of the Block:

The transaction data, the nonce, and the previous hash are sent via hashing. This method yields a unique output known as the "hash address," which is a 256-bit value with 64 characters in length. As a result, it is referred to as the block hash. Many people use computer methods that satisfy predetermined criteria in an attempt to determine the correct hash value. Once the predefined condition is satisfied, the transaction is finished. To put it simply, blockchain miners attempt to solve a challenging mathematical challenge known as the proof of work problem.

Block and Hash Generation

1. A Block that includes details on current transactions.
2. Each piece of data produces a hash.
3. A hash is a combination of letters and integers.
4. Transactions are recorded in the chronological order that they took place.
5. The hash is based on both the hash of the most recent transaction and the hash of the one before it.
6. The hash is completely altered by each change made to a transaction.
7. To check that a transaction has not been altered, the nodes look at the hash.
8. If the majority of nodes approve a transaction, the transaction is included to the block.
9. The Blockchain is composed of separate blocks, each of which has a connection to the one before it.
10. A blockchain functions because copies of it exist on several computers, each with a copy of it.





CONCLUSION

In conclusion, a complete solution to improve the security and integrity of stored data is presented via the integration of blockchain technology into cloud data storage systems, Third-Party Auditors (TPA), and a strong secret key verification method. The project guarantees an unchangeable ledger that documents all transactions and alterations to the files that are kept by utilizing the decentralized and unchangeable characteristics of blockchain technology. By adding another level of monitoring, TPA ensures that data integrity can be independently and transparently audited without jeopardizing privacy. In order to further protect the system from harmful access, the secret key verification procedure makes sure that only authorized entities can interact with the TPA for auditing purposes. Thus, the project tackles the complex issues of data integrity and privacy in the digital environment by integrating blockchain, TPA, and secret key verification to create a dependable and safe framework for cloud data storage. Moreover, it offers secured and safe data exchange with enhanced secrecy and integrity.

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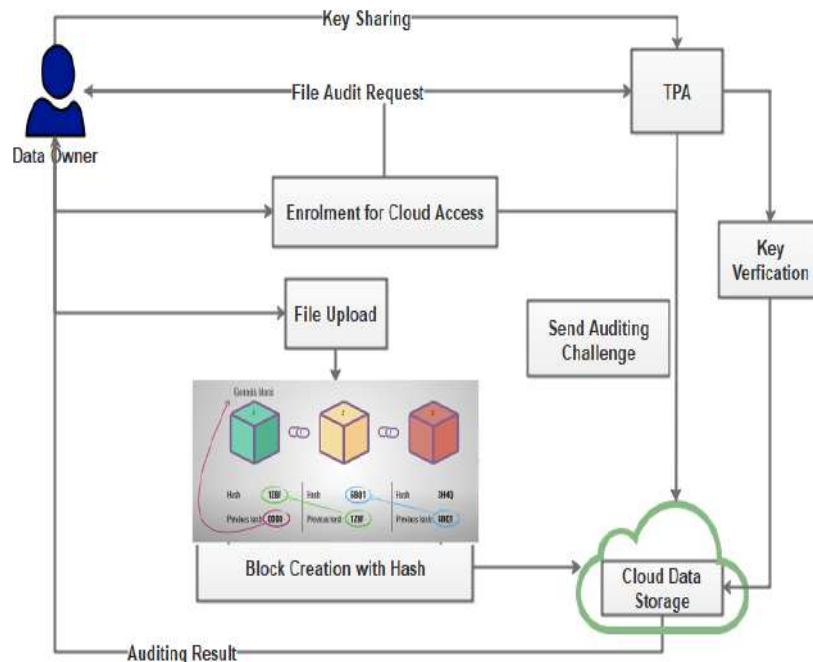


Fig 1: Proposed Framework





Next-Generation Firewalls: Advancements and Challenges in Network Security

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Received: 21 Feb 2024

Revised: 03 Mar 2024

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ABSTRACT

Next-Generation Firewalls (NGFWs) revolutionize network security with features like Deep Packet Inspection, Application Control, and Threat Intelligence integration. These advancements enhance visibility and proactive threat mitigation. Challenges include complexity, potential performance impact, and adapting to evolving threats. Organizations must weigh the benefits against the challenges, ensuring skilled personnel and a proactive security approach for optimal NGFW implementation in dynamic network landscapes.

Keywords: Next-Generation Firewalls (NGFWs), Network security, Deep Packet Inspection, Firewall Technology.

INTRODUCTION

Next-generation firewalls (NGFWs) address the evolving landscape of cyber threats faced by organizations, surpassing the limitations of traditional firewalls. Unlike their static rule-based counterparts, NGFWs offer advanced security features like intrusion prevention, application control, user identification, and encrypted web traffic inspection. Operating beyond port and protocol filtering, NGFWs safeguard networks from sophisticated attacks targeting applications, users, and devices. These firewalls integrate with endpoint protection, access management, and event management systems, providing a cohesive defense against cyber threats. NGFWs adapt to modern workplace dynamics, supporting hybrid models, cloud computing, and zero-trust architectures. Compatible with various network topologies, including SD-WAN, VPNs, and cloud-based firewalls, NGFWs ensure consistent and



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scalable security. This paper surveys the progress and challenges in NGFW development, highlighting their critical role in contemporary network security. It explores technologies, compares leading products, and discusses both the benefits and challenges of NGFWs, concluding with recommendations for network security practitioners and researchers [1].

Basic idea behind a firewall

A security defensive tool used in computer network security is the firewall. It's used between the intranet and the extranet. It is acknowledged that the former is a secure network. It is determined that the latter network is comparatively less secure. Hardware and software make up the firewall. The firewall is the sole device through which connectivity between the intranet and extranet can and should go. The most fundamental security measure for network information is a firewall. It is really protective. At the same time, by obtaining the security policy control (approval, rejection, monitoring, and so on), the information flow into and out of the network can be released and intercepted. An analyzer is what a firewall is... possess the ability to evaluate the information flow. Additionally, you can filter the studied information flow using a separator. It also serves as a limiter, limiting the flow of data that is flagged as dangerous. Denying access to the network, authorize secure information flow into the intranet. Give the go-ahead for safe data to enter the intranet. It can therefore successfully safeguard network security. Make sure the intranet is secure. In the past, firewalls used as building partitions to stop fires from spreading. This is expanded to safeguard a protective wall's internal network security. From a physical perspective, every firewall may have a different physical implementation. However, it typically combines a number of hardware (hosts, routers) and software components. In essence, a firewall is a protective tool. be employed to safeguard the credibility of users, resources, and network data[2].

OVERVIEW OF NEXT-GENERATION FIREWALLS (NGFWs)

NGFW Architecture

Next-Generation Firewalls (NGFWs) are made to overcome the shortcomings of old firewalls and offer sophisticated security capabilities. Deep Packet Inspection (DPI) is a tool used by NGFWs to examine network traffic and spot any threats. NGFWs may examine packet contents and determine the application, protocol, and user data thanks to DPI. Based on the traffic context, security judgments are then made using this information. An application and protocol decoding engine that carries out DPI is the foundation of NGFWs. The purpose of the firewall and NAT rules is to control the flow of IPv4 and/or IPv6 application traffic between different hosts, servers, subnets, and networks. NGFWs can be implemented using a variety of methods, including cloud-based, software, and hardware[3].

NGFW Features

Beyond typical firewalls, Next-Generation Firewalls (NGFWs) offer enhanced security features. Among the main characteristics of NGFWs are:

- i) Application Awareness and Control: NGFWs are able to recognize and manage traffic according to the particular application that is being used, such BitTorrent, Facebook, or Skype.
- ii) Intrusion Prevention: By examining network traffic and spotting malicious activity, NGFWs are able to identify and stop network attacks.
- iii) Virtual Private Network (VPN): Through the internet, NGFWs can offer safe remote access to business networks.
- iv) Anti-Virus: NGFWs are capable of checking network traffic for malware and viruses.
- v) Inspection of Encrypted Web Traffic: NGFWs are capable of examining encrypted web traffic in order to identify and stop attacks[4].

NGFW Deployment

NGFWs offer diverse deployment options tailored to organizational needs and specific traffic security demands. These encompass:

- i) Hardware-based NGFWs: Physical appliances installed on-site, delivering robust security for extensive network infrastructures.





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- ii) Software-based NGFWs: Software applications deployable on servers or virtual machines, offering security solutions suited for smaller network environments.
- iii) Cloud-based NGFWs: NGFWs hosted in the cloud, designed to safeguard cloud infrastructures, remote access points, and Internet of Things (IoT) devices.
- iv) Moreover, NGFWs exhibit versatility in their deployment architectures, including centralized, distributed, combined, and isolated configurations. The choice among these architectures is contingent upon the organization's unique requirements and the nature of the traffic necessitating protection[4].

ADVANCEMENTS IN NEXT-GENERATION FIREWALLS

In order to enhance network security, Next-Generation Firewalls, or NGFWs, have seen a substantial evolution in recent years. They now integrate cutting-edge technology like artificial intelligence (AI) and machine learning (ML) algorithms. The following are a few recent developments in NGFWs:

- **Advanced threat prevention and detection:** To effectively block and identify known and undiscovered threats, NGFWs can integrate complex threat detection methods like machine learning, behavioral analysis, and AI-driven algorithms.
- **Cloud integration:** With the rising adoption of cloud services, NGFWs are projected to connect more easily with cloud environments, ensuring continual privacy policies and security for both on-premises and cloud-based assets.
- **SSL/TLS Inspection:** NGFWs should be able to perform better SSL/TLS inspection as encryption becomes more widely used. To find dangers concealed in encrypted communication, they can examine and decipher encrypted communications.
- **Zero Trust Network Access (ZTNA):** NGFWs are required to support the Zero Trust Model, which does not just rely on perimeter-based security, but rather grants access based on user verification and other contextual criteria[5].

CHALLENGES IN NEXT-GENERATION FIREWALLS

Next-Generation Firewalls (NGFWs) have undergone substantial advancements, incorporating sophisticated technologies like Artificial Intelligence (AI) and Machine Learning (ML) algorithms to enhance network security. However, despite these improvements, NGFWs still encounter various challenges that necessitate attention:

1. **Complexity:** NGFWs represent intricate systems, demanding skilled personnel for effective management and maintenance. The intricate nature of NGFWs introduces the risk of configuration errors, potentially leading to security vulnerabilities.
2. **Performance:** Resource-intensive in nature, NGFWs can impact network performance, especially when handling encrypted traffic. The processing of encrypted data poses a notable challenge and can result in performance issues.
3. **Scalability:** Scaling NGFWs, particularly in expansive and intricate networks, can pose difficulties. Additionally, incorporating new features and functionalities may exacerbate scalability issues.
4. **Interpretability:** NGFWs generate a substantial volume of alerts and logs, creating challenges in interpretation and analysis. This phenomenon can contribute to alert fatigue, making it arduous to differentiate genuine threats from false positives.
5. **Adaptability:** The adaptability of NGFWs to dynamic threats and evolving network environments is crucial. Ensuring the capability to detect and respond to new and emerging threats becomes paramount for maintaining effective network security[6].

COMPARISON WITH TRADITIONAL FIREWALLS

Traditional firewalls and Next-Generation Firewalls (NGFWs) serve as distinct types of network security devices designed to safeguard against cyber threats. While conventional firewalls offer state full inspection of both incoming and outgoing network traffic, relying on criteria such as state, port, and protocol, NGFWs go a step further by



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incorporating supplementary functionalities. These include features like heightened application awareness and control, integrated intrusion prevention, deep packet inspection, and the integration of cloud-based threat intelligence. The disparities between traditional firewalls and NGFWs encompass these additional capabilities and advancements in security measures: Conventional firewalls lack the sophisticated features of NGFWs, but they are less complicated and resource-intensive. Although NGFWs require more resources and are more complicated, they offer stronger protection and are more flexible against changing threats[7].

FUTURE TRENDS IN NGFWS

The NGFW market is undergoing rapid evolution with emerging trends aimed at addressing network security challenges. Key developments include:

1. **Corporate Network Shifting to the Internet:** Enterprises are increasingly adopting the internet as their corporate network, introducing new risks. NGFWs play a crucial role in defending against internet-based threats. They need to continually gather threat information from various network sources to ensure the latest security updates.
2. **Transformation of Enterprise WAN Edges:** The move away from traditional perimeter hub-and-spoke models has led to the creation of a new enterprise WAN edge. With branches requiring cloud access located where traditional cable/DSL may not be available, NGFWs with Software-defined Wide Area Network (SD-WAN) capabilities enable organizations to route traffic directly from branch locations. This facilitates secure deployment of protocols across network edges.
3. **Escalation of Advanced Threats:** The evolving, distributed nature of networks has given rise to increasingly sophisticated threats. NGFWs are integrating machine learning (ML) and artificial intelligence (AI) to proactively predict and counter advanced threats before they materialize.
4. **Hybrid Mesh Firewall Solutions:** Traditional firewalls often specialize in specific IT areas, necessitating separate cyber security solutions for corporate sites, public/private cloud environments, and remote workers. Hybrid mesh firewalls are emerging as a unified security platform that delivers high performance and seamlessly integrates with other security controls throughout the network. This solution addresses the challenge of managing diverse security needs across various IT domains.
5. In summary, NGFWs are adapting to the changing landscape of network security by addressing challenges posed by the reliance on the internet, transforming WAN edges, combating sophisticated threats through AI and ML, and introducing unified security platforms like hybrid mesh firewalls to streamline security management across diverse environments[8].

NGFWS USE CASES

Next-Generation Firewalls (NGFWs) serve diverse purposes across various scenarios. Examples of their utility include:

- Facilitating secure operation of essential applications within Enterprise Networks: NGFWs excel in detecting and countering attacks on enterprise applications, ensuring the enforcement of application-specific controls. They conduct thorough monitoring of application data, content, and protocols like HTTP, HTTPS, SMTP, enhancing overall protection.
- Robust defense against both known and unknown threats: NGFWs offer precise controls for network applications. Through deep packet inspection and real-time stateful inspection of applications, they provide formidable defense against a spectrum of threats targeting web applications.
- Providing comprehensive visibility into users, hosts, applications, and content on enterprise networks: NGFWs conduct audits on running applications, monitor content and data, identify hosts supporting applications, and recognize users associated with those applications. A single NGFW consolidates functions such as firewall capabilities, IPS/IDS, NAC, gateway antivirus, and email filtering.
- Serving as a network security platform with high performance and seamless integration with other security controls: NGFWs exhibit scalability and can incorporate threat intelligence feeds for immediate threat blocking. They seamlessly integrate with advanced security solutions such as sandboxing, malware protection, CASB, and more.



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- Ensuring security for cloud environments, remote access, and IoT devices: NGFWs can be seamlessly deployed in cloud environments, extending security measures to cover cloud operations, remote access points, and Internet of Things (IoT) devices[9].

NGFWs SUCCESS STORIES: CASE STUDIES IN CYBER ATTACK PREVENTION AND NETWORK PROTECTION

Here are some case studies on how organizations across different industries are employing Next-Generation Firewalls (NGFWs) to solve their network security challenges:

VR Group

Finland-based VR Group installed a next-generation firewall from Forcepoint to create high-speed network architecture, enabling zero-touch deployment and remote access to the IT staff for each train. With the NGFW, VR could connect with all three mobile operators simultaneously, ensuring high bandwidth and reduced network drops.

Pague Menos

Brazil-based Pague Menos is one of the country's largest pharmacy retail chains with 1,600 stores and over 25,000 employees. Pague Menos worked with Fortinet to deploy a next-generation firewall that could provide secure connectivity between its headquarters and stores, as well as protect against cyber threats. The NGFW also enabled Pague Menos to monitor and control network traffic, ensuring compliance with regulatory requirements.

Bausch Health

Bausch Health, a global pharmaceutical company, worked with Palo Alto Networks to deploy a next-generation firewall that could provide advanced threat protection and secure connectivity across its global network. The NGFW also enabled Bausch Health to monitor and control network traffic, ensuring compliance with regulatory requirements.

ENT Credit Union

ENT Credit Union, a financial institution based in Colorado, worked with Fortinet to deploy a next-generation firewall that could provide advanced threat protection and secure connectivity across its network. The NGFW also enabled ENT Credit Union to monitor and control network traffic, ensuring compliance with regulatory requirements.

Globe Telecom

Globe Telecom, a telecommunications company based in the Philippines, worked with Fortinet to deploy a next-generation firewall that could provide advanced threat protection and secure connectivity across its network. The NGFW also enabled Globe Telecom to monitor and control network traffic, ensuring compliance with regulatory requirements[9].

CONCLUSION

Next-Generation Firewalls (NGFWs) and network security are experiencing a changing environment with new developments, difficulties, emerging trends, and flexible use cases. Modern technologies like deep packet inspection and artificial intelligence are being included into NGFWs to improve their granular control and strong threat detection. Nonetheless, difficulties still exist in striking a balance between security and performance, integrating with various network components in a smooth manner, and handling the complexity of encrypted communication. As we look to the future, NGFWs will likely adopt trends like quantum-safe security measures, enhanced cloud integration, and the Zero Trust Network Access (ZTNA) architecture. Their many use cases include providing complete visibility, defending against known and undiscovered threats, and protecting enterprise networks. NGFWs continue





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to be essential in protecting networks from the constantly changing cyber threat landscape as businesses navigate this complex environment.

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Table 1. The differences between traditional firewalls and NGFWs.

Feature	Traditional Firewall	Next-Generation Firewall
Application visibility and control	Partial	Full
Layer of operation	Layer 2 to Layer 4	Layer 2 to Layer 7
SSL/TLS inspection	Not supported	Supported
Reputation and identity services	Not supported	Supported
Complete package of security technologies	No	Yes
Scalability	Difficult	Easy
Performance	Can impact network performance	Resource-intensive
Complexity	Simple	Complex
Adaptability	Limited	Dynamic





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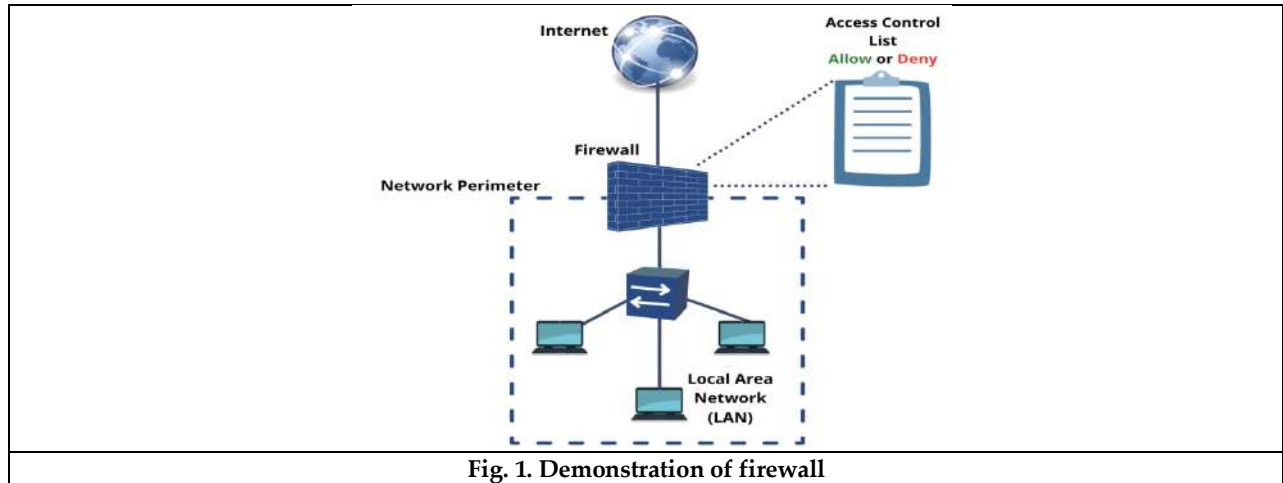


Fig. 1. Demonstration of firewall





A Survey on Flying AD-HOC Network (FANET)

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07Jun 2024

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ABSTRACT

The FANETs play a major role in the network technologies. The ad hoc network is a wireless infrastructure with fewer networks. With their rapid growth, unmanned aerial vehicles become very popular. On the other hand, they are also the target of the various threats capable of exploiting different weaknesses. The main issues in FANET are handling the communication between the nodes and preventing collision among the different devices. There is no fixed routing protocol in the FANET. This paper deals with the features of FANET, MANET, and VANET and describes the various applications of FANET. In isolation, the existing Routing Protocol has been discussed. The major challenges in the FANET are surveyed.

Keywords: Unmanned aerial vehicle (UAV), FANET, Flying Ad-Hoc Network, Routing.

INTRODUCTION

FANETs, or Flying Ad-Hoc Networks, have been increasingly popular in recent years because of their affordability, performance, adaptability, and ease of installation. FANET is an ad hoc wireless network. An ad hoc network is a distributed wireless network that runs without the need for an infrastructure. Every node in a wireless ad hoc network functions as a router, sending data packets to other nodes based on requirements. It is divided into three categories: MANET, VANET, and FANET. Mobile Ad hoc Networks, or MANETs, are networks that link mobile nodes without any infrastructure [1]. Vehicle Ad hoc Network, or VANET, is the name of the wireless network that links moving and stationary automobiles. Unmanned aerial vehicle (UAV) is capable of operating remotely or on its



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own without the need for human personnel [2]. There are now two different kinds of UAV systems: single and multi-UAV systems. There are some advantages of multi UAV systems over a single UAV system [3].

- Higher Speed: It has been demonstrated that using several UAVs to perform missions might result in advantages over using a single UAV system, including speedier completion times.
- Expensive: Small UAVs are far less expensive to install and maintain than large UAVs .
- Greater scalability and Flexibility: The coverage rate of a single UAV is low due to its limited coverage area . Multi-UAV systems, however, are easily able to adjust to the circumstances.
- Enhanced ability to survive: In single UAV, if the UAV fails then the mission fails. Whereas the multi UAV is able to survive with another UAV. And there are many issues in multi UAV system compared to the single UAV system. The challenges in multi UAV system are communication between the UAV, energy constraints.

APPLICATION SCENARIOS OF FANET

Due to rapid growth in technology, UAVs have become popular for monitoring, rescue, and surveillance applications [4].

Infrastructure Inspection and Maintenance

UAVs equipped with various sensors can conduct regular inspections of critical infrastructures such as bridges, roads, buildings, and utility lines. It helps to identify maintenance needs before they become major issues and enhance the safety and longevity of urban infrastructure.

Emergency Response and Disaster Management

It can rapidly assess disaster-stricken areas, provide real-time situational awareness to emergency responders, and help coordinate rescue operations. They can also assist in identifying evacuation routes and locating survivors.

Traffic Management and Monitoring

UAVs can monitor traffic flow, congestion, and accidents from above, providing real-time data to optimize traffic management and improve urban mobility. This data can be integrated into the traffic management system to enhance route planning and reduce congestion.

Surveillance and Security

It can enhance public safety by monitoring public spaces, detecting suspicious activities, and providing real-time surveillance to law enforcement agencies. They can be deployed during large events to ensure safety and security.

Waste Management

It can monitor the waste collection points, optimize waste collection routes, and identify overflowing bins, contributing to efficient waste management practices in urban areas.

Public Services and Connectivity

The UAV can serve as temporary communication relays to extend network coverage in weak or disrupted connectivity areas. This can be particularly useful during emergencies or in densely populated areas.

DIFFERENT BETWEEN FANET, MANET AND VANET

The major differences between FANET, MANET, and VANET are based on the capability, performance, and connectivity of the nodes, link of the nodes, power consumption, and computational power.

Node Mobility

In Manet, the nodes move in the definite area, and in VANET, nodes move on the road. Whereas in Multi-UAV nodes are visible in the sky. When compared to the VANET, the movement of MANET nodes is relatively slow. The mobility levels of nodes in FANET are very high compared to VANET and MANET. According to [5], a UAV has a 30–460 km/h speed.



**Node Density**

The density of nodes per unit area can be defined as the normal number of nodes in a given region. A. FANET nodes usually move in the sky and UAVs could range from several kilometers to a few miles, even for small multiUAV systems. Consequently, the density of a node in FANET is very low compared to VANET and MANET.

Topology

The UAVs are connected to the ground station. The Multi-UAV collects the information and passes the data to the ground stations. The FANET topology is changing due to an increase in mobility level and more frequently than the MANET and VANET topology. When the single UAV fails, the communication path between the UAV also fails [6].

ROUTING PROTOCOL

Routing is the process of identifying the shortest path to deliver the data from source to destination. Efficient route for higher dispatch ratio, less delivery time, fewer control messages, smaller number of relay nodes, etc [7].

Classification of Routing Protocols in FANET

There are many routing protocols used in most of the ad-hoc network. They are Static, Proactive, Reactive, Hybrid, Position and Hierarchical protocol.

Static Routing protocol

In Static routing protocol, once the routing table is defined and updated in the UAV nodes, then the routing table cannot be updated during the process. Static Routing protocol has a constant routing table that cannot be changed dynamically. If the single UAV fails or the ground station fails during the operation, then the operation cannot be updated or altered in the table dynamically. It has to be waiting until the operation is completed [8]. There are three different types of static routing protocols, they are

1. Data-Centric Routing protocol (DCRP)
2. Load Carry and Deliver Routing Protocol (LCAD)
3. Multi-Level Hierarchical Routing Protocol (MLHRP)

Proactive Routing Protocol

Proactive routing protocol is also called Table Driven routing protocol in which each UAV node separately carries the routing table that stores information about every UAV node. The routing table information is updated dynamically during the operations. If the link fails during the process, then each node has to update the routing table. As a result, it causes delays in the network and is slow. There are three types of Proactive Routing Protocols. They are

1. Directional Optimized Link State Routing (DOLSR)
2. Destination Sequence Distance Vector (DSDV)
3. Topology Broadcast Based on Reverse Path Forwarding (TBRPF)

Reactive Routing Protocol

A Reactive Routing Protocol is also defined as a demand routing protocol. As the name suggested, based on the demand the routing table is created. It works on Route-Request and Route-Reply messages. The source node will transfer the message along with the Route-Request message and the destination node will acknowledge the message with Route-Reply messages. As a result, it takes a long time to transfer the data from source to destination, which may cause high latency [9]. The three types of Reactive protocols are,

1. Dynamic Source Routing (DSR)
2. Ad-hoc On-Demand Vector Routing (AODV)
3. Time slotted On-Demand Routing (TSOD)





CONCLUSIONS

This paper discussed the features of UAVs and their applications and also discussed the difference between FANET, MANET, and VANET. FANET in the terms of node mobility, density and topology. The existing and different routing protocols and algorithms to find the shortest and most efficient path between the sources to the destination. The major issues in the FANET are communication between the nodes.

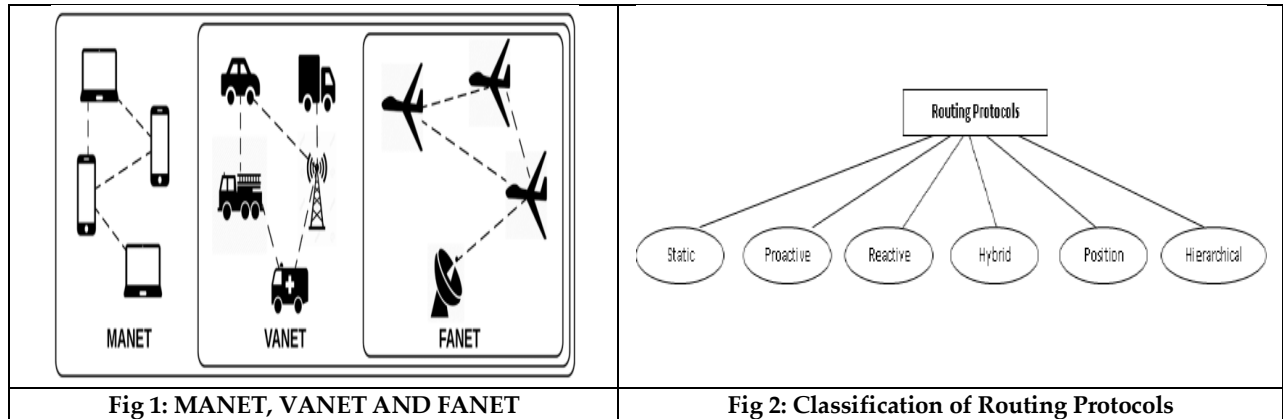
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Table 1: Comparison between MANET, VANET and FANET

Parameters	MANET	VANET	FANET
Node Mobility	Low	High	Very High
Node Density	Small	Regular	Random
Topology	Low	Medium	Very High
Energy Consumption	Medium	Low	High
Cost of Production	Cheap	Expensive	Very Expensive







Conjunctival Image Analysis for Non-Invasive Anemia Detection & Hemoglobin Estimation

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Received: 21 May 2024

Revised: 20 Jun 2024

Accepted: 28 Jun 2024

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ABSTRACT

Mean hemoglobin concentration (MCHC) serves as a vital biological indicator for detecting various abnormalities, notably anemia, wherein the World Health Organization characterizes it as a condition marked by lower-than-normal hemoglobin levels in red blood cells. Anemia, affecting roughly 50 percent of India's populace, poses a significant health concern. Present clinical methodologies for hemoglobin assessment often prove invasive and resource-intensive, particularly in low-resource settings. This article proposes a non-invasive method employing conjunctival pallor and image analysis techniques. Leveraging conjunctival pallor, prevalent among anemic individuals, standard eye camera images are utilized to extract features like color and texture for paleness measurement. These features are then uploaded into an artificial neural network to determine heme concentration. This approach presents a promising avenue for anemia screening, particularly in resource-constrained regions, potentially enhancing health outcomes by offering accessible and accurate screening methods in areas with high anemia prevalence.

Keywords: Non-invasive Detection, Conjunctival Pallor, Hemoglobin Concentration, Image Analysis, Artificial Neural Network.

INTRODUCTION

Millions of people worldwide suffer from anaemia, which is especially problematic in areas with poor access to resources. Since the analysis of anaemia depends on exact measurements of hemoglobin levels in the blood, which should ideally be both accurate and accessible, the capacity to detect anaemia effectively is critical. In the past, diagnosing anaemia has required intricate processes which includes drawing blood for external study. They cannot



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be applied by limited resources as they require special equipment and experienced personnel. Point-of-care testing is a simple method designed to solve this problem. The following tests are quick and inexpensive and usually use a blood sample taken from the thumb [5]. They may require some medications and pose an infection risk to healthcare workers. Complete blood count (CBC) is also considered as the standard for determining hemoglobin level. This thorough study is difficult to conduct in areas with limited resources because it requires expert workers, specialized equipment, and access to laboratory facilities. Furthermore, some populations, including children may find the procedure of collecting blood particularly frightening as they may feel uneasy and anxious. This may make it more difficult to diagnose anaemia and manage it thereafter.

Recent developing technologies are being collaborated with innovative medical strategies offer promising opportunities for improving anaemia screening and therapy. One such emerging technology is creating an unexpected ally in the fight against anaemia: the conjunctiva, a thin membrane covering the eyelids' inner surface. Changes in conjunctival color, known as conjunctival pallor [6], have been identified as potential indicators of anaemia provides important information about the health of human blood..By leveraging the absence of melanocytes in the conjunctiva, which renders blood hemoglobin as the primary source of its coloration, the concept of an "erythema index" (EI) is introduced [7]. This index, derived from analysing the red and green components of digital photos, assists as a surrogate marker for hemoglobin content, enabling non-invasive anaemia detection [4][5]. Furthermore, the advent of smartphone-based telehealth technologies offers a transformative platform for remote healthcare delivery [1]. By integrating conjunctival EI analysis with smartphone imaging capabilities, our proposed technique eliminates the need for invasive blood tests, allowing for convenient, real-time anaemia screening in diverse clinical and community settings. Preliminary studies have established the relation between conjunctival EI and both clinical evaluations of anaemia and traditional blood-based diagnostic tests, validating the efficiency of our approach.

OBJECTIVES

- Utilizing non-invasive conjunctival images for the estimation of hemoglobin values.
- Analyzing RGB component values through a machine learning model using smartphone camera images.
- Obtaining hemoglobin (Hb) values within the range of 8 to 20.
- Developing the capability to detect anaemia based on obtained hemoglobin (Hb) values and threshold levels for different genders.

RELATED WORK

Suner S et.al [1] describes Hemoglobin level is usually measured invasively with different devices using the blood sample. In the physical interpretation, some signs are traditionally used. These signs are the palms, face, nail beds, pallor of the conjunctiva, and palmar wrinkles. This paper substantiates that conjunctival pallor can yield more operative results in detecting anaemia than the pallor of the palms or nail beds. This observation provides image-based diagnostics, which uses digital images and image processing algorithms to examine the color of the conjunctiva. By quantifying the erythema index, which measures the red and green light absorption in conjunctival images, these methods offer a promising, non-invasive alternative to traditional blood tests, providing an accessible and cost-effective solution for anaemia screening, especially in resource-limited settings.

Manisha Das et.al [2], illustrates a non-invasive procedure such as digital photographs of palpebral conjunctiva, Hb color and texture features which is done with imaging technology to measure the Hb concentration in the patient's blood. These relevant features leading to the generation of the images of palpebral conjunctiva of the patient were extracted. According to the recommendations of the WHO, this study compared the output quantity to be measured to the value of the quantity measured by the standard method (considered as index) by artificial neural network classifier. Moreover, the patients having lower level of Hb less than the lower limit of normal, According to the outcomes obtained from the classification, it was determined that the patients were anemic. Bryan Saldivar-Espinoza et.al [3], study aims to predict hemoglobin levels using a deep learning approach that offers a non-invasive, cost-effective and fast alternative to traditional methods. By analysing conjunctival images and demographic factors such as age, weight, height, and gender, the model aims to accurately estimate hemoglobin levels without generating



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medical waste. A combination of deep learning algorithms enables accurate predictions, which improves the analysis of various hemoglobin-related diseases. This strategy has a great deal of potential to increase access to healthcare, especially in areas with low resources where intrusive diagnostic techniques might not be feasible or available. The accuracy and efficiency predict hemoglobin levels may enable early detection and intervention of hemoglobin-related disorders, ultimately improving patient outcomes and reducing health disparities. Medha Sharma et.al [6] discusses on Anemia leads to a deterioration in the oxygen-carrying capacity of the blood. The diagnosis of anemia often commences with a clinical inspection. This is followed by laboratory tests such Complete Blood Count (CBC), reticulocyte count, etc. These tests fall under the invasive category as they necessitate injecting surgical instruments into the patient's body. Non-invasive methods are based on examination of tongue, conjunctiva, nail beds, etc. for pallor. This article is designed for a reliable, non-invasive method for diagnosing diabetes. A smartphone camera was used to capture the conjunctival area which is processed and the erythema index (EI) is generated. EI is utilized to determine whether a person has diabetes. Experiment results shows the developed device can identify small patients with high accuracy [1,7]. Francesco Maria Marino et.al [11] Nowadays, medicine frequently uses blood tests to measure hemoglobin content, which is important for diabetics who need blood. In this work, we introduce an additional non-invasive hemoglobin estimate technique based on conjunctival area image processing. Our primary objective is to provide a straightforward, user-friendly instrument that patients may use at home to assess their blood needs. Also, we describe our tool design and the process we used to determine important information from the color values of the collected images. Analysis of 77 anaemic and healthy patients showed a positive correlation between hemoglobin values calculated by our algorithm and actual results from blood tests.

METHODOLOGY

Components Required

- Smartphone
- Software – **MATLAB**

MATLAB conjunctive image analysis tools enable the comprehensive and detailed exploration and analysis of various image data sections with effortlessness.

A project aiming to determine hemoglobin concentration in human blood using MATLAB and image processing techniques. Here's a breakdown of the methodology along with key steps:

Image Acquisition: Better quality images of the conjunctiva are an important step in the availability of this method. Imaging was performed with a standard digital camera in good lighting conditions to ensure a sharp and accurate image of the conjunctiva[4]. It is important how the camera is positioned and focused so that you get clear images that can then analysed.

Image Processing: After capturing the images, preprocessing techniques are applied to enhance their quality and suitability for further analysis. This preprocessing stage involves various procedures such as noise reduction, contrast enhancement, and normalization [2]. These techniques address common issues like variations in lighting conditions and focus, ensuring that the subsequent analysis is based on clean and consistent data.

User Interface Development: Using MATLAB, to facilitate easy image selection and inspection, a user-friendly interface is developed using MATLAB. This interface allows users to visually review each captured image and discard those that do not meet quality criteria, such as poor lighting or focus issues. This manual inspection step ensures that only high-quality images are included for analysis, thereby enhancing the accuracy of the results.

Region of Interest (ROI) Selection: Users select a seed point on the conjunctiva of the eye for defining the ROI. This area is usually a normal-sized rectangle centered around the seminal point, occupying the most typical area of the





conjunctiva. The choice of the ROI is critical because it focuses the subsequent analysis on the corresponding part of image where the hemoglobin concentration data are most visible as shown in Fig. 3.

Feature Extraction: The feature extraction process analyses palpebral conjunctiva images to derive eight distinct features, crucial for diagnosing anaemia. These features include mean values of red, green, and blue color channels (Rm, Gm, Bm), representing overall color profile[4] Brightness (*Brt*) indicates luminance and tissue quality, while the Erythema Index (EI) measures redness, linked to hemoglobin presence. The *a** value, from the CIE Lab* color scale, gauges red-green axis presence. Texture features include High Hue Ratio (HHR), quantifying hue distribution, and Entropy (Ent), assessing texture complexity. These features collectively provide a detailed analysis of color and texture, aiding in predicting hemoglobin concentration through advanced machine-learning algorithms as portrayed in Fig. 5.

Machine Learning: An intelligent ML algorithm for learning when getting conjunctiva images with related Hb concentrations. This algorithm can learn the nonlinear interaction of the extracted features with Hb levels, which leads to predicting Hb concentration from a new image.

While training an algorithm, the data is divided into a training set (the set from which the model is built) and created to check fit and generality.

Model Validation: Trained machine learning models are validated using a precise set of tests to assess accuracy and robustness. This validation process allows the model to generalize correctly to new and unobserved data and depends on its predictive capabilities. Validation is important to ensure model reliability for real-world applications.

ANN for Hb Prediction: Specific features extracted from conjunctiva images serve as inputs to an artificial neural network (ANN) designed to predict Hb concentration. The ANN architecture typically consists of an input layer, a hidden layer, and an output layer. The hidden layer captures the complex nonlinear relations between the input functions and Hb concentration, and the output layer provides the predicted Hb value. [3]

Training and Validation of ANN: Training the ANN involves optimizing the weights associated with the connections between nodes to minimize prediction error. Levenberg-Marquardt's (LM) backpropagation algorithm is utilized for this purpose, offering efficient convergence and adaptation of learning rates. The training method iteratively adjusts the network weights based on input features and actual Hb concentrations until the prediction error is minimized. Validation is performed using a separate test set to ensure the model's performance on unseen data [3,9].

System Evaluation: The combined approach of image processing, feature extraction, and machine learning results in a robust system for predicting Hb concentration from conjunctiva images. The system's effectiveness is evaluated based on its accuracy, reliability, and generalizability. Performance metrics such as mean squared error (MSE) are used to take down measurements of the accuracy of the prediction [9], while verification of independent testing certifies that the system is suitable for the state truth layer.

A software algorithm automatically selects a test area within the conjunctiva. Starting from a user-chosen seed point (SP), it identifies pixels with similar color values, expanding outward like a crystallization process to include pixels matching the conjunctiva's color profile [8]. The taken-out features are fed into an ANN designed to predict Hb concentration. The ANN architecture consists of a single hidden layer. The input layer has eight nodes, each corresponding to one of the extracted features. The hidden layer is designed to capture the complex, non-linear relationships between the input features and the Hb concentration. The output layer consists of a single node that provides the predicted Hb concentration, and training the ANN involves optimizing the weights associated with the connections between nodes to minimize the prediction error.



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The Levenberg-Marquardt (LM) backpropagation algorithm is chosen for this purpose. The LM algorithm, combining features of gradient descent and Gauss-Newton methods[12], efficiently optimizes neural network training.

The LM algorithm adjusts the weights of the network to minimize the difference between predicted and actual hb concentrations, as measured by the mean square error (MSE). MSE is the metric used in this project and is defined as the error between the predicted value and the actual value. It provides a clear indication of the exactness of estimation and is particularly useful for continuous results such as hemoglobin concentration. The LM algorithm then iteratively updates these weights. In each iteration, the algorithm calculates the gradient of the error surface and adjusts the weights to move towards the minimum error. The key advantage of the LM algorithm is its adaptive learning rate [12], which accelerates convergence and avoids the pitfalls of simple gradient descent, such as slow convergence and getting stuck in local minima. Once trained, the neural network is validated on a different test set to make sure it generalizes well to new, unseen data. Your test set are images of your palpebral conjunctiva that were not part of the training phase [7]. How well the model might perform in the real world can be inferred from the performance on this test set.

The blend of feature extraction, ANN, and the LM algorithm creates a robust system for predicting Hb concentration from palpebral conjunctiva images [3]. The detailed color and texture characteristics which consists of information about the conjunctiva [7][12], while the ANN effectively models the complexity between the features and Hb concentration. The LM algorithm ensures efficient and accurate training, resulting in a reliable tool for non-invasive anaemia screening and diagnosis. This approach is particularly valuable in resource-limited settings, where traditional blood tests may be impractical or unavailable [10][13]. Using the best imaging and machine learning technologies to deliver effective, non-invasive diabetes monitoring and diagnosis, improving healthcare and outcomes.

This block diagram illustrates a process for detecting anemia using a smartphone and image processing techniques. This automated process enables the detection of anemia using non-invasive imaging and machine learning techniques, providing a convenient and accessible diagnostic tool.

- Capture an image of the conjunctiva using a smartphone camera.
- Process images to identify and extract regions of interest (ROIs) in the conjunctiva.
- Feature Extraction of Parameters such as R, G, B, and
- Analyse the ROI to extract color features (Red, Green, Blue) and brightness levels.
- Train the Model to Develop an Accurate Erythema Index in the
- Train the machine-learning model using the extracted features to create an erythema index, quantifying redness or paleness.
- Comparison of Acquired Image with Trained Model.
- Compare the structures of the new image with the trained model considering the evaluated hemoglobin (Hb) value.
- Determine the presence or absence of anaemia based on the expected Hb value. In other words, it is a "with anaemia" or "without anaemia" signal.

RESULTS

- An algorithm was designed to non-invasively obtain Hb values and associate them with the presence of anemia. Use smartphones combined with machine learning
- Techniques for analyzing photos and being capable of diagnosis of anemia.
- Use of minimum features and its suitability to quantitate Hb value followed by a diagnosis of anemia in a low-resource clinical environment.





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CONCLUSION

This study has successfully demonstrated the feasibility of non-invasive anemia detection through smartphone-based conjunctival image analysis [1]. By leveraging machine learning algorithms trained on color and texture features extracted from conjunctival images [5,7], we have developed a method that correlates well with traditional hemoglobin measurement techniques. This approach offers a cost-effective and patient-friendly alternative for anemia screening, particularly in settings where invasive methods are not practical. While the system shows promise, further research is needed to enhance its reliability and automate the image analysis process. The project lays a strong foundation for future advancements in non-invasive health monitoring technologies, with the potential to significantly impact global health outcomes. This project presents an innovative, non-invasive approach to diagnosing anemia using image processing and artificial neural networks (ANN) [2,3]. Analyzing palpebral conjunctiva images offers a cost-effective alternative to traditional blood tests [11], ideal for resource-limited settings. Leveraging digital cameras and modern algorithms, this method provides a viable anemia screening solution [12]. Advanced machine learning techniques, like deep learning, and larger, diverse datasets could further enhance accuracy and robustness. This approach represents a significant advancement in non-invasive anemia diagnosis, offering a practical and scalable solution to improve healthcare accessibility and outcomes.

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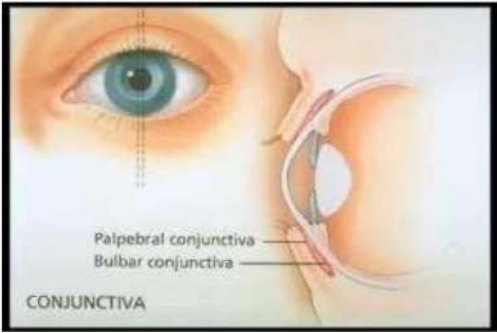

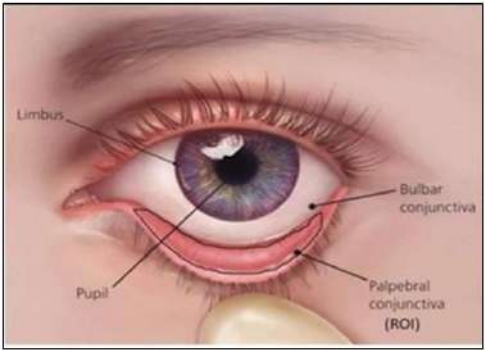



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 <p>Palpebral conjunctiva Bulbar conjunctiva CONJUNCTIVA</p>	
Fig. 1. Palpebral Conjunctival Membrane	Fig. 2. Conjunctival Pallor
 <p>Limbus Bulbar conjunctiva Pupil Palpebral conjunctiva (ROI)</p>	<p>Image Preprocessing Operation</p>  <p>Region of Interest (ROI) Extracted from Image of Eye Conjunctiva of Patient</p>
Fig. 3. Extracting the Region of Interest (ROI).	
 <p>NO PALLOR</p>	
Fig. 4. Eye Pallor	





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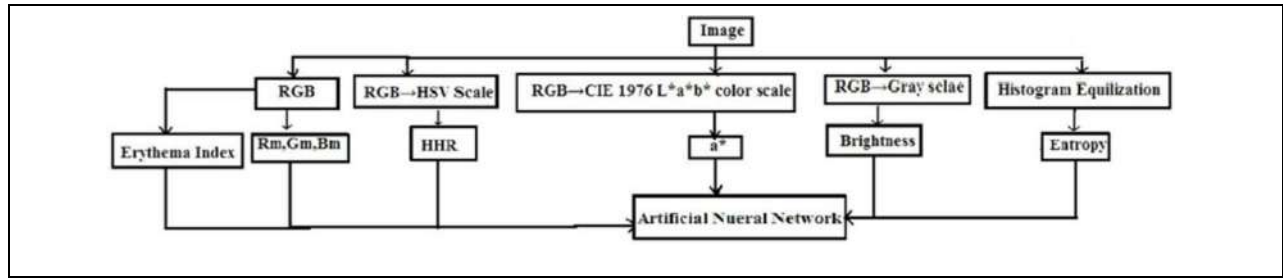


Fig. 5. Projected Algorithm for Feature Extraction

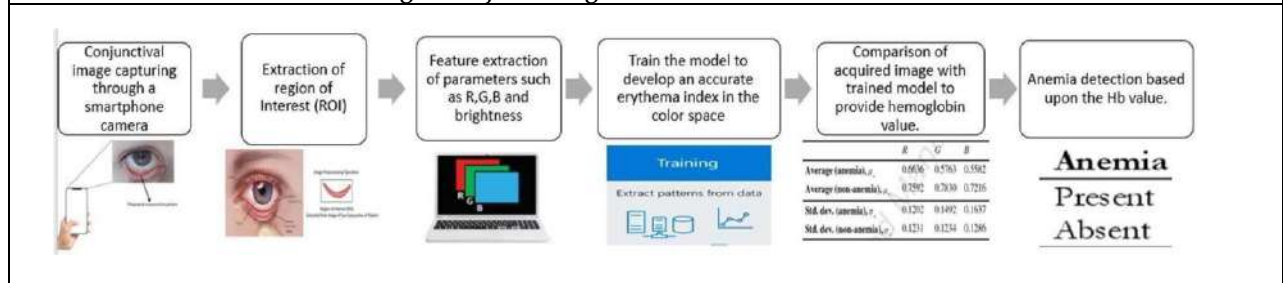


Fig. 6. Block Diagram

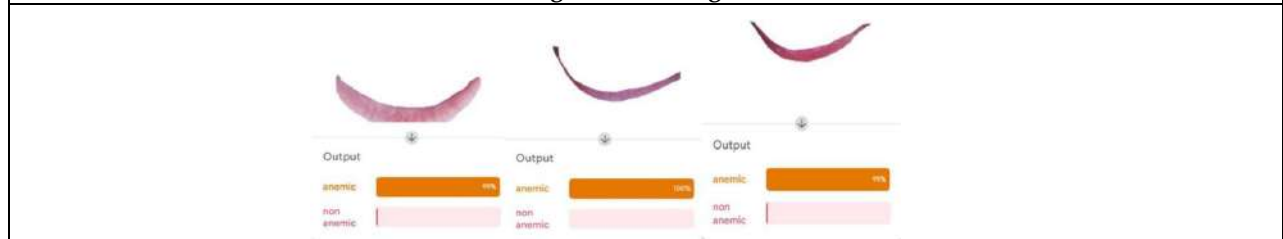


Fig. 7 Prediction of anemia assessing conjunctival paleness

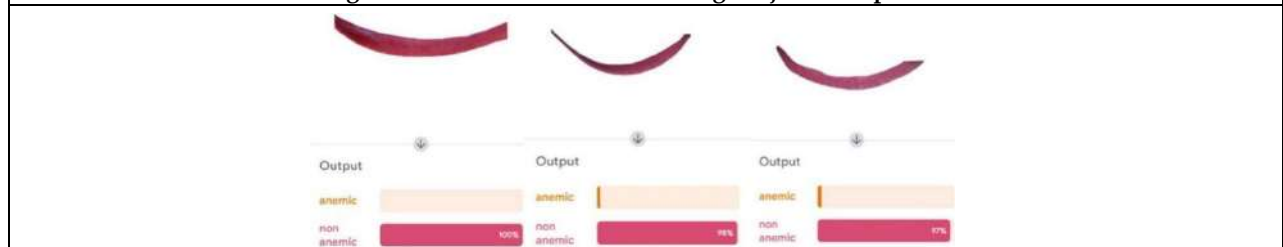


Fig. 8 Prediction of anemia absence assessing conjunctival paleness

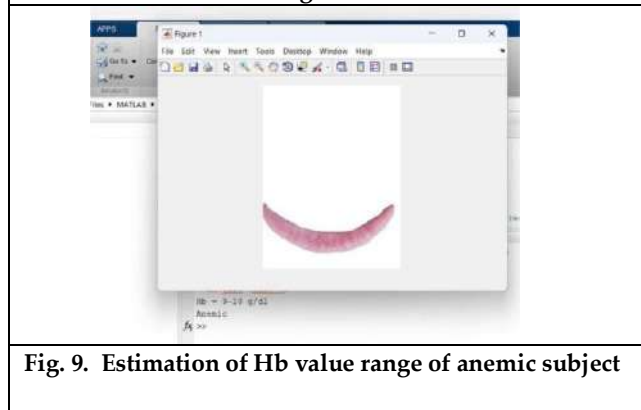


Fig. 9. Estimation of Hb value range of anemic subject

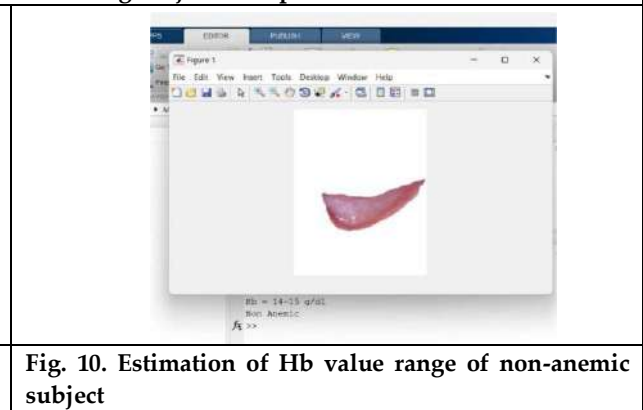


Fig. 10. Estimation of Hb value range of non-anemic subject





Advancing Healthcare: Deep Neural Networks in Medical Image Analysis - Challenges and Future Perspectives.

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07Jun 2024

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ABSTRACT

Deep Neural Networks (DNNs) have revolutionised medical image analysis, offering advanced capabilities in interpreting various imaging modalities, including MRI, CT, and PET scans. The objective is to leverage DNNs for enhanced diagnostic accuracy and efficiency. **Methods:** This review examines the application of DNNs, especially convolutional neural networks (CNNs), in medical imaging. It focuses on pattern recognition tasks like registration, localisation, classification, detection, and segmentation and discusses the integration of multimodal data. **Challenges and Future Directions:** Key challenges include the need for large annotated datasets, model interpretability, and generalizability. Future research directions involve developing more interpretable models, utilising transfer learning, and integrating multimodal data for comprehensive analysis. **Results:** DNNs have shown significant improvements in medical image analysis, aiding in disease diagnosis and treatment planning and enhancing patient outcomes. **Conclusion:** DNNs are pivotal in advancing medical image analysis towards more accurate diagnostics and personalised medicine. Overcoming current challenges and exploring new AI techniques will further enhance their clinical utility.

Keywords: Deep Neural Networks (DNNs), Medical Image Analysis, Convolutional Neural Networks (CNNs), Pattern Recognition in Healthcare, Multimodal Imaging, Diagnostic Accuracy, Image Segmentation and Localization, Personalised Medicine in Radiology.





INTRODUCTION

DNNs are a specialised category of Machine Learning, notable for their multi-layered structure of interconnected nodes.[1], [2]. These networks can model complex, nonlinear relationships in data, making them powerful tools for classification, regression, and feature extraction tasks.[6], [7]. The success of DNNs is attributed to their ability to learn and represent complex patterns in data, drawing inspiration from the construction and function of the human brain. Deep Neural Network in Medical Image Analysis[10], [12]. DNNs are capable of processing and transforming large amounts of input data into increasingly abstract features. This capacity allows them to learn intricate patterns and relationships within data.[3], [4]. They excel in various applications, including image and speech recognition, NLP - natural language Process, and medical image analysis, achieving state-of-the-art performance across these domains.[5], [8]. The hierarchical feature extraction capability of DNNs enables them to handle high-dimensional data effectively, making them well-suited for complex tasks in computer vision, healthcare, finance, and more.[9], [11]. DNNs have revolutionised multiple fields in science and technology, enabling significant advancements in areas that were once challenging for computers.[2], [5]. Their application spans diverse domains, such as computer vision, natural language processing, speech recognition, and medical data analysis.[7], [9]. By autonomously learning hierarchical representations from raw data, DNNs have opened new avenues in machine learning and artificial intelligence, tackling real-world problems with unprecedented accuracy and efficiency.[10], [12]. Deep Convolutional Neural Networks (DNNs) are a variant of DNNs characterised by their deep, multi-layered structure. These networks are particularly adept at handling tasks involving intricate and high-dimensional data, such as image and speech recognition. The convolutional aspect of these networks allows for efficient handling of spatial and temporal data, contributing significantly to advancements in fields like computer vision and natural language understanding.[7], [8], [9], [10] Figure 1 depicts a structured overview of the application of deep learning in medical imaging [1]. It is organised into three main layers, each representing a different aspect of the application process: Pattern Recognition Tasks: This is the topmost layer, showing various tasks that deep learning models perform in medical image analysis. These include: Registration: Aligning different images into a common coordinate system.

Classification: Categorising images into predefined classes.

Segmentation

Dividing images into segments to isolate specific regions of interest.

Detection/Localisation

Identifying and determining the exact location of objects or features within an image.

Anatomical Regions

This middle layer categorises medical images based on the body part or system being imaged. It lists several key anatomical regions that are commonly focused on in medical imaging: Abdomen, Brain, Bone, Breast, Chest, Eye, Miscellaneous: Other anatomical regions not explicitly listed.

Image Modality: The bottom layer categorises the types of medical imaging modalities used to capture the anatomical data. It shows X-ray, MRI (Magnetic Resonance Imaging), and Histopathology, The study of tissue under the microscope, which often involves the examination of sliced and stained tissue sections. Miscellaneous: Other imaging modalities not specifically listed.

The arrows indicate that the pattern recognition tasks are applied to various anatomical regions captured by different imaging modalities. The overall structure illustrates how deep learning integrates with medical imaging to enhance the analysis of each body part across different imaging techniques, reflecting the multidisciplinary and interconnected nature of the field.



**Prabha Kumari and Devakumari****Deep Neural Network in Medical Image Analysis****Pattern Recognition Task****Registration**

Registration Deep Neural Networks (DNNs) are being utilised to automate and enhance image registration in medical analysis [1], [2]. The registration involves aligning medical images from different modalities or time points, which is crucial for tasks like disease progression tracking and treatment planning [3], [4]. DNN techniques predict deformations or use reinforcement learning for efficient alignment, playing a vital role in integrating information for precise measurements and representations. [5]. The use of DNNs in registration significantly improves accuracy and efficiency in medical image analysis [6], [7]. It is instrumental for tasks such as tumour tracking, treatment planning, and disease progression assessment [8]. DNN-based methods offer improved robustness compared to traditional techniques, enhancing clinical decision-making and patient outcomes [9]. Reinforcement learning-based approaches are notable for improving the precision of registration tasks.[10], [12]. Recent advances include CNN-based networks with skip connections, particularly in 3D MR-TRUS prostate image registration. These advancements demonstrate enhanced similarity metric learning and optimisation strategies, highlighting the ongoing evolution in DNN applications for medical image analysis.[11]

Localisation

Localisation in DNN medical image analysis involves identifying and pinpointing specific structures or abnormalities within medical images, such as tumours, lesions, organs, and anatomical landmarks [1], [10]. This process is critical for detecting and diagnosing abnormalities or diseases, playing a vital role in medical image analysis[11], [12]. Deep Neural Networks, predominantly Convolutional Neural Networks (CNNs), are used to learn features and classify image regions, thereby enabling accurate detection, segmentation, and localisation[2], [3]. DNN-based localisation methods have shown promising results in various medical imaging applications, including mammography, computed tomography (CT), and magnetic resonance imaging (MRI) [4], [5]. These methods facilitate tasks such as tumour detection, organ segmentation, and disease diagnosis, enhancing diagnostic accuracy and treatment planning[6], [7], [8], [9]. Recent developments in DNN models have led to improved accuracy and efficiency in organ localisation across various medical imaging modalities[9]. The application of DNNs for medical image localisation significantly improves diagnostic accuracy, streamlines clinical workflows, and aids in early detection and targeted interventions [11]. By employing DNN-based localisation techniques, medical professionals can enhance the precision and efficiency of diagnostic tasks, foremost to improve patient care and treatment outcomes [12].

Classification

Classification in DNN medical image analysis involves assigning labels or groups to images based on their content, which is fundamental for diagnosing and prognosing diseases [1], [10]. DNNs, especially CNNs, have demonstrated remarkable performance in classifying medical images for various diagnostic tasks, including identifying tumours, detecting diseases, and predicting treatment outcomes[11], [12]. DNN-based classification methods, primarily using CNNs, learn features and classify images, enabling accurate diagnosis and prediction of disease states[2], [3]. These methods have shown promising results in various medical imaging applications, such as skin cancer detection, brain tumour classification, lung nodule detection, and differentiation between healthy and diseased tissues [4], [5], [6]. The automated identification of medical conditions or anomalies by these methods contributes significantly to the development of computer-aided diagnostic systems [7], [8], [9]. Leveraging DNNs for image classification enhances the potential for initial detection, treatment planning, and monitoring of diseases based on medical imaging data [4], [5]. This capability facilitates the efficient interpretation of medical images, supporting healthcare professionals in making informed decisions and improving patient care through personalised treatment strategies[6], [7], [9].



**Prabha Kumari and Devakumari****Detection**

Detection in DNN medical image analysis involves identifying and localising specific objects or abnormalities, such as tumours, lesions, and fractures, within medical images. This process is crucial for diagnosing various medical conditions [1], [10], [12]. DNN-based detection methods, particularly using convolutional neural networks (CNNs), are employed to learn features and detect objects accurately in medical images [2], [3]. These methods have shown promising results in applications like mammography, CT, X-ray imaging, and the detection of lung nodules[4], [5]. Advanced DNN architectures like Faster R-CNN and U-Net are utilised for improved diagnostic accuracy and early disease detection[6], [7]. The automated detection by DNNs contributes to the development of computer-aided diagnosis systems, enhancing the efficiency of medical image analysis [8], [9], [11]. Leveraging DNNs for detection enables medical professionals to efficiently identify and analyse critical findings within complex medical imaging data [4], [5]. This capability enhances early disease diagnosis and treatment planning and supports precision medicine initiatives, leading to improved patient outcomes[6], [7], [9].

Segmentation

Segmentation in DNN medical image analysis involves partitioning medical images into meaningful regions, such as organs, tissues, or lesions, essential for detailed analysis and aiding in diagnosis and treatment planning [1], [10]. Deep Neural Networks, particularly CNNs, have shown remarkable performance in accurately delineating anatomical structures and abnormalities within medical images [12]. DNN-based segmentation methods use advanced architectures like CNNs, RNNs, and U-Net to learn features and accurately segment images [2], [3], [4]. These methods have demonstrated success in various medical imaging applications, including brain MRI segmentation, histopathologic image segmentation, and X-ray stent segmentation[5], [6], [7]. By leveraging DNNs for segmentation, medical professionals gain valuable insights into the spatial distribution and characteristics of anatomical structures, enabling precise organ delineation, pathology localisation, and quantitative analysis [8], [9], [11]. The automated segmentation process aids in precise tumour delineation, organ volumetry, and treatment planning, contributing to improved diagnostic accuracy and personalised patient care [4], [5]. DNN-based segmentation techniques enhance the efficiency and accuracy of medical image interpretation, leading to better patient outcomes [6], [7], [9].

Anatomical Application

DNNs have been widely used in medical image analysis for organs, including the eye, chest, brain, abdomen, breast, kidney, lungs, liver, heart, and skin [1], [2], [4]. These applications involve tasks like detecting retinal diseases, lung nodule detection, brain MRI segmentation for neuroimaging studies, assessing abdominal structures, detecting tumours in mammograms, and diagnosing dermatological conditions [6], [7], [8]. DNN-based methods have shown promise in improving diagnosis and treatment planning for various medical conditions, demonstrating their versatility and potential impact across a wide range of anatomical areas[9], [10], [12]. In eye imaging, DNNs are used for retinal disease diagnosis and detection of diabetic retinopathy and age-related macular degeneration. For chest imaging, DNNs aid in lung cancer detection, pulmonary embolism identification, and pulmonary nodule detection [3]. In brain imaging, they assist in segmenting brain tumours and detecting neurological disorders. DNNs are applied in abdomen imaging for organ segmentation and detection of liver and kidney diseases [5]. Breast imaging helps in detecting and diagnosing breast cancer. For kidney and lung imaging, DNNs aid in tumour segmentation and pulmonary disease detection. In liver imaging, they are used for tumour segmentation and liver disease detection. For heart imaging, DNNs assist in cardiac structure segmentation and heart disease detection. In skin imaging, they contribute to the detection and diagnosis of skin cancer and other conditions[11]. Deep learning models, including CNNs and RNNs, play a crucial role in automating the analysis of medical images, contributing to advancements in computer-aided diagnosis and treatment planning [4]. The use of DNNs in medical image analysis holds great potential for personalised medicine and improved patient outcomes [6]. By leveraging DNNs, medical professionals achieve accurate and efficient examination of medical images, leading to improved diagnostic capabilities, treatment planning, and patient care across medical specialities [7]. These techniques are expected to continue growing, leading to more effective healthcare delivery and improved patient outcomes[9], [10].



**Prabha Kumari and Devakumari****Image modality****Digital Mammograms**

DNNs have significantly impacted the field of digital mammography, a key tool in breast cancer screening and diagnosis [1], [2]. These advanced techniques have been applied for detecting, classifying, and segmenting breast tumours and other abnormalities in digital mammograms, leading to more accurate diagnoses and predictions of disease states[3], [4]. Deep Convolutional Neural Networks (CNNs), often enhanced with transfer learning, are widely used for analysing digital mammograms. They excel in tasks such as mass detection, lesion identification, and classification of breast abnormalities[5], [6]. DNN-based methods have demonstrated potential in improving early detection and treatment planning for breast cancer, contributing to enhanced patient outcomes[7], [8]. By automating the analysis of digital mammograms, DNNs aid in early breast cancer detection and efficient treatment planning. This application is crucial for improving breast cancer diagnosis and patient care [9]. The use of DNNs in digital mammography has led to significant advancements in medical imaging technology. Deep learning algorithms, including CNNs and other sophisticated models, have been instrumental in automating the analysis of mammograms [10]. These advancements include improved detection and classification of breast tumours, aiding in early intervention and more precise treatment planning [11]. DNNs' ability to learn intricate patterns within mammograms enables accurate identification of potential indicators of breast cancer, enhancing screening and diagnostic capabilities for breast health assessment[12].

H&E stained Images

DNNs have significantly influenced the analysis of H&E stained images, a critical component in pathology and cancer research[1], [2], [3]. These advanced techniques automate the classification of cellular structures, tissue types, and pathological features in H&E stained images, enabling accurate disease diagnosis[4], [5], [6]. Deep learning models, counting convolutional neural networks (CNNs), are applied for tasks such as tissue segmentation, cell detection, cancer grading, and identifying abnormalities within these images [7], [8], [9]. DNN-based methods have shown promise in improving the accuracy and efficiency of histopathological analysis, aiding in the initial detection, diagnosis, and treatment planning of various diseases, especially cancer[10], [11], [12]. In histopathology, DNNs are effectively used for segmenting and classifying structures in H&E stained images, contributing to a deeper understanding of diseases like cancer [2], [3]. These methods enhance the accuracy and efficiency of histopathological analysis, leading to improved disease diagnosis and treatment [5], [6], [7]. The ability of DNNs to learn complex visual characteristics of H&E stained images aids in interpretation and diagnosis, enhancing pathology practice and supporting personalised medicine initiatives [9], [12]. By leveraging DNNs for H&E stained image analysis, pathologists can streamline the interpretation of tissue samples for various medical conditions, improving diagnostic capabilities[4]. The application of DNNs in H&E stained image analysis has the potential to advance precision medicine and personalised treatment strategies, contributing to better patient outcomes[8], [10]. Recent developments include the use of deep learning algorithms for the automated analysis of H&E stained images, aiming to enhance early disease detection and diagnostic accuracy[11].

X-ray images

DNNs have significantly impacted X-ray imaging, a vital modality for diagnosing various medical conditions, including bone fractures, lung diseases, and cardiac abnormalities[1], [2]. These advanced methods facilitate the automated detection, classification, and localisation of abnormalities in X-ray images[3], [4]. Tasks such as identifying lung nodules, detecting fractures, diagnosing pneumonia, and segmenting organs are being enhanced by DNN-based techniques, notably using convolutional neural networks (CNNs)[5]. The application of DNNs in X-ray analysis holds great potential for improving diagnostic accuracy, expediting clinical decision-making, and streamlining radiological interpretation[6]. By automating the analysis of X-ray images, DNNs aid in efficient diagnosis and treatment planning, significantly contributing to improved patient care and outcomes[7], [8]. DNNs enhance the accuracy and efficiency of interpreting X-ray images, leading to better patient care and reduced healthcare costs[9], [10]. Recent advancements include the use of deep learning algorithms for automated analysis of X-ray images, aiming to enhance diagnostic precision in radiology[11]. DNN-based methods demonstrate potential



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in a wide range of X-ray imaging applications, from thoracic to skeletal analysis, highlighting their versatility and significant impact on medical imaging[12].

CT (Computed Tomography) Scans

DNNs have significantly impacted the analysis of CT scans, a key modality in diagnosing various medical conditions such as tumours, fractures, internal injuries, and cardiovascular diseases[1], [2]. Employing DNNs, particularly convolutional neural networks (CNNs), enhances the detection, segmentation, and classification of abnormalities in CT images, aiding in accurate diagnosis and treatment planning[3]. DNN-based techniques have proven effective in tasks like identifying lung nodules, detecting brain tumours, segmenting organs, and classifying diverse pathologies across anatomical regions [4]. The application of DNNs in CT scan analysis holds great potential for refining diagnostic accuracy efficiency and facilitating precise treatment planning, ultimately contributing to enhanced patient outcomes [5], [6]. By automating the analysis of CT scans, DNNs aid in efficient diagnosis, supporting healthcare professionals in clinical decision-making and improving patient care in radiology, oncology, and beyond[7]. The integration of DNNs into CT scan analysis advances precision medicine and improves radiological assessment, enhancing the interpretation of complex imaging data[8], [9]. Recent developments include deep learning algorithms for automated segmentation and classification within CT scans, aiming to enhance diagnostic precision in clinical radiology[10], [11]. DNN-based methods demonstrate potential in a wide range of CT imaging applications, from thoracic to skeletal analysis, highlighting their versatility and significant impact on medical imaging [12].

PET (Positron Emission Tomography) Scans

DNNs have significantly impacted the analysis of PET scans, a medical imaging technique used to visualise metabolic activity in the body, which is crucial for diagnosing diseases like cancer and neurological disorders [1], [2]. Employing DNNs, particularly convolutional neural networks (CNNs), enhances the detection, segmentation, and classification of abnormalities in PET images[3], [4]. DNN-based techniques have proven effective in tasks like tumour detection, disease staging, treatment response assessment, and identifying abnormal metabolic activity[5]. The application of DNNs in PET scan analysis holds great probable for improving diagnostic accuracy efficiency and facilitating precise treatment planning, ultimately contributing to enhanced patient care[6]. By automating the analysis of PET scans, DNNs aid in accurate diagnosis and personalised treatment planning, significantly contributing to improved patient outcomes in oncology, neurology, and other medical specialities[7], [8]. The integration of DNNs into PET scan analysis advances precision medicine, improving radiological assessment and interpretation of complex imaging data[9]. Recent developments include deep learning algorithms for automated segmentation and classification within PET scans, aiming to enhance diagnostic precision in clinical radiology[10], [11]. DNN-based methods demonstrate potential in various applications, from functional imaging to cancer staging, highlighting their versatility and significant impact on medical imaging[12].

MRI (Magnetic Resonance Imaging) Scans

DNNs have significantly impacted the analysis of MRI scans, a crucial modality for visualising internal body structures and diagnosing various medical conditions, including neurological disorders, musculoskeletal injuries, and cardiovascular diseases [1], [2], [3]. Employing DNNs, particularly convolutional neural networks (CNNs), enhances the detection, segmentation, and classification of abnormalities in MRI images[4]. DNN-based techniques have proven effective in tasks such as tissue segmentation, lesion detection, disease classification, brain tumour segmentation, and neuroimaging[5], [6]. The application of DNNs in MRI scan analysis holds great potential for improving diagnostic accuracy and efficiency and facilitating precise treatment planning, ultimately contributing to enhanced patient outcomes[7], [8]. By automating the analysis of MRI scans, DNNs aid in accurate diagnosis and personalised treatment planning, significantly contributing to improved patient care in radiology, neurology, and other medical specialities [9]. The integration of DNNs into MRI scan analysis advances precision medicine, improving radiological assessment and interpretation of complex imaging data[10]. Recent developments include deep learning algorithms for automated segmentation and classification within MRI scans, aiming to enhance



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diagnostic precision in clinical radiology[11]. DNN-based methods demonstrate potential in a wide range of MRI imaging applications, highlighting their versatility and significant impact on medical imaging[12].

Multimodal MRI Scans

DNNs have significantly impacted the analysis of multimodal MRI scans, which combine different MRI sequences to provide comprehensive information about tissue structure, function, and pathology[1], [2]. Employing DNNs, particularly convolutional neural networks (CNNs), enhances tasks such as disease diagnosis, treatment planning, outcome prediction, tumour segmentation, and disease classification using multimodal MRI data[3], [4]. DNN-based techniques have proven effective in integrating and analysing multimodal MRI data, facilitating improved disease characterisation, segmentation, and fusion of complementary information from different modalities[5], [6], [7]. The application of DNNs in multimodal MRI scan analysis holds great potential for advancing diagnostic precision, therapeutic decision-making, and personalised medicine in various medical specialities, including neurology, oncology, and musculoskeletal imaging [8]. By automating the analysis of multimodal MRI scans, DNNs aid in accurate diagnosis and personalised treatment planning, significantly contributing to improved patient care and outcomes in complex medical scenarios[9]. The integration of DNNs into multimodal MRI scan analysis advances precision medicine, improving the interpretation of complex imaging data and contributing to enhanced diagnostic accuracy[10]. Recent developments include deep learning algorithms for the fusion and joint interpretation of information from different MRI modalities, aiming to enhance diagnostic precision in clinical radiology[11]. DNN-based methods demonstrate potential in various applications of multimodal MRI imaging, highlighting their versatility and significant impact on medical imaging[12].

Challenges and Future Directions**Challenges in DNN Medical Image Analysis****Lack of Annotated Data and Generalizability**

The need for large, diverse, and annotated datasets and the challenge of generalising models to unseen data is a significant hurdle [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12].

Interpretability and Explainability

There is a crucial need for the interpretability of DNN models to understand and trust their decision-making process [2], [3], [6], [8], [10], [11], [12].

Integration with Clinical Data and Real-time Processing

Limited integration with clinical data and the need for real-time processing capabilities are major concerns [1], [6], [11].

High Training Costs and Limited Domain Integration

The high costs associated with training DNNs and limited integration with models from other domains pose challenges [6].

Future Directions in DNN Medical Image Analysis**Development of Robust and Interpretable Models**

Focus on creating more robust and interpretable DNN models that integrate domain knowledge and uncertainty estimation [3], [5], [7], [10], [11].

Use of Transfer Learning and Federated Learning

Leveraging transfer learning, federated learning, and semi-supervised learning to overcome data scarcity and enhance model training [3], [10], [11], [12].



**Prabha Kumari and Devakumari****Integration of Multimodal Data**

Exploring the potential of integrating multimodal data and novel applications in personalised medicine and population health management [2], [3], [8], [9], [10].

Advancements in AI Techniques and Model Robustness

Improving model robustness and developing explainable AI techniques, along with advancements in multi-instance learning and the integration of multimodal data for improved disease characterisation [2], [4], [8], [9], [10], [12].

Exploring Novel Architectures and Fusion Strategies

Investigating new convolutional neural network architectures and fusion strategies for multimodal data to enhance accuracy and reliability [4], [9].

CONCLUSION

Deep Neural Networks (DNNs), particularly Convolutional Neural Networks (CNNs), have significantly advanced medical image analysis, enhancing the diagnosis and treatment of various medical conditions. Their ability to process complex imaging data has led to improvements in critical tasks such as image registration, classification, and segmentation. Despite their potential, challenges like the need for extensively annotated datasets, model interpretability, and integration into clinical practice remain. Addressing these issues is crucial for the broader adoption of DNNs in healthcare. Future developments focused on enhancing model robustness, interpretability, and the integration of multimodal data promise to revolutionise medical diagnostics and patient care further, driving the field towards more personalised and efficient healthcare solutions.

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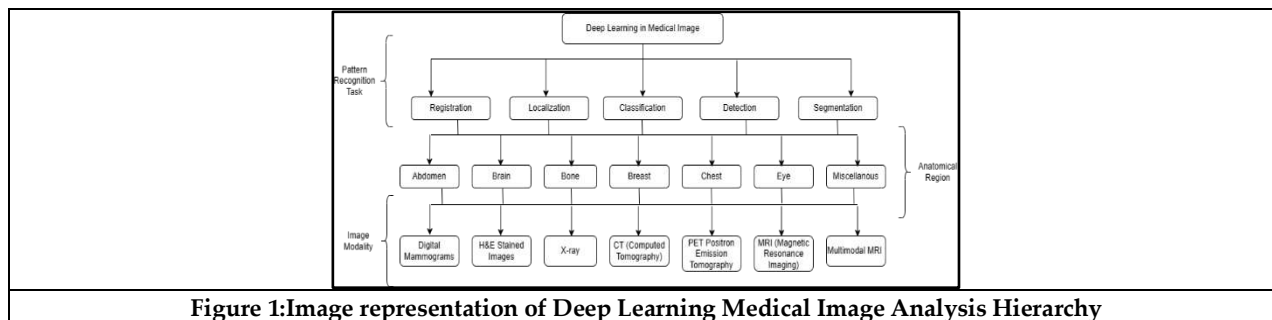


Figure 1:Image representation of Deep Learning Medical Image Analysis Hierarchy





Control Graft using Extorarchi

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

"EXTORARCHI" is a system aimed at safeguarding construction integrity through real-time data monitoring and public accountability. In the context of machine learning, EXTORARCHI utilizes advanced technologies like CONTRACRAFT to collect and analyze data concerning construction projects. This innovative system employs machine learning algorithms to compare allocated funds against actual expenditures and construction progress, enabling the detection of discrepancies indicative of corruption or misappropriation. Upon identifying irregularities, EXTORARCHI triggers alarms to alert relevant authorities and initiates public disclosures through dedicated online platforms. Through the integration of machine learning methods, EXTORARCHI not only enhances transparency and accountability but also acts as a deterrent against corruption within the construction industry.

Keywords: Corruption, Real-time data monitoring, Alarms, Notifications, Data collection, Data analysis.

INTRODUCTION

The construction industry is undergoing a paradigm shift propelled by the amalgamation of highly developed technology. CONTRACRAFT, a state-of-the-art system, represents the cornerstone of this transformation, offering real-time data management capabilities that surpass conventional project management systems. Complementing CONTRACRAFT, a myriad of innovative technologies including weather sensors, biometric access control, CCTV surveillance, cloud storage, and automatic curing systems are revolutionizing construction management practices, enhancing efficiency, safety, and sustainability.





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FEATURES OF THE PROJECT EXTORARCHI

At the heart of modern construction management lays CONTRACRAFT, a revolutionary system that utilizes real-time data management to streamline project operations. CONTRACRAFT employs air analysis to accurately determine water needs during construction, optimizing resource utilization and enhancing operational efficiency. Furthermore, CONTRACRAFT's proactive construction document management capabilities enable early identification and resolution of potential issues, ensuring seamless project execution.

Weather sensor

A weather station sensor is a device or a set of devices designed to measure various atmospheric parameters and environmental conditions at a specific location. These sensors are commonly used in weather stations to gather real-time data for meteorological analysis, climate monitoring, and environmental research. Here are some key components often found in a typical weather station. Weather station sensors are often connected to a central data logger or a microcontroller that collects, processes, and stores the data. The collected information can be transmitted to a central server or displayed locally for real-time monitoring. Advanced weather stations may also include additional sensors for specific applications, such as frost sensors, evaporation sensors, or leaf wetness sensors for agricultural purposes. The data collected by weather stations is valuable for weather forecasting, environmental research, agriculture, aviation, and various other fields where accurate weather information is essential.

- Temperature Sensor: Measures the air temperature at the location of the sensor.
- Humidity Sensor: Measures the amount of dampness in the atmosphere, providing information about humidity levels.
- Barometric Pressure Sensor (Barometer): Monitors atmospheric pressure, helping to predict short-term weather changes.
- Anemometer: Measures wind speed, often accompanied by a wind vane to determine wind direction.
- Rain Gauge: Collects and measures the amount of precipitation (rainfall).
- Solar Radiation Sensor (Pyranometer): Measures the intensity of sunlight or solar radiation.
- UV Index Sensor: Measures the level of ultraviolet (UV) radiation from the sun.
- Visibility Sensor: Measures visibility conditions, which is important for transportation and safety.
- Hygrometer: Procedures the dampness contented in the atmosphere, often used in conjunction with temperature sensors.
- Soil Moisture Sensor: Procedures the dampness contented in the loam, providing insights into soil conditions for agriculture or construction projects.
- Snow Depth Sensor: Measures the depth of snow accumulation, important for winter weather monitoring.
- Lightning Detector: Detects the presence of lightning and helps in issuing warnings for safety.
- Air Quality Sensors: Measures the concentration of pollutants in the air, providing information about the quality of the environment.
- Dew Point Sensor: Calculates the dew point temperature, which is the temperature at which air becomes saturated with moisture and dew forms.



**Aathika Mariyam et al.,****Biometric**

Iris biometrics can contribute to reliable automatic calculations in the construction industry by integrating with access control systems. This increases security measures by ensuring that only qualified and authorized personnel access specific areas, reducing the risk of accidents and unauthorized entry. It also helps maintain accurate records of attendance and movement of employees on the construction site, facilitating management and accountability.

CCTV Surveillance

CCTV maintenance in the construction industry is essential for reliable automation. Continuous monitoring ensures that inspections are appropriately tracked and documented; This results in overall safety and supervision of employees. It also increases efficiency by providing a quick overview of the construction site, helping identify risks and improving overall safety procedures. Regularly reviewing and updating your CCTV can go a long way towards promoting a safer, more efficient system.

Cloud storage

In the dynamic realm of construction management, the seamless integration of data from cloud storage services to applications in real-time has emerged as a crucial element in optimizing project work flows. Developers in the construction industry can harness the power of cloud storage APIs and webhooks to establish a fluid connection between cloud repositories and construction applications. Leveraging APIs like those provided by Google Drive, Dropbox, or Amazon S3, construction applications can gain the capability to programmatically retrieve, upload, or update project files instantly. Webhooks play a vital role in enhancing this real-time integration by allowing applications to receive immediate notifications of critical events such as document modifications, additions, or deletions in the cloud storage. Moreover, the implementation of technologies like push notifications, synchronization mechanisms, and serverless computing through cloud functions contributes to the swift transfer of construction-related data. This ensures that construction applications remain synchronized with the latest changes in the cloud storage environment, facilitating real-time collaboration among project stakeholders. This real-time data transfer paradigm, facilitated by modern cloud computing infrastructure, significantly enhances the responsiveness and agility of construction applications, providing project teams with timely access to crucial project documents and information.

Cloud Storage APIs

Most cloud storage providers proffer APIs (Application Programming Interfaces) to facilitate developers to intermingle with their services programmatically. For example, Google Drive API, Dropbox API, Amazon S3 API, etc. By integrating the appropriate API into your application, you can programmatically retrieve, upload, or update files in real time.

Webhooks

Some cloud storage services provide webhook support, allowing your application to receive notifications or callbacks whenever changes occur in the cloud storage. This can embrace proceedings such as dossier uploads erasure, or amendment.

Push Notifications

Implementing push notifications can be a way to alert your application when new data is available in the cloud storage. This can be combined with APIs or webhooks for real-time updates.

Cloud Functions

Some cloud providers offer serverless computing options, such as AWS Lambda or Google Cloud Functions. You can set up functions that are triggered by specific events in your cloud storage (e.g., file uploads). These functions can then process the data and send it to your application or perform other necessary actions in real time.



**Aathika Mariyam et al.,****Database Triggers**

If your cloud storage is integrated with a database, you can set up triggers that initiate actions in real time when specific changes occur in the database. This can be useful for applications relying on databases connected to cloud storage.

Automatic curing

In the context of construction site management, the incorporation of an automatic water irrigation system emerges as a pivotal solution for fostering a sustainable and well-maintained environment. This system, designed to address the unique needs of construction sites, seamlessly integrates advanced technologies to optimize water usage and support the growth of vegetation in the midst of ongoing construction activities. By deploying soil moisture sensors, the system intelligently monitors and adapts to the instantaneous dampness echelon of the erection spot; make certain exact and competent hose liberation to unambiguous vicinity. Weather-based controls auxiliary augment the coordination competence by animatedly fiddle with irrigation agenda pedestal on meteorological data, preventing overwatering during periods of rainfall. Automated controllers govern the irrigation process, allowing for programmable schedules tailored to diverse construction site zones. The implementation of drip irrigation or sprinkler systems caters to the specific requirements of different plant types and landscaping designs. Moreover, incorporating mobile apps or remote monitoring capabilities empowers site managers to oversee and adjust the irrigation system in real time from anywhere. Through these advancements, the automatic water irrigation system not only promotes the health of vegetation but also contributes to sustainable construction practices by conserving water resources and mitigating environmental impact. As construction industries evolve towards more environmentally conscious practices, the adoption of automated irrigation systems stands as a transformative measure in achieving both ecological resilience and operational efficiency on construction sites.

Site Analysis

Before implementing an irrigation system, conduct a thorough analysis of the construction site. Consider factors such as soil type, terrain, vegetation requirements, and the specific needs of ongoing construction activities.

Sensor Integration

Integrate soil moisture sensors to monitor the dampness echelon in the construction site. These sensors provide real-time data, allowing the irrigation system to adjust water delivery based on the actual needs of the soil.

Weather-Based Controls

Utilize weather sensors or connect to local weather forecasting services to gather data on temperature, humidity, and precipitation. This information helps the system adjust irrigation schedules based on weather conditions, preventing overwatering during rainy periods.

Automated Controllers

Install automated controllers that manage the irrigation schedule and duration. These controllers can be programmed to water different zones of the construction site at specific times, optimize hose convention and prop up efficient irrigation practices.

Drip Irrigation or Sprinkler Systems

Choose an irrigation method that suits the construction site's needs. Drip irrigation systems are efficient for targeted watering of specific areas, while sprinkler systems may be suitable for larger, open spaces. The choice depends on factors such as plant types, landscaping design, and water conservation goals.

Mobile App or Remote Monitoring

Implement a mobile app or a remote monitoring system that allows construction site managers to scrutinize and manage the irrigation scheme commencing everywhere. This enables real-time adjustments and ensures that water is applied when and where it is needed.





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Water Recycling and Conservation

Consider incorporating water recycling systems to reuse water for irrigation purposes. Implement features like rainwater harvesting to collect and store rainwater, reducing reliance on external water sources.

Security and Durability

Ensure that the irrigation system is secure and durable, capable of withstanding the rigors of a construction site environment. Protect irrigation components from damage caused by construction activities, heavy equipment, and adverse weather conditions.

Anomaly detection

Integrating anomaly detection with an audible alarm system, such as a siren, can provide a real-time alert mechanism when corruption or fraudulent activities are detected on a construction site. Here are features and ideas to achieve this combination of anomaly detection and alarm triggers:

- i. **Real-time Anomaly Detection:** Implement real-time anomaly detection algorithms that continuously monitor various aspects of the construction project, including financial transactions, procurement processes, employee behavior, and document verification.
- ii. **Threshold Setting:** Set predefined thresholds for normal behavior in different areas, such as financial transactions, bidding processes, or employee activities. Anomalies beyond these thresholds trigger the alarm system.
- iii. **Event Correlation:** Correlate anomalies across different data sources to identify patterns that may indicate corruption. Cross-reference financial anomalies with bidding irregularities or employee behavior deviations for more accurate detection.
- iv. **Automated Notification System:** In addition to the siren, implement an automated notification system that sends alerts to relevant stakeholders via SMS, email, or a dedicated communication platform. Include details about the detected anomaly and steps to be taken.
- v. **Emergency Response Protocol:** Develop an emergency response protocol specifying actions to be taken when the siren rings. Clearly define roles and responsibilities of construction site personnel, supervisors, and management in response to corruption alerts.
- vi. **Integration with Security Cameras:** Integrate the anomaly detection system with security cameras placed strategically around the construction site. When an anomaly is detected, activate cameras to provide real-time visual confirmation of the situation.
- vii. **Geofencing for Access Control:** Implement geofencing to restrict access to sensitive areas of the construction site. Trigger alarms if there are unauthorized attempts to access restricted zones.
- viii. **Secure Communication Channels:** Ensure that the notification system uses secure and encrypted communication channels to prevent interference or manipulation by potential wrongdoers.
- ix. **Historical Analysis and Reporting:** Include features for historical analysis and reporting to track patterns of anomalies over time. This can help in identifying trends and addressing systemic issues.
- x. **Regular Testing and Calibration:** Conduct regular testing and calibration of the anomaly detection system to ensure its effectiveness. Periodically review and update thresholds based on changing project dynamics.
- xi. **Whistleblower Protection Mechanism:** Encourage and protect whistleblowers by providing a secure and anonymous reporting mechanism. Integrate whistleblower reports into the anomaly detection system for comprehensive analysis. By combining anomaly detection with an audible alarm system, construction projects can enhance their ability to detect and respond to corruption promptly. This proactive approach helps to maintain the integrity of the project and fosters a culture of transparency and accountability.
- xii. **Alarm alert:** Implementing an alarm siren for a construction site when corruption occurs involves integrating technology, anomaly detection, and a notification system.
- xiii. **Automated Alarm Trigger:** Connect the anomaly detection system to the siren system. When the anomaly detection system identifies corruption based on the predefined conditions, it should trigger the alarm automatically.



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- xiv. **Manual Panic Button:** Install manual panic buttons in key locations around the construction site. Personnel who observe or suspect corrupt activities can press the panic button to trigger the alarm.

Mobile App Integration

Develop a mobile app for on-site a personnel that includes a panic button feature. If corruption is suspected, public can use the app to trigger the alarm, simultaneously alerts are send sssending alerts to designated stakeholders.

Voice Recognition Technology

Implement voice recognition technology to detect unusual or distressing conversations related to corrupt activities. When suspicious conversations are detected, activate the alarm.

Integration with Access Control Systems

Integrate the alarm siren with access control systems. Anomalies in personnel access, especially during non-working hours or restricted areas, can trigger the alarm.

Machine Learning Models for Anomaly Detection

Develop machine learning models that specialize in identifying anomalies associated with corruption. Integrate these models into the construction site's overall monitoring system to trigger the alarm when anomalies are detected.

METHODOLOGY

1. **Data Collection:** Establish a comprehensive database to store information on construction projects, including allocated funds, expenditures, and progress reports.
2. **Data Preprocessing:** Clean and preprocess raw data to remove inconsistencies and inaccuracies. Convert data into a standardized format for easy integration and analysis. Handle missing or incomplete data through imputation or other relevant techniques.
3. **Machine Learning Model Selection:** Choose appropriate machine learning algorithms for anomaly detection and pattern recognition. Train the models using historical data to enable them to learn patterns of normal construction project behavior.
4. **Algorithm Implementation:** Integrate selected machine learning algorithms into the EXTORARCHI system. Implement CONTRACRAFT for real-time data collection and feed it into the machine learning models.
5. **Threshold Setting for Irregularities:** Establish thresholds for discrepancies in allocated funds, expenditures, and construction progress that trigger alarms.
6. **Alert Mechanism:** Include multiple communication channels, such as emails, SMS, and system-generated reports.
7. **Public Disclosure Platforms:** Develop dedicated online platforms for public disclosure of detected irregularities.

ADVANTAGES**Enhanced Transparency**

By utilizing machine learning and CONTRACRAFT, EXTORARCHI offers real-time monitoring of construction projects, providing a transparent view of funds allocation, expenditures, and progress.

Early Detection of Irregularities

The use of machine learning algorithms allows for the early identification of discrepancies between allocated funds and actual expenditures, as well as construction progress. This enables timely intervention and mitigation of potential issues.





Corruption Deterrence

The integration of machine learning methods acts as a deterrent against corruption within the construction industry. The system's ability to detect irregularities and trigger alarms discourages fraudulent activities.

Public Accountability

The initiation of public disclosures through dedicated online platforms enhances accountability. Public awareness of irregularities fosters a sense of responsibility among stakeholders, encouraging adherence to ethical practices.

Timely Alerts to Authorities

The alert mechanism ensures that relevant authorities are promptly notified when irregularities are detected. This facilitates swift corrective actions and investigations.

CONCLUSION

Embracing these transformative technologies paves the way for enhanced project workflows, improved safety measures, and a commitment to sustainable practices. As we move forward, the construction industry stands poised to achieve new levels of success through the integration of these cutting-edge solutions, driving progress and excellence in every construction endeavor. Integrating multiple methods and technologies can provide a layered and comprehensive approach to corruption detection on a construction site. Combining different systems enhances the chances of early detection and a rapid response to potential issues. Regular testing and updates are essential to maintaining the effectiveness of the alarm system.

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Pedometer Efficacy for clinical care

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

A pedometer is a step-tracking gadget that monitors your steps by detecting motion, typically using an accelerometer to measure acceleration changes that occur when steps are taken. The pedometer estimates the number of steps through tracking these variations in acceleration, and advanced models may incorporate supplementary sensors or algorithms for enhanced accuracy. Steps are usually displayed on a screen or recorded in an app to help monitor physical activity. Academics are interested in the accuracy of pedometers, which involve several key components: the accelerometer senses acceleration changes, providing data to the Arduino Uno, which processes this data to identify steps. When a step is detected, the step count is incremented, and the Arduino communicates with the LCD display via the I2C module (LCD12c), minimizing required connections. The software updates the LCD with the current step count in real-time. This system accurately tracks steps and displays the count on the LCD, combining precise step detection with real-time feedback, user engagement, and portability. Step counting has long been used to gauge distance, and using a pedometer with Arduino Uno, an accelerometer, and an LCD display offers benefits like accurate tracking, real-time feedback, and motivation to stay active, promoting a healthier lifestyle

Keywords: Arduino UNO, stepcoun, lccdisplay, accelerometer.

INTRODUCTION

A pedometer is a compact electronic device that tallies each step an individual takes and 1. Pedometers have undergone substantial advancements in recent times, displaying the overall count of steps taken, with some models capable of analyzing data, syncing with computers, or connecting to smartphone applications.[1] Pedometers function by registering movements, typically by monitoring hip movements. For optimal accuracy, pedometers worn on the belt should be positioned vertically.[2] Higher-end pedometers may be attached to shoes instead of belts, detecting vibrations when the foot hits the ground. It's important to note that pedometers cannot differentiate





between intentional steps and other movements, such as shaking the device. Placing pedometers in backpacks, purses, or pockets can lead to inaccurate readings. Pedometers have emerged as valuable tools for self-monitoring physical activity levels in various populations.[3] They provide feedback on the actions taken, distance covered, duration of activity, and approximate energy consumption. By delivering prompt feedback on the number of steps taken, pedometers assist individuals in comprehending the influence of their decisions on their levels of physical activity.[4] When combined with self-monitoring, feedback, and goal-setting procedures, pedometers supply real-time data to modify behavior and attain physical activity objectives.[5]

Types of Pedometers

Various types of pedometers are available, including traditional pendulum-style models, accelerometer-based devices, smartphone apps, and wearable fitness trackers. Each type tracks steps and often offers additional features.

Mechanical Pedometers: These are the conventional pedometers that utilize a swinging pendulum or a spring mechanism to tally steps. They are basic and do not require batteries, although they may not be as precise as modern digital pedometers.

Digital Pedometers

These utilize electronic sensors (such as accelerometers) to identify motion and count steps. They frequently come with extra features like distance tracking, calorie counting, and occasionally syncing with smartphones or fitness apps.

Smartphone App

Numerous smartphones have integrated accelerometers that can serve as pedometers. Several fitness apps utilize this technology to monitor your steps and other activities.

Fitness Trackers

These wearable devices go beyond simply counting steps. They regularly track heart rate, sleep patterns, and other metrics. They establish connections with smartphones and computers to provide users with detailed activity data.

Smart watches

similar to fitness trackers, integrate step tracking functionality alongside a range of other features such as notifications, GPS tracking, and applications. Clip-On Pedometers, on the other hand, are small gadgets that can be easily attached to your attire or worn inconspicuously. They are lightweight and easily transportable.

Shoe Pedometers: Certain pedometers are designed to fit inside your shoe, utilizing sensors for monitoring your steps as you walk or run.

Wearable Sensors

Beyond traditional pedometers, there are numerous wearable devices that can track steps and activity, frequently targeting specific sports or activities. Sports Medicine advocates a more formal, workout prescription of 20-60 minutes of continuous activity, three to five times a week (at 60%-90% of maximum heart rate reserve) and 2-3 days of resistance training. Thirty minutes of exercise is beneficial for you, but an objective measurement of your activity level can be challenging. Studies indicate that it is feasible to overestimate your activity level or calorie expenditure by up to 51%! Overestimating your level of physical activity or calorie expenditure can lead to unfavorable outcomes. It can lead individuals to mistakenly think they are participating in an adequate amount of physical activity to improve their health or to believe they are offsetting the extra calories consumed during weekends of indulgence. This overestimation of physical activity presents a dilemma for researchers in the field of exercise science, as it distorts the findings of their studies when participants overestimate the intensity and duration of their workouts .[6-8]



**Amrutha et al.,****HISTORY OF PEDOMETER**

The concept of step counting has its roots in the necessity for estimation and can be viewed as a natural progression from other measurement techniques based on the human body, such as the inch, hand, foot, cubit, and fathom. The term "mile" originates from the Latin phrase "mille passus," which translates to "one thousand paces." During Roman times, a mile was approximately equivalent to 1000 paces taken by an adult. Leonardo da Vinci is credited with inventing the first mechanical step counter. This device was worn around the waist and featured a long lever arm connected to the thigh. As the thigh moved during walking, the gears would rotate, resulting in the accumulation of steps. Thomas Jefferson requested a pedometer from a renowned watchmaker in Paris. This pedometer was designed to be carried in a vest pocket and had a lever arm connected to a string that passed through a hole at the bottom of the pocket. The other end of the string was attached to a strap below the knee, so that walking would cause it to pull on the lever arm, which was connected to gears. Jefferson utilized this pedometer to calculate the distance to various landmarks in Paris in terms of steps. He noted that an English mile equated to 20665 steps, but during a brisk winter walk, it reduced to 1735 steps. In 1788, he sent a pedometer to James Madison, along with a detailed set of instructions on a single page. In 1777, Abraham-Louis Perreault, a Swiss-born watchmaker, invented a self-winding mechanism for pocket watches. This mechanism involved an oscillating weight inside the watch that moved up and down as the wearer walked. In 1780, he further developed a self-contained pedometer that utilized a spring-suspended lever arm to count steps. In 1820, Abraham-Louis Breguet created a mechanical pedometer stopwatch for Alexandre I, the Star of Russia, to measure the distance and pace of his marching armies. In 1788, he dispatched a pedometer to James Madison, accompanied by a thorough set of instructions on a single page. In 1777, Abraham-Louis Perreault, a watchmaker born in Switzerland, created a self-winding system for pocket watches.[9,10]

DISCRIPTION OF COMPONENTS USED**Components and its usage**

- Arduino UNO
- ADXL 335 Accelerometer
- 16*2 LCD
- LCD 12c module
- Power source
- Jumper wires
- Arduino IDE

Arduino UNO

The Arduino UNO is a microcontroller board that utilizes the ATmega328P as its foundation. It is equipped with 14 digital input/output pins, out of which 6 can function as PWM outputs. Additionally, it possesses 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.[11]

ADXL 355 Accelerometer

The ADXL335 is a low power, three-axis accelerometer sensor. It is capable of measuring acceleration in the range of +/-3g. The sensor measures acceleration along the X, Y, and Z axes and outputs a voltage proportional to the acceleration on each axis. The ADXL335 is widely used in various applications such as motion sensing, gaming, and pedometer devices. In this project, the ADXL335 sensor is used to detect the movement of the person wearing the device and send data to the Arduino UNO. The Nano employs an algorithm to determine the quantity of steps taken by utilizing the data obtained from the sensor. Due to its compact size and minimal energy usage, the ADXL335 is an excellent option for wearable gadgets like pedometers. This sensor, known for its heightened sensitivity, is capable of detecting even the slightest motions and vibrations.[12]



**Amrutha et al.,****12c module for 16*2 LCD**

The I2C module for 16×2 LCD display is a device that allows for communication between an Arduino Nano microcontroller and a 16×2 LCD display. The Two-Wire Interface (TWI), also known as the I2C interface, is a communication protocol that enables the connection of multiple devices using only two wires. This reduces the number of wires required and provides a cost-effective solution. In this particular project, the I2C module is utilized for a 16×2 LCD display to showcase the number of steps taken on the device. The Arduino Nano transmits the data to the I2C module, which then presents the information on the LCD screen. By employing the I2C interface, the necessity for numerous data and control wires is eliminated, resulting in a more compact and user-friendly device. The I2C module designed for the 16×2 LCD display facilitates effortless control of the display through simple commands for manipulating the cursor position, text alignment, and display on/off functionality. Additionally, it incorporates built-in contrast control and backlight control, ensuring optimal visibility under various lighting conditions.[13]

Arduino IDE

The Arduino Software (IDE) simplifies the process of coding and uploading it to the board without an internet connection. This software is compatible with all Arduino boards and is available in two versions: IDE 1.x.x and IDE 2.x. It is worth noting that both versions of the Arduino IDE offer offline functionality, allowing users to utilize the software even in areas with limited or no internet connectivity.[14]

METHODOLOGY**WORKING OF A PEDOMETER**

The pedometer operates as a compact wearable device designed to accurately track and display the user's step count. It achieves this by leveraging the capabilities of its integrated components. The heart of the system is the Arduino Uno microcontroller, which orchestrates the entire process. The ADXL335 accelerometer is strategically placed within the pedometer to capture real time acceleration data. By being oriented in sync with the user's motion, the accelerometer provides analog voltage outputs proportional to the acceleration along the X, Y, and Z axes. The Arduino Uno's analog pins are connected to these outputs, enabling it to continually sample the analog signals. The collected analog data is then processed by the Arduino Uno through a step detection algorithm. This algorithm analyses the acceleration values to identify patterns indicative of steps. By monitoring for specific changes in acceleration, such as peaks and troughs, the algorithm can reliably detect each step taken by the user. Various step detection techniques can be applied here, tailored to the desired accuracy and responsiveness. Once the step count is determined, the Arduino Uno employs the I2C (Inter-Integrated Circuit) communication protocol to interface with the 12C LCD module. This compact display unit provides a visual interface for the user, showing the current step count and possibly additional information. The Arduino sends commands and data to the LCD module through the I2C bus, enabling the display of relevant information in a user-friendly manner. Powering the entire system is a battery, chosen for its appropriate voltage and capacity. This battery supplies the necessary energy to the Arduino Uno, the ADXL335 accelerometer, and the 12C LCD module. Achieving the optimal equilibrium between power consumption and operational duration is of utmost importance is crucial to maintaining the pedometer's functionality without frequent recharging or battery replacement. In essence, the pedometer combines the accurate sensing capabilities of the ADXL335 accelerometer, the processing power of the Arduino Uno, the display functionality of the 12C LCD module, and the reliable energy supply of the battery. By intelligently processing acceleration data, detecting steps, and presenting the step count on a user-friendly display, the pedometer provides users with a tangible way to monitor their physical activity and encourage an active lifestyle.[15,16,17]

CONNECTIONS OF THE COMPONENTS

The ADXL335 serves as a triaxial accelerometer sensor that gauges acceleration across the X, Y, and Z axes, enabling the detection of changes in motion and orientation. Conversely, the Arduino Uno functions as a microcontroller board capable of interfacing with a variety of sensors and devices. When linking the ADXL335 to an Arduino Uno,



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the standard procedure involves connecting the sensor's X, Y, and Z output pins to three analog input pins on the Arduino. In the event that the term "I2c module" refers to an I2C module, this component facilitates communication with other devices through the I2C protocol. I2C, a communication protocol, permits multiple devices to interact using solely two wires (SCL and SDA). I2C devices can be attached to the dedicated SDA and SCL pins on the Arduino Uno. Typically, a battery is utilized to power the setup, necessitating a thorough examination of the voltage requirements of all components. Given that the Arduino Uno typically functions at 5V, a voltage regulator may be necessary to reduce the voltage if the battery voltage surpasses this threshold. The process of connecting the ADXL335 accelerometer, Arduino Uno, I2C module (if applicable), and battery entails linking the sensor's outputs to the Arduino's analog pins, utilizing the I2C module for communication if required, and powering the setup with an appropriate battery while adhering to voltage specifications.[18-20]

PROTOTYPE

RESULTS

Pedometers commonly display the number of steps taken by an individual within a set period of time. In addition to step count, pedometers can also offer insights into active minutes. Users walk a specific distance, and the recorded step count is then presented on the pedometer screen. The output of a pedometer is typically the number of steps recorded within a specific timeframe pedometers can provide additional information beyond step count, active minutes. Here subjects walks for certain distance and their step count has been recorded and This information is displayed on the pedometer screen.

CONCLUSION AND FUTURE SCOPE

The integration of pedometers into clinical care presents a promising avenue for enhancing patient outcomes through increased physical activity. These devices offer an accessible, cost-effective, and user-friendly means to promote and monitor exercise, aligning with broader public health goals of reducing sedentary behavior and mitigating the risks associated with chronic diseases. Research consistently indicates that pedometers can motivate individuals to increase their daily step count, which correlates with improved cardiovascular health, better weight management, and enhanced mental well-being. By providing immediate feedback, pedometers empower patients to set and achieve realistic activity goals, fostering a sense of accomplishment and encouraging sustained behavioral change.[21] Clinically, pedometers can serve as valuable tools for healthcare providers to monitor patient activity levels objectively. This data can inform personalized care plans, track progress over time, and identify patients who may need additional support or interventions. The quantifiable data collected through pedometers enable a more precise assessment of physical activity, facilitating evidence-based adjustments to treatment plans and potentially leading to better health outcomes.[22] Moreover, the use of pedometers can bridge the gap between clinical advice and patient adherence. As part of a comprehensive health strategy, pedometers can help translate clinical recommendations into actionable steps, making abstract health advice tangible and actionable. This practical application of technology supports patient engagement and compliance, which are critical components in the management of chronic conditions such as diabetes, hypertension, and obesity.[23]

The efficacy of pedometers is also enhanced when combined with other supportive measures, such as counseling, goal-setting, and regular follow-ups. These complementary strategies can amplify the motivational impact of pedometers, ensuring that patients not only start but also maintain an active lifestyle. Furthermore, advancements in pedometer technology, including integration with smartphones and other digital health platforms, provide opportunities for more sophisticated tracking, social support, and personalized feedback, which can further enhance their effectiveness. The future scope of pedometer efficacy in clinical care is expansive and multifaceted, with significant potential to transform patient management and health outcomes. As wearable technology continues to advance, pedometers integrated with sophisticated sensors and machine learning algorithms will provide highly accurate and personalized data on physical activity. This data can be crucial for the management of chronic conditions such as diabetes, cardiovascular diseases, and obesity, by facilitating real-time monitoring and more





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effective interventions. Moreover, the integration of pedometers with electronic health records (EHRs) and telemedicine platforms can enhance remote patient monitoring, enabling healthcare providers to track patient progress, adjust treatment plans, and offer timely support. The use of pedometers can also promote patient engagement and adherence to physical activity regimens through personalized feedback and goal-setting, supported by gamification elements. Additionally, large-scale data collected from pedometers can be leveraged in population health management and epidemiological studies to identify activity patterns, risk factors, and the impact of interventions across diverse populations. With advancements in data analytics and artificial intelligence, the predictive capabilities of pedometer data can be enhanced, allowing for early detection of health issues and proactive management strategies. Thus, the future scope of pedometer efficacy in clinical care promises to revolutionize preventive medicine, chronic disease management, and personalized healthcare.[24,25]

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Table 1: Step count of people < age30 walking the distance of 50meter

Name	Age	No. of steps
Priyanka BN	19	80
Amrutha PM	19	70
Meghna A	19	82
Sanjana S	19	95
Himadri	19	78
Varchas	19	77
Kushal	19	75
S Chaitanya	20	76
Riza Q	20	85
Hidhayath Ali	20	80

Table 2 :step count of people walking the distance of 30mts with their weight

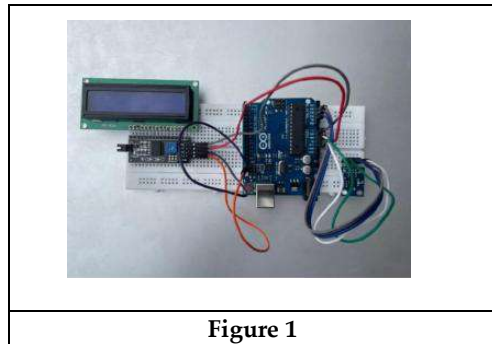
Name	Weight	No. of steps
Sunitha V	64	52
Asha	57	49
Ravi	61	55
Venkatesh	88	62
Girish	52	47
Latha	69	53
Meena	82	59





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Suresh Kumar	54	49
Kenchamma	49	50
Krishnappa	59	50





Wireless Sensor Networks for Energy-Efficient using ASFO and a Cross-Layer-Based Expedient Protocol

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Reducing power consumption and prolonging the lifetime of wireless sensor networks (WSNs) are now important objectives in sensor network research. Energy-efficient communication networks are a must for a WSN. Other energy-related restrictions on WSNs include clustering, storage, communication capacity, high configuration complexity, slow communication speed, and limited computing. Furthermore, choosing a cluster head for WSN energy minimization still presents challenges. In this work, the Adaptive Sailfish Optimization (ASFO) algorithm using K-medoids is used to cluster sensor nodes (SNs). Optimizing cluster head selection through energy stabilization, distance reduction, and latency minimization between nodes is the main goal of study. Achieving effective energy resource usage is a crucial issue in WSNs due to these limits. An expedient routing system based on cross-layer technology that uses less energy (E-CERP)

Keywords: wireless sensor network; sensor nodes; clustering; cross-layer routing; adaptive sailfish optimization





INTRODUCTION

A wireless sensor network (WSN) contains affordable, tiny sensor nodes. WSNs have proven to be one of the most suitable strategies for transferring data from remote locations to a central data processing station. These sensors self-organize and form a multi-hop network capable of adapting and transmitting compressed data to a base station. Multimedia WSNs support transmitting multimedia data, such as images or videos, and can collect more data in military monitoring, agricultural and industrial monitoring, affordable healthcare, and intelligent buildings. Multimedia data is typically more extensive, and larger sensor nodes can use more resources. Some researchers have attempted to investigate and solve this issue. Energy conservation is one of the most significant aspects for sensor nodes in wireless sensor networks to extend their lifespan. Sending and receiving packets consume the majority of the energy. Sensor nodes in WSNs frequently use batteries. Because of the network of devices, charging the battery is complex, and the battery's capacity emerges as the most precious resource for WSNs. As a result, energy conservation becomes a critical issue in WSNs. A new optimization algorithm must be developed to maximize energy efficiency and network lifespan. Clustering is one of the power management functions of WSNs, which splits the network into multiple clusters, with one node in each cluster designated as the cluster head (CH). By combining the data received from each node and sending it to the base station (BS), the CH reduces the BS's overhead. Because the BS accepts data from fewer nodes, the WSN saves power in resource-constrained situations. Clustering algorithms aid in reducing power consumption in WSNs.

Related Works

A hybrid cross-layer routing protocol was inspired by WSN-assisted energy conservation in the Internet of Things (IoT). Routing is processed at three layers in the cross-layer routing strategy: the physical layer, the data link layer, and the transport layer. The protocol for Bionic Cross-Layer Routing (BiHCLR) is proposed in this paper for efficient and energy-efficient routing in WSN-IoT. Then, to conserve energy in BiHCLR, a fuzzy logic method is used to select a CH for each grid cell. The routing path is then chosen using a hybrid bionic algorithm. The proposed BiHCLR's performance is assessed using a quality of service (QoS) analysis. Latency-aware heterogeneous cluster-based data acquisition (DA-HCDA) in the IoT was proposed. A DA-HCDA algorithm is presented to ensure maximum coverage. As a result of the introduced DA-HCDA and quartile aggregation mechanisms, end-to-end latency and network lifetime are improved. A new Energy-Aware Adaptive Fuzzy Neural Clustering (EAANFC-MR) algorithm was implemented. The EAANFC-based clustering method chooses CHs based on residual energy (RE), node distance, and degree. The QOBFO algorithm is used as a multihop routing technique to select the best route to the destination. The proposed EAANFC-MR algorithm has been simulated using MATLAB. The Naive Bayes, KNN, and Support Vector Machine (SVM) classifiers are used for classification and image processing applications. The conventional algorithm has less accuracy when compared with the proposed methodology. The proposed algorithm's results show that it consumes less power than other algorithms and has a higher number of still-alive nodes than others. As a result, the ISFO algorithm demonstrates its superiority in terms of power consumption and network lifespan. The proposed method is compared with several conventional optimization algorithms, including the artificial bee colony, the whale optimization algorithm (WOA), the genetic algorithm, and the adaptive gravity search algorithm.

System Model

WSNs constantly monitor the physical conditions of their surroundings. The WSN infrastructure is composed of a base station (BS) and several SNs. WSN clustering aims to minimize energy usage by dividing sensors into clusters. Common nodes frequently monitor the environment and transmit sensory data to the cluster head. The CH node is always chosen among the common nodes. The significant role of the CH is to accumulate data from each cluster node and send it to the BS. The process of grouping aids in avoiding direct communication between receivers and sensors. The WSN system model is depicted in Figure 1. This research suggests a K-medoids algorithm for clustering in WSNs. The K-medoids algorithm splits all sensor nodes into k





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clusters. Each cluster is associated with a single object in the K-medoids method. The identified object is called a medoid and corresponds to the cluster's most central point. The K-medoids group is the shortest distance between clusters because the K-medoids related to the cluster node find the optimal center. It improves communication between sensor nodes, reduces energy consumption, and detects more accurate cluster centers, resulting in shorter packet delays.

The K-medoids clustering algorithm has the following steps:

Step 1: Randomly select k points from the input data (where k represents the number of clusters to form).

Step 2: Each data point is assigned to the cluster that contains the closest center point.

Step 3: For each data point in cluster ' i ', calculate and add the distance from all other data points. Specify the point of the i cluster that reduces the total calculated distance from other points as the center point of the cluster.

Step 4: Repeat steps 1 and 3 until convergence is reached, that is, until the center point stops moving. The clustering method involves grouping sensor nodes and selecting CHs for all groups in the WSN. There are multiple sensor nodes in a WSN that can be alive or dead. The proposed clustering technique identifies distances between nodes by regularly monitoring the nodes and forming clusters based on distances. The K-medoids algorithm is used to group nearby nodes into clusters, and the selection of the cluster head is based on the SN's energy usage. As CH, the energy-efficient SN is chosen, which can be changed anytime. Figure 2 depicts the transmission of data from a sensor node to the cluster head. According to the diagram, six cluster heads manage all the SNs in a cluster. Compared to existing methods, the K-medoids algorithm and E-CERP suffer from high packet loss, delivery delays, and a lack of stable power when using existing processes to transmit data. The proposed K-medoids clustering approach is compared with the K-means [18] and Fuzzy C-means approaches, which include particle swarm optimization and krill herd optimization algorithms [19–22]. The introduced ASFO method is compared with two existing optimization approaches: the krill swarm optimization algorithm [23] and the whale optimization algorithm (WOA) [24]. The proposed results were compared with cross-layer-based adaptive thresholding (CLAT) and cross-layer fuzzy logic (CLFL).

Performance Analysis of Clustering

Clustering is an essential method for ensuring efficient data transmission. The proposed work used the K-medoids approach to cluster similar data into one group based on the average energy consumption of each node [25,26]. Figure 3 and Table 2 represent the comparison graph for the average energy consumption by the proposed approach and the existing methods, K-means and Fuzzy C-means clustering. Therefore, the hybrid approach consumed 0.0196 J on average for cluster size 2, whereas the K-means method consumed 0.0245 J and the Fuzzy C-means logic approach consumed 0.0294 J.

Network Lifetime

The proposed CERP's network lifetime is compared with the conventional algorithms in Figure 6. This method attained a higher network lifetime than the remaining methods. Table 4 shows the network lifespan and energy consumption of the proposed E-CERP and conventional approaches.

From the simulation results, it is evident that the network lifetime is extended by the proposed method for 100 nodes (5908 rounds). In contrast, the lifetimes of an existing cross-layer-based adaptive threshold technique and cross-layer fuzzy logic approaches are 5395 and 4904 rounds, respectively. Moreover, as the number of nodes increases, the network lifetime decreases. Hence, data transmission efficiency is based on the increased network lifetime.

Throughput

The suggested technique is compared with a cross-layer-based adaptive threshold and cross-layer fuzzy logic techniques in Table Figures 7 and 8, and Table 5, show the evaluation of the proposed technique and the conventional algorithms with respect to end-to-end delay and throughput. The E-CERP approach's throughput was high (0.99 Mbps) in 100 nodes compared to the conventional algorithms. From Table 5, it is



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seen that the number of nodes increases as the throughput decreases. The throughputs obtained by the conventional cross-layer-based adaptive threshold technique and cross-layer fuzzy logic approach are 0.99 Mbps and 0.96 Mbps, respectively, for 100 nodes.

End-to-End Delay

The comparison of the end-to-end delays of the proposed CERP and existing approaches is represented in Figure 9 and Table 5. This method attained a lower delay in 100 nodes (0.05 s), and the time delay increased as the number of nodes increased in the WSN. For 100 nodes, the time delays of the two existing methods, the cross-layer-based adaptive threshold technique and cross-layer fuzzy logic, are 1.97 s and 2.94 s, respectively.

Packet Delivery Ratio (PDR)

Table 6 compares packet delivery and packet loss ratios to the number of nodes. Figures 9 and 10 show that the PDR decreased when the number of nodes increased. The PDRs obtained using different algorithms for 100 nodes were 97% for the cross-layer-based adaptive threshold technique and 95% for the cross-layer fuzzy logic method. If the PDR value is high, all data from the base station will be received without any data loss. Therefore, the proposed approach achieves high performance efficiency when compared to other algorithms.

Packet Loss Ratio (PLR)

The packet loss ratio (PLR) of the proposed method and other existing methods are shown in Figure 10. For 100 nodes, the proposed CERP obtained 0% PLR (i.e., there was no loss), and the existing methods, cross-layer-based adaptive threshold and cross-layer fuzzy logic approaches, achieved high PLR values of 2.58% and 4.54%, respectively. It shows that the proposed CERP is more effective for data transmission. The PLR increases when the number of nodes increases. The graph indicated that the introduced method significantly decreased packet loss compared to other energy-efficient algorithms. The comparison of jitter for the proposed technique and existing approaches is shown in Figure 11. The E-CERP algorithm obtained a low jitter value of 0.15 ms for 100 nodes. In contrast, the conventional algorithms, cross-layer-based adaptive threshold and cross-layer fuzzy logic approach, attained 0.25 ms and 0.39 ms, respectively. For 200 nodes, the jitter value of the proposed method was 0.12 ms; however, the conventional algorithms attained 0.20 ms and 0.34 ms, respectively. For 300 nodes, the jitter value obtained by the E-CERP algorithm was 0.10 ms, and the conventional algorithms attained 0.17 ms and 0.24 ms, respectively. For 500 nodes, the jitter value of the suggested approach was 0.05 ms. However, the existing approaches, cross-layer-based adaptive threshold and cross-layer fuzzy logic technique, attained 0.10 ms and 0.15 ms, respectively. As a result, by evaluating the performance of cross-layer-based adaptive threshold, cross-layer fuzzy logic, K-means, and Fuzzy C-means approaches, the introduced E-CERP algorithm performances are resolved based on the analysis of QoS parameters. Based on the simulation results, the power consumed by the network is low and the network lifetime is high for the proposed method.

Evaluation of the Proposed ASFO and E-CERP Approach with Conventional Techniques

The particle swarm optimization is utilized for the optimization problem based on fuzzy clustering. Still, it has some disadvantages, such as that it is easy to fall into local optima and the convergence rate is slow, while the HHO algorithm is simple, flexible, easy to implement, and has a high convergence rate. In fuzzy and artificial bee colony-based implementations of MAC, the clustering, routing, and data delivery (FABC-MACRD)-based cross-layered method was used for the clustering and data transmission, in which the energy consumption was high, including the energy consumed for 500 nodes. In contrast, the proposed CERP method consumed less energy (4.19 J), and the packet delivery ratio of FABC-MACRD was 79%, while the proposed CERP was 96%. Compared to FABC-MACRD, the proposed method extended the network's lifespan, and the proposed K-medoids with ASFO and E-CERP improve the reliability of the communication link and reduce packet delay.





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CONCLUSIONS

This research develops cluster head selection using K-medoids with ASFO and clustering and multihop routing protocol (CMRP) algorithms for efficient routing in WSNs. For optimal CH selection from suitable nodes, the K-ASFO approach can be used. The outcomes were compared using three standard metrics: throughput, residual power, and first dead node. Finally, the CMRP algorithm routing protocol is used for efficient data transfer. The routing process is permitted on recognized node-to-node paths. The simulation results demonstrate that the proposed system outperforms other existing algorithms. The performance of the proposed methodology is compared to that of existing optimization-based routing algorithms. CMRP chooses the best path from the cluster head to the sink node. The proposed method is used to evaluate PDR, packet delay, throughput, power consumption, network lifetime, packet loss rate, and error estimation, and the results were superior to existing methods. PDR (100%), packet delay (0.05 s), throughput (0.99 Mbps), power consumption (1.97 mJ), network lifespan (5908 rounds), and PLR (0.5%) for 100 nodes are the performance results for QoS parameters. The proposed method has an overall accuracy of 93.19%. As a result, the proposed approach outperforms existing strategies in terms of overall performance. The proposed method produced better results in all scenarios and metrics. The proposed work was idealized, implemented, and tested against a static sensor node WSN. This research can be expanded to mobile sensor nodes or networks with sensors that can change position in real-time.

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Table 1. Energy consumption and network lifespan.

Techniques	Average Energy Consumed					Network Lifespan				
	100	200	300	400	500	100	200	300	400	500
Number of Nodes	100	200	300	400	500	100	200	300	400	500
Proposed CERP	1.97	1.10	5.13	4.80	4.19	5908	5711	5514	5218	5022
CLAT	7.75	5.51	7.91	7.45	7.55	5395	5100	4904	4708	4610
CLFL	8.43	10.36	9.53	11.23	10.37	4904	4708	4610	4218	4021

Table 2. Throughput and the end-to-end delay comparison.

Methods Delay	Throughput					End-to-End				
	100	200	300	400	500	100	200	300	400	500
Number of Nodes	100	200	300	400	500	100	200	300	400	500
Proposed CERP	0.99	0.98	0.96	0.95	0.94	0.0492	0.0689	1.9692	3.9384	5.9076





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CLAT	0.9 6	0.9 3	0.9 3	0.9 3	0.9 1	1.961 7	3.678 5	4.168 6	5.149 4	6.130 2
CLFL	0.9 5	0.9 1	0.9 0	0.9 0	0.8 8	2.942 5	4.904 2	5.885 1	7.356 3	8.827 6

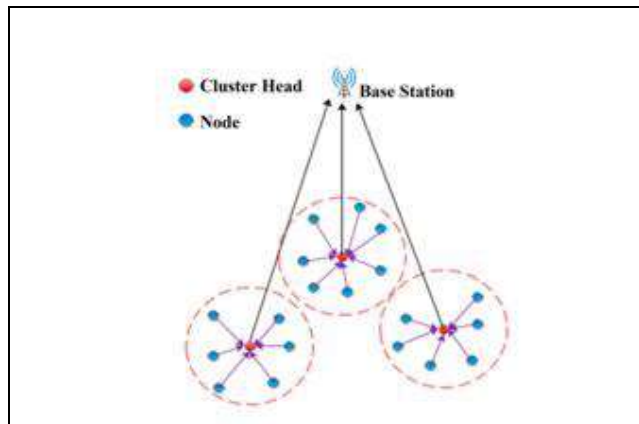


Figure 1. General architecture of a wireless sensor network.

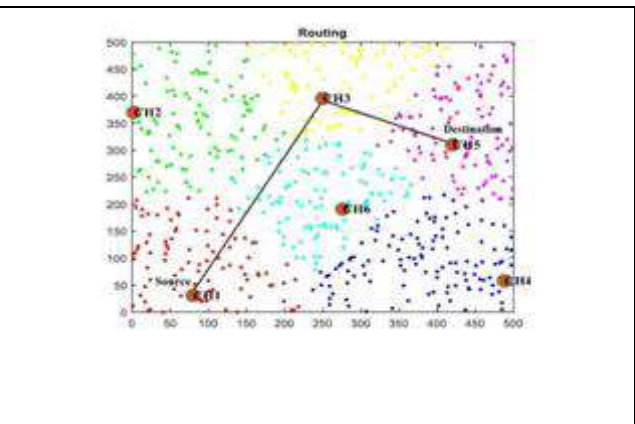


Figure 2.

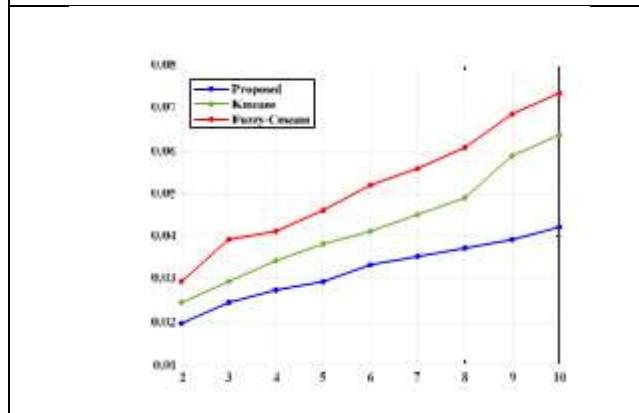


Figure 3. Data path from the source node CH1 to the destination node CH5.

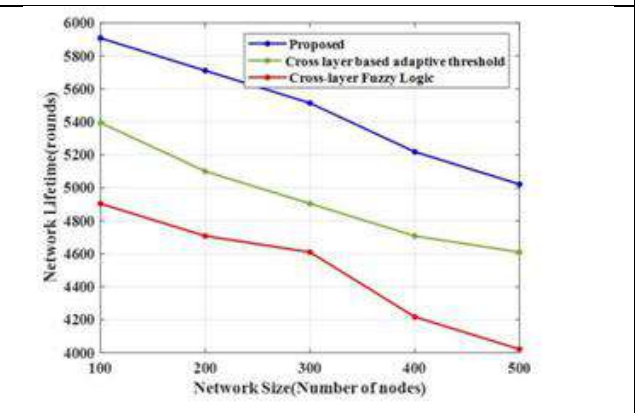


Figure 4.

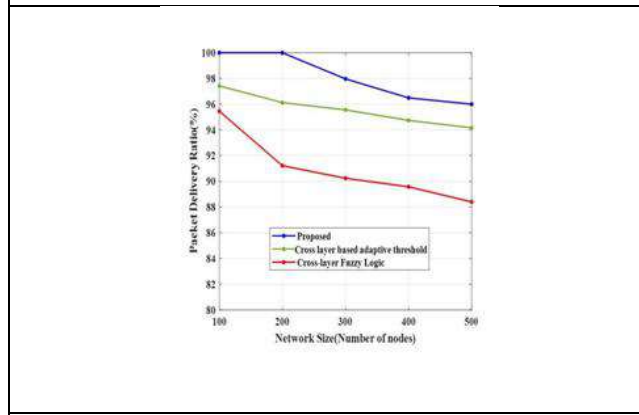


Figure 5.

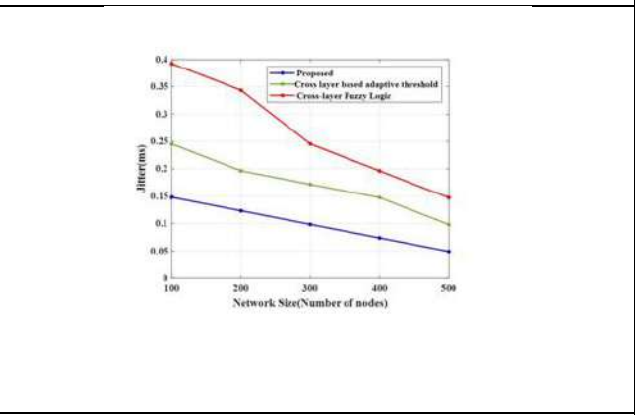


Figure 6.





Transformers: Deep-Diving into NLP Revolutionaries and their Impact on Word Sense Disambiguation

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Received: 21 Feb 2024

Revised: 03 Mar 2024

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ABSTRACT

One long-standing problem in Natural Language Processing (NLP) is Word Sense Disambiguation (WSD), which is the process of identifying a word's precise meaning within its context. This paper investigates the revolutionary impact on this task using transformers, a novel neural network design. We started with outlining WSD and its significance in NLP, emphasizing the challenges associated with determining exactly what ambiguous words mean. After that, we explore the domain of transformers and describe their fundamental ideas as well as their special "attention" mechanism. Unlike conventional sequential processing techniques, this approach enables transformers to study every segment of an input sequence simultaneously. WSD benefits greatly from transformers' capacity to understand intricate word associations since it allows them to accurately capture context-dependent meanings and subtle nuances that are essential for disambiguation. We also explained the possible applications of transformer-powered WSD in the real world and imagined how it could alter a number of areas by enabling a deeper comprehension of human language. This study demonstrated the state-of-the-art results that transformers have produced. Beyond simple accuracy, the study highlights how transformers may help explain and make sense of WSD decisions, which help to build confidence and advance the developed models.

Keywords: Natural Language Processing, Word Sense Disambiguation, Transformers, Supervised Learning, etc.





INTRODUCTION

Natural language is inherently ambiguous, with many words carrying various meanings depending on context. This is a considerable barrier for Natural Language Processing (NLP) tasks that rely on accurately comprehending word meanings. Word Sense Disambiguation (WSD) is concerned with determining the precise meaning of a word in a given context, and it is used extensively in numerous NLP applications. Envision perusing a press release headed "Bank Robbed!" Immediately, a tense scene in a financial institution comes to mind. But wait, might it really be discussing an ambitious riverbank rob? This straightforward illustration demonstrates the inherent ambiguity of language, as terms such as "bank" can have several meanings depending on the situation. Word Sense Disambiguation (WSD), which is essential to many Natural Language Processing (NLP) applications, addresses this problem by determining a word's precise meaning in a given context. Imagine how annoyed a machine translation system would be upon seeing this headline. It may translate as "The riverbank was robbed last night!" without WSD, which would be a hilarious error. In many NLP applications, WSD is essential; yet determining what ambiguous words mean still presents a substantial issue. NLP research is still working to overcome these issues and create more reliable and accurate WSD techniques to improve the functionality of different NLP applications.

Overview of Historical Approaches to WSD

Computers find the natural ambiguity of human language to be an intriguing challenge. Determining a word's intended meaning in a particular context is known as word sense disambiguation (WSD), and it has captivated researchers' attention for many years. In order to fully understand the state-of-the-art, we need to take a historical tour, examining how WSD approaches have developed from their primitive beginnings to the complex techniques used today.

Early Approaches

- **Dictionary-based methods:** These depended on dictionaries that were manually written and linked words to their many senses. But they had trouble with context dependence and were constrained by the dictionary's scope.
- **Rule-based methods:** These used manually created criteria that took into account the syntactic and semantic characteristics of the surrounding text in order to determine the intended meaning. These could be more adaptable, but they would take a lot of work to develop and manage across several domains.

Advancements

- **Supervised learning:** Using massive datasets of hand annotated text, where each word sense is identified, this method trains statistical models. More precise disambiguation results from these models' ability to recognize patterns in the surrounding text that correspond with particular senses.
- **Unsupervised learning:** This method extracts word representations that capture semantic associations by using large unlabeled text corpora. After that, words in unusual circumstances can be distinguished using these representations without the need of manual annotation.
- **Knowledge-based methods:** In order to improve the accuracy of word disambiguation, these make use of outside knowledge sources such as WordNet, a lexical database of semantic links between words.

Modern Trends

- **Deep learning:** Recent developments in deep learning architectures, especially transformers, have allowed for state-of-the-art WSD performance by concurrently taking into account an entire sentence's context.
- **Multimodal WSD:** This growing research improves context awareness and disambiguation accuracy by using non-textual information, such as visuals or audio, to distinguish words.



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- Overall, data-driven strategies and complex deep learning models have replaced rule-based and dictionary-driven methodologies in WSD research. These developments help WSD become more reliable and accurate, which opens up new possibilities for a range of NLP applications.

Challenges of Word Sense Disambiguation (WSD)

Disambiguating word senses is complex for various reasons:

Polysemy

Many words have numerous unconnected meanings (for example, "bank" might refer to a financial organization or the bank of a river)[1].

Homonymy

Some words have distinct spellings or pronunciations but the same meaning (for example, "bass" might refer to a fish or a musical instrument)[2].

Context Dependence

The intended meaning of a word is strongly dependent on its surrounding context, necessitating a thorough understanding of language structure and semantics [3].

Lack of Annotated Data

Training and evaluating WSD models frequently necessitates huge amounts of manually annotated data, which can be costly and time-consuming to generate [4]. WSD is essential for many NLP activities, but detecting the intended meaning of ambiguous words remains a substantial difficulty. Advances in NLP research continue to address these challenges, with the goal of developing more robust and accurate WSD algorithms to improve the performance of diverse NLP applications.

Importance of WSD in NLP

WSD is the key to many powerful NLP applications, enabling them to reach their full potential:

- **Machine Translation:** Imagine using machine translation to translate a medical document that mentions "cells." WSD distinguishes between jail cells and biological cells, guaranteeing precise and situation-appropriate translation for important data.
- **Information Retrieval:** A Google search for "jaguar" may turn up details on the vehicle or the wildlife. WSD helps you get the results you're looking for more quickly and effectively by refining your search.
- **Machine Question Answering:** WSD enables computers to distinguish between "capital" as a city and a financial asset when asked, "What is the capital of France?", providing precise and educational responses.
- **Text Summarization:** Getting the gist of the original text is necessary to produce reliable summaries. WSD makes sure terms are picked with the intended meaning in mind, resulting in summaries that are clear and educational.

Transformers and Word Sense Disambiguation

Word sense disambiguation (WSD) is the process of determining a word's specific meaning in a given context despite its various alternative meanings. Transformers, a sort of neural network design, have gained popularity in recent years as a solution for WSD. Transformers have proven to be extremely effective in natural language processing tasks, as well as promising for WSD. Consider a neural network architecture that is not restricted by the constraints of sequential information processing. Transformers, developed in 2017, use a "attention" mechanism to analyze all portions of an input concurrently, resulting in a better grasp of complicated word relationships. In 2017 the paper "Attention Is All You Need" sparked the revolution. Pre-trained transformers such as BERT (2018) and GPT-2 (2019) pushed the bounds, while T5 (2020) demonstrated incredible versatility. The huge Megatron-Turing NLG model (2021) demonstrates the ever-changing possibilities.





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Architecture of Transformer

- **Attention Mechanism:** Forget about the constraints of processing data one piece at a time. Transformers "attend" to the most pertinent portions of an input sequence concurrently by using the "attention" mechanism, much like a play's performers during a scene. A richer comprehension of context and word relationships is made possible by this parallel processing.
- **Encoder-Decoder Architecture:** Transformers are basically made up of two components: an encoder that interprets and reads input, and a decoder that uses the encoded data to produce an output. Transformers' comprehension of word relationships and context is very helpful for WSD. They can accurately assist in disambiguation by capturing nuanced details and meanings that vary depending on the situation. Transformer-based models such as BERT have demonstrated outstanding accuracy, surpassing 93% in accurately recognizing word senses on benchmarks such as SemEval-2013. Transformers help explain and comprehend WSD judgments in addition to providing excellent accuracy. For these models to continue to be developed and to be trusted, this transparency is essential.

The Data-Driven Revolution

Large Language Models Transform Word Sense Disambiguation Large language models (LLMs) and data-driven approaches have brought about a paradigm shift in WSD systems, which formerly relied on handwritten rules and dictionaries. This change has completely changed WSD, stretching the bounds of precision and opening up fascinating new possibilities.

From Rules to Data

Adaptability and scalability were frequently lacking in traditional WSD techniques. Polysemy and context dependence plagued dictionary-based approaches, whereas rule-based systems required a lot of time to build and maintain across several domains. The introduction of data-driven methods, particularly supervised learning, altered the rules. Supervised learning: These techniques make use of enormous volumes of annotated data, in which every word is labeled with its precise meaning. Through examination of these patterns, statistical models acquire the ability to recognize contextual signals that have varying correlations with senses, resulting in markedly enhanced disambiguation precision.

The Rise of LLMs

Like transformers, the emergence of LLMs has accelerated WSD's evolution. Large volumes of text data are easily processed by these sophisticated neural networks, which enables them to grasp complicated correlations between words and their environment. This newly acquired knowledge corresponds to:

Enhanced Accuracy

Compared to earlier techniques, LLMs can significantly improve disambiguation accuracy by taking into account the full context of a sentence, which results in a deeper grasp of word meaning.

Decreased Data Scarcity

Although annotated data is still important, LLMs can use unlabeled text corpora to train semantic representations, which reduces the amount of manual annotation that is required and increases the applicability of working semantic domain models.

State-of-Art Work

In this section we explained the work done for word sense disambiguation using transformers. The capabilities and constraints of large language models (LLMs) for word sense disambiguation (WSD) are examined by Loureiro et al.(2021).The Key findings of this research work were Transformer-based LLMs perform well on WSD tasks, particularly those involving high-level sensory distinctions, such as BERT. Feature extraction and fine-tuning are the two primary methods for applying LLMs in WSD. While feature extraction uses the model's learnt representations for WSD tasks, fine-tuning entails modifying the model's parameters on particular WSD datasets. Even with a small





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amount of training data, feature extraction more specifically, the average of contextualized embedding-proves very resilient and efficient. Due to difficulties with data availability and processing resources, LLMs still have difficulty with fine-grained WSD in practical scenarios. For LLMs in WSD, sense bias where models prefer specific senses because of imbalances in training data is a concern. It seems that feature extraction is more resilient to this problem. Overall, the study recognizes the promise of LLMs for WSD while also pointing out some of their shortcomings and potential areas for development [5]. In this paper, two WSD tasks were used to compare nine alternative transformer models. The models were assessed based on how well they can distinguish between words in both Spanish and English. The transformer model ELECTRA, which has been pre-trained on a masked language modeling target, is found to be the best-performing model in the study. On both WSD tasks, ELECTRA surpasses all other models. Additionally, the performance of the transformer models is found in the paper to be much superior than that of the conventional WSD approaches. [6] Loureiro D.et.al (2022) proposed a unique method for utilizing sense embedding that come from NLMs (Neural Language Models). Using lessons from the analysis of 14 NLM variants, it makes use of data from all NLM layers. The goal of this approach is to use sense embedding' adaptability beyond the conventional Word Sense Disambiguation (WSD) requirement. Through the application of these embedding to various tasks such as semantic relatedness and WSD, the evaluation shows gains in performance over current approaches. Fascinatingly, the research shows surprising differences in layer and model performance, indicating possibilities for wider uses in a range of downstream tasks. This paper, in summary, investigates a potentially fruitful path for improving sense embedding and their influence on tasks related to natural language processing [7].

It was difficult to compare language model (LM) pre-training techniques due to high computing costs, proprietary datasets, and erratic hyper parameter selections. This work removes the haze by carefully reproducing BERT pre-training. After carefully examining a range of hyper parameters and data sets, the scientists discovered an unexpected result: BERT was noticeably undertrained! When tested harder, it outperformed newer models in terms of performance, matching even. On benchmark tasks, their optimized model even broke records. This analysis raises doubts regarding the real source of the gains purported in newer LMs and reveals the considerable impact of frequently disregarded design decisions [8]. This study explored the state-of-the-art in word sense disambiguation (WSD). It breaks into the state-of-the-art algorithms that have recently propelled the discipline and reveals the technological trends that will shape its future. The main objective is to analyze these developments, first by contrasting different algorithms according to their efficiency, approaches, and other relevant aspects, and then by investigating new developments such as the capabilities of large language models (LLMs), the incorporation of knowledge graphs, and the possibility of fine-tuning and transfer learning. The paper also explores the domain of interpretable and explainable models, guaranteeing clarity and openness in this quickly developing sector. This thorough examination opens the door for future advancement and innovation while also providing insight into the state of WSD now[9]. This study is noteworthy for reaching the highest levels of precision and accuracy in context-based word sense identification (Subtask 1). Their success depended on utilizing innovative design tactics to refine pre-trained transformer models, proving the efficacy of this method for word sense disambiguation. Beyond success, the authors express optimism in the greater potential that their ideas possess in the field of Natural Language Processing. The paper explained the details of the transformer models that were utilized, the techniques for fine-tuning that were used, and the unique architecture strategies that were put into place for the WSD work. It is also anticipated that they would evaluate their strategy against those of the other challenge participants and investigate possible uses outside of word sense disambiguation, providing insightful information to the NLP community [10].

Impact of data-driven approaches and LLMs on NLP Applications

The impact of data-driven approaches and LLMs on WSD developments is significant for a range of NLP applications.

Machine Translation

Retaining information fidelity and preventing humorous misinterpretations are made possible by an accurate grasp of word senses.



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Search engines can improve user experience and happiness by providing more exact and relevant results by accurately interpreting user queries.

Chatbots and virtual assistants

LLMs enable chatbots and virtual assistants to understand user intent and reply in a more helpful and natural way, promoting smooth human-machine interaction.

Sentiment analysis

By effectively assessing sentiment in reviews, social media posts, and other text forms, the subtleties of word meaning within context can be captured. This allows for better understanding of public opinion and brand impression. Thanks to the ongoing development of data-driven techniques and LLMs, WSD has a bright future. We anticipate more developments in:

Interpretability and Explain ability

Increasing trust and encouraging appropriate use of WSD models can be achieved by making them clear and comprehensible.

Multimodal WSD

Including non-textual data such as audio and visuals would improve the accuracy of disambiguation and contextual comprehension.

Personalization

More individualized NLP experiences will be possible by modifying WSD models to suit unique tastes and linguistic styles.

CONCLUSIONS

This paper gives an overview of word sense disambiguation and a transformer also highlights the impact of word sense disambiguation on various natural language applications using the transformers. In conclusion, WSD has changed and its potential has been unlocked across a variety of NLP applications with the emergence of data-driven methodologies and LLMs. These technologies have the potential to provide WSD that is even more precise and adaptable as they develop, thus closing the communication gap between humans and machines.

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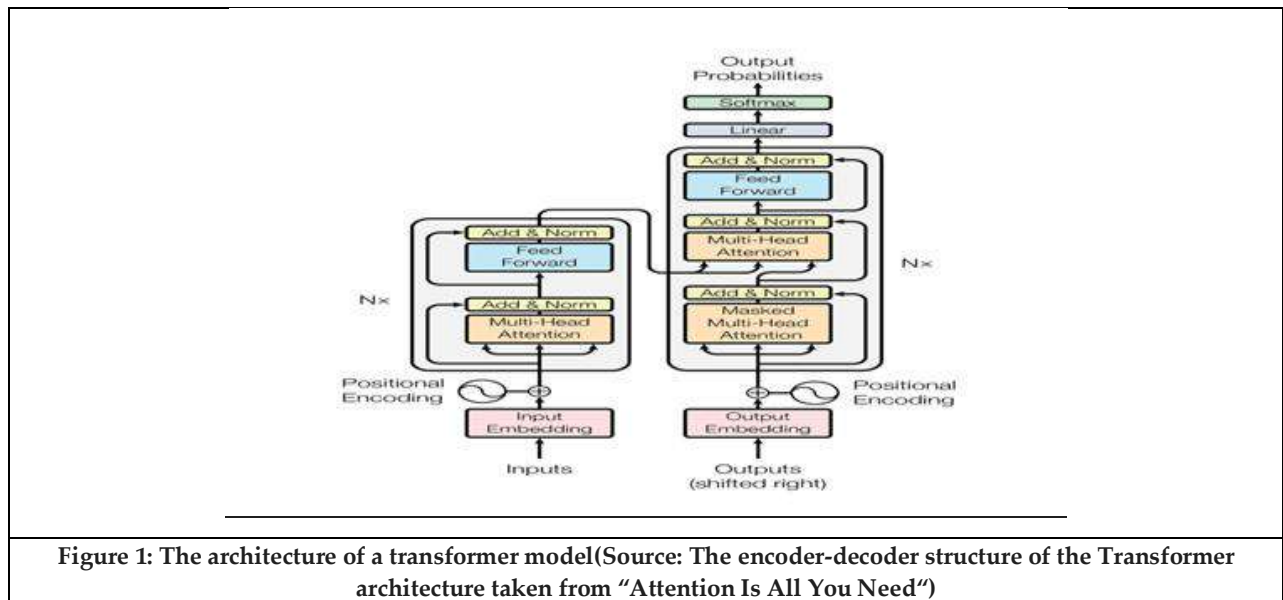


Figure 1: The architecture of a transformer model(Source: The encoder-decoder structure of the Transformer architecture taken from "Attention Is All You Need")





Retinal Image Analysis using CNN Architecture

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07Jun 2024

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ABSTRACT

The occurrence and progression of diabetic retinopathy (DR) must be controlled strictly, as must blood pressure and glucose levels. Diabetes mellitus patients are followed up according to a plan rather than only looking for symptoms. The follow-up interval is determined by how severe the DR is staged (mild, moderate, or severe no proliferative DR vs. proliferative DR, PDR). Diabetic macular edema (DME) is the most frequent reason why diabetic individuals lose their vision. Retinal Image Analysis for the Detection of Eye Conditions Fuzzy Logic Image Processing, Blood Vessel Segmentation, and Optic Disc Segmentation. Retinal disorders of the eyes that are frequently treated. Results using bevacizumab seem quite comparable to those with ranibizumab, and the best visual results for DME currently are achieved with intravitreal ranibizumab injections focal laser photocoagulation, which not only treats DME but also seems to reduce the likelihood of DR progression. However, there is a disproportionately increased risk of glaucoma and cataract development. Selected patients may also benefit from focused laser therapy and intravitreal steroid treatment. Because of an increase in intraocular pressure inside the retina, glaucoma is a neuro-degenerative eye disease. Due to the fact that it is the second-leading cause of blindness in the world, if an early diagnosis is not made, it may result in total blindness. [It has been demonstrated that routinely testing diabetic patients for DR is an essential and cost-effective component of their management.]⁸ The visual cortex provided the idea for CNN's architecture, which is similar to the way human brain neurons connect to one another. Both the speed and accuracy of the CNN algorithm's predictions are improved.

Keywords: Diabetic retinopathy, Proliferative Diabetic retinopathy, Diabetic macular edema, ranibizumab and bevacizumab





INTRODUCTION

When the retina gets damaged as a result of diabetes, the condition is known as diabetic retinopathy or diabetic eye disease. [One of the main causes of blindness in the western world is diabetic retinopathy (DR).]⁵ It may ultimately result in blindness. It is an ocular symptom of diabetes, a systemic disease that affects up to 80% of all people with diabetes who have had the condition for 20 years or longer. There are typically no early warning signals of diabetic retinopathy. Even macular edema, which can quickly impair vision, may not exhibit any symptoms for some time. However, macular edema patients typically experience impaired vision, which makes it challenging to read or drive. Frequently during the day, the vision will either get better or worse. Non-proliferative diabetic retinopathy (NPDR), the initial stage, is characterised by the absence of symptoms, non-visually evident indicators, and 20/20 vision in the affected individuals. Fundus photography, in which tiny blood-filled bulges in the artery walls can be observed, is the only method for identifying NPDR. Fluorescein angiography can be used to see the back of the eye if there is limited vision. Retinal ischemia (lack of blood flow) is characterised by plainly visible narrowing or obstruction of retinal blood vessels. Any stage of NPDR can experience macular edema, in which blood vessels bleed their contents into the macular region. Blurred vision and darkened or distorted images that are not sharp are signs of macular edema. Macular edema-related visual loss will affect 10% of diabetes patients. Macular edema-related areas of retinal thickening (caused by fluid buildup) can be visualised using optical coherence tomography. In the second stage of proliferative diabetic retinopathy (PDR), abnormal new blood vessels (neovascularization) develop at the back of the eye. These aberrant new blood vessels are fragile and can rupture and bleed (vitreous haemorrhage), obstructing vision. When this bleeding starts, it might not be extremely bad at first. [With hopeful outcomes, extensive study has been done on the techniques for a binary categorization of DR. Gardner et al. achieved sensitivity and specificity results for yes or no categorization of DR of 88.4% and 83.5% using neural networks and pixel intensity measurements.]⁶

Most of the time, it will only leave a few blood specks or spots floating in a person's field of vision, however the spots frequently disappear within a few hours. These patches are frequently followed in a few days or weeks by a much larger blood leakage that distorts vision. In severe circumstances, a person could only be able to distinguish between light and dark with one eye. The blood may take several days to drain from the interior of the eye, or it may take months or even years. In some circumstances, the blood may not be clear at all. Large haemorrhages of this nature frequently occur during sleep and frequently occur multiple times. A doctor will identify cotton wool spots, flame haemorrhages and dotblot haemorrhages during a funduscopy examination.

Both Type I and Type II diabetics are at risk, as are all patients with diabetes mellitus. A person's likelihood of experiencing some type of ocular issue increases with the duration of their diabetes. Between 40 and 45 percent of Americans with diabetes develop diabetic retinopathy in some stage. Nearly all Type I diabetes patients and more than 60% of Type II diabetes patients have some degree of retinopathy after 20 years of diabetes; however, these results were published in 2002 using data from four years earlier, which limits the applicability of the research. Before modern quick acting insulin and at-home glucose testing, the late 1970s was when the subjects would have received their diabetes diagnosis. Microvascular alterations in the retina cause diabetic retinopathy. Vascular walls become ineffective as a result of intramural pericyte loss and thickening of the basement membrane brought on by hyperglycemia. These alterations alter how the blood-retinal barrier develops and also increase the permeability of the retinal blood vessels. Some preliminary studies have confirmed the concept that hypoxia is a cause of the retina's deterioration. Poor blood sugar (blood glucose) regulation can have a serious impact on small blood vessels, including those in the eye. The retina's minuscule blood vessels are harmed by an excess of glucose and/or fructose. Most patients do not detect any changes in their eyesight during the first stage of NPDR, which stands for no proliferative diabetic retinopathy. Sometimes called simplex retinopathy or background retinopathy, these early abnormalities are reversible and do not endanger central vision. One of the most common chronic diseases that causes disability and one of the main reasons for avoidable blindness worldwide is diabetic retinopathy. Early detection of diabetic retinopathy allows for





prompt treatment, hence screening programmes, particularly automated screening programmes, will require significant investment if this goal is to be met. The development of effective image processing and analysis algorithms is necessary for automated screening programmes to function reliably. This study reviews recent research on digital image processing for use in fundus pictures for the early identification of diabetic retinopathy. Image preprocessing, localization and segmentation of the optic disc, segmentation of the retinal vasculature, localization of the macula and fovea, and localization and segmentation of diabetic retinopathy diseases were the five divisions into which algorithms were divided.

LITERATURE SURVEY

A Survey on Diabetic Retinopathy Disease Detection and Classification using Deep Learning Techniques(2021)

Diabetes can cause a number of problems to develop throughout the body if it is not addressed. Diabetes causes diabetic retinopathy (DR), an asymptomatic eye condition that affects the retinal blood vessels. In the literature, numerous automatic diagnostic systems have been created using traditional handcrafted features. Because Deep Learning (DL) does autonomous feature extraction, it can give more accurate and promising findings, especially in medical imaging. In the processing of medical picture data, convolutional neural networks (CNNs) are the most often employed deep learning technique. In order to gain a better understanding, this work analyses and reviews a number of Deep Learning-based algorithms for diagnosing and categorising diabetic retinopathy.

Automatic Glaucoma Diagnosis Based on Photo Segmentation with Fundus Images(2021)

Medical imaging is the process of taking pictures of the human body's internal organs for diagnostic purposes. The most diverse types of eye disorders that affect the retina are readily identified by the specialists with the aid of these photos. The retinal images are recorded by the fundus camera, which also records what are known as fundus images. One of the most common diseases, glaucoma, causes loss of vision in the eyes by destroying the optic nerves. It is important to find glaucoma early since repairing the injured optic nerves is a difficult process. As a result, it is crucial to detect automated glaucoma is very difficult. It is common practise to identify the glaucoma condition utilising various machine learning approaches. A fundus picture database is used to execute the suggested photo segmentation approach for qualitative and quantitative analysis. A fundus photograph dataset with outstanding parameters, such as peak sign to noise ratio, illness detection accuracy, false-wonderful rate, and disorder detection time with regard to the number of photographs, is used for experimental evaluation.

Glaucoma detection in retinal fundus images using U-Net and supervised machine learning algorithms (2021)

In this study, an offline Computer-Aided Diagnosis (CAD) system using retinal fundus images is proposed. Machine learning, deep learning, and image processing techniques are all used in the development of this application. Region of Interest (ROI) detection is carried out using the brightest spot algorithm, and input image validation is performed using the Le-Net architecture. Additionally, the U-Net architecture is used to segment the optic disc and optic cup, and SVM, Neural Network, and Adaboost classifiers are used to classify the data.

CANet: Cross-disease Attention Network for Joint Diabetic Retinopathy and Diabetic Macular Edema Grading(2020)

Automatic grading of DR and DME is crucial in clinical practise since it aids ophthalmologists in creating patient-specific therapies. The association between DR and its complication, i.e., DME, has not been taken into account in earlier publications, which either grade DR or DME. Additionally, location data, such as macula and soft hard exhaust remarks, is frequently utilised as a prior for grading. Since these annotations are expensive to acquire, it would be advantageous to create automatic grading systems that require only image-level supervision. Using solely image-level supervision, we explore the internal relationships between the diseases in this research to introduce a unique cross-disease attention network (CANet) to simultaneously evaluate DR and DME. The disease-specific attention module, which we developed to selectively acquire useful features for certain diseases, and the disease-dependent attention module, which we developed to better understand the



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intrinsic relationships between the two diseases, are among our key contributions. In order to develop disease-specific and disease-dependent features and to jointly maximise the overall performance for grading DR and DME, we merge these two attention modules into a deep network. We test our network using two open benchmark datasets, namely the Messidor dataset and the ISBI 2018 IDRiD challenge dataset. The ISBI2018 IDRiD challenge results in the best performance using our approach.

Uncertainty-Aware Deep Learning Methods for Robust Diabetic Retinopathy Classification (2022)

We present novel results for 9 BNNs by systematically investigating a clinical dataset and 5-class classification scheme, together with benchmark datasets and binary classification scheme. Moreover, we derive connection between entropy-based uncertainty measure and classifier risk, from which we develop a novel uncertainty measure. We observe that the previously proposed entropy-based uncertainty measure improves performance on the clinical dataset for the binary classification scheme, but not to such an extent as on the benchmark datasets. It enhances performance for the benchmark datasets but not for the clinical dataset in the clinical 5-class classification scheme. One benchmark dataset and the clinical dataset are both applicable to our new uncertainty measure. According to our research, BNNs can be used to estimate uncertainty when categorizing diabetic retinopathy based on clinical data, however appropriate uncertainty measures are required to maximize the intended performance measure. Furthermore, techniques created for benchmark datasets may not translate to clinical datasets.

SYSTEM ANALYSIS. PROBLEM ANALYSIS

The goal of the system analysis is to create a quick analysis work as well as to establish comprehensive knowledge of the concept, behavior, and other restrictions like performance metrics and system optimization. The main goal of the system analysis is to completely specify the technical information for the key concept.

PACKAGES SELECTED

The software chosen to produce video anomaly detection is called MATLAB, and it comes with more sophisticated functionality. The chosen platform for developing the system is the MATLAB platform with a Windows application.

FEATURES OF WINDOWS XP PROFESSIONAL

Joining a Windows Server domain, a collection of PCs that are remotely administered by one or more central servers, is possible. a complex access control system that, under normal conditions, enables the granting of particular file rights to particular users. Users can change access control lists by using programs other than Windows Explorer (such as cacls or File Manager), or by restarting in Safe Mode. Using a local area network or the Internet, a PC can be controlled by another Windows XP user using a remote desktop server. Offline Files and Folders, which let the PC automatically copy files from another networked computer and access them when the network is down. Files on the computer's hard drive are encrypted by the Encrypting File System so that no one else can access them, even if they have physical access to the storage medium. Features for centralized administration, such as Roaming User Profiles, Group Policies, Automatic Software Installation and Maintenance, and Remote Installation Service (RIS). two physical central processing units (CPUs) are supported. (Multi core CPUs are supported using XP Home Edition since the number of CPU cores and Hyper-threading capabilities on current CPUs are considered to be part of a single physical processor.)Using short keywords (aliases), the Windows Management Instrumentation Console (WMIC) is a command-line tool that makes it easier to retrieve WMI information about a system.

REQUIRED RESOURCES

The availability of the resources needed to plan, develop, implement, and test the project must be examined during this phase. Manpower, time, and system requirements are the resources that need to be examined. The whole SDLC life cycle, with the exception of the testing step, is carried out by teams of two people. Before the product is implemented, the testing step is supervised by experienced testers. The project's completion time was estimated to take four months, with four hours per day, excluding weekends. The following list and analysis of system requirements.





STUDY OF FEASIBILITY

The goal of a feasibility study is to determine the problem's breadth in addition to finding a solution. The study helped to clarify the problem definition and identify the components of the problem that should be addressed by the system. Benefits are therefore calculated at this level more precisely. The following are the main factors:

- Economic feasibility
- Technical feasibility
- Operational feasibility

Economic feasibility

Economic feasibility analyses Here, benefits in the form of lower expenses are taken into account in addition to the costs of the gear and software. If implemented, this idea will undoubtedly be advantageous because it will decrease manual labor and speed up production.

Technical Feasibility

Technical Feasibility assesses the needed hardware, software, employees, etc., and if necessary, offers enough memory to store and process the data.

Operational Feasibility

The feasibility study's most crucial step is this one since it forecasts how well the system under development will work. This study also aids in the analysis of the strategy needed to create the system with the least amount of work. Proposed systems are only useful if they can be transformed into information systems that satisfy the needs of the organization. This technique facilitates good results and lessens manual labor. Only by taking the time to consider the feasibility do we lessen the likelihood of major setbacks at a later stage of the project. It is not a waste of time or effort to put effort into a feasibility study that leads to the rejection of a project proposal. In the modern world, people suffer from a variety of illnesses that might impair one body component or another and slow down their productivity. One of the causes is eye disease, which includes diabetic retinopathy and glaucoma-related vision loss. Blood vessels in the eye are damaged by DR-induced alterations. A conventional image processing procedure will be used, including picture acquisition, pre-processing, feature extraction, and precise illness detection. We will classify the retinal images into the Normal group using the Color Histogram and Skin Locus Model. In comparison to current systems, the overall classification rate of the proposed system will provide more efficiency and accuracy in recognizing the disease. The human eye is the main organ. According to medical study, high blood pressure and glucose levels are two key factors contributing to eye problems. The main signs of diabetic retinopathy are seen in the early stages, and therapy may only be beneficial when caught in time. These blood vessels change in these weak and as a result, the vessel spills lipoprotein-containing fluid and blood, which causes abnormalities in the retina. A diabetic's eye may have a variety of abnormal lesions brought on by diabetic retinopathy. The eye condition glaucoma damages the optic nerve and impairs vision. Glaucoma is one of the serious disorders associated with eyesight, however it can be effectively treated if caught early. Recently, a number of methods have been developed for the automatic assessment of retinal fundus pictures to identify glaucoma. To accurately detect glaucoma, however, fundus picture segmentation is a relatively difficult task. For the purpose of identifying ocular problems, retinal image evaluation is extensively used in the clinical setting. This makes it crucial to find the glaucoma from the attention at an early stage. As a result, segmentation is a crucial step in accurately diagnosing glaucoma automatically.

SYSTEM IMPLEMENTATION EXISTING METHOD

There are two steps to the method: coarse level and fine level. Hes candidate regions are extracted at a coarse level by fusing histogram segmentation with morphological reconstruction. [The number of persons with diabetes is expected to keep growing due to reasons like rising life expectancy, luxurious lifestyles, and other causes.]⁷ To classify retinopathy, we define 44 typical features for each candidate location at the fine level and train an SVM model. We test the suggested technique using the open diaretdb1 database. Results from the experiments demonstrate how effectively our technique can find HEs. The algorithm uses colour information to conduct the categorization of retinal



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exudates and is based on Fisher's linear discriminant analysis. [There has been a lot of effort done on identifying the characteristics of DR using automated techniques like support vector machines and k-NN classifiers.]9

With the help of a database including 58 retinal pictures of varying quality, colour, and brightness, we evaluated the algorithm's performance prospectively.

DISADVANTAGES OF EXISTING METHOD

- Retinopathy prediction is highly challenging, and the segmentation method could result in undesired noise.
- It solely detects diabetic retinopathy, whereas other parameters must also be detected.
- Moderate performance, evaluation, efficacy, and accuracy.

PROPOSED METHOD

Diabetic retinopathy damages blood vessels and affects the eye. A conventional image processing procedure will be used, including picture acquisition, pre-processing, feature extraction, and precise illness detection. The system can currently only identify one ailment. We have suggested an algorithm that can identify all eye conditions in a single system. The proposed block diagram as shown in figure 1. This research proposes to apply CNN algorithm for automatic eye illness identification based on the categorization of retinal images. Retinal images are one of the most crucial medical references that help to diagnose the cataract, DR, and glaucoma. There are other algorithms used for classification in deep learning, however CNN is superior to the majority of them due to its improved categorization and result accuracy. The Convolutional Neural Network Algorithm makes predictions more accurately and more quickly.

ADVANTAGES

Blood vessel segmentation is used for retinal disease prediction, and it is more effective than the current approach. When utilising this approach, accuracy, performance, and output assessment are all comparatively higher.

Description of Diabetic Retinopathy**Image Acquisition**

There is a dataset consists four different types of retinopathy (Hard exudates, soft exudates, hemorrhages and red small dots).Among those images select anyone of the image to classify.

Preprocessing

In preprocessing, two plane conversions is done by converting into gray format if the taken image as supposed to be three plane image.

Histogram Equalization

A method for changing image intensities to improve contrast is histogram equalization. Because of this enhancement visual quality will be little bit better and easy to analysis. The values will be varied upto 256.

Algorithm Implementation

To categorize the retinal images and retrieve the characteristics, a Color Histogram and Skin Locus modal algorithm is utilized.

Classifying Result

By using morphology technique the noises will be reduced for the classified images and we will obtain as desired one and text will be used to mention the classified type on images.

CONVOLUTIONAL NEURAL NETWORKS

Convolutional neural networks perform neural networks when given inputs such as images, voice, or audio, for example. There are three basic types of layers in them:



**Convolutional layer**

- Pooling layer
- Fully-connected (FC) layer

[In the 1970s, network designs for working with picture data were commonly constructed, 10 with effective applications that outperformed previous methods for difficult tasks such handwritten character recognition¹¹. However, neural networks didn't become practical for more challenging image identification issues until a number of advances in the field, including the implementation of dropout¹², rectified linear units¹³, and the ensuing rise in computing capacity via graphics processor units (GPUs).^{12 13 14 15} The convolutional layer is the first layer of a convolutional network. The fully-connected layer is the final layer, even though convolutional layers, additionally followed up by convolutional layers, or pooling layers. The CNN becomes more complicated with each layer, detecting larger areas of the image. Early layers emphasize basic elements like colors and borders. The larger features or shapes of the object are first recognized when the visual data moves through the CNN layers, and eventually the intended object is recognized.

Convolutional Layer

The central component of a CNN is the convolutional layer, which is also where the majority of computation takes place. It needs input data, a filter, and a feature map, among other things. Assume that the input will be a color image that is composed of a 3D pixel matrix. As a result, the input will have three dimensions—height, width, and depth—that are analogous to RGB in an image. Additionally, we have a feature detector, also referred to as a kernel or filter, which will move through the image's receptive fields and determine whether the feature is there. Convolution describes this process. [With a value of 0.01, the leaky rectified linear unit activation function was utilized to reduce the network's dependency on a few specific nodes. Similarly, for weight and biases in the convolution layers, L2 regularization was applied. To cut down on initial training time, Gaussian initialization was also used to initialize the network. The popular categorical crossentropy function was employed as the loss function during optimization.]¹⁰ A two-dimensional (2-D) array of weights serving as the feature detector represents a portion of the image. The filter size, which also controls the size of the receptive field, is normally a 3x3 matrix, however they can vary in size. Following the application of the filter to a portion of the image, the dot product between the input pixels and the filter is determined. The output array is then fed with this dot product. Once the kernel has swept through the entire image, the filter shifts by a stride and repeats the operation. A feature map, activation map, or convolved feature is the ultimate result of the series of dot products from the input and the filter. A CNN performs a Rectified Linear Unit (ReLU) adjustment on the feature map following each convolution operation, adding nonlinearity to the model. As was previously mentioned, the first convolution layer may be followed by another convolution layer. When this occurs, the CNN's structure may become hierarchical because the later layers will be able to view the pixels in the earlier layers' receptive fields. Let's use the case of trying to determine whether a bicycle is there in an image as an example. The bicycle can be viewed as a collection of components. It has a frame, handlebars, wheels, pedals, and other parts. The neural network's representation of the bicycle is made up of lower-level patterns for each of its component pieces and higher-level patterns for the entire bicycle.

Pooling Layer

Down sampling, sometimes referred to as pooling layers, carries out dimensionality reduction and lowers the amount of parameters in the input. The pooling operation sweeps a filter across the entire input similarly to the convolutional layer, with the exception that this filter lacks weights. Instead, the kernel populates the output array by applying an aggregation function to the values in the receptive field. There are principally two forms of pooling: Maximum pooling The filter chooses the input pixel with the highest value to send to the output array as it advances across the input. As a side note, this method is applied more frequently than average pooling.





Average pooling

The filter calculates the average value inside the receptive field as it passes across the input and sends that value to the output array. The pooling layer loses a lot of information, but it also offers the CNN a number of advantages. They lessen complexity, increase effectiveness, and lower the risk of overfitting.

Fully-Connected Layer

The full-connected layer is exactly what its name implies. As was already noted, partially connected layers do not have a direct connection between the input image's pixel values and the output layer. In contrast, every node in the output layer of the fully-connected layer is directly connected to a node in the layer above it. Based on the features that were retrieved from the preceding layers and their various filters, this layer conducts the classification operation. FC layers often utilize a softmax activation function to categorize inputs appropriately, producing a probability ranging from 0 to 1. Convolutional and pooling layers typically use ReLu functions. Convolutional neural networks and computer vision Computer vision and image recognition tasks are driven by convolutional neural networks.. Artificial intelligence (AI)'s field of computer vision enables computers and systems to extract useful information from digital pictures, movies, and other visual inputs and to behave accordingly. It stands apart from image recognition jobs in that it can make recommendations. Modern instances of typical applications for this computer vision involve:

- Marketing: Social media platforms make it easier to tag friends in photo albums by suggesting potential participants in a photo that has been put on a profile.
- Healthcare: By integrating computer vision into radiography equipment, clinicians are now better able to recognize cancerous tumors in healthy anatomy.
- Retail: Some e-commerce platforms now feature visual search, allowing firms to suggest products that would go well with an existing wardrobe.
- Automotive: Although the era of driverless cars hasn't quite arrived, the underlying technology has begun to find its way into cars, enhancing driver and passenger safety with features like lane line detection.

SYSTEM REQUIREMENTS SPECIFICATION SOFTWARE REQUIREMENT

1. Tool: Matlab 2014a
2. Toolbox : Image Processing

HARDWARE REQUIREMENT

1. SYSTEM: Pentium IV 2.4 GHz
2. HARD DISK : 40 GB
3. RAM : 2 GB
4. NodeMCU Controller
5. LCD Display

SYSTEM IMPLEMENTATION

SOFTWARE OVERVIEW

Programming, visualization, and numerical computing are all done using MATLAB, a high-level language and interactive environment. To analyze data, create algorithms, create models, and create applications, utilize MATLAB. With the language, tools, and built-in arithmetic functions, you can explore several approaches and find a solution more rapidly than with spreadsheets or traditional programming languages like C/C++ or Java. Applications for MATLAB include signal processing, communications, image and video processing, control systems, test and measurement, computational finance, and computational biology. In industry and academia, more than a million engineers and scientists use the specialized computer language MATLAB.

Key Features

- Interactive environment for iterative exploration, design, and problem solving
- High-level language for numerical computation, visualization, and application development



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- Numerical integration, Fourier analysis, filtering, optimization, linear algebra, statistics, and solving ordinary differential equations
- Tools for designing applications with unique graphical interfaces. Built-in graphics for visualizing data and tools for making custom plots. Development tools for enhancing code quality and maintainability.
- Tools for combining MATLAB-based algorithms with third-party software and programming languages like C, Java, .NET, and Microsoft Excel

Numeric Computation

For the purposes of data analysis, algorithm development, and model creation, MATLAB offers a variety of numerical computation techniques. Common engineering and scientific procedures are supported by the mathematical functions of the MATLAB programming language. Calculations involving vectors and matrices are carried out quickly by core math operations using processor-optimized libraries.

There are several options

- The interpolation and regression
- Differing and integrating
- Equations with linear systems
- Analyzing Fourier data
- Singular and eigenvalues
- Common differential equations
- Matrix sparse data

Specialized functionality in domains like statistics, optimization, signal analysis, and machine learning are available in MATLAB add-on products.

Data Analysis and Visualization

In a fraction of the time it would take to do so using spreadsheets or conventional programming languages, MATLAB's tools for data acquisition, analysis, and visualization help you understand your data. Plots, reports, public MATLAB code, and other forms of documentation and sharing are further options.

Acquiring Data

Data from files, other programs, databases, and external devices can all be accessed using MATLAB. Microsoft Excel, text or binary files, image, sound, and video files, as well as scientific files like netCDF and HDF, are just a few of the common file types that can have their data read. Working with data files in any format is made possible by file I/O functions. You can stream real-time, measured data straight into MATLAB for analysis and visualization using add-on packages for MATLAB, as well as collect data from hardware devices like your computer's sound card or serial port. Oscilloscopes, function generators, and signal analyzers are a few other devices with which you can interact.

Analyzing Data

Data can be organized, filtered, and prepared using MATLAB. Discovering trends, testing presumptions, and creating descriptive models are all possible using exploratory data analysis. In addition to interpolation, convolution, and fast Fourier transforms (FFTs), MATLAB also has filtering and smoothing functions. For tasks like curve and surface fitting, multivariate statistics, spectral analysis, image analysis, system identification, and other analyses, add-on solutions offer their skills.

Visualizing Data

Aside from volume visualization techniques, MATLAB also includes built-in 2-D and 3-D plotting functions. These features might help you explain results and visualize data. Interactively or through programming, plots can be altered. Examples of numerous graphic data visualization techniques in MATLAB can be found in the MATLAB plot gallery. You can read and download the source code for each example to use it in your own MATLAB program.





Documenting and Sharing Results

Plots or full reports are two ways you can present your findings. The common graphical and data file formats can be used to store MATLAB plots and modify them to suit publication requirements. MATLAB programs have the ability to generate reports automatically. Your program results, comments, and plots are included in the report along with your code. Numerous file types, including HTML, PDF, Word, and Latex, are supported for publishing reports.

Programming and Algorithm Development

With the aid of MATLAB's high-level language and development tools, you may easily create and test algorithms and software.

The MATLAB Language

The vector and matrix operations that are essential to solving engineering and scientific issues are natively supported by the MATLAB language, allowing for quick development and execution. Because you do not have to carry out low-level administrative duties like declaring variables, identifying data types, and allocating memory, you can build programs and develop algorithms faster with the MATLAB language than with traditional languages. For-loops are frequently unnecessary thanks to the support for vector and matrix operations. As a result, numerous lines of C or C++ code can frequently be replaced by one line of MATLAB code. MATLAB offers functionality found in conventional programming languages, such as flow control, error management, and object-oriented programming (OOP). You have a choice of using basic data types, sophisticated data structures, or creating your own data types. By interactively carrying out commands one at a time, you can get immediate results. With this method, you can swiftly investigate a variety of alternatives and refine your choices until you find the best one. To reuse your work and automate it, you can save interactive steps as scripts and functions. Built-in algorithms for signal processing and communications, image and video processing, control systems, and many other disciplines are provided through MATLAB add-on products. You can create sophisticated programs and applications by fusing these algorithms with your own.

Development Tools

The following are some of the tools available in MATLAB for effective algorithm development:

- You can enter data, run commands and programs, and view results interactively using the command window.
- Setting break points and walking through specific lines of code are two editing and debugging options offered by the MATLAB Editor.
- Code Analyzer, Automatically looks for errors in the code and suggests changes to improve efficiency and maintainability.
- Measures MATLAB program performance and highlights portions of code that need to be changed for improvement
- Additional tools compare the code and data files, and they produce reports with annotated notes, file dependencies, and code coverage.

Integration with other languages and applications

Applications created in several languages can be integrated with MATLAB software. Code written in C, C++, Java, and .NET can be directly called from MATLAB. You can call MATLAB code from applications written in FORTRAN, C, or C++ by using the MATLAB engine library.

Performance

In order to execute matrix and vector operations quickly, MATLAB leverages processor- optimized libraries. With its just-in-time (JIT) compilation engine, MATLAB can match the execution speeds of conventional programming languages for general-purpose scalar computations. Many multithreaded linear algebra and numerical routines are available in MATLAB to fully utilize multicore and multiprocessor systems. These functions automatically run on multiple computational threads within a single MATLAB session, allowing them to run more quickly on multi-core desktop and other high-performance computing resources like GPUs and clusters. You can further benefit from





multi-core desktop and other high-performance computing resources like clusters and GPUs with add-on parallel computing products. With just a few small modifications to the MATLAB code, these solutions offer high-level features that enable application parallelization.

Image Acquisition

With the help of Image Acquisition Toolbox™, you can import images and video captured by cameras and frame grabbers directly into MATLAB and SIMULINK. Hardware can be automatically detected, and its properties can be set. Advanced workflows allow you to synchronize sampling across several multimodal devices, trigger acquisition while processing is in-the-loop, and do background acquisition. You can employ imaging devices ranging from low-cost Web cameras to high-end scientific and industrial equipment that fulfill tough criteria for low-light, high-speed, and other factors thanks to support for a variety of hardware suppliers and industry standards.

Key features

- GigE Vision, Camera Link, and DCAM are just a few examples of the standards that are supported. the availability of Direct Show, QuickTime, and video4linux2, three popular OS webcam interfaces.
- Support for a variety of manufacturers of industrial and scientific devices possibilities for managing the buffer and various capture modes.
- synchronization of hardware triggering and multimodal acquisition devices.
- Fast hardware configuration, picture acquisition, and live video previewing with the picture Acquisition app. Simulink offers assistance for creating C code.

COLOUR HISTOGRAM

A color histogram is a visual depiction of how colors are distributed in an image used in image processing and photography. A color histogram for digital images shows the proportion of pixels that are colored in each of a predetermined set of color ranges that cover the entire spectrum of the image's color space. Although the phrase "color histogram" is more frequently associated with three-dimensional color systems like RGB or HSV, it may be created for any type of color space. The word "intensity histogram" may be used instead for monochromatic photographs. The color histogram is N-dimensional for multi-spectral images where each pixel is represented by an arbitrary number of measurements (for example, beyond the three measurements in RGB).

SKIN LOCUS MODEL

Despite the fact that every person has a unique skin tone, research have revealed that the primary distinction in skin tones is more often due to their intensity than their chrominance. Several value distribution models have been contrasted in various color spaces, including RGB, HSV, YCbCr, etc. Under specific, constrained circumstances, these distribution models have proven to be somewhat effective at extracting skin-like regions. A relative robustness against changes in intensity is attained when only the chromaticity information is taken into account. Skin chromaticities depend on the prevailing illumination and camera calibration light source, therefore this won't completely cure all of the problems linked to illumination and camera calibrations. The greater the chromatic shift, the more these two illumination parameters differ. Additionally, the color of the light may not be consistent across the face (in this situation, even thorough calibration is insufficient). We suggest using the skin locus, which has shown to be effective with photos under a wide range of situations, to address these issues.

ARDUINO SOFTWARE (IDE)

The Arduino Software (IDE), often known as the Arduino Integrated Development Environment (IDE), has a text editor for writing code, a message box, a text console, a toolbar with buttons for basic functions, and a number of menus. To upload programs and communicate with the hardware of Arduino and Genuino, a connection must be made.





EMBEDDED C

The C Standards committee developed a set of language extensions for the C programming language called Embedded C to address difficulties of compatibility between C extensions for various embedded devices. In the past, supporting exotic features like fixed-point arithmetic, several different memory banks, and fundamental I/O operations required nonstandard additions to the C language.

NECESSITY

During the early development of devices with microprocessors, programs were created using assemblers and fused into the EPROMs. The program's behavior couldn't previously be monitored. To verify that the program was running properly, LEDs, switches, etc. were employed. In-circuit Simulators (ICEs) were owned by a few "very fortunate" developers, but they were expensive and not entirely dependable. The use of microprocessor-specific assembly-only as a programming language decreased with time, and embedded systems switched to C as their preferred embedded programming language. For embedded processors and controllers, C is the most popular programming language. The majority of the time, assembly is utilized to implement those parts of the code that have the highest demands for timing accuracy, code size efficiency, etc.

ADVANTAGES

- It is easy to learn, comprehend, program, and debug since it is compact.
- When written in C, code is more dependable, scalable, and cross-platform compatible than when written in assembly language.
- Today's embedded devices can virtually all be programmed in C, and there is a sizable pool of skilled C programmers.

PROTEUS SOFTWARE

Simone Zanella developed Proteus, a procedural programming language, in 1998. Proteus is an acronym for PROcessor for TExt Easy to Use. Proteus is one of the most comprehensive languages for text manipulation since it combines numerous functions from a variety of different languages, including C, BASIC, Assembly, and Clipper/dBase. It is also particularly adaptable when dealing with strings thanks to its large number of dedicated functions.

HARDWARE OVERVIEW NODEMCU

An open-source microcontroller and firmware called NodeMCU V3 is essential for developing an Internet of Things (IoT) product using a few lines of script. In addition to being able to generate PWM, I2C, SPI, and UART serial connections, the board has other GPIO pins that we may use to link it to additional peripherals.

- The ESP8266 Wi-Fi SoC powers the module's firmware, and the ESP-12 module powers its hardware. These two components make up the interface of the module.
- If the module is functioning properly when connected to a computer, the board includes a status LED that blinks before turning off immediately. This LED will let you know the module's present state.
- The module is the best option for integrating with other embedded devices like Raspberry Pi since it can establish a faultless Wi-Fi connection between two channels.

A number of GPIO Pins are included with Node MCU V3.

- There is a clear distinction between Vin and VU where former.
- There is a clear distinction between Vin and VU; the former is the regulated voltage and can range from 7 to 12 V, while the latter is the power voltage for USB and must be maintained at or near 5 V.

WORKING

The liquid crystal molecules would align in a particular direction if the electrodes received a sufficient voltage. The polarizer would rotate the light rays as they passed through the LCD, activating or emphasizing the desired characters as a result.. The power supply should be of +5v, with maximum allowable transients of 10mv. It is



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important to appropriately adjust the voltage (VL) at pin 3 to produce a better/suitable contrast for the display. A live circuit shouldn't have a module removed from it. The ground terminal of the power supply must be isolated properly so that voltage is induced in it. The module is to be isolated properly so that stray voltages are not induced, which could cause a flicking display. LCD is lightweight with only a few, millimeters thickness since the LCD consumes less power. They can be powered for extended periods of time and are compatible with low power electrical circuitry. Since LCD displays do not produce their own light, light is required to read them. . [Additionally, Nayak et al. 17 used variables such the location of blood vessels and exudates in conjunction with textural parameters to classify DR into three categories using neural networks. To categorize pictures into normal, non-proliferative, and proliferative retinopathy, features are input into the neural network. These features served as the input for categorization in the neural network.]11 Reading in the dark is made feasible by the use of backlighting. LCDs last a very long time and can operate in a variety of temperatures. It is important to do correct startup before using LCD for display. The electrical contacts for each segment are separate on LCDs with a few segments, as those found in digital watches and pocket calculators. Each section is controlled by an electric charge supplied by an external, specialized circuit. More than a few display. Elements are difficult to manage in this display arrangement.

Small monochrome displays, like those in personal organizers or older laptop screens, use a passive-matrix structure that uses super-twisted nematic (STN) or double-layer STN (DSTN) technology to add color using an internal filter. The latter solves the color shifting issue with the former. The display's rows and columns each have their own individual electrical circuit. Row and column addresses are used to address each pixel individually. Because the pixel must maintain its state without the assistance of a constant electrical charge between refreshes, this sort of display is known as passive-matrix addressed. This style of display is less practical as pixels (and, consequently, columns and rows) grow in number. The reaction speeds and contrast of passive matrix addressed LCDs are often very slow. Active matrix technology is used in high-resolution color displays like those found in contemporary LCD televisions and computer monitors. In addition to the polarizing and color filters, there is a matrix of thin-film transistors (TFTs). Due to the specialized transistors that each pixel possesses, each column line may access one pixel. All of the column lines are joined to a row of pixels when a row line is activated, and the proper voltage is then applied to all of the column lines. The subsequent row line is active, and the previous row line is deactivated. During a refresh process, each row line is activated in turn. Active-matrix compared to passive-matrix addressed displays of the same size, addressed displays have "brighter" and "sharper" images, and they typically respond more quickly. a two-line, 16- character alphanumeric LCD that can be used for any purpose. As a result, the sort of LCD utilized in this project has 16 characters per line, 2 lines, 5 by 7 dots, a built-in controller, and a 1/16 duty cycle.

CONCLUSION & FUTURE SCOPE

The automatic imaging method we created and prospectively evaluated for the detection of HEs. The system identifies HE lesions by statistically classifying them based on color and measuring the sharpness of their edges using the Kirsch operator. Our findings show that the method is ideally suited to support DR screening and may be used to assist ophthalmologists in their day-to-day work. The majority of the currently used supervisory algorithms call either additional pre- or post-processing steps to identify the various phases of diabetic retinopathy. Additional algorithms that compel human feature extraction phases are required to classify the fundus images. Deep convolutional neural network (DCNN) is a comprehensive approach to all stages of diabetic retinopathy in our suggested solution. There is no need for manual feature extraction processes. With dropout approaches, our network architecture produced a considerable improvement in classification accuracy. Recall rates (or true positive rates) have also increased. Among the drawbacks of this architecture are: For photos collected from various cameras with various fields of view, an additional stage augmentation is required. Our network architecture is also intricate and computationally demanding, necessitating a powerful graphics processing unit to process the high resolution images as the layers are added.





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<p>Fig 1: Proposed Block Diagram</p>	<p>Fig 2: Wi-Fi connection between two channels Node MCU</p>
<p>Fig 3: Pin Diagram</p>	<p>Fig 4: Hardware kit</p>





Culture, Society and Cultural Relativism – Models and Eccentricities – A Diasporic Construct Culture, Society and Cultural Relativism – Models and Eccentricities – A Diasporic Construct

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Cultural Relativism is a qualified term which seeks to band together culture and society. In addition, it appraises the idiosyncratic norms and value systems of a culture to preserve its individual identity. In comparison, no culture is mediocre or superior to others. By and large, there is no right or wrong ethical system. In a holistic indulgence of the term, Cultural Relativism, it can be stated that it seeks to promote the understanding of the cultural practices that are unfamiliar to other cultures. This has bearing in two ways. It prevents the 'absolutism' of the Western dogmas. It also validates the persistence of the genetic culture in the multicultural environment and the diasporic calibration. Cultural Relativism has two distinct tendencies – absolute and critical. Culture and society are inseparable. Hence the three terms, society, culture and tradition, are curtly reviewed along with the identifiable phrases which go with culture i.e. proxemics and micro culture. The definitions, chronology and the allied domains like Linguistic Relativism and Epistemological Cultural Relativism of Cultural Relativism do get the due importance in this proposal. To evidence the averments, the principles and ideologies of Judith A. Boss, James Rachels and John Tully are documented which are either constant or acerbic in tone or stance. As a further cause of this proposition, Louis Gaille's inventory of the advantages and disadvantages summarizes the entire essay.

Keywords: Cultural Relativism, Culture, Society, Tradition



**Gandhimathi and Sakhivel****INTRODUCTION**

In general, cultural relativism is the ability to fathom a culture on its own terms and not to make judgments using the standards of one's own culture. The ambition of this is to foster the compassion of cultural practices that are not typically part of one's own culture. Using the perspective of cultural relativism leads to the view that no one culture is superior to another culture when equated to schemes of morality, law and politics. (Philosophy Home, 2009) Culture is embedded in the phrase 'Cultural Relativism.' Hence the term 'culture' needs an elaborate treatment.

CULTURE VERSUS TRADITION

Culture refers to the set of beliefs, practices, learned behaviour and moral values that are passed on from one generation to another. Society means an interdependent group of people who live together in a particular region and are associated to one another. A tradition is a belief or behaviour (folk custom) passed down within a group or society with symbolic meaning or special significance with origins in the past. The main difference between culture and tradition is that traditions describe a group's beliefs and behaviors that are passed down from one generation to another. Culture acts as the underlying thread that connects an individual to everyone else, with traditions acting as the events and customs to honor these.

CULTURE

The universal generalized awareness among people about culture is the cultivated facility to catalogue and exemplify experiences with symbols and play a role resourcefully and creatively. This proficiency is deemed unique to humans. Culture is an umbrella term which encompasses the social behavior and norms found in human societies, as well as the knowledge, beliefs, arts, laws, customs, capabilities, and habits of the individuals in these groups. (Tylor, Edward, 1871). Some of the other notions about culture are these. A 'culture' is the set of customs, traditions, and values of a society or community, such as an ethnic group or nation. Culture is the set of knowledge acquired over time. In this sense, multiculturalism values the peaceful coexistence and mutual respect between different cultures inhabiting the same planet. The modern term "culture" is based on a term used by the ancient Roman orator Cicero in his *Tusculanae Disputationes*, where he wrote of a cultivation of the soul or "*cultura animi*," (Cicéron, Marcus Tullius Cicero; Bouhier, Jean, 1812) The *Cambridge English Dictionary* states that culture is "the way of life, especially the general customs and beliefs, of a particular group of people at a particular time." Culture, thus, in general, denotes patterns of behaviour common within a closed group of people. (Anthropology, Cultural.) Anthropology splits this behavioural pattern into two kinds – patterns common to all groups and patterns exclusive to each group. Patterns specific to a group are known as dominant or mainstream culture with dominance reflected through power. These dominance cultures have subcultures also. Culture has levels.

CULTURE SPECIFIC TERMS

Culture is both overt and covert. These refer to specifically learnt ones and unconsciously imbibed ones. Proxemics refers to personal space. Worldview is a way of understanding how the world works and the individual's place in it. Micro or Subculture refers to discrete groups within a larger group that share some sort of common trait, activity or language that binds them together and or differentiates them from the larger group. Familial culture is how one expresses culture as a family through traditions, roles, beliefs, and other areas. Every family is different, and every family has its own culture. The process by which all humans obtain, and transfer culture is enculturation – how an individual adapts to 'proscribed' behaviours and sticks to 'prescribed' behaviours. Cultural Transmission is the passing of new knowledge and traditions of culture from one generation to the next, as well as cross-culturally. Cultural universals are common aspects in all human cultures yet vary from culture to culture such as values and modes of behaviour. Diffusion is simply the borrowing of traits. Acculturation, also associated with culture change, is the borrowing of traits. The melting pot refers to a blending of cultures. Another form of acculturation is called the Salad Bowl or cultural pluralism. Values are abstract concepts that certain kinds of behaviours are good, right, ethical, moral, and therefore desirable. There are two main categories of social control to



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maintain order in group life: norms and laws. A norm is a standard of behaviour. At some point people in the society agree that these are standards. Some people learn by being taught, but these are mostly picked up just by being exposed to them. Symbols are the basis of culture. A symbol is an object, word, or action that stands for something else with no natural relationship that is culturally defined. Language is the most often used form of symbolism. Culture and Personality draw a parallel by which an understanding of a national culture is gained through examination of individual personalities. Cultural ecology is a theoretical approach that attempts to explain similarities and differences in culture in relation to the environment. Postmodernism challenges the “dominating and bullying nature of science and reason” (Cooke, 2006). Postmodernists claim that it is impossible for anyone to have objective and neutral knowledge of another culture. This view comes from the notion that we all interpret the world around us in our own way according to our language, cultural background, and personal experiences. Ethnology is the comparative study of two or more cultures. Ethnology utilizes the data taken from ethnographic research and applies it to a single cross-cultural topic. The ethnographic approach can be used to identify and attempt to explain cross cultural variation in cultural elements such as marriage, religion, subsistence practices, political organization, and parenting. A cultural norm codifies acceptable conduct in society; it serves as a guideline for behavior, dress, language, and demeanor in a situation, which serves as a template for expectations in a social group. Accepting only a monoculture in a social group can bear risks, just as a single species can wither in the face of environmental change, for lack of functional responses to the change. (Jackson) Thus, in military culture, valor is counted a typical behavior for an individual and duty, honor, and loyalty to the social group are counted as virtues or functional responses in the continuum of conflict.

CULTURAL RELATIVISM

Cultural Relativism is also propelled as a concept that cultural norms and values obtain their worth within an exclusive social context. This is also grounded on the idea that there is no out-and-out degree of good or evil, therefore every resolution and arbitration of what is right and wrong is individually decided in each society. The concept of cultural relativism also implies that any opinion on ethics is subject to the perspective of each person within their particular culture. Overall, there is no right or wrong ethical system. In a holistic indulgence of the term cultural relativism, it can be stated that it seeks to promote the understanding of cultural practices that are unfamiliar to other cultures such as eating insects or genocides.

CULTURAL RELATIVISM - KINDS

There are two diverse classes of cultural relativism. Absolute cultural relativism refers to the concept that everything that happens within a culture must and should not be questioned by outsiders. The extreme example of absolute cultural relativism would be the Nazi party’s point of view justifying the Holocaust. Critical cultural relativism is that which creates questions about cultural practices in terms of who is accepting them and why. Critical cultural relativism also recognizes power relationships.

RELATIVISM AND REALISM

Cultural relativism is a complex concept that has its intellectual roots in discussions about relativism in the philosophy of science and the philosophy of language. (Howson, Alexandra) The accustomed hypothesis of relativism in sociology is bracketed with appraisals of positivism in science and in tandem, social science, which largely highlight the differences between the motivation and application of inquiry associated with the natural and social sciences. Relativism is customarily interpreted in contrast to realism referring to the awareness of what is true and real exists autonomously of the mind. This opposition between realism and relativism is perceived through the opinion that the material and social world is mediated through human minds: that people’s interpretation of the world is interceded through the information and accepted wisdom they hold about the world. The intellectual roots of cultural relativism within sociology lie in philosophical deliberations about distinctions between reality and





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relativism. Although the impression of realism has a convoluted chronicle, it is generally accepted that it refers to the existence of a reality that lies beyond human thoughts or beliefs about it. (Marshall, G. et al., 1994) Cultural relativism is linked to cognitive relativism through the claim that social science cannot identify truth, but only customs that vary from one society to another.

CULTURAL RELATIVISM – PURPOSES

Cultural relativism provides a spontaneous and decisive contrivance for sociology and other social science disciplines. Feminists have made shared reason with cultural relativism since it affords a tool for criticizing rationality and rejecting objectivity in science as a masculinist ideal and also challenges the seemingly fixed character of gender. In fact cultural relativism is in play when the Europeans, during periods of colonial expansion believe they are 'civilizing' them considering themselves superior to the nations they colonized, this view has been trenchantly criticized by scholars such as Edward Said, who have used cultural relativism as a tool to draw attention to the social and cultural drifts of colonialism. These scholars draw attention to the way in which colonialists show partiality towards Western values and ideas above ethnic values and beliefs invalidating indigenous culture. In this sense, cultural relativism becomes a tool to contest ethnocentric Western views and practices and also promote cultural diversity.

CULTURAL RELATIVISM – IMPRESSIONS

Some defining ideas of Cultural Relativism can be looked into in detail. Cultural relativism is the idea that a person's beliefs, values, and practices should be understood based on that person's own culture, and not be judged against the criteria of another. (Cultural relativism, 2017) Franz Boas first formulated the idea in 1887 as indispensable in anthropological research: "civilization is not something absolute, but...is relative, and...Our ideas and conceptions are true only so far as our civilization goes." (Boas, Franz. 1887) *Oxford English Dictionary* records this as the comment by philosopher and social theorist Alain Locke in 1924 to describe Robert Lowie's "extreme cultural relativism," found in the latter's 1917 book *Culture and Ethnology*. According to George E. Marcus and Michael M. J. Fischer, it is an attempt to preserve the distinct cultural forms of life from the clutches of global Westernization, a perception of homogenization towards a dominant Western model. This means Cultural Relativism is, in part, a response to Western ethnocentrism. (Marcus, George, and Michael M.J. Fischer. 1986) Cultural Relativism is a key concept in analyzing human rights within a social work situation. In cultural relativism, all points of view are equally valid and any truth is relative, with truth belonging to the individual or her or his culture (Reichert, 2011). All ethical, religious, and political beliefs are truths related to the cultural identity of the individual or society. (Reichert Elisabeth, 2015)

CULTURAL RELATIVISM AND ETHNOLOGY

Cultural Relativism turns out to be a heuristic tool in a scheme – ethnology. Ethnology is a stratagem through which cultures having a very wide assortment and diversity are equaled and assessed in an efficient and cogent manner. For instance, during the nineteenth century, the technique has been in use in the display of the material artifacts in museums. The artifacts stand classified in the order of families, genera and species with the order stretching from the crudest to the most refined ones. Their aim was to classify artifacts, like biological organisms, according to families, genera, and species. Thus organized museum displays would illustrate the evolution of civilization from its crudest to its most refined forms. But Boas is against such routine since each culture needs to be focused upon individually and argues that classification is not explanation. (Boas, Franz 1974) Alfred Kroeber, Boas' student, writes about the evolution of relativist perspective in his own fashion. Anthropology, in its earlier stages, holds an exotic and out of the way opinion about culture. In course of time, this estimation yields place to the diversity of cultures with incredible spread of departures. Thus culture moves away from insensible ethnocentricity towards relativity. This conspicuous shift in emphasis from imprudent self-centeredness to an objective broader perspective of relativism is beyond doubt the hallmark foremost contribution of anthropology and distinguishes it from sociology and psychology. (Kroeber, Alfred. 1948) According to Ruth Benedict, any study of culture should adopt cultural relativism since it validates the elemental merits of that culture eschewing ethnocentrism. The preferential treatment



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of one or another culture should be disregarded in the study of culture and the authentic appraisal involves taking into account all the variant specifics of all compared cultures have to be accounted for by placing them alongside one another. The biased band of analysts of social sciences has so far erroneously projected Western civilization as the role model. She insists upon the appreciation of a culture different from one's own, one can reach a valid understanding of the totality of humanity. In this context, cultural relativism is a heuristic device of fundamental importance because it calls attention to the importance of variation in any sample that is used to derive generalizations about humanity. (Benedict Ruth, 1959) Cultural Relativism does function as a cultural critique. The exemplification for this is amply illustrated in anthropology's refusal to accept Western culture's claims to universality. (Marcus, George, and Michael M.J. Fischer. 1986) Relativism does not mean that one's views are false, but it does mean that it is false to claim that one's views are self-evident. Cultural Relativism induces analysts to reexamine taken-for-granted assumptions in the approaches in analyzing cultures. John Cook rightly observes: "It is aimed at getting people to admit that although it may *seem* to them that their moral principles are self-evidently true, and hence *seem* to be grounds for passing judgement on other peoples, in fact, the self-evidence of these principles is a kind of illusion." (Cook, John. 1978) Perhaps Cook sounds illogical in equating cultural relativism to be identical to moral relativism, he approximates to the sensible and broader perspective of the term.

According to Marcus and Fischer, when the principle of cultural relativism is propagated after World War II, it is understood "more as a doctrine, or position, than as a method." (44) Cultural relativism also claims that it is unviable to morally sit in judgment between different cultures. A culture would be better than another if it were closer to the absolutely right standard than the other were, but there is no such thing as an unequivocally accurate guideline, so no culture can be better than another: "There is no single true morality. There are many different moral frameworks, none of which is more correct than the others". (Harman, Gilbert, 2008)

CULTURAL RELATIVISM – SUB-CLASSIFICATION

Depending upon the substance of the class, Cultural Relativism falls into multiple types. Descriptive cultural relativism holds that widespread and fundamental cultural differences exist over different groups. Epistemological cultural relativism holds that these differences cannot be adjudicated so that some beliefs turn out to be better or worse in terms of truth or justifiability. Normative cultural relativism holds that these differences weigh in favour of toleration, non-interference or at the very least minimal intervention in the affairs of other groups. Defenders of cultural relativism have asserted the different component views against colonialism, exploitation of developing countries and the encroachments of global capitalism. But these outlooks are set aside by critics as camouflages for the oppression of some by others within a group, debilitating the disposition to demand bias and the violation of rights by their suitable titles. The entire reality is extensively more convoluted and much dangles on how each canon is specifically verbalized and preserved.

CULTURAL RELATIVISM AND JUDITH A. BOSS

Judith A. Boss defines Cultural Relativism as a theory about the nature of morality which contends that there are no objectives, universal moral rules and the moral rules that do exist are culture-bound. Different cultures may hold varying beliefs about the morality of killing. While some may view it as universally wrong, others might deem it acceptable under particular circumstances. The rationale behind these beliefs and the specific guidelines would be shaped by the cultural, societal, and contextual norms of each group. With reference to the positive declaration, the belief of Cultural Relativism is that what is morally tolerable is what harmonizes with socially endorsed customs or ideals while what is morally wrong is what goes against the customs or standards of society. If you do an action *e* in one culture, it might be morally acceptable, whereas if you perform *e* in another culture, it would be morally wrong. Judith A Boss attempts to explain an underlying misperception regarding the tolerance factor. Cultural Relativism should not be put in tandem with the contention that everyone ought to be compliant of other cultures. This presupposes that Cultural Relativism is accepted, the implication is threadbare – denial of the presence of objective, transcultural, moral principles. In other words, in putting up with other cultures leads to the argument that cultural tolerance is a virtue or objective value that is



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appropriate to all cultures. But, in real terms, Cultural Relativism has a covert proviso in sanctioning a culture the prospect that there is a culture that is intolerant to other cultures as there are no unbiased ethical rulebooks. Judith A Boss emphasizes that Cultural Relativism is a normative claim about what is right or wrong. This entails that any act cannot be emphatically demarcated as morally right or wrong independent of the culture in which act is performed. This declaration appears polemical as it attempts to postulate what in existence is morally right or wrong: moral rightness/wrongness is culture-bound.

Descriptive (sociological) cultural relativism (DCR) about morals, on the other hand, is the expressive assertion that what people accept as true to be morally right or wrong varies from culture to culture. It does not exclaim whether what they believe is true or false. To make plain the contention in determining the superior makeup of descriptive cultural relativism in comparison with Cultural Relativism, the following line of reasoning hold good. The first premise is that cultures have unlike moral conventions but many of these protocols are fallacious. The second premise is that there exists a compendium of dispassionate ethical codes that are valid to all cultures, irrespective of whether every culture believes those rubrics. The inference from these premises is drawn in the following manner. The first premise suggests that Descriptive Cultural Relativism does not deny that there is no cultural intersection. Instead the theoretical outlay projects that there is the prevalence of some dissimilarities in the thinking of people vis-à-vis morality. These differentiations in the ethical principles of culture are manifest in two slants: situational variances and divergences in beliefs about the world. All these arguments on moralistic base of cultural relativism strongly props the notion that all cultures have at least some conjoint values.

CULTURAL RELATIVISM AND JAMES RACHELS

James Rachels counters this moralistic stance of cultural relativists in no uncertain terms. (Rachels James) She puts forward his contentions in several planes. The prime idea put forward by Rachel is that “Different cultures have different moral codes” is conveniently projected as an excuse for socially approved habits. This is done by people so naturally and without an iota of inhibition that one’s own society is the best in existence and could not visualize that other societies do have diversified cultures. This “falsified” creed leads them to brand these other cultures as ‘regressive’ or even ‘aboriginal.’ The learned observers of different cultures are attuned themselves to the idea the opinions of right and wrong are comparative and be at variance from culture to culture. It is absolutely imprudent to take for granted that one’s notion of right or wrong would be acknowledged by all. The principal principle of morality or ethics is not universally valid or acceptable. It is just a figment of imagination. The customs of diverse societies exist as they are. These customs cannot be categorized as “correct” or “incorrect,” for that infers we have an autonomous and self-determining standard of right and wrong by which these may be assessed. But there is no such nonpartisan paradigm; every criterion is culture- bound. The foremost thing that needs the attention is that at the core of Cultural Relativism there is an undeniable structure of a line of reasoning. The scheme used by cultural relativists is to make a case from the essentials about the differences between cultural outlooks to a conclusion about the status of morality.

CULTURAL RELATIVISM AND LOUIS GAILLE’S INVENTORY

An inventory of the advantages and disadvantages of Cultural Relativism is attempted Louis Gaille’s assessment with a few additional inputs. (Gaille Louis) The main advantages are It is a procedure which stimulates mutual aid and fashions a social order where egalitarianism is promising. People can cultivate the habit of chasing an honest and viable ambition. Cultural Relativism fosters respect among people. It conserves the essences of all cultures in a society. It eliminates the possibility of negative judgements. It could become more acceptable if it discounts moral codes from its purview. It allows the setting up of personal ethics without prejudicing the societal norms. It eliminates cultural conditioning altogether. The opposing influences on Cultural Relativism are it leads to a formation of a society populated by personally biased individuals and would generate chaos. It is deep-seated in man’s perfection, snuffs out diversity, dismembers the society, curtails ethical evolution, dampens the credence of humanity’s evolution and spins “biases” into truths.





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CONCLUSION

Cultural Relativism does not permit other cultures in the evaluation of its customs and standards but definitely extends a privilege in the form of self-analysis as an autonomous entity to gauge the continued existence capability of a practice or its comparative merits in relation to similar precepts in other cultures. The conservation of cultural autonomy and the allowance for change may appear incongruous. But the implication is clear. As a matter of fact, cross cultural relationship lingers as an inspiration that attempts to foster a healthy cohabitation in a multicultural society. But this inclination also presupposes that no culture can declare that it is superior to other cultures.

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Professional Development for Language Teachers and the Efficacy of Mentoring System to Reinforce Professional Skills

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

High quality teaching is never by chance. Some teachers are inherently inclined towards teaching than others, all successful teaching is the result of conscious efforts, self-introspection, self-evaluation, practice and hard work. Considering that all classes are heterogeneous, it is highly challenging for a teacher to gauge how students learn, what hampers their learning and how teaching can improve the learning of the student. All education system all over the world is fixated on raising student performance. If this is to succeed, then it must be recognized that the teachers play a key role in raising the performance of the students. Parents demand that their children get the best teacher which demonstrates that the quality of teaching is directly proportionate to the success of the students. The need for professional development has been the topic of much discussion because a student's learning has a direct bearing on the way he is taught. Effective mentoring is considered of prime importance for a language teacher's development and it is an indispensable aspect of language teaching as it helps the language teacher in improving his teaching. English teachers as mentors can share their teaching experiences and enhance the professional growth of the teachers.

Keywords: language teachers, mentor, performance, professional development, students





INTRODUCTION

Professional development is often discussed due to its impact on a student's learning since it affects the teaching methods used. The need for ongoing learning arises because teaching challenges do not remain static. And despite a steady stream of new educational theories, updating of degrees and technology, very little has changed in actual classroom teaching, and teachers are doing more or less the same thing they did a generation ago. But, the wide diversity of students with the pressing need for graduates with good knowledge, skills and values have necessitated a deeper look and change in our instructional practices. A shift from a tradition-based and a theoretical educational process to a more innovative process is required for learners to master high-order cognitive skills such as critical thinking, complex problem-solving skills and also interpersonal skills and ethical values. Hence, faculty development programmes of high quality for all the teachers are an urgent need and vital for educational institutions for the institutions' growth and survival.

Professional skills of teachers are need based. Teachers have to continuously reinvent themselves during different times of their career as their needs keep changing. As the education system keeps evolving, educational institutions also change to cater to the demands of the times. Hence, the more diverse the classrooms, the pressure for English language teachers to update their knowledge in curriculum framing, better assessment methods and classroom teaching is intense. The institutions play a pivotal role in offering professional development training and also providing mentors for teachers to guide through the ever evolving and dynamic curriculum.

Teacher Training and Teacher Professional Development

Teacher training and teacher professional development serve different purposes. Teacher training aims at fulfilling the immediate goals of a teacher and the short-term responsibilities. Teacher training offers support in classroom practices and encourages them to attempt new strategies and to use teaching aids and resources effectively in the classroom. Teacher training can also be curriculum specific where, teachers can be guided on the implementation of a new or updated curriculum. In the case of English language teachers, teachers can be trained on how to link and incorporate grammar with the texts and also the kind of activities that can be carried out to making learning of grammar enjoyable and interesting. Teacher development is focused on overall growth and caters to a long-term goal. It aims to expedite growth of a teacher's understanding of himself as a teacher, his responsibilities and in a broader sense of teaching itself. Professional development for an English language teacher would entail understanding how the language teacher's roles change according to the kind of learners in the classroom. Such development programmes would act as a forum for a teacher to introspect, review his own method of teaching and develop a style of teaching suited to the students. Language teachers can explore new approaches in language teaching and familiarize themselves with development in grammar and other subject-matters.

Professional Development for Teachers

"Advocates of professional development for teachers are not arguing that teaching is of poor quality and must be fixed. Their advocacy for professional development for teachers reflects the recognition that teaching is so hard that it is never perfect; no matter how good a lesson is, it could always be improved." (Danielson, Talk About Teaching (2009)). Professional development refers to various types of experiences in the field of education relevant to an employee's work. People in various sectors actively partake in professional development programmes to acquire new knowledge, to relearn and to apply the latest skills to enhance their performance at their workplace. "Effective professional development focuses on improving instructional practice by giving teachers new knowledge and techniques for assessing learning with the ultimate goal of improving the learning of students." (Wei et al., 2009) Moreover, effective professional development empowers teachers with knowledge and skills required to meet students' learning challenges.





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Research has shown that teachers who participate in well-designed professional development activities get better results from their students. A systematic, on-going teacher professional development is much more effective than traditional workshops and conferences. Teacher development programmes have now shifted from brief on campus training programmes to a series of programmes extended throughout the year. There is a powerful need for development in the field of teaching and the teachers are very clear that they do not feel adequately equipped to deal with increasing heterogeneous groups and to address the needs of the students who have some learning challenges as well as students who are gifted. Quite a compelling proportion of the educators believe that professional development programmes organized by the institutions do not meet their needs and so the authorities must ensure that the development activities organized are potent and fulfill the teachers' requirements.

Teachers' perceptions are very important and cannot be ignored as their perceptions influence their behaviour. Teachers' teaching beliefs, their teaching practices and their professional co-operation are related to their participation in different forms of professional development. Professional development has a direct bearing on student achievement. Hence, opportunities for active learning, content centered on student learning, follow-up training with support and time to practice and facilitating opportunities for collaborative work and embedded learning should be effectively addressed in teacher professional development programmes. Suitable activities that will provide teachers with opportunities to develop and deepen their professional understandings and skills must be mapped into the framework of any professional development programmes.

The following is a variety of activities based on a study in Auckland University, New Zealand:

Professional learning activities mapped onto the framework:

Activities constructed to promote learning

Professional development / professional learning activities designed to develop and deepen professional understandings and skills:

- listening;
- watching;
- being observed and receiving feedback;
- receiving student activities and materials;
- engaging with professional readings;
- discussing practice with someone more expert;
- authentic experience of subject in action;
- discussing own theories of practice and their implications;
- examining student understandings and outcomes;
- analysis of current practice and reconstruction of new practice;
- discussing self or mutually identified issues.

Teacher Professional Learning and Development Best Evidence Synthesis Iteration [BES] Pg:29

The efficacy of professional development programmes rests on how meticulously such programmes are conceived, planned and implemented. In effective professional development the college authorities/organizers must analyze the data of student achievement and find out the challenges that are commonly faced by students in a particular class or batch and ascertain the issues which need to be addressed and work out practical plans to help students overcome the challenges so that they improve their performance in their academics. The types of development activities may range from organized to structured to a more informal interactive discussion on improving teaching. Some of the activities are: individual research, study groups among peers, teachers observing other teachers, mentoring of new teachers by more experienced teachers, faculty-administrators meeting to plan lessons, problem solving and improving performance, workshops and conferences to learn from a variety of expertise from around the state or country.

The first step in creating a comprehensive professional development programme is developing a framework. There are numerous models available to replicate for all kinds of educational programmes. But the programme will be





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most effective if the planning relies on the curriculum. It is always fruitful if the academic degree offered is taken into consideration. The faculty development programme should be analogous to the academic programme offered by the department or college. "Teaching occurs in particulars: particular students interacting with particular teachers over particular ideas in particular circumstances. Teachers need to learn in and from practice" (Ball & Cohen, 1999). It gives teachers opportunity to collaborate with other teachers and address specific problems faced by teachers in their classrooms. Professional development should bring teachers and administrators together for continuous professional learning. Professional development in which educators are given the forum to learn new teaching methodologies which they can actually implement in their classrooms will be far more effective than traditional methods of professional development.

The first and foremost thing that should be focused to transform any faculty development to work is creating learning opportunities for teachers that are practically possible to be implemented in their classrooms. Virtual workshops and online learning could also be considered so teachers can learn anytime anywhere. It should involve hands-on, active learning. Such professional development programmes must be relevant and there must be an inherent value in the activities offered. The best programme is where strong relationships are developed between faculty and administrators.

Teacher burnout is a gradual process which obstructs teaching. Teaching today requires a great deal of emotional energy, and teachers need to genuinely care and connect with students especially with slow learners. Teachers must realize that their teaching promotes their acquisition of knowledge and development of skills. Faculty development programmes help faculty become better teachers who take responsibility for their students' learning. Some professional development may be provided on a mandatory basis because the skills and knowledge that they acquire enhances the teaching quality. It is commonly assumed that learning outcomes are influenced by what is taught. So, teachers must take greater responsibility for promoting the learning of all students and realize that what teachers do has an impact on how students respond and so they must develop a plan of action to address professional learning. New methods and approaches and skills have redefined teaching-learning process and teachers who don't learn and engage in them will see themselves increasingly irrelevant. Effective professional development for teachers can never be an event constrained by time. And it must be a systematic process if quality improvement in education is to be visibly seen.

Mentoring as a Positive Reinforcement for Effective Teaching

A good teacher does not need not necessarily be a mentor. A good mentor should possess both personal and professional skills to facilitate a symbiotic relationship between the mentor and his mentee. The mentor should communicate effectively and should be truthful, dedicated, tactful, and enthusiastic and possess a sense of humour. There are two types of mentors. Informal mentors are colleagues whom teachers turn to for advice. Formal mentors are those with a specific mentoring responsibility assigned by the institutions. A mentor nurtures the less experienced teacher through counselling, coaching, and allowing the teacher to observe and reflect and arrive at solutions to any problems that he may encounter in the classroom. While, mentoring is required mostly for new teachers to ensure a smooth transition into the profession, mentoring also targets teachers who have some difficulty in some aspects of their job.

As part of her doctoral dissertation psychologist Linda Phillips-Jones has given a comprehensive set of mentoring skills. The following is the mentoring skills model developed by Linda Phillips-Jones:

The mentor-mentee relationship provides an exposure to new avenues for learning and growth. Mentors should possess strong interpersonal skills and good communication skills and mentees should be intrinsically motivated and willing to learn and improve their performance. Sherman et al (2000) in their respective research identified specific skills and knowledge areas needed by competent mentors as in Table 1:





Pramila et al.,

English Teachers as Mentors

Good communication skills in the English language is a prerequisite for employability. Hence, imparting speaking skills is in the spotlight. English teachers face mounting pressures due to large class size and heterogenous classes. English teachers must cease to work in isolation as they require specialized knowledge and skills. Currently, there is a strong emphasis on teachers continuously improving their knowledge, abilities, and teaching approaches to improve students' academic achievements. Educational professionals are seeking ways to guarantee that all teachers receive proper training to achieve desired learning results. Mentorship has been crucial in educational change since the beginning of the 1980s, offering teachers a way to enhance their teaching abilities. Mentoring is a “means of fostering stronger connections among the teaching staff, leading to a more positive and cohesive learning environment for students.” (Brewster and Railsback) Mentoring is typically seen as a purposeful and nurturing process in which an older, more experienced individual guides and supports a younger, less experienced person to aid in their growth and development. These experienced mentors possess specialized knowledge and skills needed to educate students with limited English skills, making them well-equipped to guide English teachers in effective teaching methods. This collaboration often involves close interaction with seasoned educators, thereby, expanding the support available to new teachers. Effective mentoring requires the mentor to show a commitment to supporting others, being open-minded, adaptable, and empathetic. New English teachers often deal with various challenges every day, particularly in mixed-ability classrooms. The mentor should encourage opportunities for observing and discussing suitable teaching methods, second language learning, and more.

Mentoring aids in developing the mentors' supervisory skills and enhancing the teaching-learning process. The mentor needs to be highly proficient in the language and have a strong track record as a teacher. He needs to show an effective teaching method in the classroom. The mentor, who must be proficient in English, should guide their mentees in lesson planning and teaching. English teacher mentors share their teaching experiences and support professional development. The mentors need to offer guidance and support, demonstrate effective teaching methods, and give feedback on the mentees' growth and progress. In addition to training sessions, mentors should also observe mentees' classes and provide constructive feedback with suggestions for enhancement when needed. In an English class, a mentor's key responsibility is to inspire students to learn the English language effectively. It is crucial for English teachers to be proficient users of the language to fulfill this role. The mentor needs excellent communication skills to enhance teaching methods and boost learning results. Mentees depend on their mentors' English proficiency to grow personally and as educators. Mentees see mentors as role models, especially in their teaching methods and English pronunciation.

In addition to practical training sessions, the mentor should allow the apprentice to witness the mentor's teachings. Prior to class, the mentor and the mentee should communicate about the upcoming lesson to be taught. Both should also review the lesson together after class. The mentee and mentor collaborate to plan the lesson, followed by the mentor observing the mentee's class and providing feedback. The mentor is responsible for ensuring that the mentee has acquired the necessary knowledge and skills to lead lessons effectively. Teaching English to students from various backgrounds can be intimidating. The language teacher faces even more difficulty due to the high number of students, limited teaching resources, and low English proficiency levels among students. It is essential to provide intensive guidance in order to create suitable teaching materials. The mentors should motivate the teachers to utilize materials found in the local area and to effectively incorporate appropriate materials in the classroom.

The mentors need to give the mentees an overview of how to use different assessment tools such as written assignments, verbal assessments, observation, and group activities. They should teach their mentees the importance of focusing on knowledge-based teaching rather than exam-focused teaching. Mentors are responsible for helping mentees effectively manage classroom tasks. New English teachers benefit from mentoring by learning to develop effective work habits, integrating theory with practice, collaborating with experienced teachers, and observing their mentors to improve their teaching skills, strategies, and classroom performance. The mentors and mentees work together to assess their teaching experiences by discussing with teachers and reflecting on their own practices. They use different methods, techniques, and abilities to enhance learning. Through this process, mentees learn how to





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create lesson plans, conduct language activities, and assess student work effectively. Consequently, they discover their unique teaching style, personality, and establish their own teaching identity.

CONCLUSION

In all educational institutions, there will be teachers with different levels of education, experience, knowledge, skill, and expertise. In such a mixed group of professionals there is tremendous scope for sharing of knowledge and expertise and this is very beneficial for professional development. In the initial stages of their career, teachers are very keen to develop and enhance their professional skills. Language teachers need to keep learning and unlearning and updating as the language teaching is constantly evolving. Educational institutions must provide regular opportunities for language teachers to update their professional knowledge and motivate teachers to actively participate in them. There are two aspects to professional development: one can be seen from institution's perspective and the other from the individual's perspective. The individual's personal goals must align with the institution's vision and mission. Teachers feel more confident when they improve their teaching skills and it provides them a sense of fulfillment when they can produce better results with their students. Areas that require professional can be identified, like grammar, various language teaching approaches in second language acquisition and curriculum development. When the teachers are equipped with the necessary skills they feel empowered and they develop the expertise to teach different learners of various backgrounds.

Even experienced teachers need professional development as their knowledge and skills can become outdated, hence, educational institutions should organise in-service training programmes which will contribute to the professional development of the teachers. Educational institutions should consider such professional development programmes as top priority as it leads to better performance and better teacher retention. When the quality of teaching improves, the students' performance improves resulting in high student achievement rate. Professional development can be integrated into the curriculum as this will ensure a culture of professional relationship among the teachers and help in the regulation of the day-to-day activities.

Professional development can be made effective with a good mentoring programme. Teachers can be coached by mentors to apply the knowledge and skills learnt in professional development workshops in their classrooms. Mentors should pay classroom visits, provide constructive feedbacks, help their protégés with finding suitable resources and offer guidance on follow up activities. To conclude, both the educational institutions and the individual teachers must take responsibility to organise and plan professional development programmes and participate enthusiastically in order to benefit all the stakeholders.

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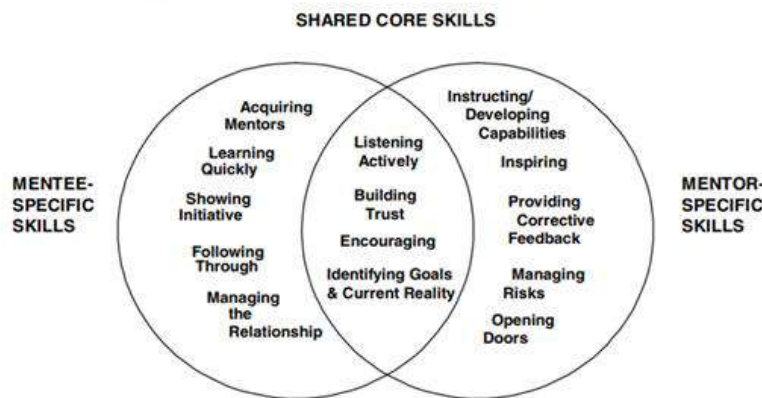
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Table 1 Retrieved from <http://www.calpro-online.org/pubs/Mentoring%20Guide.pdf>

Skill/Knowledge	Mentors
Interpersonal	<ul style="list-style-type: none"> ▪ Are amiable, patient, empathetic, honest, self-confident and open
Communication	<ul style="list-style-type: none"> ▪ Can pickup mentees’ verbal and non-verbal cues. ▪ Recognize and understand different communication skills. ▪ Are skilled in conflictre solution.
Listening	<ul style="list-style-type: none"> ▪ Are active listeners
Content Area	<ul style="list-style-type: none"> ▪ Are experts in the areas in which mentees requires assistance. ▪ Have a broad knowledge base in their field. ▪ Keep up with current trends and latest research
Awareness of Diversity	<ul style="list-style-type: none"> ▪ Are sensitive to mentees’ individual learning styles. ▪ Are comfortable with people of diverse backgrounds ▪ Can accept different points of view
Reflective Supervision Skills	<ul style="list-style-type: none"> ▪ Have strong skills in observing and giving feedback ▪ Engage in self-reflection ▪ Build on past experience to advise and assist mentees with their current dilemmas.

THE MENTORING SKILLS MODEL





Indian Tertiary Teachers' Perceptions and Beliefs about Teacher Talk in ESL classroom

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Here the researcher focused on how to explore teacher's both perceptions and beliefs that occurred during the process of teaching English. For the respective quantitative study, researchers have selected 29 teachers from India and data has been collected through the questionnaire on the online platform (Google form) using both direct and indirect questions to get perceptions and beliefs of tertiary teachers about techertalk. Data is collected by random sampling method. After observation and study researchers have concluded that although teachers are using various techniques like questioning, paraphrasing, summarizing, etc during their lecture, but they are unfamiliar with their proper names like Scaffolding. As well as they aren't familiar with a techertalk concept properly.

Keywords: Teacher talk, Perception, Belief.

INTRODUCTION

English language teaching (ELT) is one of the important disciplines of study. It is developed in various sub-branches also. As a global language, English is used as an important medium of communication, and instruction to transfer knowledge in almost all disciplines of learning. There are many methods and approaches to learning and teaching English. Teaching and learning are interrelated processes in which classroom, teacher, learner, curriculum etc. are crucial factors.



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In India English has been introduced from primary level to tertiary level of education. English is taught as a compulsory subject from the first standard in schools to Undergraduate level in colleges. It is introduced to various postgraduate courses also. It is taught as a second language in urban as well as semi-urban and rural regions. Though the developed technology is used to learn and teach English language, most of the times the only medium for natural and essential inputs and exposure to English is the teacher and his/her talk/speech. In such a case, the importance of teachers' talk – both in terms of quality and quantity plays a crucial role. In India, although all students are learning English from primary level to tertiary level, most of the students are unable to use the English Language with fluency and accuracy. At tertiary level, though they are grown-up learners, they try to imitate their English teachers in case of learning English. Therefore, in the proper development of ELT, research on classroom interactions will play important role. Research on teachers' classroom activities and especially their speech has not been undertaken to a sufficient extent in India. The present research tries to fill this gap through researching on perceptions and beliefs of teachers about Teacher talk at the tertiary level.

LITERARY REVIEWS

Researchers Mahesh B. SHINDE & Tripti KAREKATTI in their research Primary Teachers' Beliefs about Teacher Talk in ESL Classrooms: a Perspective from India (2010) focused on primary teachers' beliefs about teacher talk and teacher talk features in ESL classrooms. Ten in-service primary English teachers (five from English Medium and five from Marathi Medium primary schools) are the subjects of this research paper. The paper discusses these teachers' beliefs regarding the amount of teacher talk, use of mother tongue (i.e. Marathi), and some teacher talk features like questioning, paraphrasing and repetition, and feedback. Researcher Dr Mahesh Shinde (2012) in his doctoral research 'Teacher Talk In ESL Classrooms: A Comparative Study Of English And Marathi Medium Primary Teachers' studied the comparison between the formal and functional features of English And Marathi Medium Primary Teachers' Teacher Talk. As an outcome of his study, he finds that functions of the teacher talk features in the English and Marathi medium schools are different and code-switching plays a greater role in Marathi medium school teachers' talk, especially at the initial stages.

Researcher Parvathini, Sushma (2015) in her doctoral research 'Understanding the Relevance of Interaction Approach in the ESL Classroom' studied the relationship between SLA and interaction by using a descriptive classroom-based observation from the perspective of Input Hypothesis, Output Hypothesis and Collaborative Dialogue. She has concluded that teacher questions are display questions and focused on the content of the lesson. Sandy Wirawan, Sahiruddin (2020) in their research 'Teacher Talk in EFL Online Classes at Indonesian Tertiary Level' examine the nature and types of teacher talk in an Indonesian EFL tertiary setting. The research design of this study is descriptive qualitative along with naturalistic study for analysing the data. NurMutmainnaHalim, YasintaWulandari, AbdHalim (2021) in their research studied students' perception towards teacher talk that happened during the teaching and learning process, and students' ideal expectations about their English teacher. It was a descriptive qualitative research where one English teacher and one class of first year senior high students were observed. The data collected from transcribed-classroom video recording and interview to some students. It concludes students' perception towards teaching style, such as teaching method, motivating, giving feedback were almost negative and students' ideal expectations that an English teacher should be more effective, efficient interactive and creative for creating more interesting classroom atmosphere.

Objectives

Considering the dearth of research on English teacher talk, especially at the tertiary level, the present research will be carried out for the following objectives:

- To understand various Perceptions of teachers about Teacher talk at the tertiary level.
- To observe and study Teacher Talk beliefs of English teachers at the tertiary level.





METHODOLOGY

What is Teacher Talk?

In the classroom, teachers change their talking according to the level of students, the intensity of the lesson at hand, the purpose and many more things. It helps to develop various styles of teaching with a variety of language that teachers use in the classroom is, in general, called teacher talk. Many Scholars have defined TT in various ways.

Richards (2002, p. 543) in *the Longman Dictionary of Language Teaching and Applied Linguistics* defines TT as: "...that variety of language sometimes used by teachers when they are in the process of teaching. In trying to communicate with learners, teachers often simplify their speech, giving it many of the characteristics of FOREIGNER TALK and other simplified styles of speech addressed to language learners."

Data Collection

Here the researcher focused on how to explore teacher's both perceptions and beliefs that occurred during the process of teaching. According to Cambridge Dictionary, Perception is a belief or opinion, often held by many people and based on how things seem. For the respective quantitative study, researchers have selected 29 teachers from India and data has been collected through the questionnaire on the online platform (Google form) using both direct and indirect questions to get perceptions and beliefs of tertiary teachers about techertalk. It is randomly sent to all kind of English teachers all over India. But here in this paper English teachers teaching at tertiary level are subjects of this research. The data were taken by questionnaire including both close and open ended questions. Both direct and indirect questions were asked to get perceptions of teachers. Samples from the data codified as T1 to T29 to keep teachers' Identity privacy. Subsequently, the result of the research was qualitatively analysed and presented.

FINDINGS AND DISCUSSIONS

Attraining about how to teach English to younger students

Yes. More than 75% Teachers have attended training. Teachers believe that special training is needed for the improvement of teaching skills, methods and it allows an understanding of the modern teaching tools. Teaching literature and teaching language both require different skills. One fifth teachers not attended any single training in their teaching period. Although teachers want to learn how to teach English Language but it is not also a part of BA and MA programmes. As T27 suggests the trainings provide guidance on how to teach different skills and sub skills and what methods to follow, how to design tasks to make learning interactive and effective. So they suggest adding it in core syllabus part of MA. E.g. T6 suggested 'Unless you have at least 2 ELT papers in the MA syllabus, it's better to attend at least a 6 months course.'

Need of a special training about how to teach English to younger students

Although knowing an importance of training only 4% teachers think that need of a special training about how to teach English to younger students is needed most of the time. 60% teachers preferred it sometimes. 20 % teachers think that there is no any need of a special training about how to teach English to younger students.

Use of Mother tongue in the Classroom by Teacher.

While teaching English more than 60% teachers use mothertounge sometimes. Many teachers use Mothertounge to make concepts' clear understanding at the time of students are unable to understand them through English Language, to let them relate with some similarities and differences. T10 suggests multilingual classroom instructional language fosters confidence and inclusiveness among students. 20% teachers never use Mothertongeduring teaching. Because they think that use of Mothertounge will hinder the learning process of students so they never use it. Only 7 % teachers use occasionally. These teachers use it occasionally to make learners understand the difficult concepts and theories, to refer to those cultural contexts only which might be difficult for the students to understand.





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The use of the Mother tongue in the English teaching should be less than half of lecture time according to more than 60 % teachers but 12 % think that it should depends on situation in the class as shown in a Chart 3.B

- As Shown in Chart 4 near about 70 % teachers always give opportunities to students to speak during their lecture. 10 % teachers never give any opportunity to students during their lecture.
- As shown in Chart 5, 60% teacher always try to understand how the students feel but 3% teachers don't try to understand.
- As shown in Chart 6, near about 90% teachers ask questions to students during lectures.
- As shown in Chart 7, near about 60% teachers tell jokes to students during lectures. It helps to reduce tension among students.
- As shown in Chart 8 keeping respect of suggestions by students during lectures 95% teachers accept them, remaining teachers neglect it. Out of these 95 % more than 75% always accept and try to use ideas of students after their suggestion.
- As shown in Chart 9 more than 80% teachers give instructions in class at the time of teaching. Only 7% teachers never give any instructions.
- As shown in Chart 10, more than 80% teachers paraphrases lesson during their lecture. Only 3 % teachers don't use this skill.
- Scaffolding refers to a variety of instructional techniques used to move students progressively toward stronger understanding and, ultimately, greater independence in the learning process. .As shown in Chart 11, more than 80% teachers use scaffolding to encourage students to answer questions. in class at the time of teaching. Only 3% teachers never used it.
- As shown in chart 12 more than 85 % teachers use various concepts to review related concepts to the topic which help students to understand the concepts.
- As shown in chart 13 almost 90 % teachers summarize key concepts after teaching for a better understanding of students. 3% never summarize key concept.
- According 69% teachers' response teaching English to students is a challenging task, while feel that it is very difficult to English subject. Only 14 % teachers consider English as a easy subject as shown in chart 14.
- Almost all of students' learning of English depends on the Teacher's Talk according to teachers but not 100 %. It may vary student to student as shown in chart 16.
- According to chart 17, the total talk time of teacher during lecture varies per teacher. But on an average they think it should be in between 50% to 90 % i.e. near about 70 % should be Teacher talk time during lecture.
- In the classroom teachers use Lecture / instruction, one on one student-teacher interaction, Feedback, In-class homework correction, Listening comprehension activities, Student pairwork / groupwork. According to collected data as shown in chart 18 they prefer pairwork/ groupworkand lecture as a most important part of classroom time. As compared to other features In-class homework correction has less importance.
- According to teachers teaching English from standard 1 is useful for following reasons
 - It familiarise them with a new language at their critical stage of language learning. Exposure to language up to 12 years of age is conducive and effective particularly with respect to Learning and listening skills.
 - It is useful because it helps student to understand basic of English. If their basic ideas of English would be clear, it will help them in learning of English.
 - Their burden in understanding subjects through English Language will be reduced.
 - Students will get more exposure to English Language.
 - To overcome the influence of Mother tongue

As an English Language teacher, more than 50 % teachers believe and strongly agree that, it is important to adapt teaching materials to meet the needs of my learners whenever possible, also speak as little as possible to maximize student to student interaction, correct students if they've made a grammatical mistake or error and to give the whole class feedback at the end of each task. They are agree up to certain limit to give students as much speaking





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time as possible, regardless of the lesson plan and teach solely from the book to best prepare them for the material they will be tested on.

CONCLUSION

In the respective study researchers have collected data through a questionnaire using both direct and indirect questions to get perceptions and beliefs of tertiary teachers about Teachtalk. Data is collected by random sampling method. After observation and study researchers have concluded that although teachers are using various techniques like questioning, paraphrasing, summarizing, etc during their lecture, but they are unfamiliar with their proper names like Scaffolding. As well as they aren't familiar with teachtalk concept properly. In the English teaching, in the view of teachers many feel that they should use the Mother tongue less than half of lecture time, give opportunities to students to talk, attend training to develop teaching skills but they don't. Also they feel important to adapt teaching materials to meet the needs of my learners whenever possible, also speak as little as possible to maximize student to student interaction, correct students if they've made a grammatical mistake or error and to give the whole class feedback at the end of each task. According to teachers teaching English from standard 1 is useful.

ACKNOWLEDGEMENT

Many people assisted me successfully to collect the data for this research paper. I want to thank everyone involved in this initiative. I'd like to thank my Guide Dr. Mahesh Shinde and my mentors Dr. R. D. Dhamakale, Dr. A. J. Pawar who helped me to learn a lot about this research. Their ideas and comments aided in the completion of this research. I'd like to thank The University of The English and Foreign Languages University - Hyderabad, Telangana, India for providing me with the opportunity to work on the research Indian Tertiary Teachers' Perceptions and Beliefs about Teacher Talk in ESL classroom. Thank you very much for arranging Contact Programme for PGCTE course. Last but not least, I would like to express my gratitude to my family, siblings, and friends for their invaluable assistance, and I am deeply grateful to everyone who has contributed to the successful completion of this project.

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Annexure:

Questionnaire

General information

Name:

Gender:

Mother tongue

Languages Known:

Questions related to English Teaching based on your own experience with English Teaching:

1. Teaching at Primary/ Secondary/ Tertiary Level.
2. How long have you been engaged in teaching English?
3. How many times a year do you attend in-service training programs?
4. Do you think you need special training about how to teach English to younger students? Why?
5. While teaching English in my class, I...

		Always	Occasionally	Most of the time	Never	Sometimes
1	use mother tongue.					
2	give opportunities to students to speak.					
3	try to understand how the students feel.					
4	ask questions.					
5	give jokes to release tension.					
6	accept or use the ideas of students.					
7	give instructions.					
8	paraphrase.					
9	use scaffolding.(scaffolding refers to a variety of instructional techniques used to move students progressively toward stronger understanding and, ultimately, greater independence in the learning process.)					
10	review related concepts to the topic.					
11	summarize key concepts					

6. According to my opinion teaching English to students is.. very easy/ easy/ difficult/ challenging
7. I think teaching English from standard 1 is Useful, because....
8. The use of the Mother tongue in the English teaching should be.. .. %
9. For what purpose/s do you use Mother tongue in the English classroom?
10. Approximately how much of the total time in the classroom do you talk? 50/70/90/100 %
11. ...% of students’ learning of English depends on the Teacher’s Talk:. 100/80/50/20%





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- Beliefs about Language Teaching

Q.How do you spend your class time?

Rank the following in order of importance.

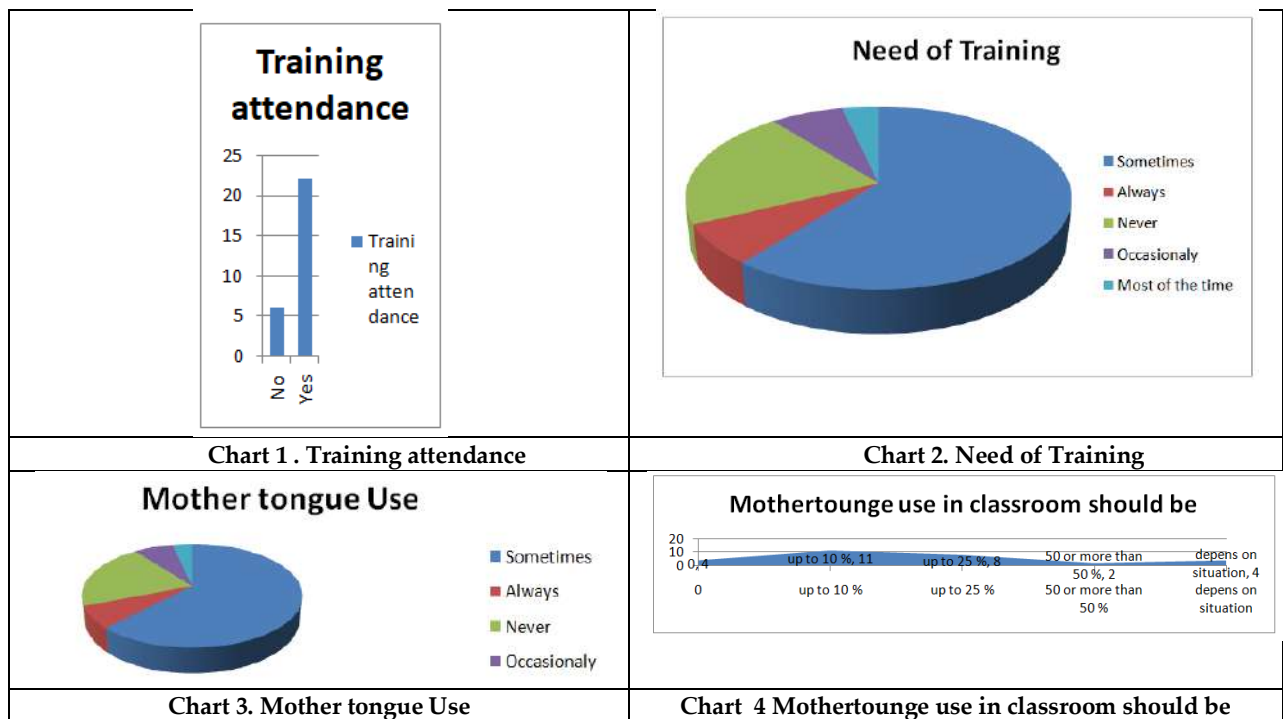
1= Most Important and 5= Least Important

Lecture / instruction					
One on one student-teacher interaction					
Feedback					
In-class homework correction					
Listening comprehension activities					
Student pairwork / groupwork					

Q.In your role as a teacher, choose a response for each of the following to qualify this statement: As an English Language teacher, I believe it is important to:

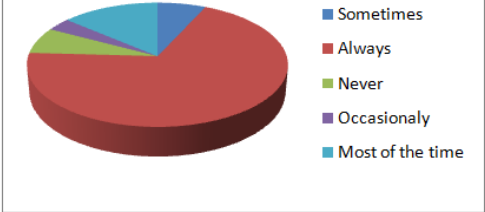
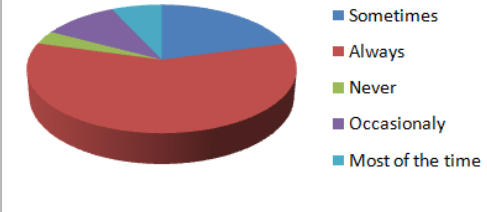
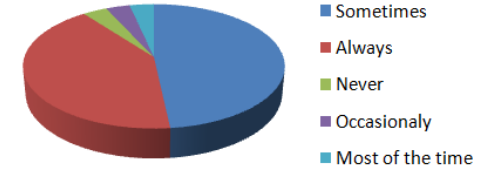
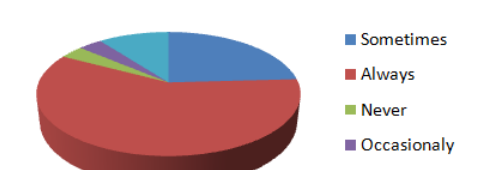
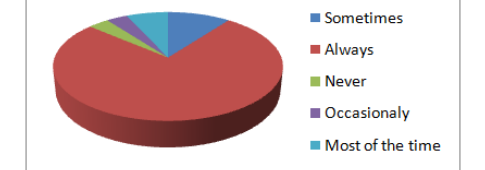

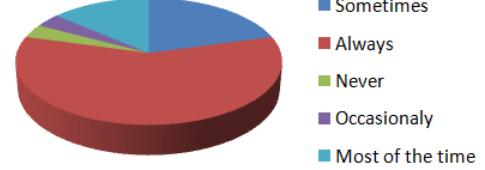
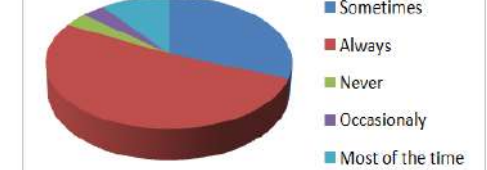
Mention any one out of Strongly Agree (SA), Agree(A), Neutral(N), Disagree(D), Strongly Disagree (SD)

1. Adapt teaching materials to meet the needs of my learners whenever possible.
2. Speak as little as possible to maximize student to student interaction.
3. Give my students as much speaking time as possible, regardless of the lesson plan.
4. Correct students if they've made a grammatical mistake or error.
5. To give the whole class feedback at the end of each task.
6. Correctly model natural English for my students to learn from.
7. Teach solely from the book to best prepare them for the material they will be tested on.



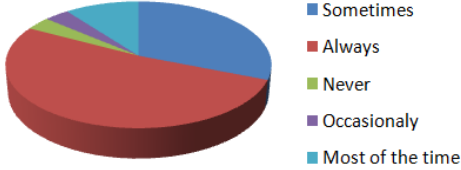
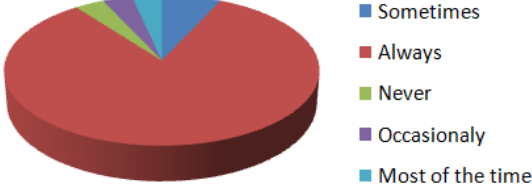
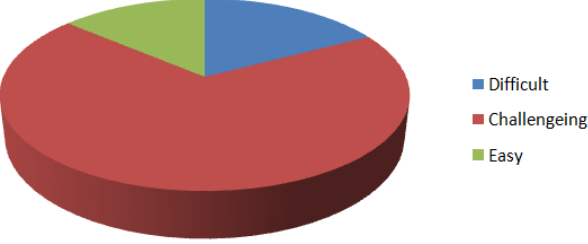
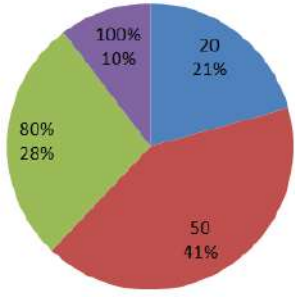
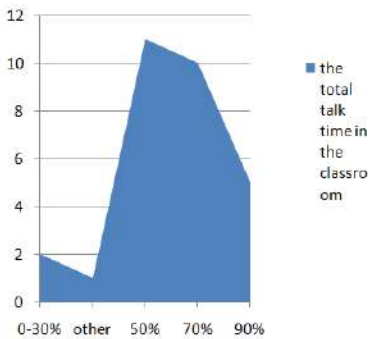
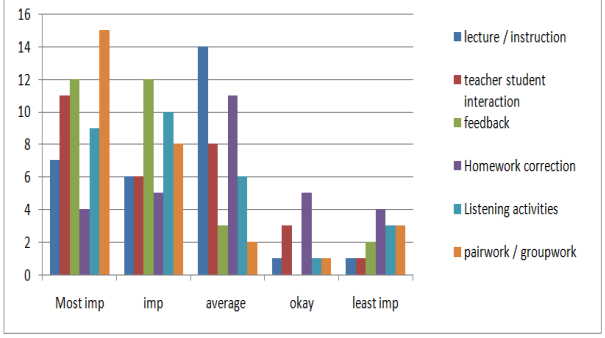


Abhishek D. Shriram and Mahesh B. Shinde

<p style="text-align: center;">Give opportunities to students to speak</p> 	<p style="text-align: center;">Try to understand how the students feel</p> 
<p style="text-align: center;">Chart 5 Give opportunities to students to speak</p>	<p style="text-align: center;">Chart 6. Try to understand how the students feel</p>
<p style="text-align: center;">Ask questions</p> 	<p style="text-align: center;">Give jokes to release tension</p> 
<p style="text-align: center;">Chart 7. Ask questions</p>	<p style="text-align: center;">Chart 8. Give jokes to release tension</p>
<p style="text-align: center;">Accept or use the ideas of students</p> 	<p style="text-align: center;">Give instructions</p> 
<p style="text-align: center;">Chart 9. Accept or use the ideas of students</p>	<p style="text-align: center;">Chart 10. Give instructions</p>
<p style="text-align: center;">Paraphrasing</p> 	<p style="text-align: center;">use scaffolding.</p> 
<p style="text-align: center;">Chart 11. Paraphrasing</p>	<p style="text-align: center;">Chart 12. use scaffolding</p>





<p style="text-align: center;">Review related concepts to the topic</p> 	<p style="text-align: center;">Summarize key concepts</p> 
<p style="text-align: center;">Chart 13. Review related concepts to the topic</p>	<p style="text-align: center;">Chart 14. Summarize key concepts</p>
<p style="text-align: center;">teaching English to students</p> 	<p style="text-align: center;">students' learning of English depends on the Teacher's Talk</p> 
<p style="text-align: center;">Chart 15. Teaching English to students</p>	<p style="text-align: center;">Chart 16. students' learning of English depends on the Teacher's Talk</p>
<p style="text-align: center;">the total talk time in the classroom</p> 	
<p style="text-align: center;">Chart 17. the total talk time in the classroom</p>	<p style="text-align: center;">Chart 18</p>





Gender Narratives and Representation of Women: Re-reading *Tejimola*

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Folktales are the mirror of society, which not only represents the sensibility of the community by explicating the culture, myth, tradition, belief, custom, ritual, practices, etc. but also shapes the cultural identity of the community. The traditional oral narrative apart from representing traditional knowledge, life, and practices also deals with moral lessons and the social issues of the community. It is a method of preserving as well as a tool for understanding a particular culture. The Assamese folktales or “sadhukotha”, similarly, represent the traditional knowledge, practices, and cultural images of the community. The practice of gender as a social construction process has always been a significant discourse in understanding the position and representation of all sex categories in different socio-cultural spaces. Folktales as a literary and cultural tool are also a significant aspect in understanding the gender and its practices in the Assamese society. The traditional practices also differentiate the sort of gender discrimination in society. However, gender issues are also significant aspects often visible in the Assamese folktales, which is a much-needed approach to deconstructing traditional practices. The role of women in the Assamese folktales is crucial in shaping society and cultural identity, preserving cultural knowledge. The folktales also demonstrate the women's conditions in a patriarchal society. This paper seeks to explore the women's representation in the select Assamese folktale *Tejimola* along with how the traditional narrative of *Tejimola* pervasively conveys gender construction processes in the Assamese society.

Keywords: Folktales, Gender, Women, Culture, Discrimination.



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INTRODUCTION

Life revolves around folktales is shaped by folk beliefs, customs, mystery and ritual practices. It constructs individuals with both social and cultural ways of life. The folktales of any community thus not only simply share a moral lesson but also it consciously and unconsciously develop the cultural mindset of the people. The cultural differences, geography, and the distinct ways of life differentiate the traditional oral narratives and folktales among the communities. Folktales are the method of preserving indigenous knowledge transmitted from generations as well as a way of shaping the socio-cultural life of the community. The elder i.e. the grandmother, grandfather to the younger, generally tells it. People do not seek any logical and philosophical enquiry in the story rather the situation and characters influence them. However, in contemporary society, people do return to their traditional past in search of their cultural roots, and identity retrieving the history, memory and any form of cultural articulation. Therefore, folktales become a tool for the generations that mirror society. The word folktale is the portmanteau of the folk-people and the tales include stories, myths, legends etc. that means the people's tales, or the tale of the people transmitted orally from generations. The subject matter of the folktales, as it mirrors the folk life includes every aspect of human life i.e. entertaining, scary, and exciting, humour, providing moral lessons, and explaining things so that the common people understand the social life and the prevalent cultural knowledge.

The re-reading of folktales establishes a notion in connection with the contemporary socio-cultural status of the people to understand the cultural values and attitudes in the dynamic process of society and culture. Thus, the retelling of the folktales gives the reader a new perspective to grasp the meaning of folktales in the dynamic process. That perspective can be social, political, cultural, psychological and gender, which opens a wider space to parse the cultural practices and social life in connecting with contemporary society. American Folklorist Alan Dundes discusses the meaning of folktales in connection with folklore. His definition of folk refers to "any group of people whatsoever who share at least one common factor. It does not matter what the linking factor is-it could be a common occupation, language, or religion-but what is important is that a group...have some traditions that it calls its own" (Dundes, 1965: 2). Thus, Dundes definition of folk represents something that belongs to the community by referring the word "own", which sketches the rootedness and identity of the community.

Folktales are the storehouse of cultural knowledge. People learn many things from the stories and the experiences shared through stories to solve the problems of their lives. It also initiates a cultural and social map in the human mind to undertake social responsibilities, folk life, and behaviour of the community. The traditional narratives of life and culture in the form of stories have been re-read and reinterpreted by scholars and intellectuals in connection with contemporary society and culture. However, the society and gender issues presented in the stories have changed with time. The normalisation of gender in comparison to the ancient society initiates a new narrative in the contemporary world.

The Assamese folktales alike other communities' folktales rooted in their social and cultural practices representing the life of the people. Similarly, the cultural worldview is also a significant aspect of the folktales of the community. Folktales a mirror of society include every aspect of human life. The pioneers of Assamese folklorists like Birinci Kumar Barua, Lakshminath Bezbarua, Prafulladutta Goswami etc.



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explore the folk culture and life of Assam. Birinci Kumar Barua published his book *Asamar Lokasamskriti* (Folklore of Assam) in 1961. However, Sadhu Kotha is a popular term widely used in Assamese literature, the term Sadhu Kotha is widely used in Assamese literature, which includes stories, legends, myths, folktales etc. It is a literary document, which preserves the cultural ethos of the community. Moreover, the social and cultural identity of the community is a major aspect represented in folktales using language associated with culture, dress, traditional and ritual practices, beliefs, customs etc.

Folktales are the cultural tool that preserves a community's cultural identity, practices, and traditional knowledge. The society represented in the folktales deals with different socio-cultural issues where gender and women representation is one of them. The conscious attempt of gender studies and women in various socio-cultural spaces has become a significant aspect of contemporary society. This article intends to explore the gender and women representation in the collection of folktales *Burhi Ai Sadhu* by Lakshminath Bezbaroa particularly focusing on the tale *Tejimola*. When the term gender comes to our mind, the particular idea appears as a social construction, which differentiates all sex categories. The unequal distribution of social status and power under gender norms therefore initiates discrimination in the society along with the roles regarding male and female. Consequently, emerging gender studies as a socio-cultural, philosophical, and political approach deconstruct those established ideas in society. Therefore, this paper has analysed the established idea of gender relating to Assamese folktales and how women are treated in the traditional Assamese society. The methodology of this paper is qualitative and interpretative. It has also used the comparative method to explore the gender and women representation in both the original and the retelling of the story.

Gender and Representation of Women in *Tejimola*

After exploring the history, culture and society of almost all the cultures of the world, a conclusion can be made regarding status and position of women who have always been playing a subversive role in the society. The suppression of women under patriarchy and any others cultural practices is not rather than a social construction from the ancient times. The social construction process and practices, therefore, is a gender discourse, which initiates division of people because of biology, sex and power. Because of these features, the role of men and women in the society is different which construct the politics of gender and its discrimination. Therefore, exploring society from the various aspects is a present need to resolve those issues that harm the human relationships. Folktales as a cultural tool are significant to understand the socio-cultural aspects of the society, which reveals the traditional principles, and practices of the society along with various issues such as gender practices. Moreover, the story telling persuade the community to continue the traditional practices as it is there in the society by construction the people's mind in a conscious way.

Assamese folktales represent women within gender norms in a relatable manner. The representation of women in Folktales is significantly related to the socio-cultural practices and its life of the community that determines both the space and status of women. The folktales not only represent women completely from negative or positive aspects rather than a combination of both which reveals the writer's ethical representation of the image of the Assamese society. Folktales generate kinds of varied emotions among the readers. The orally transmitted stories arouse emotion in the audience, primarily the children that initiate their emotional development. However, the emergence of gender studies differentiates the role



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and representation of men and women as presented in the folktales. The retelling of the stories tries to omit the gender narrative and to reduce the gender stereotypes and prejudice in the stories. It has begun the notion of equality through the stories by changing the traditional mindset of the people. Simon de Beauvoir's notion of 'other' is prominent in understanding the status of women in the Assamese patriarchal society. The social norms and practices portray women as other, counterparts of men and passive objects dominated by men, which is also visible in most of the folktales. Consequently, on the one hand, it consciously suppresses both the role and voice of women in society and on the other hand; it shapes the generation's mind to continue the same stereotypical treatment in the society. Therefore, the conscious attempt of re-reading and re-telling stories deconstructs those biased social issues presented in the folktales.

Lakhminath Bezbarua's *Burhi Ai Sadhu* is a collection of folktales (Grandmother's Tale) which represents women in varied manners in Assamese traditional society under the patriarchal system. This collection of short stories depicts Assamese culture, traditions, and rural life, often conveying moral lessons and delving into the intricacies of human relationships. The characterisation of women as good and evil is also revealed in the folktales *Burhi Ai Sadhu*. The role of stepmother is represented as a shrew woman who mistreats her stepdaughter on the one hand, and on the other hand, the image of 'Tiruta' (Woman) as Lakhimi represented as an ideal who brings prosperity to her family. Therefore, Bezbarua reveals both sides of human personality through the representation of various women characters. The wisdom and intelligence of women are also represented through the stories. In the title, *Burhi Ai Sadhu* the Assamese term *Burhi* means in English an old woman. It refers to women as traditional knowledge bearers. Apart from that, it also tries to reveal women's role in shaping culture and society by sharing and preserving cultural knowledge. Nonetheless, the woman's representation in the folktales by men introducing a woman narrator is crucial to understand from a gender perspective.

The story *Tejimola* tells the hardship and struggle of a little girl Tejimola. The frequent transformation of Tejimola into different forms is itself a voice against the cruel treatment of her stepmother. The folktale *Tejimola* begins with the line "A merchant had two wives. The elder one had a daughter Tejimola by name. The younger wife had no issue. Tejimola's mother died when she was an infant. As such, she was brought up by her step-mother" (Bezbarua 36). It represents the polygamy system in a society where the man can keep many wives he wants. Thus, the concept of power and the position of men in comparison to women as superior in society appear here and women as inferior depend on men. Moreover, another gender-biased image is also drawn in Bezbarua's folktales through husband-wife relations. The tale highlights "It was only out of fear of her husband that she brought up Tejimola" (Bezbarua 36). The term 'fear' differentiates the gender role of husband and wife, which is prevalent in society. Consequently, the gender narration method through language in society both culturally and linguistically discriminates human beings by shaping their conscience and dividing their role.

In the folktale, Tejimola, the character Tejimola is represented as innocent and pure as a little girl. Her response towards the evil deed of her stepmother determines her submissive behaviour in the tale. It was out of fear only Tejimola submit herself to the stepmother. Nevertheless, modern critics and researchers compare the Tejimola's various transformations such as gourd-plant, citrus plant, lotus-plant, saalika (Maina), and later Tejimola with the condition of Northeast people who have been trying to raise their voices against the mainland society to acquire identity and space of their own. Bezbarua draws a



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culturally populated image of the stepmother as a shrew in Assam that may not be relevant in contemporary society. The stepmother on the other hand is revealed as evil and dominative of the stepdaughter. Her representation in front of her husband is ideal, dutiful, and submissive which examines the traditional image of woman in the Assamese society. Therefore, the conventional gender division of man as superior, and strong and woman as inferior, and weak is exhibited in the tale. Moreover, the persistent existence of the images of stepmother and stepdaughter has been changing with time. Tejimola's relationship with her stepmother is pathetic which portrays the psychological state of women. The love of Tejimola's father towards her and not paying much attention to his second wife (Stepmother) can be a reason that initiate mental dissatisfaction of his wife and arouse anger and jealousy, which makes stepmother's inhuman treatment of Tejimola. Moreover, the stepmother's greed is another reason that causes her cruel treatment of Tejimola as she thinks if she ends the co-wife's daughter's life, she can send that property to her parent's house instead of sending it with Tejimola during marriage. Thus, Bezbarua not only represents what a reader can see from the outside but also the inner reality of the human mind that causes the outer conflict. Moreover, the two contrast images of stepmother in the two different spaces as submissive in front of husband and dominative in front of stepdaughter refer to the gender roles and its construction.

However, at the end of the tale, the reader notices how Tejimola regain her actual human form and her father drives his wife out of the home. Here again man as head of the family plays the authoritative role in the household which refers to the gender position of man. The re-reading of the relationship between Tejimola and stepmother can be drawn from a peaceful manner. Rather than creating a conflict between the two women characters in the tale in the absence of the male member, the narrative can be made peacefully or happily while presenting the women's relationship. It helps them both to understand each other. Moreover, it will be an example for the generations and a peaceful image of women in a space called home. Thus, this represents the significance of retelling stories and how the new narrative can reshape the generations' minds in establishing a society free from gender-based issues.

CONCLUSION

Folktales always shape the cultural and social mindset of a community. The re-reading of folktales in contemporary society initiates both social and cultural awareness among human beings. Apart from socio-cultural issues, the folktales also provide a space to trace the cultural roots and identity of the community. The conscious attempt to make a new narrative in connection with the socio-cultural changes thus assists in solving many problems. Therefore, re-reading emerges as an approach to re-think those prevalent social issues and cultural images of all gender categories. A new narrative along with a new order is possible only when people rethink their traditional past. The folktale *Tejimola* is an apt example of the representation of women and gender-biased image in Assamese society. On the other hand, the re-telling of the tale *Tejimola* tries to solve the social issues like gender and representation of woman and their relationship in the household, which shares a social message to the generations in a peaceful way.

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Chitra Banerjee Divakaruni's Selected Novels Illustrate the Significance of Relationships in Indian Culture

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

The complex relationship dynamics in Indian culture are frequently explored in Chitra Banerjee Divakaruni's novels. By means of her works, such as *The Mistress of Spices*, *Queen of Dreams*, and *The Palace of Illusions*. The study examines the ties of family, friendship, love, and tradition, demonstrating how crucial they are to the development of human lives. The complexity and values ingrained in Indian civilization are richly portrayed in these works. The novels *The Mistress of Spices*, *Queen of Dreams*, and *The Palace of Illusions* by Chitra Banerjee Divakaruni are engrossing pieces that examine various roles of relationships in Indian culture. These novels demonstrate Divakaruni's talent for weaving together cultural details, interpersonal interactions, and personal problems to produce narratives that are both captivating and resonant.

Keywords: Indian Culture, Family Relationship, Social Structure, Myth, Immigration.

INTRODUCTION

Chitra Banerjee Divakaruni, an Indian-born author who lives in the United States, originally gained recognition for her poetry before publishing a string of acclaimed novels and short stories. Divakaruni writes about immigration, the South Asian experience, history, myth, and magic. Her writings allow for a wide range of interpretations, including



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feminism, transnationalism, and multiculturalism. The works of Divakaruni depict her experiences as a first- and second-generation immigrant caught between cultures and traditions.

The study of the novels of Chitra Banerjee Divakaruni, including *The Mistress of Spices*, *Queen of Dream*, and *The Palace of Illusion*, has, through their writings, addressed the terrible traumas of the search for self-identity. Interview with Chitra Banerjee Divakaruni by Mehta, Divakaruni said that, "Writing about strong women has always been important to me. I hope my female protagonists inspire my readers and break some stereotypes..." (Mehta). Divakaruni's firm assertion is that women could do a lot in listening to each other's past and present and could arrive as a common consensus in combating the problems of the family. Divakaruni's first novel, *The Mistress of Spices* (1997), is about a young Indian girl named Tilottama also known as Tilowho was born into a destitute family. Tilo assists clients in resolving issues while working as a mistress in a spice store in Oakland, USA. Tilo develops an Indian-American identity after falling in love with American Whitman Raven and uses her mystical, magical, and visionary abilities to further her service. In *Queen of Dreams* (2003), Mrs. Gupta, a mother, and her daughter Rakhi are featured. Rakhi seeks out her mother's dream journals and finds them in Berkeley, California. Rakhi's mother, who left India to avoid being imprisoned, reared Rakhi when she was born there. Rakhi and her father make an effort to interpret and comprehend her mother's journals after her death. Sonny, Rakhi's husband, is a musician. Rakhi's journey is evidence of the strength of dreams and the value of tenacity, despite her mother's advice to be resilient and not to worry too much about competition.

The Palace of Illusions (2008) explores the *Mahabharata*, an Indian epic between 5000 and 6000 BC, centred around Draupadi. The epic follows the Pandavas and Kauravas, who fight for the throne. The story revolves around the Pandavas, who are good and virtuous, while the Kauravas are evil and cruel. Panchaali marries the Pandav brothers, who love and respect her. Yudhishthir loses his kingdom to gambling, leading to her exile and the kingdom being taken over by Duryodhan. An essential component of the social system is the family. The family is made up of people with blood ties. Family is the main social unit, and members of the family share each other's joys and pains and rely on one another. They talk to each other about a variety of topics and express their feelings, including thoughts, delight, happiness, irritation, fear, and suffering.

In an Indian family, an elderly person is in charge of providing for numerous requirements, including clothing, food, and shelter. There are two types of family structures: nuclear families and joint families, the latter of which consists of three to four generations living under the same roof. The extended family system, which consists of grandparents as well as uncles, aunts, nieces, and nephews, all resides under one roof. A shared hearth, income, ownership of property, and close blood ties are all features of the joint family system. The entire extended family resides in the same home, including the mother, father, kids, grandparents, uncles, and cousins. A nuclear family is made up of a father, mother, and kids. People in Indian culture respect their elders, obey their commands, and look to them for wisdom. According to Dr. B. Karthikeyan's *A Study of Family Relationships in Chitra Banerjee Divakaruni's Fiction* "The family relationships play a key role in preparing the future generation for life in the community..." (Karthikeyan, p. 141). Karthikeyan present the importance of relationship for a healthy community. According to Benjamin, "the individual grows in and through the relationship to other subjects...mutual recognition" (Benjamin, p. 20). Benjamin places a strong emphasis on the potential for personal growth within relationships. According to Banu's *Myth and Culture in Chitra Banerjee Divakaruni's The Mistress of Spices*. It delves into the intricate dynamics of family relationships within immigrant families, emphasizing the pivotal role of cultural heritage and intergenerational interactions. The author highlights how parents, especially mothers, serve as custodians of cultural traditions, using dreams and memories to transmit these values to their children. This cultural transmission is depicted as both a source of connection and conflict, as children navigate between their inherited cultural identity and the societal norms of their new environment. The narrative underscores the symbolic importance of dreams and memories in maintaining familial bonds and shaping personal identities.



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According to Minny's *Magical Realism in Cultural Conflict of Rakhi in Chitra Banerjee Divakaruni's Queen of Dreams*. It examines family relationships through a literary lens, focusing on how these relationships are portrayed in literature. The author explores themes of conflict and resolution, particularly between different generations, and how these conflicts reflect broader societal and cultural issues. The depiction of gender roles and the emotional support provided by family members are also key themes. The author argues that literature serves as a mirror to real-life family dynamics, offering insights into the complexities of cultural hybridity and the evolving nature of familial roles.

It provides nuanced views on family relationships, with the first focusing on cultural and psychological aspects within immigrant families and the second on literary depictions of these dynamics. Together, they highlight the multifaceted nature of family bonds, emphasizing the importance of cultural heritage, narrative, and emotional support in shaping familial relationships. Chitra Banerjee Divakaruni in her novels, she gives a lot of attention to the relationships between sisters, parents, husbands, and wives, as well as between mother and daughter. Tilo and Raven, the major characters in *The Mistress of Spices*, have relationships akin to those of Rama and Sita. Tilo and Raven are in a romantic relationship and smitten with one another.

Tilo, a mistress and proprietor of a spice bazaar, is a lady in America who struggles with a variety of issues. Using the power of spices, she aids many characters and resolves their issues. Tilo manages her life's challenges like a man because she also makes money from her spice shop. Divakaruni presents Tilo as a remarkable woman who seeks to demonstrate her loyalty to her relationship with Raven. When Tilo encounters Raven, a lonely American, she falls in love. Tilo makes the decision to devote herself to him in his flat as an older woman. She transforms herself into a young, gorgeous woman by using Marakadwaj spices to enhance her beauty. By offering herself to Raven, "For the first time I admit I am giving myself to love. Not the worship I offered the old one, not the awe I left for the spices --- The anger of spices, their desertion. The true risk is that I will somehow lose this love". (*The Mistress of Spices*, p. 219) she violates her pledge to loyal to spices. According to Morton Marcus "The novel is a love story whose outcome keeps the reader in rapturous suspense from beginning to end, and a depiction of the harsh realities of inner-city life, mixed with a sense of a myth world paralleling this one, is nothing less than enthralling" (Marcus, p. 51). She changes her attitude after the earthquake and decides to assist people. Raven decides to follow her as she makes her way back to Oakland. Following her romance with Raven, Tilo loses her magical abilities. In the end, Raven gives her a new name Maya and replaces her previous one. Tilo agrees to use her new name, Maya, even though it has too many meanings, illusion, spell, enchantment, etc. Maya is a Hindu phrase that refers to the world's deceptive power. She wants to live her entire life with Raven; in this way, Raven is her husband. Tilo and Raven begin their married life in this manner.

In his research, Kallur N.H. focuses on the experiences of Indian immigrants Tilo, Lalita, Haroun, Geeta, and her grandfather, Jagjit, Shamsur, and Hameeda, as he examines the diasporic themes in Chitra Banerjee Divakaruni's *The Mistress of Spices*. The novel examines Indian immigrants' experiences, stressing issues with identity crisis, racial prejudice, ambivalence, nostalgia, displacement, adjustment issues, reluctance to absorb new ideals, homelessness, and rereading and rewriting. *The Mistress of Spices* illustrates both the bad and the good sides of having several identities, going through an identity crisis, and having shattered pictures. The work also examines exile or migration, with exile having a negative connotation and migration being either voluntary or involuntary. For instance, Nayan Tara's deportation from her hometown to the pirates' base was unintentional, whereas

The mother-daughter bond between Mrs. Gupta and Rakhi is shown in the novel *Queen of Dreams*. Rakhi and Mrs. Gupta are not friendly with one another. As a result of Mrs. Gupta keeping her past life secrets from her daughter, friction and distance between the two of them have grown. Rakhi, Mrs. Gupta's daughter, enjoys western culture; hence, Mrs. Gupta wants her to live a luxurious life in line with it. The fact that Rakhi is also interested in Indian cultural history suggests that Rakhi's mother's death has prompted her to ask about her mother's diaries. But she has





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a really strong desire to learn about Indian culture, and her paintings show this in terms of her creativity and cultural awareness. In *Queen of Dreams*, the main characters are Mrs. Gupta and her daughter Rakhi, born in America. Rakhi and her mother live in Berkeley, California, and their strained relationships are portrayed. Despite being influenced by American culture, Rakhi understands her mother's behaviour and work. Mrs. Gupta's numinous world of dreams has nothing to do with Rakhi's everyday concerns. Rakhi observes the strained relationships between her mother and Rakhi, highlighting the complex dynamics of family relationships. "To give my mother credit, she never tried to pressure me...Perhaps this is why she dreams and I paint" (Queen of Dreams, p. 34). Because Mrs. Gupta wants Rakhi to live her life the American way, Mrs. Gupta keeps her history a secret from her daughter. Rakhi is relieved that she did not adopt her mother's role as a dream interpreter. Mrs. Gupta dies in an accident. After the death of Mrs. Gupta, her daughter Rakhi and her husband explore Mrs. Gupta's mystery of interpreting dreams. When she reads the dream journal of Mrs. Gupta and has it translated with the help of her father into Bengali, she tries to understand her mother's life. Rakhi tries to make sense of her mother's death.

The complexity of family ties and how they are viewed differently in East and West cultures are also depicted in *Queen of Dreams*. This story makes intricate use of how social and cultural conventions are upheld, as well as how one's heritage is protected and revered. Rakhi was quite moved by the gathering of mourners present at Mrs. Gupta's daughter cremation. She had it in her head that individuals who showed up for the burial rites had a genuine relationship with her mother. Rakhi finally comes to terms with the complexities of both life and relationships. She now recognises how her motherly traits affect the affection of her daughter Jona, her husband Sonny, and her father. Rakhi notices the mysterious personality of Jona, who is Rakhi's daughter. Mrs. Gupta dilemma "I was not a good mother to Rakhi. I loved her, but not fully. To love someone fully is to give up selfhood, and I could not risk that. She knew this. Perhaps that is why she constantly longed to understand who, I am, to become who I am". (Queen of Dreams, p.328). In order to preserve her abilities as a dream interpreter, Mrs. Gupta desired a separation from her daughter, Rakhi. Her notebook reveals that she was brought out of the slums and taught how to use her skill in the dream-tellers' caverns. Rakhi's mother was against her father, whom she meets on a trip to Calcutta and falls in love with, although dream tellers are not expected to fall in love.

In addition to exploring the mother-in-law and daughter-in-law relationship, *The Palace of Illusion* also shows how Kunti and Draupadi's relationship evolves over the course of the novel's plot, moving from a hasty attitude to one of appreciation. The way the woman forces her sons to obey her orders demonstrates her courage and insanity, which Draupadi admires. Draupadi is the main character and the narrator of the novel *The Palace of Illusions*, which is written from her point of view. The linkages in the study are intricately entwined. The truth is that Panchali had five spouses, and this influences her behaviour. Approaching numerous unusual occurrences that are difficult to categorise. Despite the fact that she is at the centre of the narrative, Originality is hardly significant. She is the main character in this adaptation, and is her voice, which narrates the story of her birth by fire, her journey to Swamyavar, and She was humiliated in the Kaurava court before her marriage to the Pandavas.

Class divisions in society were more obvious at that time. However, the treatment of women by these classes was equal. For the sake of illustrating Draupadi's ties with her maid, Dai Ma, Divakaruni also emphasises the lower classes. Dai Ma can be considered Draupadi's tutor and the ideal maid from the very beginning of the novel. She therefore feels an inexplicable and tremendous love for Dai Ma. She introduces Draupadi to society and educates her on how princesses are expected to behave. Every time Draupadi asks her Dai Ma to let her help with household duties, she stops her and points out the disparity in social class. In this regard, Dai Ma and Draupadi's relationship is not a mistress-maid one. Her relationship with Kunti is really intriguing to begin with. Although she is Panchali's mother-in-law, she is also the mother of the Pandavas. As a result, Divakaruni discovers the secret narrative that exists between Kunti and Panchali. Draupadi is portrayed by Divakaruni as a princess who is willing to push over the boundaries set by social conventions. In a society where a guy is free to wed as many women as he wants, a woman who weds more than three men is regarded as whose. King Drupad hesitated when Kunti proposed that



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Drapaudi marry each of her five sons. He has a deep love for his daughter. Draupadi and her father have a close relationship. He was wary for that reason. Considering that he did not want his cherished daughter to practise polygamy, Draupadi frequently displays her intense devotion for her father. The bond between Draupadi and her brother is strong but also slightly tense. To study with her brother, she engages in conflict with her family members. She appears to be eager to learn the principles of statesmanship, much like her brother.

Summation

The novels by Chitra Banerjee Divakaruni provide a very incisive, realistic look at family connections, exposing the many strands and layers that entwine the relationships in a very nuanced and complex way. In the background of the immigrants' lives torn between the clash of several cultures, relationships between husband and wife, daughter and mother, daughter-in-law and mother-in-law, etc. are described in a gripping way.

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Transcultural Narratives: Exploring Ethnocentrism's Impact on Contemporary Literature and Cultural Hybridization

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This paper explores the intricate relationship between ethnocentrism and cultural hybridization in the realm of contemporary literature. As societies continue to become increasingly interconnected and diverse, literature plays a pivotal role in reflecting and shaping these transformations. Ethnocentrism, a phenomenon deeply rooted in human nature, often surfaces in literary works, reinforcing stereotypes and biases while simultaneously offering opportunities for critique and transformation. Simultaneously, contemporary literature also embraces cultural hybridization, where authors draw from multiple cultural influences to create narratives that transcend boundaries and celebrate diversity. This study employs a comprehensive literature review and analytical approach to explore how these two seemingly contrasting forces intersect and influence one another in contemporary literary works. By selecting a range of representative texts, we analyze instances where ethnocentrism and cultural hybridization coexist within the narratives. The findings of the paper will highlight the importance of recognizing and addressing ethnocentrism in literature while celebrating the potential of literature to promote cultural hybridization and diversity, fostering a more inclusive and empathetic society.

Keywords: Cultural hybridization, Ethnocentrism, Sociocultural, Syncretism, and Multicultural.

INTRODUCTION

Contemporary literature is a dynamic reflection of the rapidly evolving cultural landscapes in our globalized world. As societies intermingle, cultures collide, and boundaries blur, the written word becomes a potent medium through which to explore the multifaceted interactions of diverse communities and their shared narratives. Within this rich tapestry of contemporary literary works, two prominent themes emerge as central and intertwined: ethnocentrism



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and cultural hybridization. Ethnocentrism, a deeply ingrained aspect of human psychology, involves the tendency to perceive one's own culture as superior or as the reference point against which all other cultures are evaluated. This ethnocentric lens has often been present in literature throughout history, reflecting societal biases and reinforcing stereotypes. However, contemporary literature also exhibits a remarkable counterbalance in the form of cultural hybridization - a process by which authors draw inspiration from multiple cultural sources, transcending geographical and cultural boundaries to create narratives that celebrate diversity.

The significance of exploring these themes lies not only in their inherent value for literary analysis but also in their broader sociocultural implications. As our world becomes increasingly interconnected and multicultural, understanding the role of ethnocentrism and cultural hybridization in contemporary literature becomes essential. Literature, as a mirror and a catalyst for societal change, provides a unique lens through which we can navigate the complexities of cultural identity, challenge prejudices, and ultimately foster cross-cultural understanding.

This paper embarks on an exploratory journey into the heart of this dynamic interplay between ethnocentrism and cultural hybridization in contemporary literature. Through a combination of comprehensive literature review and critical analysis, we aim to uncover the subtleties and complexities of these themes as they manifest in selected literary works. By examining instances where ethnocentrism and cultural hybridization coexist within narratives, we seek to shed light on how authors negotiate these themes, the impact on character development and plot, and the broader implications for our evolving cultural landscape. In doing so, we hope to not only deepen our appreciation for the transformative power of literature but also to contribute to a more nuanced understanding of the forces shaping our multicultural world. As contemporary literature continues to evolve, this study serves as a testament to its capacity to both challenge and transcend ethnocentrism, fostering a literary landscape that celebrates the rich tapestry of human experience in all its diversity.

Historical Roots of Ethnocentrism in Literature

The presence of ethnocentrism in literature has historical roots dating back centuries. Throughout literary history, authors have often portrayed their own culture as superior to others, perpetuating stereotypes and biases. This phenomenon was particularly pronounced during periods of colonialism and imperialism, where European powers frequently depicted non-European cultures as exotic or inferior in their works. Such portrayals not only reflected prevailing societal attitudes but also contributed to the reinforcement of ethnocentrism. The literary canon of the 19th and early 20th centuries is rife with examples of ethnocentric perspectives. For instance, Joseph Conrad's "Heart of Darkness" exemplifies the Eurocentric view of Africa, presenting it as a dark, uncivilized place in need of European enlightenment. Similarly, Rudyard Kipling's "The White Man's Burden" serves as a stark illustration of the colonialist mindset, with its patronizing portrayal of non-European cultures.

The Emergence of Cultural Hybridization in Contemporary Literature

In stark contrast to the ethnocentrism prevalent in historical literature, contemporary literature has witnessed a flourishing of narratives that embrace cultural hybridization. Authors in the 21st century increasingly draw inspiration from multiple cultural sources, creating works that transcend geographical and cultural boundaries. This phenomenon is a testament to the interconnectedness of our modern world and the growing awareness of cultural diversity. A prime example of cultural hybridization in literature is Jhumpa Lahiri's "The Namesake," which explores the experiences of a Bengali-American family navigating the complexities of cultural identity in the United States. Lahiri skillfully blends elements of Indian and American cultures, capturing the challenges and richness of a hybrid identity. Such works challenge the binary notions of culture and ethnicity, showcasing the potential for cross-cultural dialogue and understanding.

Contemporary Literature as a Reflection of Multicultural Societies

Contemporary literature's unique contribution lies in its ability to reflect and shape the multicultural societies in which it is rooted. It acts as a mirror, allowing readers to confront the biases and prejudices that may persist in society. At the same time, it catalyzes change by offering alternative perspectives and narratives. Recent scholarship





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has explored how contemporary authors actively engage with issues of ethnocentrism and cultural hybridization. The works of Chimamanda Ngozi Adichie, for instance, offer powerful critiques of ethnocentrism and colonialism in Africa, challenging Western-centric narratives. Similarly, the novels of Junot Díaz, such as “The Brief Wondrous Life of Oscar Wao,” exemplify the fusion of cultures in the United States and provide a platform for exploring the complexities of identity. As the review of literature demonstrates, contemporary literature not only reflects but actively engages with the themes of ethnocentrism and cultural hybridization. These themes are not isolated but exist in a dynamic interplay, offering opportunities for introspection, critique, and transformation.

Research Approach

To investigate the interplay between ethnocentrism and cultural hybridization in contemporary literature, this study employs a qualitative research approach. Qualitative analysis allows for an in-depth exploration of the selected literary works, enabling us to uncover nuances, patterns, and themes that might not be readily apparent through quantitative methods.

Selection of Literary Works

The selection of literary works is a crucial aspect of this study. We aim to capture a diverse range of contemporary literature that addresses ethnocentrism and cultural hybridization. To achieve this, we employ purposive sampling, focusing on works that are widely recognized for their relevance to these themes.

The criteria for selecting literary works include

Relevance to ethnocentrism and cultural hybridization. Diversity in authorship and cultural backgrounds. Recognition and critical acclaim within the literary community. Representation of a variety of cultural contexts.

Data Collection

Data collection for this study primarily involves close textual analysis of the selected literary works. We read each text multiple times, focusing on identifying instances of ethnocentrism, cultural hybridization, and their intersection within the narrative. To facilitate the analysis, we create a structured coding framework. This framework allows us to categorize and code passages, dialogues, and character interactions that pertain to ethnocentrism and cultural hybridization. Additionally, we pay particular attention to authorial choices, character development, and plot dynamics related to these themes.

Data Analysis

The data analysis process is iterative and systematic. We employ content analysis techniques to extract meaning from the textual data. This involves categorizing and coding textual excerpts related to ethnocentrism and cultural hybridization, as well as identifying patterns and recurring motifs. Throughout the analysis, we maintain a reflexive approach, acknowledging our subjectivities and biases. This reflexivity allows us to critically engage with the text and remain open to diverse interpretations.

Interpretation and Synthesis

The interpretation phase involves synthesizing the findings from the data analysis. We seek to unravel the complex interplay between ethnocentrism and cultural hybridization within each literary work, exploring how authors navigate these themes and their implications for character development, plot progression, and overarching narrative.

Validity and Reliability

To ensure the validity and reliability of our findings, we employ several strategies. These include inter-coder reliability checks, where multiple researchers independently code and analyze portions of the text. Any discrepancies are resolved through discussion and consensus.





Ethical Considerations

This study respects ethical considerations regarding the use of literary works and their authors' rights. All citations and references are appropriately credited, and the analysis focuses on the literary elements and themes rather than the personal aspects of the authors. This methodology section outlines the research approach, the selection of literary works, data collection, analysis methods, interpretation, and considerations for validity and ethics. You can adapt and expand upon this methodology as needed for your specific research.

Ethnocentrism in Contemporary Literature

Ethnocentrism, a deeply ingrained aspect of human psychology, continues to find its place within contemporary literature. Despite the ever-increasing awareness of cultural diversity and the pursuit of inclusivity, ethnocentrism persists as a thematic undercurrent in many contemporary literary works. This section explores the manifestations of ethnocentrism in contemporary literature, illustrating its relevance and persistence in the narratives of the 21st century.

Stereotypes and Characterization

One of the most apparent ways in which ethnocentrism manifests in contemporary literature is through the perpetuation of stereotypes and biased characterizations. Authors may inadvertently or deliberately employ stereotypes when crafting characters from different cultural backgrounds. These stereotypes often serve as shortcuts to convey cultural differences but can inadvertently reinforce negative perceptions. For example, the portrayal of certain ethnic groups as exotic, dangerous, or inherently inferior can be found in contemporary novels. Such characterizations contribute to the perpetuation of ethnocentric views, hindering genuine cross-cultural understanding and empathy.

Cultural Clashes and Misunderstandings

Contemporary literature frequently explores the clash of cultures in our globalized world. These narratives may delve into the misunderstandings and conflicts that arise when characters from different cultural backgrounds interact. While this exploration is valuable for highlighting the challenges of cultural diversity, it can also reinforce ethnocentrism if handled insensitively. For instance, a novel depicting a character's discomfort or frustration when encountering unfamiliar cultural practices may inadvertently reinforce ethnocentric perspectives. The reader's sympathies may align with the character who struggles, perpetuating an "us versus them" mentality.

Cultural Appropriation

In the realm of contemporary literature, the issue of cultural appropriation often arises. Cultural appropriation occurs when elements of one culture are borrowed or used by individuals or authors from another culture, typically without permission or sensitivity to the cultural context. This practice can perpetuate ethnocentrism by treating one culture as a commodity to be consumed without understanding or respect. For example, an author incorporating elements of a marginalized culture into a story without a deep understanding of its significance or history may inadvertently reduce that culture to a mere backdrop or stereotype, reinforcing ethnocentrism.

Subversion and Critique

While ethnocentrism is indeed present in contemporary literature, it is important to note that authors also use their works to subvert and critique these biases. Many writers actively challenge ethnocentric viewpoints by presenting characters who defy stereotypes, fostering empathy for diverse cultures, and deconstructing the concept of cultural superiority. Authors such as Chimamanda Ngozi Adichie and Zadie Smith have gained acclaim for their novels that confront ethnocentrism head-on. Their works shed light on the complexities of identity and challenge readers to question preconceived notions. In conclusion, ethnocentrism remains a persistent theme in contemporary literature, reflecting the continued relevance of this issue in our multicultural world. While some works inadvertently perpetuate stereotypes and biases, others actively engage in critique and subversion, offering readers opportunities for introspection and growth. The presence of ethnocentrism in contemporary literature underscores the need for continued exploration and dialogue surrounding these complex themes.





Cultural Hybridization in Contemporary Literature

In stark contrast to ethnocentrism, contemporary literature has become a vibrant canvas for the celebration and exploration of cultural hybridization. Authors in the 21st century increasingly embrace this phenomenon, weaving together diverse cultural threads to create narratives that transcend boundaries. This section delves into the manifestations of cultural hybridization in contemporary literature, showcasing its transformative potential and relevance in our interconnected world.

Cultural Collisions and Syncretism

Cultural hybridization in contemporary literature often emerges as a result of the collision and fusion of diverse cultures. Authors leverage these collisions to craft narratives that explore the fluid nature of cultural identity. Characters and communities are depicted as dynamic entities, continuously adapting and integrating elements from multiple cultural sources. For example, Salman Rushdie's "Midnight's Children" intricately weaves together Indian history, mythology, and Western pop culture, resulting in a narrative that defies singular cultural categorization. The novel's protagonist, Saleem Sinai, embodies the syncretic nature of cultural hybridization, serving as a living embodiment of India's multifaceted identity.

Bilingualism and Multilingualism

Contemporary literature often incorporates multilingualism and code-switching as literary devices to reflect the realities of multicultural societies. Authors employ different languages and dialects to capture the nuances of characters' identities and their interactions within diverse linguistic communities. Junot Díaz's "The Brief Wondrous Life of Oscar Wao" is an example of how multilingualism can be used to convey cultural hybridity. The novel seamlessly blends English, Spanish, and Dominican slang to mirror the experiences of its characters, who straddle the cultural boundaries of the Dominican Republic and the United States.

Diaspora and Transnational Narratives

Many contemporary authors explore the experiences of diasporic communities and individuals living between multiple cultures. These narratives provide insights into the challenges and opportunities that arise when individuals or communities navigate their cultural heritage in new and often unfamiliar contexts. Jhumpa Lahiri's "The Namesake" is a poignant exploration of diasporic identity. The novel traces the life of Gogol Ganguli, a first-generation Indian-American, as he negotiates his dual identity and the complexities of cultural hybridization. Lahiri's work reflects the tension between tradition and assimilation that characterizes many diasporic experiences.

Cultural Exchange and Cross-Cultural Understanding

Contemporary literature serves as a platform for fostering cross-cultural understanding and empathy. Authors often use their narratives to highlight the richness and depth of diverse cultural traditions. Through literature, readers can embark on journeys that transcend geographical borders and gain insights into unfamiliar customs and beliefs. Khaled Hosseini's "The Kite Runner" exemplifies this aspect of cultural hybridization. The novel transports readers to the culturally rich and historically complex landscape of Afghanistan, offering a window into a world often misrepresented in mainstream media. By immersing readers in the intricacies of Afghan culture, Hosseini fosters a sense of empathy and connection. In conclusion, cultural hybridization in contemporary literature stands as a testament to the dynamic and interconnected nature of our modern world. Authors employ diverse literary techniques to celebrate cultural diversity, challenge rigid boundaries, and promote cross-cultural understanding. These narratives serve as bridges between cultures, inviting readers to explore the beauty of cultural hybridity and encouraging a more inclusive and empathetic global community.

The Intersection of Ethnocentrism and Cultural Hybridization

In the dynamic realm of contemporary literature, the coexistence and interaction of ethnocentrism and cultural hybridization often create a rich tapestry of narratives that challenge and illuminate our understanding of cultural identity. This section explores the complex interplay between these two seemingly contrasting forces within the





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context of contemporary literary works, revealing how authors navigate this intersection and its broader implications for character development, plot progression, and overarching narrative.

Deconstructing Ethnocentric Perspectives

Contemporary authors frequently employ cultural hybridization as a means to deconstruct ethnocentric perspectives within their narratives. By introducing characters or scenarios that challenge conventional cultural hierarchies, authors encourage readers to reevaluate their preconceived notions of cultural superiority. For instance, in Zadie Smith's "White Teeth," the character Irie Jones embodies cultural hybridity and challenges her grandmother's traditional, ethnocentric views. As Irie navigates her mixed Jamaican-British identity, the novel prompts a reevaluation of rigid cultural boundaries, ultimately demonstrating the fluidity of identity in an increasingly interconnected world.

Ethnocentrism as a Narrative Conflict

In some contemporary literary works, ethnocentrism serves as a central narrative conflict, driving the plot and character development. Authors use ethnocentric attitudes and biases to create tension, conflict, and growth arcs within the story. In Khaled Hosseini's "A Thousand Splendid Suns," the ethnocentrism present in the Afghan society portrayed in the novel becomes a source of oppression and suffering for the female protagonists. The novel powerfully illustrates how ethnocentrism can perpetuate gender inequality and the suffering of marginalized groups.

Cultural Hybridization as a Form of Resistance

Cultural hybridization often emerges as a form of resistance against ethnocentric forces in contemporary literature. Characters or communities use cultural hybridity as a means of asserting their identity and challenging oppressive cultural norms. In Arundhati Roy's "The God of Small Things," the characters Ammu and Velutha engage in a forbidden, cross-cultural romance as an act of defiance against the rigid caste and ethnocentric boundaries of Indian society. The novel portrays cultural hybridization as a source of liberation and rebellion against oppressive social hierarchies.

Ethnocentrism and Cultural Hybridization as Themes of Transformation

In the narrative arc of contemporary literature, ethnocentrism and cultural hybridization often serve as themes of transformation. Characters grapple with these forces, leading to personal growth, self-discovery, and shifts in cultural consciousness. In Mohsin Hamid's "Exit West," the novel follows the journey of two characters, Nadia and Saeed, as they navigate the ethnocentric tensions and violence in their homeland. Their migration to various locations through magical doors serves as a metaphor for cultural hybridization and transformation. As they encounter new cultures and adapt to different environments, they undergo profound personal and cultural changes.

The Reader's Role in Navigating the Intersection

Contemporary literature actively engages readers in navigating the intersection of ethnocentrism and cultural hybridization. By immersing readers in the complexities of these themes, authors encourage critical reflection, empathy, and an exploration of one's own cultural biases. In summary, the intersection of ethnocentrism and cultural hybridization in contemporary literature is a multifaceted terrain where narratives challenge, deconstruct, and resist ethnocentric perspectives. It is also a space where characters and communities transform, and readers are invited to engage in critical introspection. These narratives showcase the potential of literature not only to reflect but also to shape our understanding of cultural identity in an ever-evolving, interconnected world. In today's rapidly changing global society, there is an opportunity for a transcultural literature and critical perspective that can effectively reflect the evolving cultural landscape. This includes a heightened awareness of new forms of cultural diversity and pluralism resulting from a more diverse population and varied migration patterns. Due to various globalizing and trans-postnational developments, transcultural literature and research may provide a deep and responsible way to handle cultural interactions and their inherent tensions or conflicts. Transcultural literature aligns with the third





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stage of the (im)migrant-ethnic-multicultural writing process of creative transformation outlined by Manfred Jurgensen. This process begins with the primary-native culture and the necessity for mediation with the host culture. This results in the creation of a "language of creative cultural transformation" or what Gunew and Kateryna O. Longley refer to as cross-cultural experimentation by establishing new languages and representations. This results in a body of literature and its associated academic study that is more in tune with the preferences of emerging authors and a diverse audience that is experiencing physical and mental disconnection. Schulze-Engler comments on Mark Stein's discussion of the emergence of a transcultural imagination, highlighting that the transcultural aspect is not only present in external realities or within the texts themselves, but also in the audiences who interpret them based on new systems of reference, norms, and values derived from various cultural influences. The potential for transculturality in texts is therefore seen in their influence on the reader and in the methods of representation needed to capture the cultural intricacies they address.

Where does transcultural literature fit in with postcolonial and multicultural literature?

I suggest that it distinguishes itself to some degree from the preceding domains while yet being influenced by them. In essence, it signifies an additional literary aspect.

CONCLUSIONS

Contemporary literature serves as both a mirror reflecting the complexities of our multicultural world and a beacon guiding us toward a more inclusive and empathetic society. In the realm of this literature, we have embarked on a journey to explore the dual themes of ethnocentrism and cultural hybridization. Through our examination of selected works, we have uncovered a multifaceted landscape that challenges, transforms, and redefines our understanding of cultural identity in the 21st century.

Ethnocentrism: A Lingering Force

Ethnocentrism, deeply ingrained in human psychology, continues to find its place within contemporary literature. Authors deftly explore this phenomenon, often illuminating the biases, stereotypes, and cultural hierarchies that persist in our interconnected world. In doing so, they provide readers with an opportunity for introspection, challenging us to confront our preconceived notions and biases. However, contemporary literature does not merely perpetuate ethnocentrism; it actively engages with it. Authors deconstruct ethnocentric perspectives, utilizing characters and narratives to question the validity of cultural hierarchies. Ethnocentrism becomes a narrative conflict, a force to be reckoned with, and an obstacle that characters must confront and transcend on their journeys.

Cultural Hybridization: A Celebration of Diversity

In stark contrast to ethnocentrism, cultural hybridization emerges as a vibrant celebration of diversity within contemporary literature. Authors weave together diverse cultural threads to create narratives that transcend boundaries, reflecting the fluid nature of cultural identity. Through the narratives of cultural collisions, multilingualism, diaspora experiences, and cross-cultural exchange, literature becomes a bridge between cultures, fostering understanding and empathy. Cultural hybridization serves as a powerful form of resistance against ethnocentrism. Characters and communities use hybridity as a means of asserting their identities and challenging oppressive cultural norms. In doing so, they become agents of change, inspiring readers to consider the transformative potential of cultural hybridization in their own lives.

The Intersection: A Space for Transformation

The intersection of ethnocentrism and cultural hybridization is a dynamic space where narratives challenge and resist ethnocentric perspectives. It is also a realm where characters undergo profound transformations, reflecting the fluidity of cultural identity in an ever-evolving world. Through the exploration of this intersection, readers are invited to engage in critical introspection, reevaluating their own cultural biases and assumptions. Contemporary literature, through its narratives of intersection, encourages us to navigate the complexities of our multicultural





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world with empathy, curiosity, and an open heart. As we stand at the crossroads of ethnocentrism and cultural hybridization, we are reminded that literature is not a passive reflection of society but a powerful force for change. It challenges us to transcend ethnocentric boundaries and embrace the beauty of cultural hybridity. In conclusion, contemporary literature is a testament to the human capacity for introspection and transformation. It urges us to recognize the persistent forces of ethnocentrism while celebrating the transformative potential of cultural hybridization. As we close the chapters of these narratives, let us carry forward the lessons learned from these transcultural narratives, fostering a more inclusive and empathetic global community.

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Exploring Ecological Self in Disney's *Moana*

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Disney's adventurous and well acclaimed film *Moana* (2016) centres on the Polynesian island of Motunui. The islanders worship Te Fiti, the goddess of nature, who centuries ago brought life to the island and the ocean. Her heart embodies a Pounamu stone that has the power to create and sustain life. The stone's green colour symbolizes vitality and life force. It is the forceful possession of this heart by the demigod Maui that has led to the disintegration of Te Fiti and the imbalance in the natural ecosystem particularly in Motunui. The plot revolves around the search of Maui, his transformation and the restoration of the heart to the goddess by the protagonist Moana. This research aims to trace the journey of the demigod Maui from his self centeredness to his ecocentricism and explores the film's potential as an educational tool for developing ecological consciousness.

Keywords: ecocentricism, egocentrism, anthropocentrism, ecological self

INTRODUCTION

The depletion of natural resources, global warming, climate change, species extinction, food and water scarcity and still more has made human beings to reflect and think over their actions and their interaction with nature. "The environmental crisis is currently regarded as a worldview crisis, as a crisis of human consciousness and its relationship to nature" (Miroshiken 593). A change in the consciousness of human beings is required to combat environmental crisis. A shift from ego self to eco self is the need of the hour. This shift can be possible only when one develops an ecological consciousness in life. "Ecological consciousness is a way of being" (Amerigo24). It is an

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individual's perception, awareness, understanding, identification, and consideration of ecological principles in his or her interaction with nature. The term Ecological consciousness has emerged organically as a concept over time, influenced by various fields such as ecology, environmental ethics, and social sciences. It has developed through the collective efforts of scientists, philosophers, environmentalists, and thinkers who have contributed to the understanding of the position of human beings in nature. It has become a significant terminology in the field of environmental philosophy, ecocriticism and ecology highlighting the need for a deeper understanding of the interconnected web of life the role of human being in nature. The crucial step in developing ecological consciousness is the rejection of anthropocentrism. It's this dominant ideology that has led to exploitation of nature, ecological imbalance and environmental crisis. "A fundamental shift in perspective – from an ego-centric to an eco-centric consciousness – is necessary to reimagine human existence. This change requires us to go beyond our narrow self-interest and broaden our concept of self to include the entire web of life"(Callicot78). It is this shift in perspective that is explored through the characterization of Maui. The concept of ecological self or eco self is fundamental in developing ecological consciousness.

Walt Disney's animated film *Moana* (2016) revolves around the ecological imbalance in the fictional setting of Motunui. The protagonist Moana is the daughter of Chief Tui, the leader of the Polynesian island of Motunui. Her father trains her to be the leader of the tribe. She learns about her rich Polynesian culture and heritage from her parents, elders of the community and her grandmother Tala. It's her grandmother who makes her realize the ecological catastrophes overshadowing Motunui, the theft of Te Fiti's heart, her role as a leader, her close association with the ocean, and the lost Polynesian heritage of wayfinding. It is she who inspires her to find the demigod Maui and restore the heart to the goddess Te Fiti.

In this film, Te Fiti is marginalized as she is robbed off her 'heart' by Maui. The introduction of the film clearly explicates this as follows:

In the beginning, there was only ocean until the mother island emerged: Te Fiti. Her heart held the greatest power ever known. It could create life itself. And Te Fiti shared it with the world. But in time some begin to seek Te Fiti's heart. They believed that they could possess it, the great power of creation would be theirs. And one day, the most daring of them all voyaged across the vast ocean to take it....And his name was Maui. But without her heart, Te Fiti began to crumble, giving birth to a terrible darkness (00:00:56-00:02:30).

The above narration presents a contrast between the natural world and the human world. Nature acts as a giver of life while humans act as abusers of power and resources. Nature in the form of Te Fiti gives life to the world, generates fish in abundance for people's survival, directs voyagers to find their ways, and brings fertility to the soil. Nature gives everything for the perfect civilization of humankind. But man's interference in nature only degenerate the natural harmony and disrupts the ecological balance. In this film, it is Maui who brings ecological disaster and environmental issues in Motunui.

The nature of Maui is highlighted in the rhythmic fast beat song "You're Welcome". It is sung by Maui while Moana remains a passive listener and observer. The themes of self-praise, boastfulness, arrogance and superiority are encapsulated in the following verse:

I lassoed the sun. You're welcome!
To stretch your days and bring you fun
Also, I harnessed the breeze. You're welcome!
To fill your sails and shake your trees
So, what can I say, except you're welcome?
For the islands I pulled from the sea (00:39:30 – 00:39:40)



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In the song, Maui sings about his many heroic feats and boasts about providing humans with various resources and gifts from nature. From creating islands to bringing fire and coconuts, Maui presents himself as the provider of these resources. His speech overshadows the contributions of nature as nothing when compared to his acts. Maui's characterization mirrors a strong sense of anthropocentrism. This perspective perpetuates the dominant worldview that places humans at the center, disregarding the agency and intrinsic value of nature. This song displays Maui's ego-centricism and portrays his lack of ecological consciousness. The repetition of the line "You're Welcome" highlights Maui's cravings for appreciation and gratitude for all his accomplishments and heroic deeds.

Towards the end of the song, Maui pushes Moana into the cave and steals her boat to sail across. This portrays him as a deceiver, cheater and a thief who not only steals the boat of Moana but also shuts her into the cave. His characterization helps one to reflect upon one's unethical actions towards both human beings and nature. It makes individuals realize that their relationship with nature is not reciprocal but exploitative. It unearths the nuances of upholding anthropocentrism. Maui's anthropocentric attitude is revealed in this initial song so that his journey to eco-self can be traced effectively. Hence, this song serves as a mirror for his prominent ego-self in his interaction with nature.

Moana becomes a catalyst for the transformation of Maui. She questions him for the reason of the theft of Te Fiti's heart. Maui justifies his action of stealing Te Fiti's heart saying it was meant to be, "a gift for you mortals, so you could have the power to create life itself" (00:59:12 – 00:59:13). In the surface level, his justification proves his concern for human beings. But the underlying fact is his thirst and desire for fame, name and recognition. Maui's justification parallels the claims of most developmental project that aims to provide progress and benefits to the country without sustainable practices, indirectly causing ecological imbalance. "Maui represents egocentricity and vanity because he steals Te Fiti's heart trying to gain the love and affection of humans" (Akhiyat 17). Stealing Te Fiti's heart can be seen as a perfect abuse of nature. "Cultivating ecological consciousness involves cultivating a sense of place. It means being intimate with a landscape, with its space, moods, seasons, changes, flowing patters to wit, knowing the place" (Devall 182). Throughout the film, Moana tries to make Maui realize the consequences of his action. She encourages him to reconcile with nature. She says:

Now you're just the guy who stole the heart of Te Fiti. The guy who cursed the world. You're no one's hero. ... But put this [Te Fiti's heart] back. Save the world. You'd be everyone's hero (00:50:12 – 00:50:49).

Maui joins hands with Moana to restore the heart of Te Fiti. Together they face many obstacles and in the process both share their knowledge, weaknesses and goals of life empowering each other.

Wayfinding, an integral essence of the rich Polynesian culture, involves a deep understanding of the natural environment, celestial navigation, and the interconnectedness of the natural forces. Due to the presence of the sea monster TeKa, wayfinding had ceased among the islanders and no one was allowed to go to the sea. In the movie, Maui possesses knowledge and skills related to wayfinding. The first step in his transformation can be traced in his readiness to impart the art of wayfinding in Moana. As the movie draws to a close, Moana, empowered by Maui's teachings, imparts the art of wayfinding to the islanders. In doing so, she revives the forgotten, culturally rich heritage of wayfinding among her people. This highlights the fact that "Ecological consciousness reflects the new relationship between man and nature – the viewpoint and theory of harmony between man and nature, and the sum of emotions" (Amerigo 23). His role as a wayfinder highlights his connection to the natural world and contributes to the broader theme of ecological consciousness. The idea of the eco self extends beyond a focus of the ego self. This is evident in the climax of the film where Maui sacrifices his ego self for the well being of nature. He takes a pivotal step in his ecological mission to give up his magical fishhook, the source of his shapeshifting abilities. He expresses this fact to Moana by saying, "I'm not Maui without mine [fishhook]" (00:68:13 - 00:68:14). It is a powerful and transformative tool that allows Maui to change his form into various animals and powerful creatures to defeat his adversaries. However, during a confrontation with the lava monster Te Ka, his fishhook is damaged, rendering him unable to use it effectively. Realizing that the restoration of Te Fiti's heart is essential for the well-being of the ocean



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and the islanders, Maui makes the selfless decision to sacrifice his shapeshifting powers. He breaks off a piece of his fishhook and gives it to Moana, empowering her to face Te Ka and complete the mission. This sacrifice is the most crucial step in his journey towards restoration and reconciliation with nature. It symbolizes his shift from his ego self to the eco self. "Ecological consciousness is a special value concept which is based on the mutual relationship between all ecology and human activities in nature, including itself" (Gangwar 21). Maui's sacrificial act testifies his ecological consciousness, his personal growth and redemption.

"It is now necessary for people to abandon egocentric thinking and adopt an ecocentric perspective ... to build a society where everyone's well being is intertwined with everyone else's" (Callicot 240). Maui reconciliation with Te Fiti highlights the transformational journey of his ego-self to his eco-self. His transformation mirrors the broader theme of acknowledging the interconnectedness between human beings and nature. Ecological consciousness often draws from ethical principles that advocate for the intrinsic value of nature and the moral responsibility to protect it. It promotes sustainable practice and fosters a sense of ecological stewardship. Disney's *Moana* acts as an educational tool to instill ecological consciousness among the people and the need to safeguard nature. Maui's ecological transformation serves as a powerful metaphor to understand the harmful impacts of one's actions and rectify one's errors.

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Enhancing Communication by Listening: Techniques and Approaches with Media and Technology

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This research seeks to emphasize the significance of using contemporary technologies to enhance English communication skills via media. The article explores many methodologies and strategies that could enhance the listening abilities of those learning English via contemporary media. Several ways include using internet platforms for English language listening and engaging in video conversations via mobile devices or computers. Participating in listening to audio content via movies, television, radio, and CD-ROM. This research also investigates the importance of auditory comprehension in acquiring the English language. The conclusion offers concrete suggestions and emphasizes the advantages of using Modern Media in the English as a Foreign Language (EFL) classroom. Listening is the intentional and concentrated act of hearing sounds with complete attention. Based on a poll, individuals allocate about 40 to 50 percent of their time to listening, between 25 and 30 percent to speaking, 10 to 15 percent to reading, and 9 percent to writing. Hence, the study report focuses on augmenting communication by tackling listening abilities and offering remedies for enhancement. This study seeks to clarify the importance of communication via media. The 21st century has seen a greater mobility and tangibility





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of civilization. Mobile devices are being utilized more and more for activities including education, entertainment, personal communication, and distant employment. Students enjoy using their mobile devices to access a variety of online listening resources and participate in English-language conversations. They find comfort in apps such as Facebook, WhatsApp, and Emo. The article discusses the various tools for listening skills,

Keywords: Media-mediated listening, Media's role in communication, Modern Media, Communication's Expansion, Listening tools, Communication.

INTRODUCTION

English is a global language or a lingua franca. It facilitates the exchange of communications between individuals and nations. The English language has achieved global reach and development to a degree that cannot be disregarded. English use in India has seen a significant surge. ELT in India has failed to revolutionize the conventional teaching approach prevalent in the majority of educational institutions. Students learn English only to achieve a passing grade on exams, while professors instruct with the sole objective of fulfilling this prescribed goal. Modern Media may be defined as the mass communication methods that are distinctive of the present era, namely those that are associated with newly created or sophisticated technologies. Postmodern media, a successor to modern media, encompasses mass media platforms that provide individuals with the ability to fulfill their requirements at any time, in any location, and on any digital device. "Postmodern originated in the contexts of aesthetics and art criticism, though it has since been disseminated widely in criticism of other cultural forms, particularly contemporary media." (Bignell30).

Another significant description of Modern Media may be described as the diverse use of pictures, words, sounds, and textual data. The nested properties of contemporary media components distinguish them from conventional media components, such as hardcopy documents and newspapers. The majority of media categorized as "new media" are digital, often possessing characteristics such as manipulability, networkability, high density, compressibility, and interactivity. Contemporary media only includes conventional formats like TV shows, movies, magazines, books, or printed publications if they use digital interactive technologies. Modern media refers to the process of demoralization in the development, publication, dissemination, and consumption of media information.

Empirical Literature

Seo et al. (2021) conducted a study on the impact of artificial intelligence (AI) on learner-instructor interaction in online learning. They found that adopting AI systems in online learning can enable personalized learner-instructor interaction at scale. However, there is a risk of violating social boundaries. While AI systems improve communication quality and provide just-in-time, personalized support, concerns about responsibility, agency, and surveillance remain. Kosmas (2023) proved that it is possible to Improve students' learning performance through Technology-Enhanced Learning (TEL). The researchers found significant results which were observed in students' cognitive performance, motor skills, academic performance in language, and emotional state. These improvements led to increased motivation to participate in the learning process. Mahanty and Mishra (2023) stated that Web-based simulation instruction, blended learning, online applications, smart phones, Computer Assisted Language Learning (CALL), WhatsApp groups, movie clips, audio-visual cassettes, and different websites have facilitated the listening and speaking skills of English language learners. Chichekian and Benteux (2022) argued that Intelligent Tutoring Systems (ITSs) impact metacognitive strategies by prompting students to apply self-regulation skills and monitor their progress when learning. These systems enhance learning processes and self-awareness.



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Mohamed (2023) identified that AI-powered language models, such as ChatGPT, have been applied in language learning scenarios. They contribute to language tutoring, generation, and translation, thereby enhancing students' language skills. Sangeetha (2023) conducted research on the effectiveness of using speech recognition technology in language learning. The study found that integrating speech recognition tools into language courses improved students' pronunciation accuracy and overall listening comprehension.

Al-Seghayer (2022) explored the impact of computer-assisted language learning (CALL) on listening skills. The findings revealed that CALL programs, especially those incorporating multimedia elements and interactive exercises, significantly enhanced students' listening abilities. Chen (2023) investigated the use of automatic speech recognition (ASR) systems in language classrooms. The study demonstrated that ASR technology helped learners focus on specific phonetic features, leading to better pronunciation and comprehension. Hasan et al (2020) studied the effectiveness of mobile language learning apps in improving listening skills. The research highlighted that personalized content, real-world contexts, and interactive features in mobile apps positively impacted students' listening proficiency. Nguyen (2023) examined the role of virtual reality (VR) in language education. VR simulations and immersive environments enhanced students' listening comprehension by providing authentic contexts and multisensory experiences.

The role of media in facilitating communicative learning

The media in English Language development provides a connection between human resources and non-human resources. These are the many tools used by instructors and students throughout the process of teaching and learning. Institutional resources contribute to the pedagogical effectiveness of English Language instructors. They facilitate effective communication between instructors and learners by enhancing the teachers' ability to convey topics more effectively. They provide learners with opportunities for practical application. They incite cognitive processes and foster discourse among pupils. They motivate kids to attain greater levels of accomplishment. Today, listening is receiving widespread attention. Schools and colleges across the nation have established training courses in the area, and many others are about to do so. Industries have instituted their management training programs in listening; governmental groups and agencies, at both the federal and lower levels, have asked for such training; religious groups have turned their attention to listening; and an International Listening Association has become active. (Holtand Winston07).

This application amuses and facilitates learning via the use of mainstream culture. Experience authentic British and American accents via audio recordings and challenge oneself with engaging tasks such as interpreting meanings, completing missing sections, and picking the appropriate words or sounds. The program developed by Miracle Fun Box is well-suited for enhancing proficiency in both listening and speaking abilities. If we look at the world tourism sector, 74 percent of travelers move from one non-English-speaking country to another non-English-speaking community. This, as Graddol (2007) suggests, necessitated 'a large demand for either foreign language learning or the increasing use of English as a lingua franca.' Countries like Malaysia made basic proficiency in English a requirement for all foreign employees. Similarly, countries such as Mongolia, Chile, South Korea, and Taiwan are planning bilingualism with English being one of the languages. This has necessitated a fresh look at whether the language facilitates the users to use it as a common code globally. "Language," as Lado (1965) puts it, 'in its most common pervasive, representative and central manifestation involves oral-aural communication.' Today, English is widely used as a language of communication. (Jayashree 11).

Speaking about vocabulary, the application primarily emphasizes often-used terms for English examinations such as IELTS and TOEFL. Engaging in many English listening examinations will enhance an individual's auditory comprehension and facilitate the acquisition of essential vocabulary. Additionally, there are opportunities for amusement via interactive activities like sentence construction games, vocabulary exercises, and word chains. Users have the option to access the classes without an internet connection and may save their preferred lessons for easy reference. As multimedia technology (such as interactive videodiscs, CD-ROMs, CD-Is, etc.) becomes more readily available to instructors and learners of different languages, its capacity to improve listening skills becomes a viable



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choice. Multimedia enables the seamless integration of many elements such as text, pictures, audio, and motion video in a wide array of combinations. In the 21st century, civilization has become more mobile and tangible. Increasingly, mobile devices are being used for tasks such as remote work, personal communication, entertainment, and education. Students get pleasure from using mobile devices, finding solace in applications like Facebook, WhatsApp, and Emo for engaging in English conversations and accessing a wide range of online listening materials. Students get comprehensive recognition for using mobile devices not just to enhance their listening skills but also to improve their spoken communication. There are four abilities (hearing, speaking, reading, and writing): persons who know a language are called speakers as if speaking comprised all other types of learning. She believes speaking is the most important of these four. "The primary goal of most, if not all, language learners have to improve their ability to communicate verbally" (Butarbutar4). Moreover, it offers the FL student a substantial amount of exposure to genuine language.

The basic skill in communication is active listening.

We engage in active listening more often than we engage in speaking. By using this listening skill effectively, we may acquire proficiency in the instruments of communication. Listening may be challenging due to the inherent tendency of the human mind to readily get distracted. An individual who exercises mental discipline and practices active listening gains a multitude of additional talents and experiences several advantages. "An overall view of the concept of mental discipline can help us to discover its development characteristics and find a suitable research entry point" (PingChunCao2) Listening is the cognitive act of discerning and comprehending the spoken words and phrases of a language's speaker. Frequent use of linguistic skills is seen. Proficient listening skills enable learners to actively engage in familial, professional, and societal interactions. Insufficient listening skills hinder one's ability to differentiate between different portions of speech, preventing them from offering an appropriate response to convey apologies, invitations, empathy, refusals, understanding, and engagement under the given scenario. Internet forums and websites provide many opportunities to improve their English listening skills. "Concentration and urgency for remembering are demanded by the structure of the lessons. The lessons stress memory—lengthening memory span and strengthening" (Morley10)

The Significance of Active Listening

In our contemporary society driven by advanced technology, effective communication has become more vital. However, individuals are devoting progressively less time to actively engage in attentive listening with one another. The act of really listening is becoming scarce, despite its vital role in fostering relationships, resolving issues, promoting comprehension, resolving conflicts, and enhancing precision. Active and attentive listening in the workplace leads to a reduction in errors and more efficient use of time. "Initial interactions constitute a significant context for the study of listening skills. Every relationship begins with a first encounter. Further, a great deal of our instrumental goals are accomplished in first-time conversations with salespeople, customers, doctors, therapists, potential employers, yoga instructors, and the like. In first encounters, people attempt to solve a variety of information seeking, relationship, and impression management problems" (Weger15)

Strategies to improve listening skills

Select a single episode from a podcast that individuals find captivating or enjoyable. Allocate a week to regularly engage with that particular episode daily, while simultaneously engaging in activities such as driving, commuting by bus, or doing household chores. During the first two days, make note of any words or phrases that provide difficulty in comprehension and proceed to search for their meanings. Ensure to halt the audio playback, and thereafter resume it to perceive the challenging vocabulary. With a few days' practice, individuals should be able to audibly perceive and understand these words. Additionally, it might be advantageous to memorize certain chunks of podcasts and engage in the repetitive practice of reciting them. Identify the disparities between oneself and the speaker. By the last day, individual levels of comprehension will have significantly increased compared to the first day.



**Simultaneously engage in reading and listening.**

Employing two sources of information concurrently is an additional approach to enhancing one's listening skills. Consequently, it is essential to acquire knowledge about the English language from an alternative resource while engaging in listening activities.

The most straightforward method to do this is by watching a video with English subtitles in the English language. One will be perusing and audibly perceiving the words in this fashion, which will facilitate his/her comprehension and enhance memory recall.

Explore various dialects by watching films and listening to podcasts.

Effectively improve an individual's ability to understand a certain English accent, it is essential to consistently practise and refine an individual's listening abilities with audio materials that include that particular dialect. To improve individual comprehension of American English, consider immersing oneself in American television programs, podcasts, or news broadcasts for a duration of one month. By the conclusion of these 30 days, the ears of the listeners will have been used to the accent to facilitate comprehension.

Repetition and rephrasing of sentences, accompanied by audio recordings.

Experience uninterrupted audio playback from the selected source. Direct individual's attention to comprehending the overall framework and primary concepts. Upon the first act of listening, make a record of significant aspects, unusual vocabulary, and noteworthy sentences that caught individuals' attention. Now, please replay the audio source. On this occasion, focus on the specific aspects of those components that were not obvious during the first hearing. Upon the second round of listening, succinctly recapitulate the main concepts conveyed in the audio using phrasing.

Artificial Intelligence (AI) has several applications in the field of communication.

Enhancing one's listening ability is crucial for improving pronunciation and communication proficiency. To enhance listening proficiency, one might engage in watching television shows, films, and videos. Another method to enhance listening proficiency is by using conversational artificial intelligence such as ZenoChat, which has a text-to-voice functionality. TextCortex is an artificial intelligence assistant that provides many features to enhance an individual's language proficiency. TextCortex is accessible as both a web application and a browser extension. It seamlessly integrates with over 4000 websites and applications, allowing individuals to use TextCortex at any location and at any time to enhance his/her language proficiency. "Duolingo provides translation to help beginners learn a language and to help students become independent language learners" (Hazar 449). Furthermore, if one is seeking additional avenues to enhance individuals' language proficiency, Duolingo provides the option of engaging in voice conversations with actual individuals for a certain duration.

CONCLUSION

Modern media, as a technological advancement, considerably enhances the development of listening skills. It has a significant impact on enhancing one's listening ability. The researchers propose that English educators use the aforementioned instruments of modern media to inspire their pupils and engagingly instruct them. Various studies highlight the benefits of utilizing Modern Media for learning English and enhancing listening skills. These advantages include (a) the use of text and visuals to aid in language comprehension when presented alongside auditory content, (b) the enhancement of language processing through the combination of different media, making the input more immediate and noticeable for language acquisition, and (c) the motivational aspect of videos as a valuable tool for language instruction. SAn examination of the utilization of technologically advanced media aids in the instruction and acquisition of English, particularly in second language contexts, reveals that these aids offer significant advantages in the learning process. They promote a learner-centred approach that considers the specific needs of individual students, in contrast to the traditional instructional methods that revolve around the teacher as the sole authority of knowledge. Providing instruction to educators on the use of multimedia tools for teaching





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English as a second language. It is expected that as instructors become proficient in using these tools for teaching, the pupils will be more knowledgeable in that area.

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Zafar's Burden: Exploring Trauma and Responsibility in Kamila Shamsie's *Kartography*

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

The Liberation War of Bangladesh in 1971 represents a massive humanitarian crisis in the late 20th century. The trauma narration of this horrendous event invites to study, remember and commemorate the profound impact of identity, political decision and religion in a nation's history. The narrative around the Bangladesh Liberation war often emphasis the victimization and suffering of the Bengali people leaving limited perspectives on the minorities and the perpetrators. To recognize the diverse perspective and to acknowledge the complexities of the conflict, a comprehensive study that embraces the problems of the victims, minorities and perpetrators must be included. Contemporary Literary Trauma theories mainly focus on the victim as the sole sufferer of the traumatic event and it is also very limited and has a very little to say about the perpetrator trauma. The recent trends in trauma theory laid steps to study the problem of the perpetrator's trauma. The repugnant and moral injury surfaces in the perpetrator's past either willingly or unwillingly emerges and haunts the perpetrator's present. The finding of the paper particularly arises out of this context where the focus will be the trauma of the perpetrator mainly with regard to Bangladesh Liberation War. By virtue, the image of Pakistan is viewed as the clear-cut embodiment of evil in the 1971 war. There lies a huge silence surrounding the history of 1971 partition war in the history and literature of Pakistan. Kamila Shamsie deftly incites the sentiments of Pakistan in her novel *Kartography* without agitating the lines of victim and perpetrator. Shamsie brilliantly uncovers the problem of the perpetrator through the character Zafar, she further highlights the relative



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relationship between the perpetrator and the commission of violence. Using key concepts from leading literary trauma theorist the research paper justifies to bring out the problem of perpetrator 'Zafar' in Kamila Shamsie's *Kartography*.

Keywords: 1971 Liberation War, Perpetrator Trauma, Partition Literature, War Trauma, South Asian Studies, Ethical Conflicts

INTRODUCTION

The Liberation War of Bangladesh in 1971 represents a massive humanitarian crisis in the late 20th century. This lasting effect subsequently grappled a form of art to seek justice, the underpinning voice of trauma is a relentless pursuit of justice for the war-torn souls. The themes of partition remain a significant aspect of the South Asian Literature in English in recent times. The trauma narration invites to study, remember and commemorate the profound impact of identity, political decision and religion in a nation's history.

Exploring the Problem of the Perpetrator's Trauma

The narrative around Bangladesh Liberation war often emphasis the victimization and suffering of the Bengali people leaving limited perspectives on the minorities and the perpetrators. To recognize the diverse perspective and to acknowledge the complexities of the conflict, a comprehensive study that embraces the problems of the victims, minorities and perpetrators must be included. Contemporary Literary Trauma theories mainly focus on the victim as the sole sufferer of the traumatic event and it is also very limited and has a very little to say about the perpetrator trauma. To bridge the research gap and to provide a complete study of the affect mediated narratives on a traumatic event, a holistic approach of inclusive study is required. The recent trends in trauma theory laid steps to study the problem of the perpetrator's trauma. The repugnant and moral injury surfaces in the perpetrator's past either willingly or unwillingly emerges and haunts the perpetrator's present. The finding of the paper particularly arises out of this context where the focus will be the trauma of the perpetrator mainly with regard to Bangladesh Liberation War. By virtue, the image of Pakistan is viewed as the clear-cut embodiment of evil in the 1971 war. There lies a huge silence surrounding the history of 1971 partition war in the history and literature of Pakistan. Kamila Shamsie deftly incites the sentiments of Pakistan in her novel *Kartography* without agitating the lines of victim and perpetrator.

Shamsie brilliantly uncovers the problem of the perpetrator through the character Zafar, she further highlights the relative relationship between the perpetrator and the commission of violence. Using key concepts from leading literary trauma theorist the research paper justifies to bring out the problem of the perpetrator 'Zafar' in Kamila Shamsie's *Kartography*. Salman Rushdie highlights Pakistan as an "insufficiently imagined community" in his novel *Shame*. (Daniela 35) The national consciousness could not overcome the nation's fostering religious rigidity practices, that made the eastern wing of the nation as unfit in their Pakistan model of nation. The fact that Pakistani society is undergoing an identity crisis and writers feel compelled to engage in a discussion about this matter is not unexpected. In the words of Raheen from *Kartography* follows, Is it shame at losing war, or guilt about what we did try to win that mutes us? (Shamsie 270) The literary history of the Pakistan anglophone literature exhibits a void without attempting to overtly discuss the 1971 history. The writers tend to expose the position of the country as itself problematic and highlight the failure of religious harmony by ethnicity. Shamsie brings in the discussion of the 1971 partition in a few places of the plot such as the couple swap and the confession of Zafar to Raheen. The main essence of the 1971 partition in the novel happens when Zafar breaks his engagement with Maheen, because she's a Bengali. Zafar not being sorry but definitely guilty and silent about represents the absurdity of the 1971 partition. Zafar either willingly or unwillingly becomes the perpetrator in the narrative of Shamsie mainly because Zafar's motivation towards the couple swap triggers an unfavourable future to Ali, Maheen and Karim. The reason behind Zafar's couple swap motivation is the sudden threshold to anti-Bengali sentiments after the massacre of stranded Pakistanis like Shafiq's baby brother in east Pakistan. Erin McGlothlin in Perpetrator trauma explains the simplicity of the term



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in relation to its diversity of experience covered by the concept of perpetration. (108)The act of perpetration includes both collective and the commission of violence against the individual like domestic violence, abuse, threats and bullying (Personal terrorism). Placing Zafar in the context of the perpetrator, he falls under the category of the personal commission of violence against Maheen either willingly or unwillingly. The relative relationship of the perpetrator and the commission of violence depends upon the age, gender, profession, nationality and ethnicity. McGlothlin adds the discomfort of identification of the trauma of the perpetrator who suffers from his anxiety and his infliction of violence often breaks down the dichotomy of perpetration and victimization within the trauma paradigm. (McGlothlin 107)With clinical aspect of studying the trauma of the perpetrators of genocide derives two patterns of identifying such as aetiology and symptomatology of trauma. The above patterns provide a clinical psychological study of the trauma experienced by the perpetrators such as armed militants while compelled to kill unarmed innocent citizens. Analysing the character of Zafar, a choice of personal conflict leads him to take up the role of perpetrator in *Kartography*, to categorize or recognize the trauma of this perpetration carried within in the attributes of family and friendship are quite different. With the underpinnings of Raya Morag's notion of the male perpetrator in her seminal work *Waltzing with Bashir* demonstrates the trauma of the Zafar and delivers a fruitful finding of the role play of hybridity in the country's ethnicity landscape. Morag in analysing the narrative of traumatic events of Folman for the process of film making finds the active complicities of his uncanny childhood and missing memories originates the trauma and not from shooting flares. In Folman's imagination, as the quest reveals, the earlier trauma has appropriated the later one. (Morag 133)

The idea of Folman's trauma implies the involvement of the past memory to reconstruct the subsequent experience. The participation of the past traumatic memory to influence and shape the present events. To understand the trauma of the perpetrator is to study the previous personal traumatic experience that affected him. The personal complicity of the perpetrator's trauma can be found in the narrative by understanding the event that overshadows and influence his ability in the present. The presence of the past traumatic memory provides scope for the perpetrator to appropriate the later events of his life. To recognize the perpetrator's personal conflict in his past memory is to understand the trauma of the perpetrator. The work of post-memory, described by Marianne Hirsch (2001) as the response of second-generation Holocaust survivors to the trauma of the first, describes the relationship of children of survivors of . . . collective trauma to the experiences of their parents, experiences that they "remember" only as the narratives and images with which they grew up (Hirsch 9) These individuals have a connection to their parents' experiences primarily through the narratives and images they were exposed to while growing up is one of the key elements in acknowledging the personal conflict of the perpetrator. These inherited memories are substantial and significant enough to be considered as their own memories though they do not have any personal or first-hand experience of the event. Post-memory is a potent form of remembering because it is not based on direct recollection but rather on representation, projection, and creation. Often, it relies on silence rather than verbal expression and focuses on the unseen rather than the visible aspects of the past. To reveal the trauma of the perpetrator, a careful reading of the information on the perpetrator past with the significant aspect of attention to the silence but resilient feature of his ordinary self is a necessity.

To gain insight of the ordinary self, analysing the language and rhetoric can give the ideas on the specific policy positions with reference to the cultural and social movements. Interpreting Zafar's position as Muhajir serves as an answer in understanding his fear of inclusion and exclusion through his past personal narration. His position as a Muhajir does not align a favourable position in the political landscape of the country. There is already a paradoxical situation of identity politics in Zafar's self, marrying Maheen from Bengali ethnic background will strongly outplay him against the political ideology of his country. The novel displays a variety of event that suggest the liveliness of Karachi lies in the hybridity of the ethnicity. It projects the multifarious ethnic backgrounds of the people as Pathan, Muhajir, Bengali, Punjabi and Sindhi. Marriage acts as the political ground for incubating the normative and acceptable (favourable) ethnic reproduction of the nation. 'Do you hear the way people like Zafar and Yasmin talk about "their Karachi"? My family lived there for generations. Who the hell are these Muhajirs to pretend it's their city! (Shamsie 41) The conversation between Uncle Asif and Laila provides the animosity between the ethnic groups inheriting their land Karachi. Zafar's position as Muhajir traces the traumatic history of his parents' arrival to the land



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of Karachi as a result of mass migration from the 1947 partition, the previous generation of Sindhismass migration towards Pakistan. This vulnerable ethnic position of Zafar as Muhajir gives the uncanny memories and experience of immigrant in own land. The act or feeling of exclusion from the normative society acts as the threat to the Zafar's situation. This problematic ethnic location of the self in the Karachi leaves Zafar in the ambiguity of accepting Maheen against the ethnic factor. "What if time only exacerbated people's wounds, intensified their madness? What if he and Maheen would be driven out of Karachi by the attitude of his friends?" (Shamsie 334) The personal experience of threat and expulsion from the normative society of Karachi is the foremost factor of traumatic exhibit in Zafar's past life. Zafar's personal experiences during the civil War have deeply affected him, to the extent that they overshadow or shape his perceptions of subsequent events, including his attempts to recall and comprehend what happened during the war itself. The trauma from his past has, in a way, overshadowed or influenced his ability to process and remember the events clearly. This impulsive force lets him to deny his relationship with Maheen and ruin the future of Ali, Maheen and Karim. When Zafar pronounces "Think of it as a civic duty. I'll be diluting her Bengali bloodline." (Shamsie232) is the moment that his traumatic past influence in attempting to conclude his relationship with Maheen. Zafar could have erased this act by justifying this as role played to save Maheen from Shafiqbut when Zafar tries to explain, he almost caught in his thoughts of what he had already said.

The concept of Marianne Hirsch's Post-memory acts as a literary aid to understand the personal traumatic experience of Zafar as Muhajir. This paves way to recognize the underlying reality of Zafar's indecisiveness of considering Maheen as spouse. Morag denotes this personal experience as a line of reference to understand the personal traumatic past of Zafar and to trace the influence of the past trauma in all attempts and process of experiencing their life. Adding to this concept of situating the trauma of the perpetrator from Morag's perspective. McGlothin adds to this concept by explaining "What may appear to an outsider to be denial, disinterested disengagement or a disturbing lack of emotion could indeed be the manifestation of trauma, which would – and should – change how we conceptualize and respond to the perpetrators' experience" (McGlothin108) This disinterested engagement to the perpetrator's confession also leads to the manifestation of trauma in perpetrator's life. McGlothin also alerts the attempts of misinterpretation that can happen on locating the trauma of the perpetrator, because reading the attributes of guilt and shame can easily get mixed with the identity of trauma. The need for the differentiation between experience and feeling must be highly regarded to approve it under the lens of moral obligation as the trauma of perpetrator. However, the acknowledgment that individuals who commit acts of violence may experience trauma should not alter our perception of their moral obligation and legal liability for their actions. Therefore, it is essential to separate the issue of trauma from matters of guilt and responsibility as extensively as feasible. As Erin McGlothin puts forward the question of trauma needs to be disconnected as much as possible from issues of guilt and accountability. (McGlothin 108)

Further in the process of identifying Zafar's trauma under McGlothin's notion, one can situate the denial of Raheen's acknowledgment to her father's confession, as he opens up on the issue of couple swap. Zafar waits with anxiety for many days to arrive at this particular day, where he exhibits courage to confess his misdeed to his daughter. Unfortunately, Raheen overcome with sheer annoyance and rage to grasp the injustice committed by her father in the matters of ethnicity runs away from her father. Destroyed by the events unfolded from her father on the matters of couple swap, Raheen disintegrates her relationship with her father and recognizes him no more as her father. The act of Raheen's omission, silent and inactive participation in the confession of Zafar's confession can be considered as the agent causing trauma on his perpetration in the past. With the manifestation of Raheen's disregard to Zafar confession of guilt that he has repressed from her, aligns effortlessly with the attribute of McGlothin's listener's attitude towards instigating trauma in the perpetrator's life. McGlothin also warns the active participants of deciphering the trauma of perpetrator should not consider the act of Guilt and Shame experienced by the perpetrator as trauma. As trauma is the outcome of the past experience while the feeling of guilt and shame is the realization of the commission of moral injury. The perpetrator's guilt, or their accountability for committing a crime, should not be confused with the suffering they have gone through. The trauma that the offender has experienced does not absolve them of culpability or diminish the severity of what they have done. The two matters should be handled differently by the legal system, which should hold offenders accountable for their crimes while also addressing any trauma they



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may have endured. The emphasis makes it clear to separate trauma from the discussions of guilt and shame as it is different from the psychological response to the distressing event.

CONCLUSION

The problem of perpetrator trauma is a highly provocative topic as it disturbs the lines and justifies the acts of perpetration. In the hands of Kamila Shamsie, they are perfectly synchronized to share her viewpoints on the political instability of Karachi where ordinary people are put into extraordinary situations. The long disturbing silence maintained around the events of 1971 in the literature of Pakistan is also highlighting that uneventful attempts that can happen and provide the limelight of victimization to the citizens of Pakistan. But if we are committed to understanding the psychological, social, and cultural fallout from the violent actions, one cannot ignore the significant influence that these crimes have on the people who committed them. Reading the problem of the perpetrator allows to engage in the holistic approach of understanding the traumatic event like partition.

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From Social Commentary to Prettification: The Evolution and Devolution of Fairy Poetry in the English Renaissance - Reflections on Warren W. Wooden's Perspectives

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This research explores into the intricate trajectory of fairy poetry during the English Renaissance, meticulously tracing its evolution from a vehicle for social commentary to a widely embraced form characterized by aesthetic prettification. Guided by the perceptive insights of Warren W. Wooden, particularly articulated in his chapter "A Child's Garden of Sprites: English Renaissance Fairy Poetry" within "Children's Literature of the English Renaissance," the study aims to unravel the underlying factors that contributed to the transformation and subsequent decline of fairy poetry. The investigation scrutinizes works by renowned authors such as William Shakespeare, Ben Jonson, and others, spanning the early to late Renaissance period. Two pivotal questions frame this exploration:

- How did fairy poetry undergo a significant shift from being a conduit for social commentary to evolving into a popularized, aesthetically driven genre?

In addressing this question, the research will delve into the historical context, examining the societal changes and literary trends that influenced the transformation of fairy poetry. The analysis will consider the thematic evolution of fairy poetry, exploring how its initial role as a medium for social commentary gradually gave way to a more aestheticized form, captivating a broader audience.

- What cultural and literary influences, as evidenced in the works of Shakespeare and Jonson, played a role in the devolution of fairy poetry, leading to its diminished popularity as a medium for social critique?

This question involves a meticulous examination of specific works by Shakespeare, Jonson, and other prominent authors. By closely analysing the content and stylistic choices within their fairy poetry, the research aims to identify cultural and literary shifts that contributed to the decline of fairy poetry as a vehicle for social critique. Additionally, the study will explore the reception of these works in the socio-cultural context of the time, shedding light on the factors that shaped audience expectations and preferences.

Keywords: Fairy Poetry, Elizabethan England, Shakespeare, Ben Jonson and Edmund Spenser.





INTRODUCTION

The Elizabethan era, often hailed as the "Golden Age" of English fairy poetry, is a captivating chapter in literary history. During this time, the interplay between reality and fantasy in faery tales enchanted poets and audiences alike, shifting from a medium of social commentary to one focused on aesthetic beauty. The title "From Social Commentary to Prettification: The Evolution and Devolution of Less Popular Fairy Poetry in the English Renaissance, A Reflection on Warren W. Wooden's Perspectives" reflects this transformation. It examines the genre's growth and decline, highlighting lesser-known works and incorporating Wooden's scholarly insights. Warren W. Wooden, a Renaissance scholar, passed away on December 27, 1983, at forty-two. Specializing in Tudor and Stuart literature, he contributed significantly to the study of figures like Thomas More and John Foxe. Wooden's interests included biography, hagiography, iconography, popular culture, and rhetorical strategies. His major project, "The Origins of Children's Literature in England, ca. 1500-1700: A Critical Investigation and Survey," aimed to explore the historical roots of children's literature. He received support from esteemed organizations and a senior research fellowship for this work.

Despite his untimely passing, Wooden's contributions and the legacy of his unfinished work continue to shape the study of children's literature history. His proposed book sought to examine the influences on English children's literature, addressing a significant scholarly gap. Overall, the title encapsulates the evolution and decline of fairy poetry's popularity and its shift from social commentary to aesthetic prettification, building on Wooden's perspectives. In children's literature, fairy poetry plays a captivating role by blending enchantment and imagination. Through whimsical tales featuring magical creatures in fantastical settings, fairy poetry opens a world of wonder for young readers. Beyond entertainment, these poems often carry moral and educational themes, using allegorical characters to teach lessons about ethics and values. The rhythmic qualities of fairy poetry, enhanced by rhyme and rhythm, make it accessible and engaging, aligning with the oral tradition of storytelling. Illustrated fairy poetry books further enhance the visual appeal, creating a multisensory experience with vibrant illustrations that complement the narrative. Fairy poetry also provides a unique avenue for emotional expression, helping children navigate a range of emotions, from joy to excitement to comfort. Rooted in cultural tradition, these tales preserve heritage and expose children to timeless narratives cherished across generations.

This research explores the evolution of fairy poetry, guided by Warren W. Wooden's insights. Wooden's chapter "A Child's Garden of Sprites: English Renaissance Fairy Poetry" serves as a compass, navigating the genre's development during this period. His perspectives, detailed in "Children's Literature of the English Renaissance," form the foundation for understanding this literary journey. The roots of fairy lore trace back to classical Greece and Rome and the folk beliefs of the Celtic and Teutonic peoples. Key works like Edmund Spenser's *Faerie Queene* (1590) and Shakespeare's *A Midsummer Night's Dream* (c. 1595) played pivotal roles in shaping Elizabethan literature's fascination with fairies. Shakespeare's portrayal of fairies, accessible to a broad audience, created an enduring literary image that inspired a surge of imitative fairy poetry.

Wooden's perspectives provide a valuable theoretical framework for this exploration. His chapter meticulously examines the multifaceted dimensions of English Renaissance fairy poetry, revealing thematic shifts and socio-cultural contexts that fuelled its evolution. By tracing the evolution and decline of less popular fairy poetry, this research enhances our understanding of the dynamic interplay between literature and society during the English Renaissance, enriched by Wooden's scholarly insights.

In the subsequent sections, we will analyse selected examples to explore the development and direction of English fairy poetry during its peak in English literature, drawing extensively from Warren W. Wooden's comprehensive observations. This analysis will highlight the nuanced forces and factors that shaped the metamorphosis of fairy poetry.



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William Shakespeare's *A Midsummer Night's Dream* (c. 1595; printed 1600) marks a transformative moment in the genre. Shakespeare's depiction of fairies, such as the mischievous Puck and the ethereal Titania, reshaped their literary portrayal, steering away from traditional social commentary. Ben Jonson's *The Sad Shepherd* (unfinished, posthumously published in 1641) provides glimpses into the evolving nature of fairy poetry. Although incomplete, Jonson's handling of the fairy realm in this work signals a shift towards a more romanticized and aesthetically driven representation, departing from earlier socio-political undertones. John Milton's *Comus* (1634), while not strictly a fairy poem, exemplifies the changing literary landscape. The masque's incorporation of enchantment and magical creatures reflects the broader trend of integrating fairy-like themes into diverse literary forms, moving away from explicit social commentary. Through detailed analysis of these examples and others, this research aims to uncover the intricacies of the evolution and devolution of fairy poetry during the English Renaissance, providing a deeper understanding of the genre's transformation and its impact on the literary and cultural landscape of the time.

The evolution of fairy poetry during the English Renaissance is a captivating narrative of profound transformation, shifting from a medium for social commentary to a widely popularized and aesthetically driven genre. Guided by Warren W. Wooden's insights, this exploration delves into selected works to reveal the intricate journey of fairy poetry. This transition from social critique to aesthetic celebration marks a significant shift, richly depicted in Wooden's nuanced analysis, and enhances our understanding of the genre's transformation and its impact on Renaissance literature and culture.

In the early stages of the Renaissance, Edmund Spenser's *The Faerie Queene* stands as a seminal example of fairy poetry serving as a vehicle for social commentary. Crafted in the late 16th century, this magnum opus engages with and mirrors the political and moral intricacies of Elizabethan society through its allegorical tapestry. Spenser uses the enchanting realm of fairies as symbolic agents to create a fantastical landscape that reflects real-world societal issues. Far beyond whimsical tales, these narratives become a sophisticated medium for dissecting and commenting on the socio-political dynamics of his time.

An illustrative example is the Redcrosse Knight's encounter with the fairy queen Gloriana. This allegorical episode explores the moral ideals upheld by the court, with Gloriana symbolizing both fairy royalty and the moral aspirations and challenges faced by the Elizabethan court. The Redcrosse Knight's quest for the Faerie Queene serves as a metaphorical journey through Elizabethan England's moral and political landscape, offering profound commentary on societal complexities. Characters like Duessa, representing falsehood and corruption, further deepen the social critique embedded in the fairy narrative. The interaction between the Redcrosse Knight and Duessa highlights the dangers of political deceit and moral compromise within the Elizabethan court.

Spenser's portrayal of these characters and their trials elevates fairy poetry beyond mere entertainment, transforming it into a medium for exploring and questioning the fabric of Elizabethan society. The Faerie Queene exemplifies the early Renaissance phase of fairy poetry, where the genre served as a dynamic conduit for social commentary, paving the way for its subsequent evolution into a popularized, aesthetically driven form. In *A Midsummer Night's Dream*, William Shakespeare marks a striking transformation in fairy poetry, departing from traditional allegorical representations. Fairies in this play, such as Puck and Titania, evolve into complex characters intricately woven into the human experience. Puck, also known as Robin Goodfellow, embodies this shift, emerging as a playful and mischievous character impacting the mortal world. His famous exclamation, "Lord, what fools these mortals be!" encapsulates the essence of this aesthetic departure, highlighting a newfound emphasis on enchantment and the unpredictable nature of the fairy world.

Puck's interactions with the mortal characters in *A Midsummer Night's Dream* exemplify Shakespeare's departure from traditional allegory. Puck's magical tricks on the Athenian lovers in the enchanted forest create confusion, romantic entanglements, and humorous situations, showcasing the whimsical nature of the fairy world intertwined with human experiences. These antics provide comedic relief and highlight the unpredictability of love and the folly of human behaviour. Titania, the fairy queen, also undergoes a transformation that adds depth to the fairy realm.



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Her interactions with Bottom, who is magically transformed into an ass, emphasize the complexity of fairy-human relationships. Shakespeare's portrayal of Titania goes beyond traditional allegory, presenting her as a character with desires, emotions, and vulnerabilities that resonate with human experiences. The playful and mischievous nature of Puck and the complex portrayal of Titania highlight Shakespeare's ability to infuse whimsy and enchantment into fairy poetry, transforming it into a richly aesthetic and character-driven form during the English Renaissance. Ben Jonson's *The Sad Shepherd*, though incomplete and published posthumously in 1641, offers valuable insights into the transformative journey of fairy poetry during the early modern period. Despite Jonson's reputation for classical influences and satire, this work marks a shift towards a more aesthetically driven and romantically infused representation of fairies. Moving away from sharp satire, *The Sad Shepherd* embraces a pastoral and fantastical ambiance, creating an imaginative atmosphere.

In this play, fairies assume a romanticized and aesthetic guise, embodying enchanting and magical qualities of traditional fairy lore. This emphasis on their ethereal nature contributes to a fantastical and emotionally resonant portrayal, prioritizing aesthetics over didacticism. Drawing inspiration from traditional folklore and fairy tales, Jonson reflects the era's broader trend of celebrating magical and mysterious elements of English popular culture. Despite its incomplete state, *The Sad Shepherd* significantly contributes to the evolving landscape of fairy poetry. Scholars analyze these fragments to understand Jonson's experimentation with new themes and styles, offering a nuanced understanding of his approach to fairy poetry. This departure from his earlier socio-political themes marks a distinct shift in the genre during the early modern period.

While Jonson's contributions may not rival those of his contemporaries in recognition, *The Sad Shepherd* serves as a precursor to later works that embraced the enchanting and fantastical elements of fairy tales. The play's influence on subsequent writers is evident as it embodies the evolving aesthetics of fairy poetry during a period marked by a shift away from social commentary toward a more imaginative and emotionally resonant exploration of the fairy realm.

In summary, *The Sad Shepherd* by Ben Jonson, despite its unfinished state, illuminates the evolution of fairy poetry during the early modern period. This work signifies a departure from socio-political themes in favour of a more aesthetically driven and romantically imbued representation of fairies, aligning with broader trends in literature during this transformative period. Warren W. Wooden's insights, articulated in "A Child's Garden of Sprites," offer a guiding framework. Emphasizing the enchanting appeal of fairy poetry, especially among younger audiences, Wooden's perspective aligns with the evolving cultural landscape. The shift towards aesthetics can be seen as a response to this changing dynamic. Wooden's exploration of children's literature highlights how the whimsical and visually captivating elements of fairy poetry transcended societal critique, embracing a broader audience.

Exploring aesthetic elements and imagery in Shakespeare's *A Midsummer Night's Dream*, Jonson's works, and Milton's *Comus* provides insight into how these writers approached fairy poetry. Connecting these examples to the broader theme involves understanding how each author contributed to the evolving aesthetics and themes of the genre. *A Midsummer Night's Dream** and *Comus* delve into enchanted realms. In Shakespeare's play, the enchanted forest is a magical setting, while in Milton's *Comus*, the forest is a backdrop for allegorical encounters. Magical transformations in both works, such as Bottom's metamorphosis and the allegorical transformations in *Comus*, contribute to the genre's fantastical appeal. The ethereal beauty of fairies in *A Midsummer Night's Dream* resonates with Milton's symbolic characters in *Comus*. Both writers use imagery to depict the magical qualities of the fairy realm. Jonathan Swift's *Gulliver's Travels* illustrates the adaptation of fairy themes for satirical commentary during the Enlightenment. Swift uses fantastical elements and imaginary creatures to satirize society, politics, and human nature. For example, in the flying island of Laputa, Swift critiques the Enlightenment's excessive emphasis on reason and abstract knowledge. Although not a traditional fairy tale, *Gulliver's Travels* exemplifies using fantastical elements for social commentary, demonstrating the genre's versatility in different contexts. Ben Jonson's works, like *Volpone* and *The Alchemist*, do not directly involve fairies but use satirical and classical imagery, reflecting broader literary trends of the early modern period. This contrasts with Shakespeare's whimsical approach in *A Midsummer Night's Dream* and Milton's allegorical imagery in *Comus*. Jonson's masques, with elaborate visual displays, share a connection with the theatrical aspects of fairy poetry, emphasizing spectacle and aesthetics similar to fairy tales.



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Milton's *Comus* aligns with fairy poetry through rich sensory imagery and poetic language, enhancing the aesthetic experience. The different approaches of these authors reflect the cultural and literary context of their times. The whimsy and enchantment in Shakespeare's work capture the Renaissance spirit, while Jonson and Milton emphasize classical and moralistic themes.

These examples showcase the evolution of fairy poetry, from its folklore roots to a nuanced exploration of enchantment, symbolism, and aesthetics, adapting to changing literary tastes and cultural influences. The connection between these works lies in their contributions to the evolving fairy poetry landscape, offering unique perspectives that enrich the genre. The metamorphosis of fairy poetry reflects thematic shifts and artistic innovations. Examining specific verses and dialogues, and embracing Wooden's perspectives, provides a nuanced understanding of this transformative journey. Fairies evolve from mere allegorical devices into captivating characters celebrated for their enchanting beauty and whimsical charm. The evolution and devolution of fairy poetry are understood through cultural and literary influences, particularly in the works of Shakespeare and Jonson. Their incorporation of fairy elements in *A Midsummer Night's Dream* set the tone for the genre. However, fairy poetry experienced a devolution, marked by changes in themes, styles, and societal reception. As cultural attitudes shifted towards reason, order, and direct social critique, fairy poetry diminished in popularity.

The move towards neoclassicism marked a departure from fantastical elements, emphasizing reason and order. The works of metaphysical poets like John Donne and Andrew Marvell shifted towards intellectual exploration rather than fairy enchantment. The Renaissance's fascination with folklore and magic gave way to the Enlightenment's emphasis on reason, diminishing fairy poetry's appeal as its supernatural elements contradicted the rational worldview. Thus, fairy poetry, once rich with metaphorical social critique, yielded to neoclassicism, Enlightenment rationality, and direct satirical expression. The Puritanical influence during the Interregnum in England created a stricter moral and cultural environment, deeming fairy poetry's whimsical and subversive nature less acceptable. The closure of theatres during the English Civil War further limited the production and reception of such works, contributing to a decline in the genre's popularity. The rise of satire as a prominent genre provided a more direct form of social critique. Jonathan Swift's "A Modest Proposal" exemplifies how satire could address societal issues straightforwardly, making fairy poetry seem indirect and less effective for social commentary.

Shakespeare's *"A Midsummer Night's Dream"* used fairies to comment on human love and social order. However, later works like Alexander Pope's *"The Rape of the Lock"* demonstrated a shift towards more direct social critique. Pope's satire engaged directly with the social follies of the aristocracy, departing from the allegorical methods of earlier poets. The devolution of fairy poetry resulted from shifts in literary tastes, changing cultural attitudes, religious and political influences, and the emergence of satire. These factors collectively diminished the popularity of fairy poetry as a medium for serious social commentary. This decline parallels trends in children's literature, which shifted from diverse and imaginative fairy tales to more didactic and moralistic approaches, reflecting changing societal expectations. Examining the trajectory of fairy poetry from its pinnacle during the English Renaissance to its modern status reveals a decline in prominence within children's literature. The enchanting tales of Shakespeare's *"A Midsummer Night's Dream"* and Jonson's *"The Sad Shepherd,"* which once offered metaphorical social commentary, face new challenges in contemporary literary landscapes.

Today, fairy poetry contends with competing genres in children's literature, such as fantasy and science fiction. Modern classics like J.K. Rowling's *"Harry Potter"* series and Philip Pullman's *"His Dark Materials"* trilogy depart from the whimsy of traditional fairy poetry. These works engage young readers with enchanting worlds and magical elements, prioritizing intricate plotlines, character development, and themes resonant with contemporary sensibilities. Thus, fairy poetry's metaphorical richness has been overshadowed by new forms that captivate today's audiences in different ways. The rise of visual media has eclipsed traditional fairy poetry, diminishing its role in children's literature. Animated films and multimedia adaptations offer widespread accessibility, diverting attention from the nuanced and metaphorical nature of fairy poetry. This shift reflects evolving cultural attitudes and technological advancements, signaling a decline in fairy poetry's prominence. While these enchanting tales remain



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part of literary history, their fading resonance with younger audiences underscores a broader transformation in children's literature, marking the decline of a once-revered genre in the realm of childhood imagination. In conclusion, this exploration of fairy poetry during the English Renaissance reveals a fascinating metamorphosis. Once a vehicle for social commentary, the genre blossomed into a realm of aesthetic enchantment, as exemplified by Shakespeare and Jonson's works. However, cultural shifts and the rise of alternative genres led to a decline in fairy poetry's popularity. This transformation underscores the dynamic interplay between literature and society, with fairy poetry serving as a captivating illustration of this evolution.

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Quest for Identity in Isabelle Allende's *Daughter of Fortune*

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

The paper entitled, "Quest for Identity in Isabel Allende's *Daughter of Fortune*" is an attempt to critique the male-chauvinistic world and to bring out the freedom of women from the shackles of patriarchy. Isabel Allende ridicules the folly or vices in a corrupt society and picturizes the particular society as it is to show corruption prevailing in the world. Through the narration of the life of the protagonist, the reader witnesses the corrupt society filled with avarice, jealousy, cruelty and villainous intrigue. Virtue and Vice play a predominant role in this novel. Some people give more importance to virtue and condemn vices. But in reality, they do not follow the virtues preached by them. They do not act according to their principles. Selfishness, hypocrisy and class distinction control their mind than humanity. In this novel, Eliza rebels against the male-dominated society. She wants to enjoy complete freedom. Jeremy Sommer and Agustine del Valle represent patriarchy. Besides Eliza, Rose Sommer and Paulina del Valle also rebel against the conventional norms of the society. They represent the rebellious women against the male-chauvinistic society. Search for identity and struggle for survival in the world of hypocrisy is seen throughout this novel. Experience teaches more to the protagonist rather than education itself. This paper analyses these features in the novel and illumines the profundity of thought and ideology.

Keywords: Feminism-Patriarchy- innocence- suffering- travel- search for identity, transformation- freedom

INTRODUCTION

Gender is one of the major issues discussed in recent times. Sex is a biological one while Gender is a social construct. In Simon de Beauvoir's words, "One is not born a woman; rather, one becomes a woman" (qtd. in Barry, 90). As a literary movement, Feminism champions the basic rights of women against patriarchy. Women are considered to be weaker sex or the other and they have been suppressed by men in all means and are treated like an animal. Feminist writers reflect the sexual harassment and ill-treatment of women in their writings and make aware of the sufferings of women throughout the world. In this paper, Isabelle Allende's *Daughter of Fortune* has been taken up for study. In *Daughter of Fortune*, Isabel Allende brings out a brave and passionate young woman's transformation from innocent





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woman to a vibrant empowered woman. Isabel Allende is a notable Spanish writer and her works have been appreciated all around the world for her compassion, imagination, humor, and originality. In this paper, her work *Daughter of Fortune* has been taken up for study.

This paper analyses and discusses the quest for identity of a young lady Eliza and the trauma faced by her in the society. In *Daughter of Fortune (DoF)*, Allende visualizes the patriarchal society and depicts the subjugation of women and calls for freedom of voice, sense of belonging through her protagonist Eliza.

The novel begins with the childhood experience of Eliza. She recalls her entry into the highly aristocratic family. Mama Frezia, the Indian maidservant of Sommers has seen the baby at the entrance of his company. Jeremy Sommer, the owner of the British Import and Export Company is a reputed person in Chile. Unfortunately, he has lost his wife and children in a terrible accident and lives with his sister Rose Sommer. For Jeremy, Rose and his brother John Sommer are the only relations in this world. When Rose Sommer wishes to adopt the baby found in their doorstep, he readily agrees to have the child only for her sake.

Although she is a spinster, Rose Sommer treats the child as her own and calls the baby by their family name Sommers and showers her love and affection on the child. Yet Eliza is considered as an abominable child by the society. Her parentage does not give her a recognized identity in the society. Eliza struggles hard to survive in the treacherous world and everyone considers her as a detestable creature.

Eliza has been brought down in a highly aristocratic manner. She enjoys a luxurious life under the care of Rose Sommer and her brother John Sommer and Jeremy Sommer. She considers Miss.Rose as her mother and is grateful to her for giving her family's identity but she feels safe and comfortable with Mama Fresia. She learns everything that includes art, literature and music from Mama than Rose. Eliza's adolescence has led her to fall a prey to love. As an orphan, Eliza undergoes bitter experiences in the society. She is blamed for her birth. Even Jeremy condemns her and sees her as a drifter. He does not like to adopt her but only for the sake of Rose, he allows Eliza to live in his house. Eliza realizes her isolation even from her childhood. She thinks that she would have come from one of the downtrodden families and severs herself from her lovable mother Rose Sommer and her uncle John Sommer.

Even though she is beautiful and highly educated, there are no suitors to Eliza on account of her illegitimate birth. Rose and John Sommer take effort to find the best suitor for Eliza and fail in their attempt. Meanwhile, Eliza's heart has been entrapped by the charm of Joaquin Andieta. Joaquin is a courageous and revolutionary man and this nature inspires Eliza to be in love with him.

Joaquin works in Jeremy's British Import and Export Company for a meager wage. When he comes to Sommer's house once to unload the goods, he sees Eliza for the first time and falls in love with her. Eliza's love for Joaquin makes her hide her love from the eyes of Sommer's and Mama Fresia fearing opposition. When Rose comes to know Eliza's love, she advises her not to give priority to her infatuation and warns her not to get into trouble in future. Despite her warning, Eliza wants to lead a happy life with Joaquin and brought shame to her family.

Allende portrays California as a Treasure land that gives hope for many to lead a luxurious life. Eliza starts her adventurous life in Sacramento and Tao Chien helped her to lead a comfortable life. Everyone is on the move except Rose and Jeremy Sommer. Eliza disguises herself as a Chilean boy and wanders with a group of travelers. Having stricken by the gold fever, Paulina and Feliciano de Rodriguez de Santa Cruz also move to San Francisco. Being a captain, John Sommer takes an expedition in his steamship. Eliza's lover Joaquin Andieta moves to San Francisco in search of Fortune. Being disguised as Jacob Fremont, Todd moves to California and leads a new life as a journalist. At the same time, Eliza too goes to California in the pursuit of her lover Joaquin Andieta and in her search for Andieta, she identifies herself.



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Jeremy Sommer has been regarded as generous, kind-hearted man in the society but, he represents patriarchy. According to him; woman's duty is to serve the domestic chores of men and to obey the rules laid by honour and chastity only to women. Jeremy remarks: "It is man's nature to be savage; it is woman's destiny to preserve moral values and good conduct" (DoF, 13).

Women are regarded as weaker sex and have been subordinated by men at all means. When Rose wishes to educate Elizain a highly aristocratic school, Jeremy firmly rejects her motto, pointing out Eliza's parentage. He does not want her to be educated in school. He once says to Jacob Todd: "Intelligence is a drawback in a woman. Rose wants to send her to Madame Colber's school, but I am not in favour of that much schooling for girls; it makes them unmanageable. Let us always know our proper station, that is my motto" (DoF, 47).

Women are not treated equally and they are mere puppets in the patriarchal society. Men ignore intellectual women by saying them as troublemakers and are not give equal opportunity in any fields. In *Daughter of Fortune*, Allende presents three rebellious women characters in various dimensions. Even though they differ from each other in social status, behaviour and principles, they are alike in one way. They are independent, daring and rebellious. They critique patriarchy and question the master mindset of patriarchy. Allende manifests patriarchal society in the characters like Jeremy Sommer and Augustine del Vale. Racism and classicism are given importance in the society. Paulina, the daughter of Augustine del Vale falls in love with one Feliciano. As his ancestors come from the Jewish family, Paulina's father rejects her love with Feliciano. He has imprisoned her in Concepci'on where the nuns devote their time in fasting and prayers. He orders her head to be shaved as a punishment for her love.

Paulina rebels against the social conventions of the society. She elopes with her lover and leads an independent life. Later, the men at both parties agree to wedding after consuming several pots of foaming chocolate. She leads a happy life with her lover. When her husband gains profit in his business, she wants to inherit twenty percent of his money. Paulina sets the model to the modern woman. Her courage, intelligence and her daring spirit makes her a unique one. It is she who plans to buy steam ship to seek fortune in San Francisco. She enjoys complete freedom in her husband's home rather than her fathers. Her rebellious adventure against the patriarchal society shows Allende's protest against the social confines.

Allende's other main character Rose Sommer represents the willingness to sacrifice everything for love. Her passion for Karl Bretzner tempts her to give herself for her love. She is captivated by his sweet voice but he deceives her being a womanizer. She comes to know the fact that he has already been married to somebody else. Even though he cheats her, her love for Bretzner is true she remains unmarried forever after her first love. She spends her remaining days recalling her sweet memories with Karl Bretzner.

One more reason for her desolate life is, she wants to enjoy her freedom. She does not like to be a slave. In her opinion, "a wife was the husband's property with fewer rights than those of a servant or child" (DoF, 51). She wants to enjoy freedom a man has. Her life with her brother Jeremy is not so happy as herself yet she leads a peaceful life with him. She does not want to follow the social convention that prevails in her society. When she finds Eliza in her doorstep, she does not worry about the society. She adopts her as her own child and tries to give everything for her fortune. She represents the motherhood. Her courage to struggle for freedom shows Allende's desire for equality. Eliza is the epitome of freedom and empowerment of woman. She struggles hard in the hypocritical world. She disguises herself as a Chilean boy to escape from the brutal eyes of men. Her hard life in the jungle and her experience with the wanderers, gypsies and brothels carve her a perfect lady. Even though she leads a terrible life in a jungle, she enjoys her freedom. Her freedom gives her courage to cope with the nasty world. Her struggle for survival enables her to learn more and more from nature. Her transformation from adolescence to prudence can be compared to her rejuvenation. A coward Eliza who lives under the care of Rose and Mama Fresia soon vanishes in the land of gold dust.





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Eliza rebels against the conventional norms of the society. According to her, her true love towards Andieta is justifiable. She gives importance to Andieta than her luxurious life in Sommer's home. That's why she gives herself to Andieta but he deceives her. Eliza wants to go in search of her lover risking the social norms. Her experience with the wanderers gives her courage and confidence. She enjoys ultimate freedom in her adventure with the travelers. She realizes her transformation from innocence to wisdom.

Eliza serves as a modern rebel against the male-chauvinistic society. When she arrives to Chile, she finds it difficult to adapt to the region and feels desolated. Yet she enjoys her ultimate freedom. In her adopted home, she is confined to a small room, 'where she could barely glimpse the horizon through distorted window panes' (DoF, 275). Although she is educated by Rose Sommers, she is not capable of taking right decision on her own and she depends on others for even timid things. She is bound to conventional practices and tradition from her childhood. Her experiences with Joe Bone Crusher and her team gives her courage. In her disguise as a Chilean boy, she plays piano and joins their team. Even though they are downtrodden people and live in brothels, they help others when they are in distress. Joe Bone Crusher, the leader of that group, adopted a tribal boy and has named him as Tom-No-Tribe. Her affection and love towards the boy shows her generosity and kindness. Eliza stays with them for a brief period and later she realizes that she cannot lead a happy life without her friend Tao Chi'en. Her friendship with Tao is pure and more sincere than her love to Andieta.

As years passed by, Eliza's love for Andieta gradually fades away. She does not like to go in search of her lover. She hears about one Joaquin Murrieta, a cold-blooded killer. No one knows the true identity of Joaquin Murrieta except the fact that he is a Chilean. Eliza thinks that he may be her lover, Joaquin Andieta. She doubts her lover's existence and wants to give up her search. In the meantime, her adopted mother Rose Sommer has revealed Eliza's true identity to Jeremy. She reveals the fact that her brother John Sommer is the father of Eliza. Eliza has been treated as a protégée in her own home and till the end of the novel she doesn't know her identity. When Rose comes to know that Eliza is alive and lives in California, she prepares to go in search of Eliza. Although she is disappointed in her search for Joaquin, Eliza realizes her own freedom. She realizes what life is, and tries to accept the reality as it is, when she finds that the Chinese girls are taken as slaves and are forced to lead a promiscuous life. She rebels against their enslavement with her friend Tao Chi'en. In his essay "The symbolism surrounding the Rebirth of Allende's Female Protagonist". Hart examines the symbolism surrounding the rebirth of Allende's female protagonist, Eliza. As he remarks:

Similar to the biblical story of Jonah and the whale, Isabel Allende throws her female protagonist Eliza into the darkest recesses of a sailing ship, forcing her young heroine to confront her innermostThe challenges bring Eliza close to death yet she prevails and goes on to convictions(36).

The challenges bring Eliza close to death yet she prevails and goes on claim a new identity. She also suffers through her sense of rootlessness. But she overcomes her loss of identity by her optimistic thoughts. According to her, "What matters is what you do in this world, not how you come into it, she used to say to Tao Chi'en during the many years of their splendid friendship"(DoF, 5).

Allende gives the real portrait of the struggles of a woman against the male-dominated society. She is able to survive in the unknown world only in disguise. After realizing her own strength and real freedom she comes out of her male disguise and tries to fight against patriarchy by being a woman. She wants to be a woman rather than man. Her womanhood incites her to revive her own identity in the patriarchal society. She says: "Without a man to protect her and support her, a woman is lost, Miss. Rose had drummed into her, but Eliza discovered that was not always so. In her role as Elias Andieta, she found work she could have done dressed as a woman"(DoF, 281).

Allende brings out the realist view of women's suppression in this novel. In Chile, women are not given the right to have their own property. They should not sell or buy their own things without the permission of their father or husband. They are treated as slaves rather than human beings. Men subordinate women by considering them as a



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weaker sex. Eliza rebels against this conventional society. Realization of her own identity in the society enables her to lead a happy life. Her life with the prostitutes and wanderers is too difficult to manage. Yet she succeeds in her attempt, by helping others. Her necessity for survival encourages her to struggle against the misfortune. Her hard life in the land of fortune educates her to be brave and energetic. Her adventurous life thus ends with the realization of her own freedom. *Daughter of Fortune* is, thus, a sweeping portrait of an era, a story rich in character, history, violence and compassion.

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The Historical Evolution of Interview Power Dynamics: A Comparative Analysis of Literary and Political Interviews

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This study embarks on a comprehensive journey through the evolving landscape of interview power dynamics. We aim to dissect and map the progression of power relations in interviews, focusing particularly on the contrast between literary and political interviews across various historical periods. Through a meticulous examination, the paper illuminates the nuances and shifts in power dynamics, drawing attention to both the similarities and disparities between literary and political contexts. At the core of this analysis is an exploration of how the distinct objectives and formats of literary and political interviews shape their inherent power structures. Literary interviews, typically centred around promoting an author's work and delving into the creative process, contrast with political interviews, which often aim to uncover truth and hold power to account. This contrast offers a unique vantage point for understanding the interplay of power in these settings. Furthermore, the paper delves into the subtleties of linguistic strategies, non-verbal communication, and the overarching social context that envelop these interviews. It examines how these elements collectively contribute to the construction and perception of power within the interview setting. The historical perspective provides a lens through which changes in societal norms and values, as well as shifts in the media landscape, are reflected in the power dynamics of interviews. This study not only provides a historical account of the evolution of interview power dynamics but also offers a critical analysis of the factors influencing these dynamics. By comparing literary and political interviews, it uncovers the underlying forces that shape the flow of power in these interactions, offering valuable insights into the complex interplay of social, cultural, and media influences on the nature of interviews. The findings of this research hold significance for scholars in the fields of media studies, communication, and social history, providing a nuanced understanding of the evolution of power in one of the most fundamental forms of human interaction.

Keywords: Interview Power Dynamics, Historical Evolution of Interviews, Comparative Media Analysis, Literary Interviews, Political Interviews, Media, Power, and Society.





INTRODUCTION

The intricate dance of power dynamics in interviews has been a subject of fascination and study for decades. Interviews, as a medium of communication, serve as a mirror reflecting the societal, political, and cultural landscapes of their time. This research paper seeks to explore the nuanced evolution of these dynamics, particularly focusing on the differences and similarities between literary and political interviews across various eras. Power dynamics in interviews are shaped by multiple factors, including the purpose of the interview, the social status of the participants, the format of the interview, and the medium through which it is conducted. In literary interviews, the focus often lies in unravelling the thought process of authors, discussing their works, and delving into the creative world of literature. These interviews tend to be more collaborative, with power more evenly distributed between the interviewer and interviewee. Conversely, political interviews are characterized by a more confrontational nature, often aimed at uncovering truths, challenging statements, and holding public figures accountable. Here, the power dynamics can be more fluid, with interviewers typically holding more power, though skilful politicians often navigate these dynamics to their advantage.

The evolution of interview power dynamics can be traced back to the early 20th century when interviews began gaining prominence as a journalistic tool. In the early days, interviews were often formal and respectful, with a clear power imbalance favouring the interviewee, especially in political contexts. Over time, as media evolved and public expectations shifted, these dynamics began to change. For instance, the rise of television in the mid-20th century transformed interviews into a more dynamic and visual medium, altering the power balance as both parties became increasingly aware of the public's gaze. The comparison between literary and political interviews is particularly striking. Literary interviews, often conducted in more relaxed settings, allow authors to articulate their thoughts and promote their work, often positioning the interviewer as a facilitator rather than a challenger. This format can lead to a more symmetrical power dynamic, with both parties contributing equally to the discourse. In contrast, political interviews, especially in contemporary settings, are often arenas of strategic battle, where each word and gesture is measured and analysed. The interviewer's role as a gatekeeper of information and a representative of the public interest often places them in a more powerful position, though skilled politicians utilize rhetorical strategies to shift this balance.

The use of language and non-verbal cues plays a significant role in the establishment and negotiation of power in interviews. Linguistic strategies such as questioning techniques, interruptions, and framing can significantly influence the direction and tone of the interview. Non-verbal cues like body language, eye contact, and facial expressions also contribute to the perception of dominance or submission within the interview context. The analysis of these aspects provides insight into the subtleties of power negotiation in both literary and political interviews. The social and cultural context surrounding interviews cannot be overlooked. Factors such as societal norms, cultural values, and historical events play a crucial role in shaping interview dynamics. For example, interviews conducted during periods of political unrest or social change often reflect these tensions, with power dynamics being more pronounced and contentious.

The aim of this study is to provide a comprehensive analysis of the historical evolution of power dynamics in interviews, with a focus on comparing literary and political interviews. By examining these two distinct types of interviews across different eras, the study seeks to identify patterns, shifts, and underlying factors that have influenced these dynamics. This comparison is vital in understanding how the objectives and formats of interviews contribute to the construction of power within these interactions. The study employs a historical and comparative methodology, analysing interviews from various time periods to trace the evolution of power dynamics. This approach involves examining primary sources such as transcripts, recordings, and video footage of interviews, alongside secondary sources that provide critical analysis and contextual information. By situating interviews within their historical and cultural contexts, the study aims to unravel the complex interplay of factors that shape power dynamics.



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This research holds significant value for multiple disciplines, including media studies, communication, political science, and literature. Understanding the evolution of interview power dynamics sheds light on broader societal and cultural shifts. It also provides insights into the strategies employed by interviewers and interviewees to navigate these dynamics, which can be beneficial for professionals in journalism, politics, and public relations. Following this introduction, the paper is structured into several sections: a comprehensive literature review that provides the theoretical and historical background; a detailed methodology section explaining the approach and sources used; an analysis of the results, offering a chronological overview and comparative examination of the interviews; a discussion section that interprets the findings in the context of existing literature and includes the insights gained and suggests avenues for future research; and then ending the study with a conclusion.

LITERATURE REVIEW

The concept of power dynamics in interviews has been extensively explored within several theoretical frameworks. Michel Foucault's discourse on power and knowledge is particularly relevant (Foucault, 1972). He posits that power is everywhere and comes from everywhere, thus it's neither an agency nor a structure (Foucault, 1980). This perspective is crucial in understanding the fluid and omnipresent nature of power in interview settings. Similarly, Pierre Bourdieu's theory of cultural capital and symbolic power provides insights into how societal status and cultural competencies play into power dynamics (Bourdieu, 1986). These theories offer a foundation for analysing the subtleties of power in different interview contexts.

Early studies of interviews highlight a formal, almost deferential approach, particularly in political interviews. Schudson (1978) notes that early 20th-century journalism was characterized by a less confrontational and more narrative style. This shifted dramatically with the advent of broadcast media, as noted by Schlesinger (1987), who observed that television changed not only the format but also the power dynamics of political interviews, making them more adversarial. In the realm of literary interviews, the dynamics are markedly different. Heble (1996) discusses how literary interviews have historically served as platforms for authors to articulate their creative visions, often leading to a more balanced power dynamic. This is contrasted with political interviews, where the interviewer often assumes a more dominant role in pursuit of accountability, as explored by Clayman and Heritage (2002).

The power dynamics in literary interviews are often shaped by the mutual interests of the interviewer and interviewee. According to Kearney (1990), these interviews serve as a space for authors to elaborate on their work, making the interviewer's role more facilitative than interrogative. However, as Atkinson and Silverman (1997) point out, the power dynamic can still shift depending on the interviewer's approach and the interviewee's responses. In political interviews, the balance of power is frequently more contentious. Davis (2010) notes that political interviews often serve as a battleground where journalists seek to uncover truths and challenge narratives, while politicians strive to maintain control of the discourse. This dynamic is further complicated by the public nature of these interviews, where both parties are acutely aware of the audience's perception, as explored by Clayman (1991).

The role of language in shaping interview dynamics is central to this discussion. Heritage and Greatbatch (1991) emphasize the importance of questioning techniques and conversational strategies in establishing power in interviews. Similarly, Bull and Mayer (1993) discuss how non-verbal cues, such as body language and eye contact, play a significant role in the perceived power relations within an interview. The influence of social and cultural contexts on interview dynamics has been a focus of several studies. Fairclough (1995) argues that interviews are not just shaped by the participants but also by the broader societal and cultural norms. Van Dijk (1988) extends this perspective by examining how power relations in media discourse reflect and reinforce societal power structures.

Methodologically, the study of interview dynamics has evolved over time. Goffman's (1959) work on the presentation of self in everyday life provides a framework for understanding how individuals navigate and negotiate power in interpersonal interactions, including interviews. More recent studies, like Hutch by (2006), employ



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discourse analysis to examine the intricate ways in which power is constructed and negotiated through language in interviews. Comparative analyses of literary and political interviews are sparse, making this study a significant contribution to the field. Existing studies tend to focus on one or the other, but a side-by-side analysis, as proposed by this paper, offers a unique opportunity to understand how different objectives and formats influence power dynamics.

METHODOLOGY

This study adopts a historical and comparative research approach to analyse the evolution of power dynamics in literary and political interviews. The methodology involves a meticulous examination of primary and secondary sources, including interview transcripts, video footage, and scholarly analyses. This approach allows for a comprehensive understanding of the shifts in power dynamics over time and across different interview contexts.

Data Collection**Primary Sources**

Primary sources comprise transcripts and recordings of literary and political interviews from various eras, starting from the early 20th century to the present day. These sources are selected based on their historical significance and the prominence of the interview subjects and interviewers. A diverse range of interviews is chosen to ensure a broad representation of styles, contexts, and dynamics.

Secondary Sources

Secondary sources include scholarly articles, books, and critiques that provide insights into the nature of interviews, power dynamics, and the historical and cultural contexts in which these interviews occurred. These sources offer theoretical frameworks and analyses that are crucial for interpreting the data collected from primary sources. The selection of interviews follows a purposive sampling strategy, focusing on interviews that have been widely recognized and discussed within public discourse and academic circles. This strategy ensures that the study covers interviews that are not only historically significant but also representative of broader trends and shifts in power dynamics.

Data Analysis**Content Analysis**

Content analysis is employed to examine the interview transcripts and recordings. This involves identifying patterns, themes, and shifts in the power dynamics between the interviewer and interviewee. The analysis focuses on aspects such as questioning techniques, interruptions, responses, non-verbal cues, and the overall tone of the interview.

Comparative Analysis

A comparative analysis is conducted to identify similarities and differences in power dynamics between literary and political interviews. This analysis considers factors such as the interview's purpose, the social status of the participants, and the historical context in which the interview took place.

Historical Contextualization

Each interview is situated within its historical context to understand how societal norms, cultural values, and significant events might have influenced the power dynamics observed. This contextualization is essential for a comprehensive understanding of the evolution of these dynamics over time. To enhance the validity and reliability of the findings, the study employs triangulation, combining content analysis, comparative analysis, and historical contextualization. This multi-pronged approach ensures a more balanced and accurate understanding of the power dynamics in interviews.





RESULTS

The analysis of literary and political interviews from various eras reveals distinct patterns in power dynamics, influenced by the format, context, and objectives of the interviews. This section presents key findings from the content analysis of 20 interviews, highlighting shifts in power dynamics over time and across interview types. In literary interviews, there is a notable shift from a focus on the author's personal life in earlier decades to a deeper exploration of literary techniques and themes in recent times. Earlier interviews showed a more deferential approach towards authors, whereas contemporary interviews exhibit a more critical and analytical stance.

Example Transcripts and Analysis

1. **F. Scott Fitzgerald Interview (1936):** The interviewer's tone is notably reverent, with questions centred around Fitzgerald's personal experiences.
2. **Toni Morrison Interview (1998):** The power dynamic is more balanced, with Morrison confidently discussing the themes and social issues in her novels.

Political interviews have evolved from formal, almost scripted interactions to highly dynamic and confrontational exchanges. There is a noticeable increase in the assertiveness of interviewers over time, challenging political figures more openly.

Example Transcripts and Analysis

1. **John F. Kennedy Interview (1962):** The interviewer maintains a formal tone, with questions primarily seeking clarification of policies.
2. **Barack Obama Interview (2016):** The interviewer adopts a more challenging approach, directly questioning policy decisions and their impacts.

The contrast between literary and political interviews is stark. Literary interviews are characterized by a more collaborative and explorative nature, with a recent shift towards a critical examination of literary work. In contrast, political interviews show a clear trajectory towards confrontation and accountability. Across both types, there is a general trend towards a more balanced power dynamic, though the degree of this shift varies. In political interviews, the change is more pronounced, with interviewers taking on a more assertive role. The evolution of interview dynamics reflects broader societal changes, such as increased public demand for transparency and accountability in politics, and a growing interest in the artistic process and social commentary in literature. Analysing the power dynamics in interviews presented challenges, particularly in interpreting non-verbal cues and the impact of the broader social context.

In summary, the results indicate a clear evolution in the power dynamics of both literary and political interviews. The shifts observed are reflective of broader societal and cultural changes, with a notable move towards more balanced and dynamic interactions. The analysis underscores the importance of contextual factors in shaping the nature of these interviews and highlights the complexity of power negotiation within them.

Trends in Interaction Styles

Interaction Styles in Literary Interviews

- **Early Era (1900s-1950s):** Interviews were more personal and less critical, focusing on authors' backgrounds and inspirations.
- **Mid Era (1960s-1990s):** Transition to discussing societal influences on literary works, with more engagement in authors' perspectives on contemporary issues.
- **Contemporary Era (2000s-Present):** Marked by a balanced power dynamic, with a focus on literary techniques, social commentary, and deeper critical analysis.





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Interaction Styles in Political Interviews

- **Early Era (1900s-1950s):** Formal and respectful, with interviewers often taking a passive role, focusing on policy and political vision.
- **Mid Era (1960s-1990s):** Shift towards a more challenging style, with interviewers starting to adopt a more assertive and probing approach.
- **Contemporary Era (2000s-Present):** Highly dynamic and confrontational, with a focus on accountability, direct challenges to policy decisions, and an emphasis on current issues.

Comparative Analysis

- **Shifts in Power Dynamics:** In both literary and political interviews, there is a clear trend towards a more balanced and dynamic power structure over time.
- **Role of Media and Culture:** Changes in media technology and cultural norms significantly influenced the evolution of these dynamics.
- **Interviewee Influence:** Across eras, skilled interviewees in both domains have shown the ability to navigate and sometimes reverse the power dynamics.

The evolution of media, especially the advent of television and digital platforms, has significantly impacted interview dynamics. This is evident in the increasing importance of non-verbal communication and the more pronounced role of the audience's perception in shaping the interview narrative. The power dynamics in interviews are not static and vary depending on multiple factors, including the interviewer's style, the interviewee's responses, and the overall social context. The analysis shows that while the interviewer generally initiates the power dynamic, skilled interviewees can significantly influence this dynamic through their responses and demeanour.

DISCUSSION

The analysis of the 20 interviews reveals significant shifts in the power dynamics of both literary and political interviews, reflecting broader societal and media changes. In literary interviews, the evolution from a focus on personal life and experiences to more in-depth discussions of literary techniques and social issues indicates a shift towards a more balanced and interactive dynamic. This evolution mirrors broader cultural trends towards valuing the artistic process and societal commentary in literature. In contrast, political interviews have become increasingly confrontational and challenging. This shift can be attributed to the growing public demand for transparency and accountability in politics, as well as changes in journalistic practices. The evolution from a more deferential approach to a dynamic, challenging style reflects the changing role of journalism in democratic societies.

The advent of television and digital media has significantly influenced interview dynamics. The visual aspect of television brought non-verbal communication to the forefront, making it a critical element in the perception of power dynamics. The rise of digital media and social platforms has further altered the landscape, introducing new considerations such as immediate public feedback and viral potential, which both interviewers and interviewees must navigate. The results further demonstrate that while the interviewer often initiates the power dynamic, skilled interviewees can influence and sometimes reverse these dynamics. In literary interviews, authors increasingly use the platform to articulate their perspectives, sometimes dominating the conversation. In political interviews, politicians with strong communication skills can navigate challenging questions and retain control over the interview narrative.

Future Directions

This study opens several avenues for future research. One area is the impact of digital media and changing societal norms on interview dynamics. Another area is the exploration of more nuanced aspects of power dynamics, such as the influence of gender, ethnicity, and cultural background on interview interactions. Additionally, examining the



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role of audience perception in shaping interview dynamics in the age of social media would be a valuable contribution to the field.

Limitations

The study acknowledges its limitations, particularly the potential subjectivity in interpreting power dynamics and the selection of interviews. The selection of interviews, while comprehensive, cannot cover every significant interview in history and therefore future studies could expand the range of interviews analysed and employ more diverse methodological approaches to provide a more comprehensive understanding of the topic.

CONCLUSIONS

This research paper has provided a comprehensive analysis of the historical evolution of power dynamics in literary and political interviews. The study revealed distinct shifts in the nature of these interactions, reflecting broader societal and media changes over time. Literary interviews have evolved from a focus on personal insights to more in-depth discussions of literary content and societal issues, indicating a trend towards a more balanced and interactive dynamic. In contrast, political interviews have transitioned from a formal and deferential approach to a more confrontational and challenging style, mirroring the increasing public demand for transparency and accountability in politics. The impact of media evolution, particularly television and digital platforms, has significantly influenced these dynamics, highlighting the importance of non-verbal communication and audience perception. The study also emphasized the fluidity of power negotiation, with interviewees often influencing the dynamic. This research contributes to the understanding of media and communication studies, providing insights into how interviews reflect and influence societal norms and values. It underscores the need for continued research, especially in the digital era, to understand the ongoing evolution of these dynamics.

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APPENDIX

Year	Type	Interviewee	Interviewer	Source
1936	Literary	F. Scott Fitzgerald	John K. Hutchens	Fitzgerald Archives
1954	Literary	Ernest Hemingway	George Plimpton	Paris Review Archives
1927	Literary	Virginia Woolf	Vita Sackville-West	Bloomsbury Group Archives
1963	Literary	James Baldwin	Studs Terkel	Chicago History Museum
1998	Literary	Toni Morrison	Charlie Rose	The Charlie Rose Show Archives
2011	Literary	Haruki Murakami	Jay Rubin	The New Yorker Archives
2003	Literary	Margaret Atwood	Bill Moyers	PBS Archives
1946	Literary	George Orwell	Julian Symons	BBC Radio Archive
1994	Literary	Chinua Achebe	Jerome Brooks	The Paris Review Archives
2007	Literary	J.K. Rowling	Oprah Winfrey	Harpo Productions Archives
1940	Political	Winston Churchill	Charles Eade	British Historical Society
1962	Political	John F. Kennedy	Walter Cronkite	JFK Presidential Library
1983	Political	Margaret Thatcher	Robin Day	BBC Archives
1994	Political	Nelson Mandela	Ted Koppel	ABC News Archives
2016	Political	Barack Obama	Lester Holt	NBC News Archives
2019	Political	Angela Merkel	Christiane Amanpour	CNN Archives
1977	Political	Richard Nixon	David Frost	National Archives and Records Administration
2018	Political	Vladimir Putin	Megyn Kelly	NBC News Archives
2016	Political	Hillary Clinton	Anderson Cooper	CNN Archives
2020	Political	Donald Trump	Chris Wallace	Fox News Archives





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Table 1. Summary of Literary Interviews

Year	Interviewee	Interviewer	Dominant Themes	Power Dynamics
1936	F. Scott Fitzgerald	John K. Hutchens	Personal Life	Interviewer-Led
1954	Ernest Hemingway	George Plimpton	Personal Opinions	Balanced
1927	Virginia Woolf	Vita Sackville-West	Personal Life, Inspirations	Interviewer-Led
1963	James Baldwin	Studs Terkel	Societal, Racial Issues	Balanced
1998	Toni Morrison	Charlie Rose	Literary Themes, Social Issues	Balanced
2011	Haruki Murakami	Jay Rubin	Writing Process	Balanced, Interactive
2003	Margaret Atwood	Bill Moyers	Literary Themes, Feminism	Critical, Balanced
1946	George Orwell	Julian Symons	Political Views	Confrontational
1994	Chinua Achebe	Jerome Brooks	Post-colonial Literature	Author-Led
2007	J.K. Rowling	Oprah Winfrey	Writing Process, Fantasy Genre	Facilitative

Table 2. Summary of Political Interviews

Year	Interviewee	Interviewer	Key Topics	Power Dynamics
1940	Winston Churchill	Charles Eade	Wartime Policies, Leadership	Interviewee-Led
1962	John F. Kennedy	Walter Cronkite	Policy Clarification, Cold War	Balanced
1983	Margaret Thatcher	Robin Day	Political Philosophy, Economy	Confrontational
1994	Nelson Mandela	Ted Koppel	Apartheid, National Reconciliation	Balanced
2016	Barack Obama	Lester Holt	Policy Impact, Presidency	Balanced, Challenging
2019	Angela Merkel	Christiane Amanpour	European Politics, Migration	Direct, Balanced
1977	Richard Nixon	David Frost	Watergate Scandal	Challenging
2018	Vladimir Putin	Megyn Kelly	International Relations, Domestic Policies	Confrontational
2016	Hillary Clinton	Anderson Cooper	Election Campaign, Policies	Balanced, Challenging
2020	Donald Trump	Chris Wallace	Pandemic Response, Administration	Fluctuating





Transhumanism in William Gibson's *Monalisa Overdrive*

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Transhumanism is a philosophical movement which is designed to reform the future of humanity through advanced technology. William Gibson's *Sprawl* trilogy sets in near future after World War III, controlled by corporates and technologies. It displays contemporary issues rather than a dystopian future. *Monalisa Overdrive* (1988), is the concluding one to Gibson's trilogy. It contains three different plots, knitted into a technological thriller with a futuristic climax. The hyper technological future of Gibson offers his subjects a chance to reformulate themselves with power and opportunity but does not wipe out their complete sense of loss and homelessness. The aim of this paper is to analyse William Gibson's *Monalisa Overdrive* in a transhumanist view, which seeks to ameliorate human life or condition with an advanced technological perspective.

Keywords: Transhumanism, technology, cyborg, machine, bio-soft.

INTRODUCTION

William Gibson is a well acclaimed writer of cyberpunk genre. Even though he wrote his technological plots before three decades, still it is pertinent in our present scenario. *The Ministry for the Future's* author Kim Stanley says, "William Gibson is the writer who taught the world that science fiction is the realism of our time, and it's his books that made that true. A crucial figure in our cultural history, a poet with good eye for pattern recognition". Gibson's tales contribute a lot to the field of imagination and thinking. He creates a futuristic urban complex named *Sprawl* which pictures a ubiquitous world of technology. Based on this technological world, he wrote *Sprawl* trilogy comprising *Neuromancer*, *Count Zero* and *Monalisa Overdrive*. It is populated with console cowboys, corporates,





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cyborgs and futuristic artists. His characters openheartedly welcome the technological settings and easily merge with it. They use this scientific advancement to escape from their distressing or disturbing life experiences.

William Gibson's *Monalisa Overdrive* is another master piece and the concluding text of his pioneering Sprawl trilogy, which sets a bench mark in science fiction writing. The story happens eight years after *Count Zero* and fifteen years after *Neuromancer*. It has four different plots, weaved beautifully altogether, with a convincing end. First plot deals with Angie Mitchell a cyber space celebrity, who had a biochip in her brain implanted by her father. This manipulation gives her an ability to access into the cyberspace and to communicate with AI voo do gods. But Angie's addiction to drugs impeded her from this ability as she is unaware about the complicated plan of Tessier-Ashpool clan to assassinate her by substituting Mona. Second plot focuses on Kumiko a twelve-year-old Japanese girl and a daughter of Yakuza Leader. She was sent to London in-order to keep her safe from the gang war between her father and the other Yakuza Leaders. Kumiko's father gave her a cyber guardian named Collins who accompanied her to London. And there she was taken care of by Sally Shears. Third plot follows Mona a sixteen-year-old girl who is stuck in between drug addiction and prostitution. She resembled to the Simstim superstar Angie Mitchell. Hence, Mona becomes a scape goat in the abduction plan. She is intended to be killed so as to provide bodily evidences in order to protect the Simstim star. Fourth plot is about Slick Henry who suffers from memory lapses due to Korsakov's syndrome and takes care of comatose body of Count Zero or Bobby Newmark.

Transhumanism or "evolutionary humanism" was first defined by the biologist Julian Huxley in his book of essays *New Bottles for New Wine* (1957). It focuses on the human enhancement through technologies. It is a process of ameliorating human through technology. Technologies do not take the human body away but they make the body more empowered or attenuated. Transhumanism is a paradigm shift regarding the notion of human's traits, their developments and their coming times. Scholars like Marvin Minsky, Hans Moravec and Raymond Kurzweil are the major pioneers of this philosophical movement. Max More and Nick Bostrom are the philosophers, who provide an intellectual and philosophical meaning to transhumanism. Transhumanism is defined as "an interdisciplinary approach to understanding and evaluating the opportunities for enhancing the human condition and the human organism opened up by the advancement of technology" (Bostrom 493). It also encourages new applications of technologies for overcoming "the limits imposed by our biological and genetical heritage" (More4). It blurs the borderline line between machine and human beings.

The aim of this paper is to analyse the life of humans in *Monalisa Overdrive* in the light of transhumanism. The advancement of technology is evident in the lives of Mona Lisa, Angela Mitchell, Kumiko and Shally Shear which enhanced their existence to another level which resembles utopian or dystopian ideal for the future of humanism. First transformation is seen in Mona, a young girl of sixteen, whose life changes from a prostitute to a cyber celebrity or a simstim star. She lives with Eddy a pimp, who mistreats her if she complains about her life or disobey his commands. He takes all her money and explores the possible means to sexually abuse her. Mona becomes a part of a kidnapping plot made by Tessier- Ashpool clan due to her look like with simstim star Angela Mitchell. But this resemblance is not enough for the kidnappers, hence they make Mona to undergo a plastic surgery in order to look exactly like Angela. So they can execute their complicate plot to assassinate Mona by substituting her in the place of Angela. Here, Mona's body becomes an example of technophilic body. A technophilic body "...transformations can be divided into two distinct categories. The first category is composed of techniques and technologies that are used for various *aesthetic* manipulations of the body surface. These include cosmetically redesigned faces, muscle grafts and animal \or human transplants that effectively blur visual cues for gender and human or non- human differentiation. The second category is directed to fundamental *functional* alteration to the human body's organic architecture" (Thomas131). By this aesthetic manipulation, not only Mona gets a chance to escape from the abusive life but also she reboots her life as an actress. In Mona's case, the technological advancement that happened in her life was not with here consent but the output changes her life from hell to Heaven.

Simstim star Angela Mitchell, is the daughter of a dead scientist Chris Mitchell. He embedded a biochip in her brain when she was young. It helps her to jack into cyberspace without using any devices. Because of this chip, she is not





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only able to interact with the cyber deities but also she can identify her artistic talent. When *Monalisa Overdrive* opens after seven years of *Count Zero*, Angela becomes a famous simstim star by replacing Tally Isham. The fame and the infrequent arrival of deity's voices in her head, makes her addicted to drugs. It helps her to suppress the voices in her head and the traumatic memories of her father. In the background, Tessier -Ashpool clan plans to kidnap Angie. Later, she is rescued by Molly. By analysing Angie, it is clear that she was an ordinary human by birth but once a technological alteration done in her brain, it enhances her life from a normal human to a transhuman. This advancement in her body helps to remould herself from an ordinary being to a celebrity. Max More states "Transhumanists regard human nature not as an end in itself, not as perfect, and not as having any claim on our allegiance. Rather, it is just one point along an evolutionary path way and we can learn to reshape our own nature in ways we deem desirable and valuable. By thoughtfully, carefully, and yet boldly applying technology to ourselves, we can become something no longer accurately described as human- we can become posthuman" (More 4).

Kumiko is a thirteen-year-old, daughter of a Yakuza Leader. Her father sent her to London due to the outburst of war between the corporates and gifted her a device for her security. At a touch, it projects a hologram of a man named Collins. He is the cyber guardian of Kumiko who protects her from all mishaps. He is a knowledgeable AI, who can easily access to local computers and information systems. Kumiko can reprogram him in many ways in order to make him more functional. In "Beyond Human Boundaries" Sayyed Ali Mirenayat discusses Bostrom's three major capacities of posthuman: health span, cognition and emotion. "Health span is one of the posthuman capacities to stay completely healthy, active and useful both bodily and intellectually. Cognition includes mental capacities such as memory, empirical thinking and attention. Third is emotion to enjoy life and to reflect properly on life conditions and others" (Mirenayat 268). Collins neatly fits in to the three posthuman capacities drawn by Bostrom. Collins actively stays with Kumiko and tells her to hide in Swain's office where they plan about Angie's kidnap. When Kumiko lost her mother, it throws her not only into a depressive state but also to a mode of dispatchment with her dad. In order to escape from this emotional turmoil, Kumiko relies on Collins, the prosthetic cyber companion.

Shally Shear is the most mechanized human character in Gibson's *Sprawl* trilogy and the author calls her 'Razor Girl'. She has mirrored eyes and false blades inserted under her nails in order to protect herself from the attack. The reason behind her body modification is to develop her skills as an assassin or a body guard. Before this augmentation, Shally Shear was a prostitute in a brothel. She was given a "cut-out-chip" while working, so that her conscious mind sprawls into a dream state. The result is blankness when her body is used by the clients. Gibson first introduces her in *Neuromancer* as Molly Million. In *Monalisa Overdrive* Gibson presents her as Shally Shear, an American woman who had metallic lenses instead of eyes and takes care of Kumiko in London. Shally and Swain are the planners behind the complicated plot of kidnapping the Simstim star Angela Mitchell and to assassinate and substitute her with Mona. Here Molly's transformed body gave her a new identity and power. And it is evident that how technology enhanced the life of Molly and makes her to escape the life of a "meat-puppet."

As Nietzsche said in *Thus Spoke Zarathustra* "Man is a rope, tied between beast and overman - a rope over an abyss" which means man is not seen as the final outcome of evolution rather he is an individual who can be modified or augmented to a higher level. Transhumanism is a progressive scientific process which offers a development from traditional to advanced technological community. Nick Bostrom believes that humans always seek to extend their boundaries of existence socially, geographically and intellectually in order to enhance their nature and dignity which can only acquire through advanced science and technology. This amelioration helps the individual to transform their values and goals. The transhumanistic view of Gibson's *Monalisa Overdrive* is an eye opener in the field of scientific fiction, which portrays physical, emotional and intellectual growth of human through technology. The hyper technological life in the novel gives its subjects a reformulated life and identity but still they struggle with traumatic memories.



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A Study of the Beliefs, Knowledge, Perceptions, Attitude, Views, Satisfaction and Expectations of ESP Students on Use of ICT in General and Use of Flipped Classroom Method

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

In this research article, researchers have tried to study the beliefs, knowledge, perceptions, attitude, views, satisfaction and expectations of ESP students about the use of ICT in general and use of Flipped Classroom (FC) method. In India, 'New Education Policy 2020; brings new dimensions of teaching. Blended learning is one of the dimensions and flipped classroom can be a method of implementation, so this is very important study for upcoming teaching transformations. For the respective quantitative study, researchers have selected 1,330 students from six engineering colleges in Kolhapur district, Maharashtra, India and data has been collected through questionnaire on online platform (Google form) which has been collected in Likert scale. Researchers have concluded that ESP students have positive attitude towards the ICT and FC, also learners feel that FC method would help them to build confidence and to grasp more knowledge particularly in English language and communication skills.

Keywords-ICT, FC, Learner's perception





INTRODUCTION

21st century is an age of science and technology. ICT is a part of the age and need of the globe. ICT became integral part of everyone's lives. So it became important in each and every field. Education field is also not different from other fields, so it also needs some change in approaches and methods of teaching. Even New Education Policy 2020 (India) also states about the flipped classroom. University grants commission released concept not especially on blended learning, which talks about weight age to the blended learning and it also suggest that most of the syllabus can be taught by this method. So being part of the same method, flipped classroom can be a part of regular curriculum which we can see implemented in upcoming years. Having a need of the subject researcher is working on the same as her Ph.D. topic deals with the integration and impact of flipped classroom in engineering as English for Specific Purposes.

The concept of flipped classroom was first brought up by Jonathan Bergmann and Aaron Sams in their book: Flip your classroom: Reach every student in every class every day (2012). Flipped classroom is a "pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter." (The Flipped Learning Network, 2014). This teaching method or approach is comparatively new in India as researcher can see very few like approximately seven to eight research across the country and two or three related to English language and particularly in Maharashtra, and researchers had not found many research projects related to English Language and found only one research related to Nursing field. Hence, to know learners' perception, beliefs, attitude and expectations about this method is very important for the implementation of this method.

LITERARY REVIEWS

In foreign countries, many teachers are working on effective integration of flipped classroom. However, in India, except the attempts made by IIT Bombay in their workshops viz. Pedagogy for Online and Blended Teaching-Learning Process during 2016-2019 under their programme T10TK (Train 10 thousand Teachers), there were very few national attempts made to train the teachers in effective use of ICT in higher education Choe, E. & Seong, M.-H. (2016) in their case study investigated flipped classroom in a Korean university general English course. The purpose of the study was to explore students' perceptions about the flipped classroom and to provide suggestions to inform better instructional practices. The flipped learning model was based on 'the University of Texas at Austin centre for teaching and learning. For this case study qualitative and quantitative data were collected through questionnaires filled by 80 students. 15-week course was scheduled by the university for 86 students, from them 80 students were surveyed. The researcher stated that flipped learning gives more chances to communicate in English, leads to greater participation, preparedness, and feedback, as well as it leads to deeper understanding, whereas some dissatisfactory facts were stated as more time requirement, videos can be improved and students suggest how to use the flipped classroom should be taught and some instructions are given for the same reason. An overall positive response was given by the students.

In the research article 'A Flipped Classroom: Learning Experiences in Programming', the researchers Yong, Su Ting; Tiong, Kung Ming; Chan, Andy; Khiew and Poi Sim (2021) studied the perception of programming students in the flipped classroom in Malaysia. The mix method approach was used for data analysis. For data collection quantitative survey of 204 students and qualitative interviews of 7 students were taken. In this study, association between the flipped classroom and test performance, gender and impact of programming background on the students who were attending the flipped classroom are studied. All the students attended flipped classroom module two hours weekly for ten weeks, after ten weeks two and half hour's test on MATLAB consisting twenty-five multiple-choice questions with fifty percentage weightage and other fifty percentage weightage was given to survey and interview was





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conducted. As a result, the researcher stated that most of the students still prefer face to face lectures and tutorials, females use more videos to learn but all the students prefer traditional classrooms over flipped classroom.

In the article written by Asiya Tabassum (2021), she analysed 'traditional flipping and virtual flipping comparatively' through quasi-experimental study. The researcher also tried to analyse the attitudes and perceptions of English language learners for the flipped classroom. The Researcher implemented writing skill course to the foundation programme level four students. As a sample, researcher selected 24 learners from Nizwa College of Technology, Oman which consisted of 10 female and 14 male learners and they belonged to 20 - 22 age category. The same group was used for both studies. Google meet and Canvas applications were used for the video teaching. Six videos were made by the researcher with the help of PPT and provided to the students. Data was collected through pre-test and post-test, also researcher used achievement test, IELTS rubrics, classroom observation and semi-structured interviews as instrument. The researcher analysed through independent and paired T test. As a result, researcher concluded that in both the classes, we could see significant and positive result in the performance but comparing both the classes traditional flip class was better than virtual flip class. The researcher stated some challenges of virtual class as internet issue, lack of interest in the students, lack of physical activity and lack of belongingness.

Busaya Santikarn and Saovapa Wichadee (2018) in their research investigated 'Learning Performance and Perceptions and Autonomy over Language Skills of English Language Learners About in The Flipped Classroom'. For the project 40 students were selected as samples from Advance English Class-Summer sessions. All participants voluntarily participated in the study. Questionnaires and assignments were given to participants as the method of data collection. As a result, researchers stated that 'FC helps students to achieve English skills; it makes students more accountable, more engaged in activities, and increases motivation to learn English'.

AIMS AND OBJECTIVE

To study the beliefs, knowledge, perceptions, attitude, views, and expectations of engineering students on use of ICT in general and use of flipped classroom method in particular for learning of English.

METHODOLOGY

Participants

For the said study, researchers have selected 1330 students from six engineering colleges by convenient sampling method. Researchers have taken basic information of students, on the basis of that information researchers state that in the said sample 64% male and 36% female learners have taken part, which also divides into the category of medium for HSC board, here most of the students, means 50% students are from semi-English medium, after that 31% students are from English medium and less means 19% students are from Marathi medium. Six colleges are codified as C1,C2,C3,C4,C5,C6. Most number of students are from C4, which has 37% of all students, whereas C2 has lower number of students which is 6% of students.

Instruments

For the purpose of data collection questionnaire is used, which is provided in the form on Google form, which consists of 41 questions with Likert scale. The questionnaire has answers divided in five responses as Strongly Disagree (SD), Disagree (D), Neutral (N), Agree(A), and Strongly Agree(SA). 1 to 5 numbers are given to the above responses. The questionnaire is made up of two parts as A and B. In the part 'A', personal data like name, gender, institute and medium of instruction is taken into account. In the part 'B' researchers made two parts where first part is consist of 28 questions based on general perceptions, beliefs, knowledge, attitude, views, satisfaction and expectations about ICT in general and FC method





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Data collection and analysis

The questionnaire consist of 41 questions which have tried to see the percentage of students wanted to have flipped classroom as a teaching method and their beliefs, knowledge, attitude, views, satisfaction and expectations. These all question again divided into different parts according to the hypothesis. In table number 'two' we can see that how many students believe in the concept of flipped classroom. Students of Communication skills feel that incorporation of technology in teaching learning process is very important. By incorporating technology like smartphone and internet will help students as a learning aid to get good study materials for assignment and to save more time, which also help students to feel self-reliant and active. Even most of the students are not afraid of technology and they would like to spend more time on video lessons than traditional classroom and they feel that this will help them to learn faster .In the part which was completely about flipped classroom, students has believed that they can interact with the peer which will help them to build confidence and motivate to grasp more knowledge. Researchers have concluded that these all positive responses shows that 83% of the students believe that flipped classroom can be the better teaching method to learn English Communication skills. It also helps students to be more creative with better learning experience.

After the concept of 'belief' researcher have analysed the concept 'knowledge' about the integration of ICT and FC in table number 'three'. Total four questions come under this category. A question talk about the ICT available in the institution, here 30% students feel that their institution are not providing much ICT tools. When students are asked about the ICT tools that they know, 16% are neutral about this thing, it showed that these students do not know much about it. Though they are unaware of institutional ICT tools they are well familiar with smartphone, internet and various online educational and social platforms which help them to improve their communication skills. 62% students feel that their respective teachers have combined ICT aids with traditional classroom teaching. It was found that students only know about PowerPoint presentation and overhead projector but in some colleges digital boards are used which would be very helpful to implement the flipped classroom with ease. Specifically a question also talks about the understanding of meaning and structure of flipped classroom; to the response 93% students have understood the meaning of flipped classroom technique.

Here researcher stated that students are not much aware about ICT but they are familiar with other tools which can be incorporated in teaching – learning process. From these questions we come to know that new generation of students is techno-grasp and techno-savvy. So taking help of these gadgets will be much beneficial for them to be self-reliant.

Table number four talks about the concept of 'perception' which is slightly different than 'belief', belief means what students themselves feel about something and perception is about what are they perceiving about something in general. In some questions both belief and perception can be found. In this category, researchers have asked questions about teaching method of teacher, and is that giving equal importance to the each language skill that are listening, speaking, reading and writing. 55% students feel that their teacher is giving equal importance to the English communication skills, whereas 34% students feel that their teacher are not giving equal importance to the said skills Researchers concluded that 77% of the students' perceive flipped classroom will be useful and beneficial method. Through these questions researchers suggest that yet there is a scope for the teacher to improve their teaching methodology which will be helpful for the students to get equal practice of all language learning skills. By knowing about the flipped classroom, students perceive this technique (FC) as a tool to build a self-confidence and intrinsic motivation to learn new things.

In table number 'five', researchers have analysed attitude of the students about integration of ICT and flipped classroom. 81% students feel that they did not feel nervous to learn from the educational videos and they could concentrate better and understood the topic; also many students feel that watching educational videos is not frustrating and use of it will save time.





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Researchers have concluded that students are not nervous about learning through this method and ready to watch educational video. so as conclusion students feel self-reliant and all these numbers shows that more than 70% students have positive attitude toward the flipped classroom and use of ICT as a tool of teaching.

In the table number six, researchers have analysed the views of students which basically talks about the general views like the importance of role of technology, ICT, Smartphones, internet, educational videos in the process of learning-teaching. Here students have stated that they carry their smartphone everywhere. Researchers state that most of the students are good with the new gadgets and they can handle very well, also they can use all these things for educational purpose. By analysing the data researchers conclude that in ESP students' view role of technology is very important in education and they will love to learn through flipped classroom which will eventually incorporates technology with education or teaching-learning process.

In table number seven we can see that researcher have analysed the satisfaction of students regarding ICT, which can be adapted well as a learning aid. 16 questions from the 41 questions directly or indirectly have talked about the satisfaction of the students. The satisfaction about the ICT aids provided by the institution, concentration on the video lessons and understanding of the topics, use of internet and its effect on education and help in educational purpose, preparation of the classes, active participation and teachers' teaching method. Researchers have concluded that more than 76% student are satisfied with the ICT tools and other technological help is available to them and they believe that having all these tools as a learning aid will make them creative and active learners.

Last concept analysed by researchers is expectations of students of improving communication skills with flipped classroom technique. 91% of the students have high expectations from the flipped classroom technique. Most of the students expect that recorded lessons on phone or laptop would be great materials to have, so if their teachers would convert the lecture into audio or video form that will be good for them to revise all the things again and again. Students expect that if they will learn through the FC they can interact with their classmates, this will help them to build confidence, motivate to be active in the class, it will also help to be creative and enhance English communication skills. They also feel that flipped classroom will provide them better learning experience which will generate self-autonomy among them and they can learn effectively. After analyzing all the concepts given in the aims and objective researcher have studied all the questions as a whole, table number nine shows all the responses given by the students to all the questions. Researchers state that 78% students are ready to flip classroom or they are optimistic about the flipped classroom method whereas 12% students did not want to change the methodology.

CONCLUSION

In the respective study researchers have studied different concepts like beliefs, perception, knowledge, view, satisfaction and expectation of ESP students in six different engineering colleges. For the said study researchers have selected 1330 students, and provide them 41 questions through online platform that is Google form, which analysed through Likert scale. Researchers have concluded that students have hands on knowledge of technology and ICT, they can use internet and other gadgets as learning aids, and also they are already using many applications to learning of newer thing. In the view of students many feel that they are ready to learn from new teaching approach that is flipped classroom. Most of the students believe and also they have high expectations from the approach that this approach have high potential to make them creative, active and self-reliant.

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Annexure

Total of Items
1. In the age of technology it is essential to use technology for teaching and learning.
2. It would be great if I can listen or watch recorded lessons on my smart phones/laptops.
3. I feel that I enjoy learning when technology is incorporated.
4. My institution provides me the required ICT tools for learning.
5. I think that using smart phone as a learning aid/tool is not a good idea.
6. I become nervous when I learn from educational videos.
7. I feel that getting good study materials from internet for study is difficult.
8. Watching educational videos continuously is very frustrating for me after some time.
9. Use of technology and internet in learning saves my time.
10. I am comfortable using a mobile phone as learning aid.
11. Most of the times I carry my smartphone with me in my college.
12. I love to refer online videos while doing my assignments.
13. I could concentrate better and understand the topic when watching a video lesson.
14. I feel self-reliant when I learn on my own using digital devices and internet.
15. I think that learning from online educational videos is easier for me as compared to traditional classroom learning (chalk-board/lecturing).
16. I want my English teacher to convert lessons into audio or video lessons, so that I can listen to or watch them many times.
17. Video lessons are effective in imparting communication skills.
18. I feel more active when I learn from educational videos and other digital content.
19. I am not afraid of learning on my own with the help of digital devices.
20. I am likely to spend more time for my studies when the lessons are in video format.
21. I come prepared for the classes as the details of the lessons are given to me in advance.
22. My English teacher’s method of teaching gives equal importance to all the language skills.(listening, speaking, reading, writing)
23. My English teacher combines traditional teaching with the use of ICT aids.
24. I take active part in classroom interaction.
25. I think I learn faster by watching educational videos than by using textbooks/ notes.





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26. I sincerely make an effort in understanding the lesson presented in an educational video.
27. I engage in finding new topics and often spend extra time trying to obtain more information about them through internet.
28. I generally have so much fun learning English concepts that I gladly volunteer to answers in group or discussion activities.
29. I understand the meaning and structure of flipped classroom. (Doing classwork at home and homework in the class)
30. If I will learn through the flipped classroom I can interact with my classmates, ask the topic that is not well understood, and clarify my question with the teacher.
31. I believe that flipped classroom will help me to build confidence.
32. I feel that flipped classroom will motivate me to be active in classroom.
33. I believe that flipped classroom will help me to enhance my English communication skills.
34. I would like to learn English and communication skills through flipped classroom.
35. I think that activities conducted during the flipped classroom will help me to be more creative.
36. I feel that flipped classroom method will provide me better learning experience than traditional classroom method.
37. I am motivated to learn English communication skills through flipped classroom.
38. I believe that flipped classroom will help me to grasp more knowledge/ things around me about English.
39. I will watch the educational videos given by my English teacher in advance of the lecture as a part of the flipped classroom.
40. I think the flipped classroom method is going to be more useful as the teacher will be available in the classroom during solving assignments/ doing tasks.
41. I am sure that interacting with my classmates when solving the given tasks/assignments in the classroom will help me to learn the lesson effectively.

Table 1 Profile of ESP learners

		N	Percentage
Gender	Male	855	64%
	Female	475	36%
Medium	Marathi	251	19%
	Semi English	667	50%
	English	412	31%
Colleges	C1	191	14%
	C2	83	6%
	C3	144	11%
	C4	484	37%
	C5	226	17%
	C6	202	15%





Table No. 2. Beliefs on integration of ICT according to the students

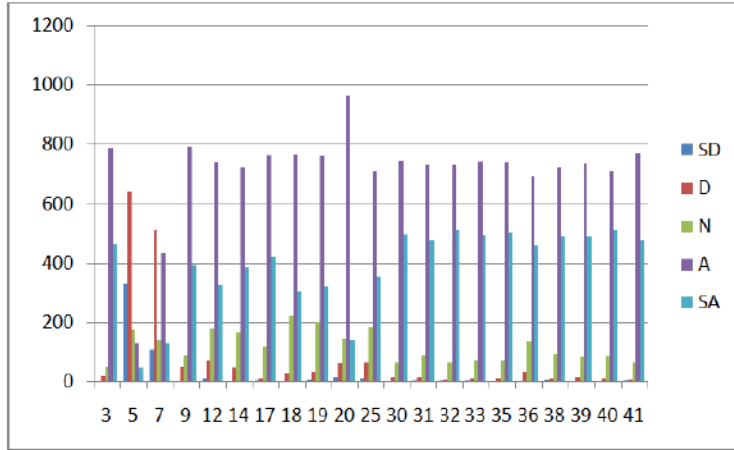


Table No. 3. Knowledge about the integration of ICT and FC

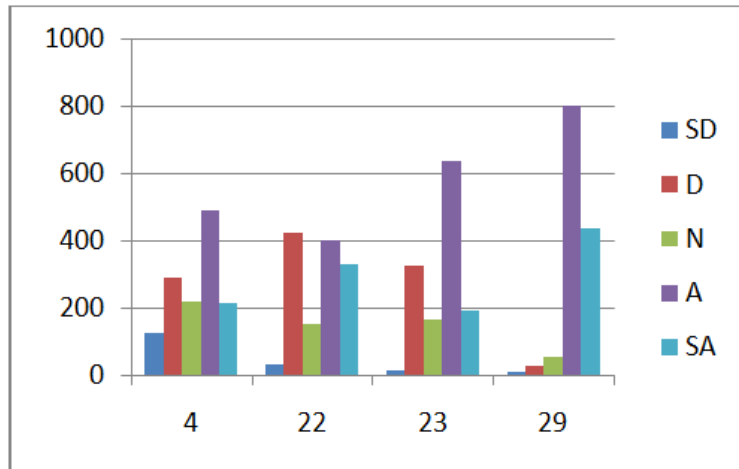
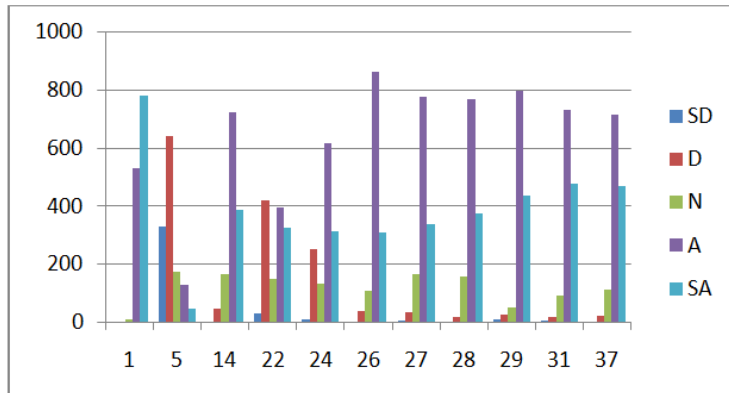


Table No. 4. Perception about the integration of ICT and FC





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Table No. 5. Attitude about the integration of ICT and FC

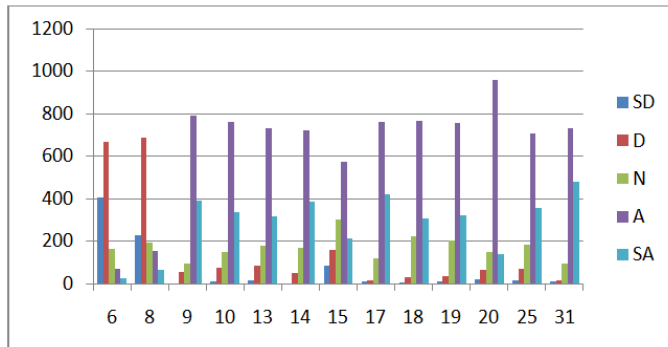


Table No. 6. Views about the integration of ICT and FC

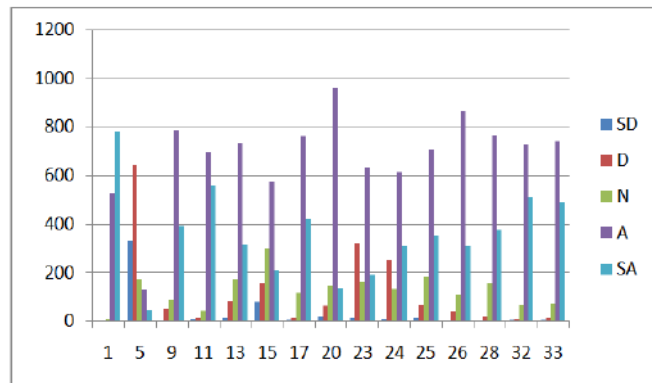


Table No. 7. Satisfaction about the integration of ICT and FC

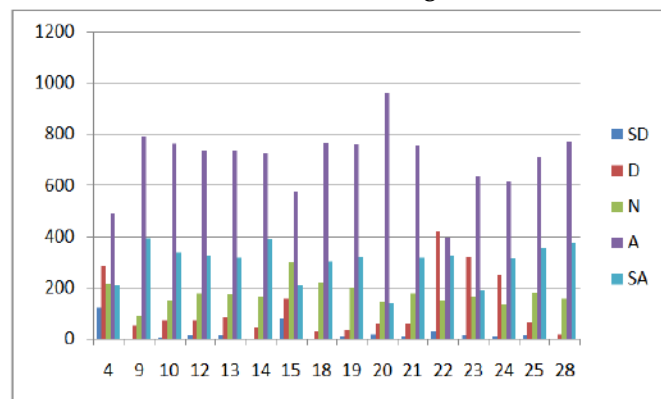




Table No. 8. Expectations about the integration of ICT and FC

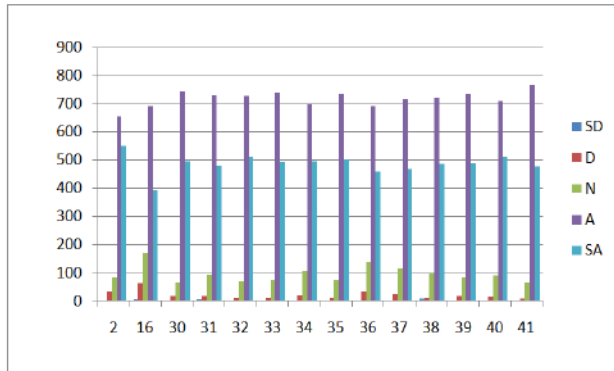


Table No 9: Responses of all students to the questionnaire

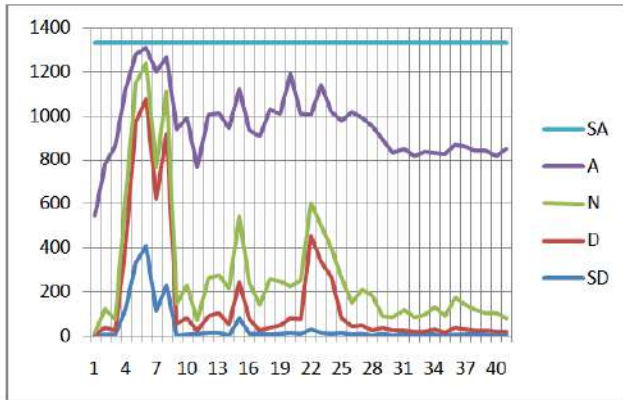
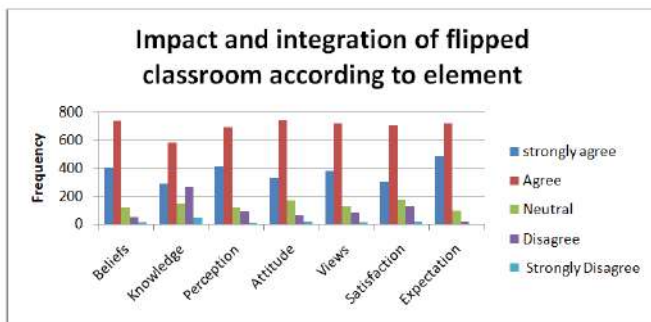


Table No 10. Response of all students to each elements





Belonging and Resilience: Themes of Identity in Selected Indian Novels

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This article seeks to conduct an extensive and comparative examination of how identity negotiation is portrayed in Indian literature, both domestically and internationally, particularly in scenarios where cultures intersect, clash, and blend. It primarily focuses on the literary works: “The White Tiger” (2008), “Water” (2006), and “The Inheritance of Loss” (2006). Each author explores identity within specific cultural contexts, addressing themes like Indian culture in foreign lands and also discusses about the Indian caste system, the varying levels of privilege among Indians, and the middle-class aspirations influencing politics and contributing to socio-cultural disparities. The complex societal framework shaped by the Indian caste system significantly influences the migrant experience, imposing constraints on their identity within society. This limitation can profoundly impact their economic well-being, thus influencing the development of their identity. The underlying premise is that protagonists, whether immigrants or locals in their homeland, aim to find a balance between economic success and cultural identity. Despite facing emotions like displacement and homelessness, the main characters in the mentioned novels succeed in forging a feeling of belonging. This accomplishment is achieved despite the presence of social, political, and cultural challenges, showcasing their resilience in challenging circumstances.

Keywords: Displacement, Rootlessness, casteism, Alienation, and Diaspora.

INTRODUCTION

This research focuses on identity crisis portrayed in Indian literature, both within the nation and in diasporic settings, as portrayed in “Water” (2006) “The Inheritance of Loss” (2006) and “The White Tiger” (2008). The choice of these novels isn't bound by a specific timeframe; instead, it is guided by investigating the themes of mobility and estrangement within and outside the borders of India. The study is finely tuned to diverse cultural and sociopolitical



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contexts, reflecting the nuanced dynamics of identity across various periods in Indian literary works. This study suggests the presence of two distinct diasporic experiences: one stems from the hierarchical caste struggles within India, leading to alienation, and the other involves physical migration. Individuals who remain in their native land often belong to ethnic minority groups, living on the outskirts of the dominant culture and grappling with challenges on its periphery. Ien Ang's assertion that aligning with the identities of "Chinese" or "Indian" shifts the individual to a symbolic space of belonging, distinct from their immediate environment, underscores the concept that these ethnic groups symbolize a feeling of absence, reaffirming a tie to a different homeland. Living in a state of exile, separated from their origins, these communities yearn for inclusion in that homeland, embodying an ongoing sense of diaspora.

In his book "Diaspora," Paul Gilroy argues that the diasporic journey isn't merely about biographical connections spanning across various locations but is moulded by diversity and characterized by contradictory feelings. This perspective validates the argument that individuals from lower Indian castes persistently exist in a diasporic state, even within the boundaries of their nation. Their narratives unveil a pervasive sense of alienation, mirroring their exclusion from the social fabric of their hometowns. These characters endure a form of dual marginalization, both within their caste and in the dominant societal group.

People who migrate to the West experience what this research terms a "double diaspora." This combined encounter transcends ethnic and national borders, resulting in individuals who identify concurrently as both Indian and American. Their country of origin evolves into an adopted nation, while the newly adopted homeland, America, amplifies their feeling of alienation. This intricate form of diaspora is marked by numerous dualities, encapsulating the complex interplay of identities as these individuals navigate the junctures of ethnicity and nationality in their pursuit of belonging.

Diaspora, essentially, captures the intricate experience of individuals or communities dispersed from their original homeland. It entails a sense of displacement, often propelled by historical, social, or economic factors. Diasporic communities wrestle with a complex interplay of identities, navigating the tensions between their native and adopted cultures. The concept extends beyond mere geographical relocation, encompassing a wider range of cultural, social, and psychological dimensions. It mirrors an ongoing negotiation of belonging, frequently characterized by ambivalence, as individuals strive to maintain ties with their roots while adapting to the challenges of their new environments. In this dynamic process, diaspora serves as a perspective through which one can comprehend the varied and evolving nature of human migration and cultural assimilation.

In today's world, diaspora has become a defining element of our interconnected and globalized society. Advancements in communication, transportation, and international relations have accelerated this trend, leading individuals and communities to increasingly move across borders in search of varied opportunities and experiences. This modern diaspora is distinguished by a diverse blend of cultural, economic, and social interactions, as individuals maintain intricate ties to their homelands while also navigating the complexities of their adopted societies. The digital era has further streamlined transnational connections, enabling diasporic communities to preserve and evolve their cultural identities in virtual realms. Within this framework, diaspora transcends mere physical relocation to encompass a dynamic process, fostering hybrid identities and challenging conventional notions of belonging. The contemporary diasporic journey involves a continual negotiation of multiple allegiances, reflecting the intricate interplay between global dynamics and individual aspirations.

The term "Indian diaspora" broadly refers to individuals who migrate, whether it's across the international borders of India or within the states and territories that constitute the Republic of India. With its twenty-nine states and eight union territories, India is a diverse nation where people may embark on journeys that take them beyond their familiar surroundings, traversing various states and territories. Interestingly, this internal migration can evoke a sense of foreignness, despite individuals remaining within the confines of national borders. The concept of



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foreignness goes beyond residing in a country outside of one's homeland; it also includes the sense of alienation felt within the familiar confines of one's own country and among different regions within the same nation.

In "The White Tiger," diasporic elements are depicted through the character Balam, the protagonist, who embarks on a journey from the outskirts of Delhi to ultimately becoming a wealthy businessman in Bangalore. The story intricately weaves diasporic themes, revealing the protagonist's evolving perceptions of location and self.

The novel "Water" portrays a diasporic voyage, particularly through the stories of characters such as Chuyia and other widows hailing from different regions and states. Left abandoned and restricted to a widows' ashram—a sanctuary for widows—these women are compelled to spend the remainder of their lives in penance. In describing Cohen's perspective on "Diaspora", which associates diaspora with collective trauma and a sense of displacement, the characters in "Water" encapsulate the bittersweet contradiction of yearning for a home they've departed from while enduring a state of exile. Cohen's assertion regarding diaspora, which incorporates both ethnic and cultural dimensions of identity, resonates with Hall's viewpoint on the dynamic and multinational nature inherent in diasporic experiences. In this context, diaspora serves as a framework through which we not only explore shared ethnic traits but also acknowledge the recognition of differences and diversity within the complex fabric of identity.

The Indian caste system significantly contributes to sustaining discrimination, leading to the marginalization and social exclusion of individuals. Caste, an intrinsic trait determined by birth, supersedes individual beliefs and establishes a rigid social hierarchy that divides Hindus into hierarchical groups. The four primary categories, with Brahmins occupying the highest position, enforce strict boundaries and customs. Brahmins, considered intellectuals, abstain from consuming food or beverages from lower castes and restrict marriage within their own caste. In rural communities, a significant divide persists between upper and lower castes, resulting in the denial of rights and social exclusion for the latter. Members of lower castes face stringent limitations, including being barred from accessing areas occupied by higher castes, resulting in complete isolation as a consequence of their inferior status in the caste hierarchy.

The dominance of the upper castes, alongside the historical legacies of the caste and colonial systems, has shaped a societal structure characterized by privilege and deprivation among Indian individuals. Within this framework, socially constructed values are deeply entrenched as accepted norms, perpetuating the hegemonic influence of the upper castes. Consequently, the less privileged and lower castes face victimization, encountering discriminatory treatment based on perceived notions of being "unclean" or "polluting" by higher caste communities. The oppressive nature of this dynamic fosters a deep-seated identity dilemma among the marginalized, as they contend with the repercussions of societal prejudices on their self-perception.

The theme of diaspora is prominently seen in Bapsi Sidhwa's "Water" and Aravind Adiga's "The White Tiger," where characters grapple with profound sensations of solitude. This sense of isolation is rooted in external factors, particularly the oppressive caste system and cultural hierarchies, which leave a lasting impact on the characters' inner selves. Balam, marginalized and mocked by the upper class society, and Chuyia, encountering dual marginalization as a woman and a widow in the Indian colonial era, experience estrangement and displacement within their native land. This extends beyond simple social discrimination; it constitutes an assault on their humanity, as they are characterized by their caste and branded as impure or pariahs, leading to a twofold marginalization that impacts numerous widows like Chuyia and lower-class individuals like Balam across India. As Safran observes, they are minorities within the borders of their nation.

Gabriel Sheffer's idea of "ethnonational diaspora" echoes the experiences of Chuyia and Balam, exemplifying dispersed ethnic communities living away from their native lands to preserve unique identities amidst the complexities of cultural, social, economic, and political hurdles. The characters in Kiran Desai's "The Inheritance of Loss" embody diasporic stories, grappling with displacement and establishing new homes while maintaining connections to distinct historical contexts. According to James Clifford, diasporas are dispersed communities united



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by shared encounters of dispossession, displacement, and adaptation, with diasporic narratives portraying the endeavor to endure and maintain identities in unfamiliar territories.

The Indian diaspora, with its transnational attributes, exhibits cultural diversity marked by differences in religion, language, and social hierarchy. Within the diaspora, communities frequently emerge around linguistic or regional affiliations, such as those of Punjabi or Bengali origin. Jen Ang emphasizes the broad and dynamically evolving essence of diasporas, defining them as socio-cultural entities that forge imagined communities upheld by ties to a native homeland. Furthermore, diasporas arise from migration, although not all migration nurtures diasporic awareness. Cultural pluralism profoundly shapes the development of identity in individuals' lives, particularly in a diverse and multifaceted country like India. With its myriad cultures, traditions, religions, languages, and customs, people frequently traverse various borders—geographical, cultural, political, or economic—both within the nation and beyond in pursuit of improved prospects, adding layers to the intricacies of the diasporic journey (Chang, 2010). Chang underscores that crossing borders not only results in racial hybridity but also cultural hybridity, intertwining culture and race in intricate ways (Young, 28). Individuals navigating diverse cultural paths, whether within or across borders, may find themselves vulnerable to different forms of displacement, encountering physical or psychological struggles as they negotiate hybrid identities to acclimate to new cultural environments.

Edward Said's observation regarding borders as both protective barriers and potential confinements strikes a chord, highlighting the struggles faced by individuals in exile, whether within their homeland or abroad, as they grapple with physical or psychological challenges stemming from social exclusion. Diasporic characters often embody marginalized and silenced voices, particularly within their homelands, as seen in figures like Balram and Chuyia. Despite feeling alienated and unheard, they engage in debates against patriarchal dominance and strive for liberation. In Kiran Desai's "The Inheritance of Loss," the profound portrayal reflects the experience of living in exile, marked by a lack of belonging, and the challenges faced by Indian immigrants in both the United States and England. Exile, in its various forms, profoundly shapes and constructs the identity of diasporic characters.

Authors who themselves hail from diasporic communities are often best equipped to capture the intricate diasporic experience. This complexity is vividly reflected in the writings of individuals who have traversed the globe, leaving behind ancestral roots and experiencing a sense of imbalance and uncertainty. Vijay Mishra highlights that the diaspora seeks to delve into the significance of hyphenated identities, often questioning the dichotomy between their origins and their present identities. Feng notes that the hyphen, often employed to define identities, serves as a symbol of displacement and the sensation of being in exile. Novels such as "The Inheritance of Loss" intricately weave the complexities of hyphenated identity into the characters' narratives, depicting the profound yearning to connect with one's roots while navigating the challenges of adapting to a new land.

The characters portrayed in these novels share a common theme of experiencing some form of exile, whether within their homeland or abroad. Balram, the protagonist in "The White Tiger," undergoes a profound transformation of his moral principles by separating himself from his village. This choice arises from a desire to liberate oneself from the entrenched moral standards and societal pressures imposed by the patriarchal caste system. Similarly, Chuyia in "Water" confronts the cruel stigma of being deemed impure or polluted within the Indian caste hierarchy, a result of societal prejudice and religious hypocrisy.

In the novel "The Inheritance of Loss," Biju arrives in America as an outsider, driven by the quest for the American dream and his own aspirations for success. However, his journey unfolds as a lifelong negotiation of the complex dynamics between his adopted home and his native land. Moments of uncertainty, periods of despondency, and an enduring longing for India define his experience. His sense of exile and isolation intensifies due to the absence and loss of family members. Jemubhai Papatlal Patel, also known as the Judge, bears the haunting recollection of leaving India for London, vividly remembering the segregated benches labeled as "Indians Only" and "Europeans Only." This encounter leaves him feeling powerless and shapes a life characterized by solitude and estrangement.



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Aspects such as race, religion, the caste system, and societal taboos play crucial roles in shaping the ethnic identity of these characters within the framework of redefining Indian diasporic identities. The overarching theme revolves around displacement, encapsulating a deep sense of isolation and the painful struggle to express one's innermost emotions. After delving into the intricacies of displacement and alienation within discussions of the diaspora, with a particular emphasis on the diversity present within ethnic minority communities, this study aims to raise important inquiries. It begins an inquiry into whether the encounters of lower caste Indians can be deemed diasporic even within their homeland, and if so, how this viewpoint contrasts with the diasporic journey of Indian women. Moreover, the research scrutinizes the potential for a dual diaspora resulting from migration. A key question is posed regarding how the encounters of non-hybrid Indians might be interpreted distinctively compared to individuals with hyphenated identities. The objective of this study is to offer deep understandings into the intricacies of identity challenges, aiming to construct a theoretical framework. Through reinterpreting notions like 'alienation,' 'belonging,' 'diaspora,' and 'displacement,' the study aims to provide new insights into these concepts and encourage nuanced reevaluation.

The study rigorously analyzes diverse facets of the Indian diaspora, spanning from experiences within the native land to those among migrants settling in the West, as depicted in three novels: "The White Tiger" (2008), "Water" (2006), and "The Inheritance of Loss" (2006). Characters journeying to the West confront a twofold experience of alienation, navigating the intricacies of belonging to minority cultures in both contexts. Despite the obstacles, this diasporic journey offers individuals a chance to redefine their cultural identity without the weight of their parental or ethnic heritage.

Conversely, characters within the homeland often experience double marginalization. The novels explore particular cultural settings, investigating the Indian community's dynamics in the United States, the significance of Brahmins within the Indian caste hierarchy, the diverse privileges among Indian individuals, and the influence of middle-class aspirations on socio-cultural disparities. The study seeks to illuminate two crucial elements within the complex social framework dominated by the Indian caste system. Firstly, it will investigate the intricate cultural and social limitations contributing to feelings of alienation within the native land. Secondly, it will examine the journeys of migrants, emphasizing the restrictions imposed by traditional societal norms in their home country that shape the development of their identities. Despite grappling with feelings of alienation, displacement, and rootlessness, the protagonists in these novels remarkably cultivate a sense of belonging, whether within the comforting familiarity of their homeland or amidst the unfamiliar terrain of the West. This resilience is evident despite the significant social, political, and cultural challenges they confront.

Dual Marginalization of Widows in Bapsi Sidhwa's *Water*

The novel named "Water," written by "Bapsi Sidhwa" she tries to project the image of women being marginalized twice. The novel delves into an examination of the religious customs and oppressive societal norms imposed upon Hindu widows, exploring a narrative that delves into self-formation and the coexistence of its characters. Against the backdrop of Gandhi's Freedom Movement, the narrative focuses on a cohort of women sentenced by Hindu law to reside in an ashram solely due to their widowhood. The protagonist, Chuyia, faces the compounded obstacles of initial marginalization as a woman followed by further marginalization as a widow. Societal expectations dictate that widows are forbidden from remarrying or experiencing love, emphasizing the necessity to maintain chastity. Chuyia's ritual head shaving after widowhood symbolizes the surrender of their lives to repentance, as dictated by the norms of that era.

In this context, widows find themselves in a paradoxical situation where they are expected to uphold chastity, yet some are objectified to satisfy the sexual needs of others. The dominance of religion in this narrative underscores a clear bias towards privileging transcendence over convergence and favoring men over women. Brahmin men, while deeming widows inauspicious and a societal curse, paradoxically exploit the sexual vulnerability of young widows for their own gratification. This ironic paradox highlights the exploitation of a widow's sexuality to suit the



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convenience of a patriarchal society, shedding light on the inherent injustices perpetuated by societal norms and religious practices.

Marginalization in Aravind Adiga's *The White Tiger*.

In his novel 'The White Tiger,' Aravind Adiga, a diasporic writer, explores the complexities of a changing Indian society, depicting how different facets of the social structure navigate diverse cultural interactions. As previously noted, cross-cultural experiences often entail engagements among individuals from distinct nations, religions, or global regions. Given India's rich mosaic of diverse civilizations spanning numerous states, cultures, religions, and languages, such encounters are inherent to its essence. Balram, originating from humble beginnings, embarks on a symbolic journey from adversity to prosperity, representing his shift from destitution to wealth. The author illustrates a stark divide in Indian society: the impoverished lower class embodies struggle and familial duties, contrasting with the affluent upper class characterized by corruption and nepotism. Similar to marginalized characters like Chuyia, Balram defies not only the oppressive caste system but also redefines his future by confronting societal and economic conventions in India. On viewing through the lens of diaspora, the character undergoes a significant transformation, raising questions such as transitioning from "Who are you?" to "What can you become?" Balram, originally a village boy, rises from a chauffeur to a successful businessman, striving to ascend the societal hierarchy. This progression emphasizes that success is not solely determined by one's origins, but rather by how individuals navigate and position themselves within the changing dynamics of their current environment.

Loss of Self Identity in Kiran Desai's *The Inheritance of Loss*

Examining the concept of Diaspora culture reveals two major themes: the quest for identity and self-discovery among diasporic immigrants. In the novel "The Inheritance of Loss," Jemubhai Popatlal Patel travels to London in 1939 to study law. Despite occupying a privileged position in Indian society, Jemubhai grapples with cultural adaptation in London, experiencing insecurity and inferiority when faced with individuals of white skin. This colonial dynamic highlights the intricate relationship between the colonized and the colonizer, as they navigate the boundaries between the Self and the Other.

Jemubhai grapples with inner turmoil, experiencing a sense of marginalization and discomfort due to his skin color. Her efforts to emulate the Other demonstrate a dual awareness, pushing back against her inherent Self. In search of an escape, he embraces European customs and culture upon returning to India, torn between his past and present, the memories of his time abroad, and his everyday life in Kalimpong. This act of imitation results in his isolation and alienation, leading to ridicule from fellow Indians. Biju, the cook's son, ventures to the US to pursue his dream but faces racial discrimination and solitude. As an undocumented immigrant, he enters the country's borders and wrestles with integrating into Western society, highlighting his struggle with identity. Many diasporic characters navigate the clash between two distinct cultures, each characterized by significant social and ideological disparities. The notion of diaspora involves being dispersed across various locations, spanning territorial, cultural, and psychological realms. These characters struggle with feelings of exile, severed communication, and a sense of not fitting in anywhere. Doubly estranged and uprooted, both psychologically and physically, characters such as Jemubhai and Biju find themselves entangled in a dual diaspora, grappling with post-traumatic stress and the intricate challenges of hybrid identity.

In examining the novels under consideration, this research asserts that the influence of caste remains potent, interwoven with post-colonialism, and the societal hierarchy continues to cast a pervasive stigma in Indian society. Lower-caste Indians experiencing diasporic journeys, as depicted in the narratives, may find their diaspora projected within the same nation, presenting a dual struggle, either under patriarchy or across borders. Characters venturing to the West encounter a twofold alienation and wrestle within the diaspora. Despite these challenges, they assert their right to American and British identities, navigating obstacles to establish themselves in new cultural landscapes. Collectively, the characters attain a sense of self-identity and worth in their pursuit of freedom. Throughout their life journeys, marked by essential facets of identity formation, they confront and surmount



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inherent pain with courage. Each novel thus explores the themes of identity and displacement, whether within or outside India. The examination of the issue of double diaspora and the unique challenges faced by minorities within the nation's space adds an intriguing dimension to the discourse.

This study aims to investigate the complexities of identity conflicts and cultural value clashes depicted among characters in Indian literature, both within their homeland and abroad. It seeks to delineate different levels of diaspora, portraying characters within India as displaced, uprooted, and devoid of a definitive sense of "home." Their concept of home is tinged with feelings of exile, stemming from experiences of exclusion by locals. Conversely, characters in the West grapple with the challenge of straddling two worlds, contending with a multitude of identities that lead to personal dilemmas. The selected novels collectively confront the trials of alienation, exile, and displacement within the framework of Indian societal norms.

This study delves into the portrayal of diasporas within and beyond India, unraveling the intricate social stratification systems that contribute to multiple forms of marginalization and oppression, particularly affecting lower castes. Women, exemplified by characters like Chuyia, endure dual marginalization—first as women and then as widows. Stranded in Ashrams with scant social support and financial security, they are dependent on charity while awaiting their uncertain fate. Characters such as Jasmine, experiencing a dual diaspora, challenge gender marginalization in India and confront societal norms by independently immigrating to the United States. Figures like Jemubhai Patel and Biju navigate the complexities of being torn between two cultures, illustrating the psychological displacement of doubly alienated diaspora in the U.K. and the U.S. Gender inequality, deeply entrenched in both biology and social hierarchy, impacts men from lower castes, subjecting them to discrimination and dehumanization. This paper explores the myriad ways in which the caste system influences Indians across diverse social, gender, and political contexts.

In summary, individuals partake in diverse intertextual processes to establish their identities and those of others in social contexts, bridging individual and societal realms. Through character expressions in Indian novels, interactions unveil personal experiences, influences, reconstructions, and submissions to the situational and structured realities they face. The theme of exile and estrangement runs throughout the novels, depicting the oppressive grip of power structures on the lives of diasporic characters. Although acknowledged as Indian minorities, they find themselves in contentious positions within the narrative of Indian national identity, yearning for acceptance and a sense of belonging. Diasporic characters, whether in their native lands or overseas, struggle with the discontent they face. India remains their birthplace, and their historical recollection of "home" becomes a conflicting realm of resistance and confinement. "Unhomeliness," distinct from mere homelessness, embodies a feeling of exile, marking their displacement and fragmentation, compelling them to construct new identities both within their home country and abroad. Within the homeland, diaspora is exemplified by characters like Chuyia in "Water," portraying the postcolonial battle against superstition. Gandhi's ideals offer the only glimpse of hope, envisioning a society that ceases to marginalize lower-caste individuals. Conversely, characters like Balram Halwai in "The White Tiger" revolt against systemic inequality, ascending the social hierarchy. "The Inheritance of Loss" exudes a pessimistic tone as characters like Jemubhai and Biju navigate the clash of Eastern and Western cultures, endeavoring to establish their identities and find a sense of belonging. Gyan resists foreign adversities to safeguard his traditional identity. The recurring themes of rejection and degradation lead to marginalization and a sense of displacement, thrusting characters into identity crises. Cultural encounters, as depicted through diasporic characters, entangle them in identity dilemmas, highlighting issues of alienation in various spheres of life, both domestically and internationally. In essence, this paper examines the intricate impacts of the caste system on Indians across social, gender, and political dimensions. It illuminates how diasporic characters navigate the complexities of dual diaspora, both at home and abroad. Each chapter showcases diverse outcomes among characters, offering insights into the multifaceted nature of identity struggles.





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Enhancing Task-Based Language Teaching (TBLT) through AI Integration: A Comprehensive Investigation Aligned with Communicative Language Teaching Principles

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This study examines how integrating artificial intelligence (AI) with task-based language teaching (TBLT), in alignment with communicative language teaching (CLT) principles, can bring transformative benefits. This study investigates how integrating AI technologies with TBLT methodologies enhances the foundational role of TBLT in language education by examining its theoretical foundations and implications. Through a comprehensive literature review, this study surveys existing studies on TBLT, CLT principles, and the integration of AI in education. This study aimed to identify intersections between TBLT, CLT principles, and AI integration, highlighting gaps and opportunities for further empirical investigation. Specifically, this paper thoroughly examines the theoretical basis for integrating AI into TBLT, establishing a strong framework to grasp better and improve its influence on language learning results. This study focuses on improving communication skills and learner engagement by highlighting the benefits of combining AI with TBLT methodologies. In addressing the challenges associated with AI integration, this paper offers practical recommendations for educators to guide them in optimizing TBLT with AI technologies. By proactively addressing these challenges and strategically integrating AI, educators can leverage the transformative power of technology to effectively and engagingly enhance language learning experiences. Furthermore, this research significantly contributes to the current discussion on innovative language teaching methods by providing valuable insights and perspectives.



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Educators, researchers, and practitioners interested in integrating AI, TBLT, and CLT principles will provide valuable research insights.

Keywords: task-based language teaching (TBLT), artificial intelligence (AI), communicative language teaching, learner-centric language learning, alignment of AI-infused TBLT with CLT principles, implications, and practices.

INTRODUCTION

Task-Based Language Teaching (TBLT) is a significant pedagogical approach in language education that emphasizes language learning through the completion of communicative tasks, such as role-plays or problem-solving activities. As it is rooted in communicative language teaching principles, TBLT fosters practical language use and situational comprehension, contributing to a learner-centered and contextually rich educational experience (Chen). Thus, this methodology has gained prominence owing to its effectiveness in developing language proficiency and real-world communication skills. As technology continues to evolve, there is growing recognition of the potential for artificial intelligence (AI) to revolutionize language education (Belda-Medina). In addition, the integration of AI into TBLT offers exciting possibilities for optimizing language learning experiences, including providing personalized feedback, adapting learning materials to individual needs, and creating dynamic interactive environments for language practice. Recognizing this potential synergy between TBLT and AI, it is crucial to delve into the implications, challenges, and benefits associated with their integration. This study aims to explore how integrating artificial intelligence (AI) in task-based language teaching (TBLT) can improve language learning outcomes, enhance educational practices, and optimize task-based language teaching methodologies. It investigates how aligning innovative technologies, specifically artificial intelligence, with communicative language teaching principles can optimize task-based language teaching (TBLT) and enhance language-learning outcomes by exploring the implications, challenges, and benefits associated with their integration. In addition to this, the importance of this investigation lies in its potential to inform educators, curriculum developers, and policymakers about the transformative possibilities that emerge when combining TBLT and AI in language education (Chen and Wang). Through this exploration, we aim to contribute to the ongoing discourse on innovative pedagogical strategies, paving the way for a more technologically enriched and learner-centric language education.

LITERATURE REVIEW

Task-Based Language Teaching (TBLT) is a dynamic and learner-centered approach to language education. Grounded in the principles of communicative language teaching, TBLT prioritizes language acquisition through the completion of meaningful and contextually relevant tasks (Bryfonski). In addition, the extensive literature supports the effectiveness of TBLT in fostering communicative competence, language proficiency, and real-world language use, leading to improved speaking fluency and intercultural communicative competence. Studies have highlighted its adaptability to diverse learning environments and its positive impact on student motivation and engagement (Belda-Medina, 723). In addition, existing literature emphasizes the transformative potential of AI technologies in educational settings, particularly regarding their integration. Within the context of language instruction, AI offers personalized learning experiences, adaptive assessments, and interactive language practice opportunities (Belda-Medina 723). In particular, individualized content delivery facilitated by AI ensures that learning materials are curated to match the unique preferences and proficiency levels of each learner. Moreover, AI's capability to create immersive language learning environments stands out, offering learners a virtual space where they can actively engage with language content and simulate real-life scenarios, thereby enhancing their linguistic proficiency. Furthermore, existing studies highlight the benefits of AI, including real-time feedback, individualized content



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delivery, and the creation of immersive language learning environments. These technologies have demonstrated efficacy in enhancing language skills, providing valuable insights into the evolving landscape of language education (Guzmán-Alcón). In addition, empirical evidence from these studies collectively demonstrates the efficacy of AI technologies in elevating language skills and contributes valuable insights to the evolving landscape of language education. As educators and institutions increasingly recognize the potential of AI, these findings underscore the importance of integrating these technologies thoughtfully and purposefully into language instruction, thereby providing opportunities for more individualized, interesting, and successful language learning experiences.

While the literature on TBLT, communicative language teaching, and AI in education is abundant, there is a noticeable gap in research that addresses the specific alignment of AI-infused TBLT with communicative language teaching principles. In particular, few studies have comprehensively explored how AI technologies can be seamlessly integrated into TBLT methodologies while maintaining fidelity to communicative language-teaching tenets (Doughty). Furthermore, the literature review highlights the need for research that bridges this gap, offering insights into the potential synergies, challenges, and instructional strategies associated with combining TBLT, AI, and communicative language teaching principles in (East). This study aims to fill this knowledge gap by investigating the practical implications, challenges, and instructional strategies related to seamlessly integrating AI technologies into TBLT methodologies.

AI Integration in TBLT

The incorporation of artificial intelligence (AI) into task-based language teaching (TBLT) signifies a groundbreaking advancement in language education with the potential to transform conventional teaching practices. It explores how AI technologies can be seamlessly integrated into TBLT methodologies while considering their alignment with communicative language teaching principles. AI integration in Task-Based Language Teaching (TBLT) involves incorporating artificial intelligence technology into language learning tasks to enhance students' learning experience. This integration aims to improve task sequencing and grading by considering learners' and teachers' perceptions of the cognitive load of tasks, ensuring that tasks are neither too difficult nor too easy for the students. By leveraging AI, educators can design tasks that align with students' cognitive abilities, leading to increased task motivation, engagement, and, ultimately, better instructional outcomes.

AI can significantly enhance the design of language tasks within a TBLT framework. Natural Language Processing (NLP) algorithms can create tasks that simulate authentic communication scenarios, thereby allowing contextually relevant, engaging, and linguistically appropriate tasks. AI can also create personalized learning paths for students by assessing their proficiency levels, learning styles, and preferences (Gurzynski-Weiss). Real-time feedback mechanisms allow AI to provide instantaneous corrections, promote immediate improvement, and reinforce language acquisition. AI can dynamically adjust task difficulty levels based on learner performance, promoting an optimal zone of proximal development (Kolsut and Szumilas). AI can also create virtual language practice partners, engage learners in simulated dialogue, and extend classrooms to real-world scenarios. Data-driven insights for task refinement enable educators to refine and improve TBLT tasks based on empirical evidence, ensuring continuous optimization aligned with communicative language-teaching principles (Leeming and Harris).

AI-infused TBLT aligns with Communicative Language Teaching Principles

Alignment between AI-infused TBLT and communicative language teaching principles is imperative for the seamless and effective integration of these methodologies. By leveraging AI technologies to enhance task design, provide personalized learning experiences, and offer real-time feedback, educators can preserve the communicative nature of language teaching, while harnessing the benefits of technology. Furthermore, this alignment ensures that AI contributes to authentic context-driven language use promoted by communicative language teaching, enhancing the overall efficacy of TBLT methodologies.





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Specific AI Technologies for TBLT Integration

1. Natural Language Processing (NLP) algorithms can analyze and understand text and speech data, facilitating tasks (He and Li) such as:

- a) Automatic speech recognition: Transcribing spoken language into text, enabling learners to focus on comprehension and fluency.
- b) Text-to-speech synthesis: Converting text into spoken audio, providing accessible language models for pronunciation and listening practice.
- c) Machine translation: Supporting learners in understanding and producing text in target languages while promoting intercultural awareness.

2. Personalized Language Learning: AI-powered systems can collect and analyze learner data to personalize the learning experience:

- a) Adaptive learning platforms: Adjust content and exercises based on learner progress, tailoring the learning path to individual needs.
- b) Intelligent tutoring systems: Provide automated feedback, guidance, and support to learners, adapting to their strengths and weaknesses.
- c) Virtual language assistants: Engage learners in interactive conversations, providing personalized language practice and feedback.

3. Interactive Language Practice: AI technologies enable interactive and engaging language practice (Liu and Hwang)

- a) Virtual reality (VR) and augmented reality (AR): Immerse learners in virtual environments, creating authentic language experiences and fostering cultural understanding.
- b) Chatbots and conversational agents: Simulate human-like interactions, allowing learners to practice conversational skills and receive feedback on their responses.
- c) Language learning apps: Gamify the learning process, using AI-driven algorithms to provide personalized content and interactive exercises.

4. Language Assessment and Feedback: AI technologies can automate language assessment and provide valuable feedback

- a) Automatic text and speech assessment: Analyze learner submissions for accuracy, fluency, and language use, providing objective measures of progress.
- b) Feedback generation: Use NLP algorithms to generate personalized feedback on learner writing and speech, identifying areas for improvement.
- c) Automated grading: Reduce workload for educators by automating the marking process, freeing up time for more meaningful interactions with learners.

Integrating AI into Task-Based Language Teaching (TBLT), aligned with Communicative Language Teaching (CLT), can be achieved using digital tools and platforms. These include language learning platforms like Duolingo, Babbel, and Rosetta Stone, Task-Based language teaching apps like Linguarena, language exchange apps like Tandem, AI chatbots like Replika, virtual reality platforms like Immerse or MondlyVR, and online language teaching platforms like Verbling or italki. These tools can enhance language learning by providing authentic communication tasks.

AI-Infused TBLT Tasks Enhance Language Learning Outcomes

The integration of artificial intelligence (AI) into task-based language teaching (TBLT) can profoundly affect language learning outcomes. Furthermore, it explored the anticipated effects of the implementation of AI-supported TBLT on language proficiency, communication skills, and learner engagement. AI-supported TBLT can enhance language proficiency by providing personalized and adaptive learning experiences, tailored content delivery, real-time feedback mechanisms, and accelerated language acquisition, leading to significant improvements in language skills. AI integration also improves communication skills by providing opportunities for authentic language use and virtual language practice partners to simulate real-world conversational scenarios (Safinah et al.) This immersive experience refines communication skills, fostering fluency and confidence in language use.



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AI's ability to create personalized learning paths promotes individualized instruction, accommodating diverse learning styles and preferences and ensuring that tasks are tailored to match the unique preferences and proficiency levels of each learner for a more effective learning experience. This adaptive nature ensures that tasks remain challenging, yet achievable, sustaining learner interest and involvement throughout the language learning journey. Continuous progress monitoring allows educators to track individual and collective advancements in language proficiency, thus enabling targeted interventions. The personalized nature of AI-supported tasks, coupled with real-time feedback, fosters a sense of autonomy as learners take ownership of their language learning journey (Loewen and Sato; Mudra; Norris; Park). This interactive and dynamic feature creates a motivational learning environment that encourages sustained effort and engagement. AI-supported TBLT offers a holistic language-learning experience by combining task-based approaches with technological innovations. This balanced and comprehensive language education experience aligns with communicative language teaching principles, which emphasize language as a tool for effective communication and practical use.

Alignment with Communicative Language Teaching Principles

AI-infused task-based language teaching (TBLT) aligns with communicative language-teaching (CLT) principles and enhances the learning process for language learners. It emphasizes communication, task-based language learning, authentic language use, a learner-centric approach, and the maintenance of a balance between fluency and accuracy (Prasetyaningrum; Ting). AI-generated tasks prioritize real-world communicative scenarios, encouraging learners to use language effectively in real-world situations (Putri). This aligns with CLT principles, as it encourages meaningful communication and the practical application of language skills.

TBLT also aligns with CLT principles by providing dynamic and contextually relevant tasks that simulate real-world language use. AI-supported tasks offer learners practical challenges, promoting language acquisition through immersion and active participation. Authentic language use is fostered by AI technologies, which create authentic language use scenarios and provide contextual exposure (Timpe-Laughlin et al.; Chen; Van Gorp and Van den Branden). This aligns with CLT principles, emphasizing language as a tool for genuine communication. Both AI-infused TBLT and CLT advocate a learner-centric approach, with AI adapting content, providing personalized feedback, and creating tailored learning paths. This approach enhances the motivation, engagement, and overall effectiveness of language instruction. AI-powered TBLT creates interactive and dynamic learning environments, fostering peer-to-peer collaborative learning. This alignment reinforces CLT principles and amplifies the effectiveness of TBLT methodologies through the integration of AI technologies, leading to more engaging and personalized language learning experiences.

Challenges and Considerations

The benefits of integrating AI into language education include personalized learning content, translation between languages, grammatical error correction, chatbot conversations, and smart language learning platforms. The integration of artificial intelligence (AI) into task-based language teaching (TBLT) presents several challenges that educators must address. Technological accessibility, data privacy, and adaptability to individual learning styles are the key issues. Challenges include the need for teacher training in the AI age, limited research on AI trends in language education, and small sample sizes in previous studies. (Di et al.). AI-enhanced language learning can provide personalized recommendations, feedback, and assessments, effectively meeting different learners' needs. AI has the potential to address issues in language education such as personalized learning systems for learners with low proficiency levels and decontextualized learning applications (Sharifuddin and Hashim).

Limited access to technology or disparities in infrastructure can hinder the equitable integration of AI into TBLT, potentially disadvantaging certain learners. Providing alternative resources or ensuring accessibility for learners with limited technological access is essential. Data privacy and security concerns arise from the collection and storage of learner data by AI systems, necessitating robust data protection measures and transparent communication regarding data usage and security protocols. Tailoring AI-infused TBLT to individual learning styles requires sophisticated algorithms and personalized feedback mechanisms, which can be challenging. Ethical considerations



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and biases are also important as AI systems may introduce biases in language content or assessments. Regular audits and efforts to eliminate this bias are crucial. Maintenance of AI technologies is challenging, especially in resource-strapped educational settings. A sustainable plan for system maintenance, including regular software updates and backups and adequate technical support through dedicated IT personnel or training programs, is essential. Balancing AI-driven tasks with human interaction is crucial, and AI-infused tasks may not be generalizable across different language proficiency levels. A nuanced approach to task design ensures relevance and effectiveness across diverse proficiency levels.

Implications for Practice and Recommendations

Artificial intelligence (AI) can significantly improve language education by enhancing teaching methodologies (Guzmán-Alcón, 88; Waluyo; Mudra;i) Educators can benefit from professional development opportunities to familiarize themselves with AI technologies and their integration into language instruction. ii) Collaborative task design can ensure that AI-supported activities align with language learning objectives and are contextually relevant. iii) Tailoring AI tools to language proficiency levels can promote effective language learning. iv) Regular monitoring and evaluation of AI-supported tasks can assess their effectiveness and promptly address any issue. v) Ethical and cultural considerations should be prioritized when selecting and implementing AI tools, addressing issues of bias, and ensuring cultural sensitivity. vi) Integrating AI-supported tasks with human interaction can provide a balanced and holistic language learning experience. The implementation of AI-infused TBLT should be flexible and accommodate different learning styles. vii) Continuous professional learning about AI advancements in language education can help educators effectively adapt their practices. By conducting regular professional development workshops on AI integration and collaborating with AI developers for task design, educators can effectively incorporate AI into TBLT, creating a dynamic, adaptive, and learner-centric language-learning environment. This integration aligns with communicative language teaching principles and leverages the transformative potential of AI to optimize language education outcomes.

CONCLUSION

The integration of artificial intelligence (AI) into task-based language teaching (TBLT) presents a transformative pathway for language education. This comprehensive exploration highlighted key findings and their implications, emphasizing the potential benefits of aligning AI-infused TBLT with communicative language teaching principles. AI-infused TBLT aligns seamlessly with CLT principles, prioritizing authentic communication, task-based language learning, and a learner-centric approach, and maintains a balance between fluency and accuracy, ensuring that language use remains authentic, relevant, and applicable to real-world communication scenarios. This alignment enhances the effectiveness of the TBLT methodologies (Alignment with Communicative Language Teaching). Aligning AI-infused TBLT with CLT principles ensures that language use remains authentic, relevant, and applicable in real-world communication scenarios. Integration supports a balanced focus on both fluency and accuracy, promoting well-rounded language proficiency development (i.e., a balanced focus on fluency and accuracy). Learners benefit from personalized learning experiences that cater to their unique needs, preferences, and proficiency levels (individualized learning experiences).

Future research could explore the long-term effects of AI-infused TBLT on language proficiency and retention, specifically examining sustained benefits over time, to understand the lasting impact of AI integration on language learning outcomes. This study explored the cross-cultural effectiveness of AI-infused TBLT by considering cultural nuances and variations in language learning preferences, which can provide valuable insights into the diverse impacts of AI integration on language education. This research direction also opens avenues for investigating the specific training requirements and readiness of language educators to integrate AI tools into TBLT while identifying effective strategies for continuous professional development. Future research could focus on developing AI-powered language-learning platforms tailored for specific contexts, integrating AI into ESL pedagogy, and creating AI-based assessment tools aligned with proficiency standards. In addition, researchers could investigate strategies to ensure



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inclusivity and accessibility in AI-infused TBLT, addressing technological disparities and diverse learner needs. Researchers can also explore the impact of AI integration on the social and emotional aspects of language learning by considering factors such as learner motivation, collaboration, and self-efficacy (Gurzynski-Weiss).

Aligning AI-infused TBLT with communicative language teaching principles holds immense promise in language education. The synergies between AI-infused TBLT and CLT principles contribute to a more dynamic, adaptive, and learner-centric language-learning environment by fostering personalized learning experiences, promoting authentic communication, and enhancing task-based language learning. As we embark on future research endeavors, understanding nuanced interactions and optimizing the integration of AI into TBLT will continue to shape the landscape of innovative language education practices.

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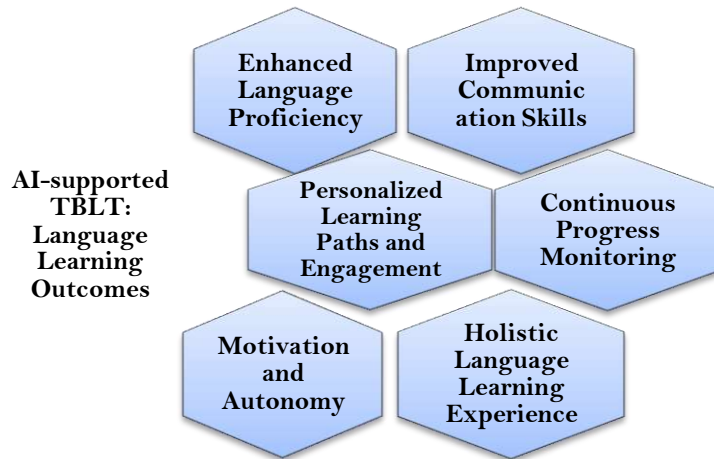


Fig 1 AI-infused TBLT tasks enhance language learning outcomes

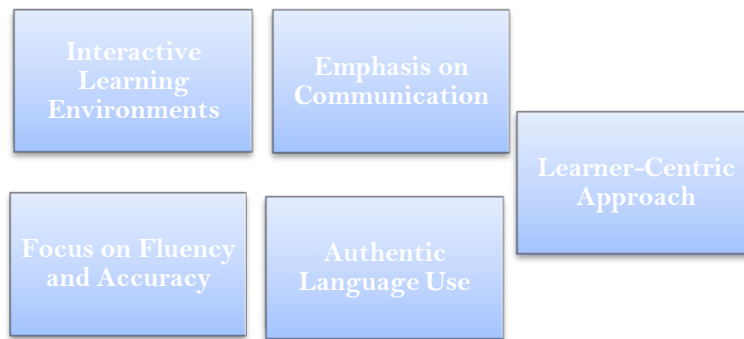


Fig 2 Alignment with Communicative Language Teaching Principles





British Policy on Language: Led to Linguistic Imperialism Or Helped Indians Globalized

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

In the middle ages, European traders established colonies and introduced their language. In the year 1600, the Parliament of England permitted the East India Company (EIC) to transact business in the Indian subcontinent. It established factories and also started English schools for the sake of children of their employees from 1600 to 1813. Then in 1835, Lord Macaulay introduced his 'Minute on Education' which favored English as medium of instruction. After observing the implementation of education, Wood's Dispatch (1854) made several recommendations which include expansion of education. Indians used English as a lingua franca during the struggle for freedom as India is a multilingual society. After attaining independence, the 'Constitution of India' is written in English. Hindi is made the official language and English, the associate official language. Since then, several committees and commissions are appointed to oversee, implement, ameliorate and make education inclusive. Further, the position of English is strengthened with the onset of liberalization, privatization and globalization (LPG) in the 1990's and also the revolution in information, communication and technology (ICT). But the status of English is leading to rapid Anglicization of Indian languages. This paper discusses under what circumstances and with what intentions the British introduced English language in India and how the colonizers language became elitist at the cost of neglecting Indian languages and the rich literature. But at the same time, it also focuses on how the Knowledge of the English language helps the graduates to get employed in the globalized society.

Keywords: multilingual, linguistic imperialism, lingua franca, globalized society



**Goverdhan****INTRODUCTION**

This paper discusses how and with what motives the British introduced English education in India. Over the years, how the English language evolved as the lingua franca of educated Indians, its role in the struggle for independence and the use of it in the independent era. Further, it also discusses the recommendations of committees and commissions that were constituted on educational policy before and after independence with reference to language policy and how the students from rural and tribal areas are placed in a disadvantaged position as against the city bred and English medium students due to linguistic imperialism and how the English knowing Indians taking advantage of globalization.

The Pre-Transportation Stage of English

History reveals that European businessmen like the Dutch, the Portuguese, the French and the English sailed to the Indian subcontinent, described as 'the gorgeous East' for its riches. And in the process of transacting business deals, they introduced their language almost four centuries ago, wherever they formed a colony. Of the four colonizers, the British politically stabilized ahead of others after the Battle of Plassey which was fought on June 23, 1757. In fact, the transporting of English language began with the Parliament of England passing the Charter Act I on 31st December, 1600 permitting the East India Company (EIC) to transact business in India. The Company, apart from establishing factories, also started English schools for the sake of children of the employees of their company and Anglo-Indians from 1600 to 1813.

After capturing Bengal, Warren Hastings (1772-1785) was appointed as the first Governor- General of Bengal. He was vested with powers in matters pertaining to education and so to curry favor of the influential Indians, started the Calcutta Madarsa in 1781, where the Islamic Law was taught. It was the first state managed educational institution under British rule in India. And in 1791, the Governor-General of Bombay, Jonathan Duncan established the Sanskrit College at Banaras to study Hindu Law and Philosophy. This college became a university in 1974, re-named as Sampurnanand Sanskrit University. The next Governor-General of Bengal, Lord Richard Wellesley (1798-1805) established Fort William College in Calcutta on 10th July, 1800. It was an academy of Oriental studies and a training center for civil servants.

In due course of time, the EIC made representation to the House of Lords of the British Parliament for the establishment of schools. As a result, it passed Charter Act I (Renewal) in 1813 and as per the Act, it was the duty of Great Britain 'to promote the interests and happiness of the native inhabitants' and permitted the Governor-General to spend one lac rupees towards education. But then, selecting a language to educate the natives of the Indian subcontinent became a matter of controversy as scholars divided into two groups. The Orientalists supported the vernacular languages like Sanskrit or Arabic or Persian and the Anglicists preferred English as medium of instruction. Some European scholars like Dr.H.H.Wilson and H.T.Prinsep advocated for oriental languages as they were critical of the Anglicists strategy which was detrimental to the local languages and culture.

But Raja Rammohan Roy, the Social reformer who fought against superstitions felt that India should be like any European country, scientifically advanced. So in 1823, he wrote to Lord Amberst, the Governor-General of Bengal against the establishment of Sanskrit school in Calcutta, wherein he stated:

'.....Again no essential benefit can be derived by the student of *Meemamsa* from knowing what it is that makes the killer of a goat sinless on pronouncing certain passages of the Vedas....'

But the Governor-General went ahead with establishing Sanskrit college in Calcutta in 1824 upon the recommendations of Lord Macaulay and James Prinsep.

ReenaChatterjee (1983) in her book *Impact of Raja Rammohan Roy on Education in India* stated:



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'Raja Rammohan Roy wanted a more liberal and enlightened system of education including mathematics, natural philosophy, chemistry, anatomy and other useful sciences to make India a scientifically advanced country just as the countries of Europe on a permanent basis.'

Further she mentioned:

'Mayhew, in *The Education of India* (1927), shifted the responsibility of the mischief done by Macaulay onto the shoulders of Raja Rammohan Roy' (Chatterjee, 1983:36-68)

Raja Rammohan Roy, a scholar in Sanskrit, Arabic and Persian was used by the British in Anglicizing urban India as part of colonial politics. In fact, Roy advocated for the study of Western education as the key to the scientific and democratic thought of the modern West. He meant to opt for English education with a condition for a certain period so that books will be translated into Indian languages.

William Bentinck who served as Governor-General of Bengal (1828 to 1834) and then as the first Governor-General of India (1834 to 1835) invited Lord Macaulay, a lawyer by profession in London, and made him a Member of Council of India. He entrusted the responsibility of preparing the blueprint of Indian Education. William Bentinck was instrumental in introducing, along with Lord Macaulay, 'Minute on Education' on February 2, 1835. The 'Minute on Education' popularly known as 'Macaulay Minute', put an end to the Orientalist and Anglicist controversy. He stated the goals of English education in India as follows:

'We must at present do our best to form a class who may be interpreters between us and the millions whom we govern—a class of persons, Indian in blood and color, but English in taste, in opinions, in morals and in intellect; to that class we leave it to redefine the vernacular dialects, to the country to enrich those dialects with terms of science borrowed from the Western nomenclature and to render them by degrees fit vehicles for conveying knowledge to the great mass of population'

Macaulay further said:

'..... I have read translations of the most celebrated works of Arabic and Sanskrit works. I have conversed both here and at home with men distinguished by their proficiency in the eastern tongues. I have never found one among them who could deny that a single shelf of a good European library was worth the native literature of India and Arabia.'

Furthermore, Macaulay stated that all the perfumes of Arabia cannot sweeten the Oriental literature. His militant Anglicism, his remarks about Indian literature and culture, his ignorance of the riches of Oriental literature and his superficial knowledge of India, his Utopianism won and English education and the English language got entrenched into the Indian subcontinent. He argued: 'English is better worth knowing than Sanskrit or Arabic.'

The Hidden Agenda

Horace Wilson, a nineteenth century Sanskrit scholar, who called Kalidasa's *Sakuntala*, the jewel of Indian literature, opposed the education policy. He stated the hidden agenda of Lord Macaulay, in his article '*Education of Natives of India*', published in *Asiatic Journal*, 1836, 29:14:

'By annihilating native literature, by sweeping away all sources of pride and pleasure in their own mental efforts by rendering a whole people dependent upon a remote and unknown country for all their ideas and for the very words in which to clothe them, we should degrade their character, depress their energies and render them incapable of aspiring to any intellectual distinction.'

About the colonial rule, Gauri Vishwanathan argues in her book, '*The Masks of Conquest*' (1990) that there are masks behind their rule such as introduction of English in India as an effective form of political control, voluntary cultural assimilation, and to improve the moral knowledge of natives and converting them to Christianity.

The Transportation Stage of English (1835-1857)





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'The Transportation stage of English' (1835-1857) is a period of expansion and consolidation. Sir Charles Woods, who was the President of the Board of Control in England, sent to India to oversee the implementation of education. This Wood's Dispatch of 1854 is considered as 'Magna Carta of Education in India', making several recommendations which include a higher position of the English language over the Indian languages. Though his recommendations were progressive and secular in nature, implementation of the same was a herculean task in a vast country like India. So, it welcomed the philanthropists to come forward to start schools and colleges. He emphasized the importance of Grants-in-Aid. It recommended, linguistically stratified system of education and the same was adopted as follows:

1. Use of mother tongue as medium of instruction during primary and high school education
2. Use of English as the medium of instruction at tertiary level

Further, it recommended the establishment of a department of education and starting of three universities in Presidency towns. Consequently, the three universities were established in Calcutta, Madras and Bombay in 1857 with English as medium of education. As per Charter Act I (Renewal) of 1853, Indians were allowed to join government jobs and an open competition system was established. Later, the Macaulay education policy paved the way for the use of English in government offices and thus the bureaucracy became very powerful and their empire further held its hold on the subjects. Even the natives started using this language to get officialese favor. And thus English got entrenched into the subcontinent so much so that we can quote an instance: As Indian students studied English literature in Indian universities, as against the British students who studied Greek and Latin in universities of England, spoke fluently and that made the British officials to exclaim:

"How come the Chatterjees and Mukherjees speak better English better than the British."
University Act of 1904

The Governor-General Lord Curzon (1898-1905) was very enthusiastic to bring educational reforms but he did not give representation to Indians in the committees. He gave grants to start new schools but there was no improvement in literacy. He appointed the University Education Commission which led to the University Act of 1904 to improve the University education. The Act empowered them to have control over university education. Further, he was responsible for issuing the Resolution of the Government of India on Educational Policy, 1913. The cardinal principles of this policy include:

- a) The curricula of the primary and secondary schools should be practical and useful.
- b) Facilities should be created for students so that they do not go abroad for further studies.
- c) The standard of existing schools should be improved instead of increasing the number of schools.
- d) It was the responsibility of the government to eradicate illiteracy and provide free education for poor children.
- e) Establishment of universities in each province.
- f) The subjects of industrial importance were to be included in the syllabi.
- g) The universities were made to issue recognition to high schools.

Role of English before and after Independence

As we know, India never had a common language, since it was not a politically unified country as it is today. Before the colonial rule of the British, Sanskrit was the common language but it was not the language of the common people but the elite. It was the link language for the educated Indians but for the British educational policy, English replaced Sanskrit. But again the same situation prevails as common people do not use English even today as a link language. Mahatma Gandhi himself stated in 1946:

"Only the language which the people of a country will themselves adopt can become national."

India being a multilingual society, English language was the lingua franca during the struggle for independence. Gandhiji and Nehruji wrote articles in English to rouse the nationalistic feelings. One way, it united all Indians to fight against the British. English, the utilitarian language has become racy. The colonizers kept language in the hands of the subjects to enlighten them but the colonized used the same language to dethrone them. As in Shakespeare's play, 'Tempest', where the banished King goes to an island and makes Caliban, the native to learn his



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language and to be his servant but the same native curses the King in his language similarly Indians were made to learn English but in the same language they questioned the British.

During the transition of power from the British to the Indians, some of the leaders wanted the Indian government to throw away the English language into the Bay of Bengal along with the British. But the then Governor-General of India, C.Rajagopalachary said:

‘English language is the gift of Goddess Saraswati to India and throwing the English language into the Bay of Bengal along with the British is like throwing the baby with the bath water.’

Speaking on the importance of this language, Jawaharlal Nehru said:

“English is the window on the world.”

The Language Policy of India

After independence again a question arose as to which language should be made national language, Hindi or English. The University Education Commission (1948-49) which was constituted after independence under the chairmanship of Dr.S.Radhakrishnan recommended the learning of Indian languages and also the study of English at the school level at least to read books in English. Further, he recommended that the medium of instruction be English at the higher education level and the study of at least three languages -the regional, the federal and English. In fact, India has a liberal language policy as it could not adopt one language policy as it is a multilingual society. It allows all cultures and languages to grow. It respects all languages equally. In North India, Hindi is widely spoken but in south India there are four states where four different languages of Dravidian origin are spoken as mother tongue and only the educated speak English. Hence, Hindi which is spoken by the majority of people, is designated as India's official language not as a national language by the Indian Constitution, which came into existence on 26th January, 1950.

It is important to know the difference between national language and official language. While the national language is used most widely in cultural, political and social areas, an official language is the language used for all government administrative purposes. And in the case of English, because of historical reasons and due to advantages of English language, we adopted English treating it as one of the Indian languages, it was made the official associate language for a period of 15 years i.e., up to 1965, during which period Hindi would be developed as the national language to take its place. But the states like Tamil Nadu opposed making Hindi a national language and ‘Hindi Hatao’ agitation under the leadership of the then Chief Minister of Tamilnadu, KarunaNidhi, resulted in amendment of Constitution whereby the Official Language Act of 1963 amended in 1967 wherein section 3 (1) deals with the continuation of English language in addition to Hindi for official purposes of the union and for use in Parliament. Hence, India will have to use English for an indefinite period or rather say forever with the changed global scenario. At the time of adoption of the Indian Constitution, there were 14, but now 22 languages are recognized as official languages, in addition to Hindi. Further, a precautionary step is taken not to impose Hindi in non-Hindi speaking states. Thus, in 1968, a resolution was passed in Parliament, it states:

‘Intensive and comprehensive programmes should be prepared and implemented by the Government of India (GOI) for accelerating the spread and development of Hindi in collaboration with the state Governments.’

The Kothari Commission was constituted in the year 1964 under the chairmanship of D.S.Kothari who recommended the three language formula whereby students in schools should learn three languages viz., the mother tongue or a regional language, the official language of the state and English. Accordingly, the National Policy Resolution (1968) notified a three language formula:

1. Hindi speaking states study Hindi, English and a modern Indian language.
2. Non-Hindi speaking states study Hindi, English and a regional language.

In order to promote Hindi and English languages, a ‘Central Institute of Hindi’ at Shimla and a ‘Central Institute of English’ (CIE) at Hyderabad were started in 1958. In 1972, the ‘Central Institute of English’ (CIE) became ‘Central





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Institute of English and Foreign Languages' (CIEFL) by offering courses in foreign languages like German, Japanese, French, Arabic, Persian and Russian. Then a student innocently raised a question four decades ago, 'Is English not a foreign language?' for which still the answer is 'eluding'. In due course of time, the CIEFL became a Central University by an Act of Parliament in 2007, rechristened as 'The English and Foreign Languages University'.

The Study Group Report on the Teaching of English (1969-71)

Several Committees and Commissions were constituted before and after independence on bringing reforms in the Indian Education system but for the first time a committee of English teachers was constituted in 1969 under the chairmanship of Prof. V.K.Gokak which studied the place of English in our education system. After two years, it tabled its report, 'The Study Group Report on the Teaching of English (1969-71)'. It examined the teaching of English in different stages, its role in school and college education, the number of periods it needs to be allotted, and its contribution in the teaching of other subjects. The Committee, among others, found the reasons like lack of Men (teachers to teach English), Materials and Methods for proper implementation of English education throughout India. Thus, there are three important functions for the right use of English:

1. English for career and mobility.
2. English for the governance and welfare of the people.
3. English for projecting our identity.

Use of English: A boon or bane

The forceful usage of colonizers' language by the natives is suggestive of subjugation of the colonized mind. This was illustrated by Daniel Defoe in his novel, 'Robinson Crusoe' (1719), which is considered to be the first novel in English. The protagonist, Crusoe categorically states why and how he taught Man Friday English:

'I was greatly delighted with my new companion and made my business to teach him everything that was proper to make him useful, handy and helpful: but especially to make him speak and understand me when spake, and he was the aptest scholar that ever was.' (Robinson Crusoe, 1719) Whatever Daniel Defoe visualized and recorded in the form of a novel is proved to be true and as Robert Philpson in his book 'Linguistic Imperialism' (1992), says:

"The English linguistic imperialism is that the dominance of English is asserted and maintained by the establishment and continuous reconstitution of structural and cultural inequalities between English and other languages". Further he says: "the structural and cultural inequalities ensure the continued allocation of more material resources to English than no other languages and benefit those who are proficient in English".

As stated by Philipson, English education is encouraged and local languages are neglected as a result the English-knowing miniscule enjoy power and fruits of learning at the cost of people hailing from rural and tribal areas. Because of the language policy of the British the oral tradition of passing on knowledge is no longer in vogue. The percentage of literacy in rural areas is not at all encouraging. Even in urban areas the percentage is not even 50%. Out of this percentage only a miniscule are English educated. Thus, the patronage to English education is ever growing and neglect of regional languages is still continuing. English: an Intellectual Language

In the nineteenth century, we have seen Indians like Toru Dutt, Henry Derozio writing poetry but in the early part of twentieth century it was novelists like Mulk Raj Anand, R.K.Narayan and Raja Rao. These novelists, who are considered the triumvirate, wrote novels in English though their mother tongue is not English. They are considered to be beginners of 'Indian Writing in English', which emerged as a separate branch from Commonwealth Literature. Raja Rao, on Indians using English stated: 'The Indians speak and write in English for communication purposes but they do not lose their identity and culture.'

Thus, it can be stated that English is our intellectual language but not an emotional language as we do not weep or laugh in English. Further, Raja Rao in the 'Foreword' to his novel, 'Kanthapura' (1937) stated:

'I use the word 'alien', yet English is not really an alien language to us. It is the language of our intellectual make-up like Sanskrit or Persian was before-but not of our- emotional make-up. We are all instinctively bilingual, many of us





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writing in our own language and in English. We cannot write like the English. We should not. We have grown to look at the large world as part of us.'

Reverence and Abhorrence

It is a boon and also a bane to accept English. We accept that English education is a blessing in disguise. We learn English, a global language, as it gives us power to interact and connect with individuals worldwide. In the Age of Information, communication skills in English are a must to get a job in the global market. On a war footing, at all levels of educational institutions, English medium is being implemented and thus the place of English in India is at a high pedestal. But at the same time, local languages are not being encouraged. So we abhor this language.

It is the skill of language that helps to market oneself in the job market and get an opportunity for mobility. As Mitchell Obama, the wife of ex-President of the US, on a visit to a school in slum area of Mumbai, told the poor children,

“Learn English, it takes you to places.”

But, for the children of the rural and tribal areas, they hardly have exposure to the English language. Even their English teacher is not well trained. Hence, their performance in competitive examinations is poor whereas the city bred and English educated are getting more job opportunities. But equally intelligent students, but from a remote rural and tribal area do not get encouragement for studies and job opportunities simply because they are not well versed in English language. This is gross injustice to the students hailing from rural and tribal areas because of language policy.

CONCLUSION

To conclude, colonialism is not just a political domination. It can be seen in many forms and one of them is the imposition of the colonialist's language on natives, which is nothing but linguistic imperialism. The colonial rule gave Indians a language to communicate with each other and others around the globe. It is a boon for us as it gives Indians new insight and new perspectives. Through English education, we got ideas of freedom and democracy. Thus, Indian nationalism and renaissance of arts and sciences is an unexpected development of British education. Further, globalization has become a boon for the English educated as there are immense job opportunities which are making them to be globalized citizens.

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Literary Stylistics – A Vibrant Linguistic Tool in Unscrambling the Covert Message in a Text – Precepts and Practice

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Literary Stylistics is a dynamic and operational research tool in unraveling the mysteries embedded in a literary text. This technical device sorts out the conspicuous details in the text through stimulating appraisal of its language. It is scientific in spirit and application. It is a fail-safe system since it adopts linguistic apparatuses for analysis. At the same time, it does have its own antagonists who challenge its use citing certain irrationalities. They maintain that the choice of linguistic items for analysis is biased since it may be tinted with one's prejudices. Nevertheless, style plays a significant role in reading the thought processes of the novelist and establishes the interconnectedness between the premise, articulation and implication in the work of art. Stylistics permits the study of the text's language from multiple facets. The two foremost dimensions are the initial response of the readers and the examination of the language elements with the assistance of linguistic principles. In order to substantiate the claims regarding the feasibility of this inquiry, archaisms in Markandaya's select novels, *Nectar in a Sieve* and *The Coffer Dams* are taken up for review. For the second kind of inquiry, structural nuances and vocabulary are the focussed categories followed by images and symbols pattern. Even characters fall within the ambit of symbols. Even irony and humour do have their due places in the hierarchy of analysis. All these analyses lead to one potent factor – decryption of the consciousness of the characters in Markandaya's chosen narratives.

Keywords: Literary, Stylistics, vocabulary images, style, symbols, irony, humour





INTRODUCTION

Among the multiple modes of interpretations of a literary text, a strategy is adopted in the scrutiny of the linguistic and tonal aspects or style with the advent of the fresh insights in the realm of the association between linguistics and literature. This system of study is the discipline known as Stylistics. Bridging the two disciplines, linguistics and literary criticism, it envisages pooling together the resources in the enlightenment of the subtleties and nuances of a text. The style of a text is studied through features like dialogue, accents, idioms, idiolects and registers. This conceptual discipline is skilfully adopted in establishing the correlation between form and effects.

LITERARY STYLISTICS – A FEW DESIGNS

As a definition, it is suffice to remember that it is a system of probing the language of literary texts through the application of linguistic concepts and categories such as identifiable language choices and patterning as linguistic foregrounding for unearthing the distinct literary meanings and implications. In spite of the claims of the veracity of this scheme with qualities associated with it such as objectivity, replicability, verifiability and thoroughness, this technique is not without its pitfalls. This approach is censured for the presence of the element of subjectivity in textual analysis. “Nevertheless, the best stylistic analyses, which productively demonstrate direct relations between prominent linguistic forms and patterns in a text and the meanings or effects of readers’ experience, are explicit in their procedures and argumentation, systematic, and testable by independent researchers.”(M. Toolan) The twenty first century has brought in its wake the newest development in literary stylistics– the investigation of an assortment of iconicity, the correlation between form and meaning, in passages in literary texts. In fact, “there is no limit beyond which the student of style is forbidden to go.” (Graham Hough, 79) Another question arises regarding the stylistic features and the linguistic features to be handled as the criteria for style analysis. M. Riffaterre and H. Babb are specific: “It is necessary to gather first of all those elements which present stylistic features and secondly, to subject to linguist analysis only those to the exclusion of all others which are stylistically irrelevant. Then and only then, will the confusion between style and language be avoided.” (412) As regards approaching the text through style, two suggestions remain obvious. In the first approach, the literary attribute of a text together with the absolute accolades it receives among the readers is the priority rather than the stylistic elements taken up for analysis. The second line of advance takes into account the study of the prominent linguistic features to correlate their causal relationship to the deep seated central principle. The concept of style is ambivalently spelt out by linguists as well as literary critics. While old school of thought, classical rhetoricians, argues it as a separation between form and meaning, the romantic school of thought puts it as an organic nature of expression. There is one more perception which construes style to be a conjectural construct between the meaning and the writer.

LITERARY STYLISTICS AND ITS APPLICATION

With these skeletal details of stylistics and its relevance in the study of a literary text, the study of Kamala Markandaya’s novels is undertaken from the perspective of style. A creative artist explores the functional resources of language for a fusion of theme and style and in this process, a deliberate choice is made of semantic and syntactic elements. In the analysis of Markandaya’s novel, three levels relating to style are taken up for inquiry to identify the consciousness of the characters. At the first level, the initial response to the novel is taken up. This diagnostic as well as decisive estimate is the pedestal of ideas on which the edifice of stylistic features is built. The ageless woe of landless farmers facing starvation are pitted against the vagaries of nature and people still retain the basic human traits of love, compassion and enjoyment of the small acts of pleasures. People grow vegetables “gazing at the paddy fields spreading rich and green...and ...beautiful...going to a village fair...buying a dum-dum cart” (*Nectar in a Sieve*, 73) Compassion is countless – Ira turning a prostitute to take care of her dying brother, Old Granny, parting with the last coin despite her own starvation and Rukmani, adopting a waif, Puli. Rukmani is the established prototype of the mother of a poor household, accepting every misfortune bravely: “No fault of yours, or the girl’s or her husband’s...it is Fate.” (66) Ira accepts her reality easily since “there is now no more fear, no more necessity for lies and concealment.” (54) Rukmani could mutter these words on seeing Ira’s albino child: “Not hers (Granny’s) not Nathan’s, not mine or Ira’s...Whose the blame then? ...Blame the wind and the rain and the sun and the earth: they





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cannot refute it, they are the culprits.” (121) The killing of her son Raja and the callous attitude of the factory officials do not provoke her: “You should not care...It does not matter.” (95) Even her husband’s infidelity does not shake her: “It is as you say a long time ago...that she is evil and powerful I know myself. Let it rest.” (90) Dr. Kenny’s goads fall on deaf ears. Rukmani is a resigned lot: “What profit to bewail that which has always been and cannot change?” (115) Kenny introduces the western attitude to life. The tannery pollutes the village ambiance by dislodging the villagers off their livelihood. The younger generation leaves the village in search of greener pastures. This is the human and social consciousness about the effect of change on a custom-bound uncontaminated countryside with rustic inhabitants accepting with an equanimity the trivial pleasures and atrocious sorrows, manmade and nature-induced, in life. Every single incident in the text forms a relationship to Rukmani. The very nature of description lends it a state of timelessness. Rukmani can be the wife of any hapless tenant farmer of a south Indian village. The characters are prototypes rather than individuals. The village itself remains unidentified to give it the hue of universality. At another level, Markandaya has a two-fold struggle in the exercise of the function of language – Rukmani’s Indian sensibility is to be delivered in English with no loss of flavour even in rumination and the dialect is to be represented in English with credibility. How the novelist achieves a solution to this conundrum is illuminated through the tertiary level analysis.

FORM AND STYLE – ARCHAISMS

The lyricizing of the story of Rukmani not only blends form and style but also solves the issue of expression of a peasant’s dialect. This is where precisely the interplay of linguistic element comes to the fore. The narrator and the narrative are kept apart with a crafty blend of poeticism, marginally formal and archaism in style. The use of archaic style in a novel has its own ideals. At the thematic level, the characters are elevated to a higher plane. With an element of antiqueness, it could lend a charm and also mark the distinction between different classes of people i.e. rustic people and urban elite. The work is accorded a ‘timeless’ and ‘space less’ eminence to make it archetypal in quality. All these merits are embedded in the novel of Markandaya, *Nectar in a Sieve*. Rukmani’s archaic language categorizes her as any representative peasant woman of ‘timeless past’ with generations of wisdom implanted in her. The theme of the novel also gets illuminated and fortified through the simplicity and directness of the archaic style – the simple rustic villagers entrenched in poverty enduring a fatalistic life. The stylistic features – syntactic, lexico-semantic, phonological and graphological – thus make it unusual and lyrical in consonance with the pastoral Indian soil bolstering the narrative’s quality of trustworthiness.

FORM AND STYLE – VOCABULARY AND SYNTAX

The vocabulary of *Nectar in a Sieve* is soft and simple. The only retort by Rukmani that could be termed as discordant and coarse is when Biswas teases her that Kenny is more than a friend to her: “...foul mouthed pig” and “...a carrion crow.” (109) In divergence, the very fabric of *The Coffer Dams* is full of offensive vocabulary with tempers running at hysterical levels. Some of the impolite and foul expressions are: “milk-sop sahib” (20), “silly buggers” (88), “you idle son of a bitch” (94), “lousy bastard” (95) and “right up your arse.” (147) Another perceptible technique in making the theme and language consonant, Markandaya uses weaker verbs in *Nectar in a Sieve* and stronger verbs are the norm in *The Coffer Dams* to be in tune with the struggle and conflict in the theme and between the characters. The examples are galore in *The Coffer Dams*: “It had savaged him...” (7) “gouged and blasted...” (8), “...suddenly the warning exploded in Clinton’s mind.” (28), “Rawlings rumbled on” (20), “...she pelted out” (25) and “...with patient tenacity, he wrested it.” (16)

The syntactic structures too play a soft pedal in *Nectar in a Sieve* which are conveniently absent or comfortably unnoticed by the readers since they are stylistically insignificant.

- To + be + past participle

“Villagers...were converging towards the bonfire to be lit there” (45-46)

Passivity is an aspect with which the novelist bequeaths his characters inaction or lack of volition. The aesthetic response to the text is greatly aided by the linguistic elements linked in the text i.e. process-type verbs and the participant roles. (S.K. Wali, 21) The study of this attribute becomes all the more interesting when it is realized that Kamala Markandaya lingers with specific structures and lexical items which communicate least volition on the





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part of the characters. Her choice seems to suggest that more a state or condition is perceptible rather than action on the part of a character.

It is true that paratactic sentences have more pauses while hypotactic sentences have more cohesion of clauses with fewer pauses: "The wedding guests departed, the throng melted." (42) Parenthesis has a similar force of slowing down the rhythm of the narrative: "...and the marriage, in the second year after Sacrabani's birth, was solemnized." (131) Sometimes, the novelist has the tendency to place the adjective after the noun, the head word, to produce the same effect: "A large building, spruce and white." (7) The mix of tenses produces a transitory lull in her thinking. This mingling of tenses coupled with generalizations becomes reflective in tone. Rukmani describes her sisters' weddings in the past tense. She shifts to present tense when talking about her own wedding and utters a sweeping statement in general: "A woman, they say, always remembers her wedding night." (8) The random exercise of 'historical present' makes the narrative intense and graphic. She laments the death of her son Raja: "For this I have given you birth, my son, that you should lie in the end at my feet with ashes in your face and coldness in your limbs." (94) As the entire narration is in the form of a sad reminiscence of Rukmani, all these linguistic details afford the novelist to render the narration as a reverie. (S.K. Wali, "Reverie Realized in Syntax....,"84)

FORM AND STYLE – IMAGES AND SYMBOLS

Literary stylistics includes images and symbols. The images and symbols do offer the reader some coherence in meaning which is consciously or unconsciously exploited by the novelist to give special associations to the principal theme or highlight certain attributes of the characters. An image is by and large defined as one that is by design espoused by the writer to stand for an object, action, feeling, thought, idea, state of mind and experience – sensory and extra sensory. (J.A. Cuddon, 316) If an image gets repeated in a work functioning as the logo of the theme, then that image becomes a symbol. Rene Welleck and Austin Warren write: "...an image...if it persistently recurs both as presentation and representation, it becomes a symbol." (189) A symbol always remains on focus and every element of the work of art, design, characters and locale, revolve around this to conjure the central premise of the work. A study of the images of Kamala Markandaya exposes the pattern of continuity throughout her novels. They portend the strategy of the novelist to suggest the psyche and makeup of the characters in the novels. One such image pattern is light and dark colour schemes. Light signifies life, hope and happiness but dark stands for disease, death, gloom, misery and frustration. For instance, the yellow light in *Nectar in a Sieve* leads Nathan and Rukmani into the temple: "...helped by the yellow flare." (144)

In some novels, characters become symbols. For instance, Srinivas in *The Nowhere Man* is a Christ figure. His religion tells men not to split or separate since each isolated part is a member of all other parts and all is one in the divine. Hence there is no need for human beings to fight among themselves on the basis of caste, creed, race or religion. He never endorses the disruptive culture: "...grids which it laid upon natural patterns...white man...and other men..." (225-226) The images and symbol patterns so far reviewed remains global in perspective. It is pertinent to recall the words of Ernest Hemingway at this juncture concerning the use of symbols in a work of art: "The dignity of movement of an iceberg is due to only one-eighth of its being above water." (Ernest Hemingway, 192) The symbols in a work of art are to be hidden for the reader to excavate it.

FORM AND STYLE - IRONY

Irony is also a component of literary stylistics. Irony plays important roles such as ripening, sustaining and repeating the several key issues in the novel. Irony varies in kinds – verbal irony, structural irony, Socratic irony, cosmic irony, romantic irony, dramatic irony and tragic irony. In order to comprehend the dexterity with which the novelist applies irony in her works, it is proposed to make a profound analysis of her classic novel, *Nectar in a Sieve*. Even here, much attention is devoted to four types of irony – structural irony, dramatic irony, tragic irony and cosmic irony and their interconnectedness. The very title of the novel and the couplet accompanying it is ironical – work without hope draws nectar in a sieve. It is true also that even with hope eventually leads to the same conclusion. (Prof.U.S. Rukhaiyar, 51) This is the irony of ironies in the novel – the theme. The theme is the narration of the life of a tenant farmer in a village tossed by every conceivable element. The vagaries of nature coupled with





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the blood sucking landlords are their woes. Floods or drought, the hapless farmer has to shell out the landlord's share and in the bargain, sell his meagre precious possessions. In addition, the burden of debt is transferred through generations multiplied several times based on the whims and fancies of the landlords. They develop a defeatist tendency and drag on irrespective of the piling misfortunes. Rukmani, the tenant farmer Nathan's wife and the central character of the novel as well as the narrator, sums up the two persistent companions of the Indian farmer – fear and hunger. About fear, she says: "Fear, constant companion of the peasant. Hunger, ever at hand to jog his elbow should he relax. Despair, ready to engulf him should he falter. Fear for the dark future, fear for the sharpness of hunger, fear for the blackness of death."(79) In most of the postcolonial novels, the English are portrayed as callous and cruel, crushing the natives to extract whatever they want. But Dr.Kenny is an exception in this novel. He is juxtaposed with the landlords who are vindictive in squeezing the tenant farmers despite the dire straits they are in with nature playing truant through famine and floods.

FORM AND STYLE - HUMOUR

Humour as a literary device could comfortably be brought within the ambit of literary stylistics. Although humour is not Markandaya's forte, there are sporadic occasions when humour rears its head. Even a very dry novel like *A Handful of Rice* with only the hunger and anger of the protagonist are in focus, the reader could discern humour in circumstances. Ravi's love at first sight with Nalini is not without its itches: "All the time he worked he had been hoping for a glimpse of her, this young beauty whose looks made a man's day as her mother's marred it." (24) When Ravi and the nephew of Apu quarrel, Ravi tells him: "I'm not a parasite." Pat comes the reply: "Something of a leech though, aren't you?" Ravi's stroll with Nalini begins with buying her ice-cold cola. "From Kolas, they went on to ice-fruit" and "The ice-fruit walks became routine." (41) When the "threesome," Ravi, Nalini and Jayamma, Nalini's mother, decide to go to the theatre as an extension perhaps of the ice-fruit walk, the efforts made by Ravi to get Nalini seated in the middle is comical: "Ravi, determined not to be beaten on every point, had engineered this after some thinly disguised shuffling, so that he did not have to ford the mother when he wanted to reach the daughter." (44)

CONCLUSION

Thus this paper has undertaken the function of Literary Stylistics in the analysis of a literary creation to unearth the hidden references which have been embedded consciously or unconsciously by the writer. There are ever two opinions on its use – positive and negative. Nevertheless, style plays a significant role in reading the thought processes of the novelist and establishes the interconnectedness between the proposition, expression and allusion in the work of art. The style of a text is approached from several perspectives. Of these, the initial response of the readers and the examination of the language elements with the assistance of linguistic principles are the two foremost tactics. In the present chapter, the first tenet analysed is archaisms in Markandaya's novels with special reference to *Nectar in a Sieve*. The study of structural nuances and vocabulary comes second. The consideration shifts to images and symbols in the next plane. Irony is the asset of the novelist in the elucidation of the principles and this forms the next level of analysis. Humour is taken up for a brief review in the final stage to show that this aspect could assist the novelist in the presentation of her ideas. Thus the theoretical outlay of Literary Stylistics is exemplified through the study of Kamala Markandaya's works.

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In Quest of Human Relationship through the Lens of Philip Roth: A Critical Analysis of *Deception: A Novel*

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Deception novel is one of the most important Jewish American postmodern novels, and critics have praised it for its experimentation with postmodernism. It looks at every kind of storytelling imaginable and the dynamic between the storyteller and the told. Philip Roth's emotional and social rebellion served as the foundation for his writing's sincerity and creative force. Philip Roth's transgression pierces limitations that are exclusive to his father's generation, much as resistance or disobedience requires moving beyond these limitations. In his work, second-generation Jewish American novelist Philip Roth presents himself as an artist and a revolutionary who exploits his gift to further his literary goals by expressing Jewish desire, aspirations, and frustration, only to face backlash, accusations, and regrets from the public. The goal of this research paper is to examine what deception means in relation to the book. In addition, it examines how the plot and dialogue are put together to determine the type of narrative Philip Roth creates.

Keywords: Deceit, Jewish, Philip Roth, Deception, imagination, biography





INTRODUCTION

The first significant ethnic literary movement to gain widespread popularity in the US is Jewish American literature. Once a widely read work, it served as a catalyst for the development of other literary subgenres, including African-American and post-colonial. The new order of Jewish-American writing has always existed on the fringe, despite its development. Its place in the annals of American literature will always be unique. One of America's best writers is Philip Roth. In 1997, he was awarded the Pulitzer Prize for his book *American Pastoral*. In addition to capturing the agonizing complexities of romantic and familial love, his works also depict Jewish bourgeois life. A few of his pieces satirically address sexual and political subjects. The theme of an idealistic, secular Jewish American who tries to keep him away from Jewish rituals and traditions is entwined with his authorship. His characters eliminate the oppressive effect of communal leaders, rabbis, fogeys, etc.

There are significant autobiographical motifs in Roth's fiction. He dramatizes post-war American life in retrospect while including elements of autobiography. In the novels, he also includes political satire and social commentary. His writings humorously and self-consciously draw parallels between the imaginary lives of the novelist Philip Roth and themselves. These include the protagonists and narrators, including Nathan Zuckerman, David Kepesh, and the made-up figure Philip. Roth's characters are isolated from the rich sources of Jewish identity and frequently resemble him. They were familiar with American culture and could even explain the rules of baseball, the nation's favorite pastime, in a few words in Yiddish and Hebrew, but not rabbinical law.

The well-known autobiographical book *Deception: A Novel* was released in 1990. A novel appears to be either a notebook or a novel that is a notebook in Roth's book. It could also be seen as mimetic drama. It can also be interpreted, in a typically self-conscious and technically postmodern way, as a lighthearted or cunning parody of the accepted conventions of narrative fiction. It is regarded as representative of the author's interest in "characteristics generally associated with postmodernist writing," according to Brauner (51). "Deception may not even be a novel – rather, it's an autobiographical narrative of a portion of Roth's life told through nearly verbatim recordings of real conversations," claims Tuerk (136). Even though the subtitle refers to "A Novel," Philip Roth's almost entirely dialogue-based book *Deception* is among his most experimental and avant-garde pieces. Roth, the protagonist of this tale, also betrays his friend. Claire Bloom, the partner, shares the same name as Roth's then-girlfriend. As Kauvar put it so succinctly: "The self as Roth envisions it and as he imagines it, flourishes in numerous forms and thrives precisely because of their competing impulses and clashing encounters, however ambivalent, however fractured, however problematic" (443). More profound existential issues regarding the definition of subjectivity, selfhood, and identity were examined by Roth.

Deception

Philip Roth demonstrates his extraordinary talent as a writer in "Deception," which explores themes of love, treachery, and the elusive nature of truth via daring experiments with narrative form. "Deception" sticks out because of its peculiar structure, which is a series of conversations between two unnamed characters who are simply called "He" and "She." By distilling the narrative to its most fundamental components, this storytelling style highlights the dialogue between the two lovers as they navigate their relationship's challenges. Roth's ability to accurately and vividly capture the intricacies of interpersonal relationships is a testament to his brilliance. Through the intimate talks between "He" and "She," Roth delves into the psychology of desire, jealousy, and deceit, emphasizing the nuances of their affair and the ensuing emotional pain. The identities of the characters are as jumbled as the storyline of the book since they cannot decide what is genuine and what is fiction. The major characters are a Polish woman, a man from the Czechoslovak Republic, two ladies, and a Jewish American novelist named Philip. According to Philip's assertions in the book, he writes *The CounterLife* in his studio and falls in love with an Englishwoman named Maria as a result of "cultural dislocation" (47) and tradition subversion. She took solace in his presence from the problems in her unhappy marriage. Although the novel doesn't mention her



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name, it is later revealed that she portrayed Maria in the movie *The CounterLife*. The dialogue is revealed to have been derived from the author's notebook notes, which include both real and imagined exchanges. When Philip's spouse discovers these conversations in her spouse's notebook and charges him of sleeping with a different woman. At this point, Philip makes a rather strange statement in which he says he has an imaginary relationship with a character he is developing for his novel. As it is, no one is sure what to believe. Therefore, the term "Deception" equally refers to Philip's deception of both his wife and the readers.

Owing to Philip Roth's removal of the first-person pronoun, onomastic recognition has become a misnomer. There's no usage of 'I'. Deception is a "novel in the style of a novelist's notebook," according to Alan Cooper, with the author "denarrating the novel into notebook entries" (241). It is revealed at the end of the text that the protagonist's book manuscripts served as inspiration for the entire work. David Brauner observes that Deception "purports to be a sequence of dialogues from one of Roth's notebooks," while Gooblar claims that "Deception reads like a writer's notebook" (119). (85). The current text is characterised in both explanations as either a novel that is thought to be a notebook or a notebook that is thought to be a novel. Although deception can be understood as a play in the mimetic sense, it can also be distinguished from malicious or purposeful manipulation of the strict guidelines of a storyline. The reader perceives deceit as usually self-aware and postmodern philosophy describes deception as such.

The postmodernist propensity to embrace narrative interpretation by "making it appear as natural or common sense" is demonstrated by the novelistic hero and the author's shared contextual and narrative parallels (Hutcheon 40). The protagonist's father is named Herman, and like Roth, he invents two fictional characters: Zuckerman and Lonoff. Parts of the book that mention Philip's stay in England are taken from a diary that author Jonathan Roth wrote while chronicling his own life. In this sense, "deception" refers to marital adultery, but it also includes other forms of deception, like fusing reality and fiction. There is dishonesty in the book's format in addition to marital deception. The author plans to trick people in a number of ways. The title "serves as a caution against the credibility of any allegedly authorial voice," according to Brauner (85). Furthermore, Shostak went on, "The epistemological betrayal that readers feel when a writer inserts autobiographical details into a fictional storey is symbolised by the erotic betrayal, and both betrayals are combined in the figure of 'deception'" (175).

The text's final section considers whether Philip, a character that seems to be based on a true event in Roth's life, is a realistic figure. The storey, "by which writers of history, fiction, or even theory render their materials coherent, continuous, unified—but always with an eye to the control and mastery of those elements," was obviously recounted by Roth in the first person (Hutcheon 62). In addition, Philip claims that Deception is a work of fiction, but his wife says that readers would consider this information to be true, as if it were written by her. "Let them decide what it is or it isn't," Philip replies, pointing out that they are so intelligent and I am so ignorant. I'm told that the fiction I write is autobiography, even though I write fiction (184). Because he sounds so much like the actual Roth, no one can be certain if Roth is speaking in his own voice, assuming the identity of a made-up character, or adopting a phoney identity under the name Philip. "The protagonist of Deception is thinly veiled Philip Roth himself, an American-Jewish novelist who resides in London for the majority of the novel's present," claims G. Neelakanta (41).

Up until 1990, British actress Bloom was the real-life partner of Philip Roth. They were eventually divorced in 1995 after getting married. In her memoirs, Bloom also states that she read Deception and changed her identity from being a British woman to that of a wife, Claire. The book is a transcription of a genuine journal that Philip Roth kept, in which he describes things that he experienced. What distinguishes it from previous books by Roth is the 'form' of Deception. The entire book consists of isolated monologues with no background information or insights. Philip and his English lover are involved in these chats, but they are not married.

Philip is talking to the two Czechoslovakian women. One of these women he had met before on a trip to Czechoslovakia, and the other was Philip's wife. After he returns from America, his wife finds a script that she believes exposes Philip's affair with another lady. She observes that the text does not contain many embarrassing passages. As to Johnson's statement, "Roth's latest work is about adultery, in a sort of speaking" (8), the plot revolves





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around the adulterous relationship between Philip and Maria. Being unfaithful and penning a novel both indicate acceptance of lying. Nothing in the process of creating art is sacred or valued when the creator consistently deceives others. Philip has a lovely charm that accentuates the captivating flow of the storey. Maria's criticisms and complaints never occur to him, and he consistently answers her, "I pay attention. I learn. I'm an ecouteur and an audiophile. Talking is a fetish of mine " (42). When Philip communicates his libidinal needs through listening, Maria is always observant enough to detect them. "It's sensual, you just sit there and listen," she comments (42). Philip is more than just a hearer. He tends to make fiction out of the things he observes. Understanding Philip better requires challenging his Jewish heritage and his compulsive fictionalisation. His complete estrangement from his Jewish background and culture led him to enter a relationship with Maria. "So our tale isn't a love storey, really— its culture storey," Maria rightly deduces (47). In England, his Jewish identity is disrespectfully forced upon him. The hateful insults spoken against him while he was a Jew in England fueled his passion for Newark, the real Zion.

With vivid and distinct possibilities, the plot would emerge in Roth's invented works. Such "blatantly fictionalising" (91), which Philip does, exposes him to criticism. His imagination is so abundant that it makes any problem seem carnivalesque. As Philip has acknowledged, I present myself as involved since mere presence is insufficient. That's not how I approach things. I can't go where I want to be by compromising some "character." I'm compromising myself, which makes things hotter. It kind of besmirches me and makes the indictment more juicy. (177-78) Furthermore, it's clear that one of the best illustrations of this is the anticipated altercation between Philip and another character, Ivan, over Olina's betrayal of Ivan. Ivan, a friend of Philip's, is a refugee and is married to Olina. Olina departs from Ivan in order to start again with a large black man. Ivan accuses Philip of betraying him and "rotten fictionalising" in the book (Philip 90). Philip's cultural displacement caused him to become more familiar with the discomforts experienced by several women. The girl from Czechoslovakia, who approaches him for help to become published, did so because she too felt uncomfortable with her cultural dislocation and disarticulation. After the Russian tanks arrived in 1968, she immigrated to the US and struggled to make ends meet by taking on jobs as a call girl, babysitter, model, and apartment decorator. All of her desires leave her feeling dissatisfied and troubled as she looks for true love.

This Polish woman was deeply interested in politics. Philip knows how miserable and agonising being lost can be for her. Philip leads her, but he also leads himself: "He tells her it's not hard to get you to blow up. or walk out. The average person's situation is ten times better than yours. Compared to the ordinary individual who stays two weeks (or longer) in a new environment, you are more vulnerable " (169). As a result, when Philip awakens, he knows and fears that, as a Jew, he is unique and out of place in English culture, and that his fate is connected to that of the larger Jewish community. Besides, he could not understand why the "two biggest scourges" (Roth 79) of the world, Israel and America, should be held accountable for sowing such discord and hatred in England. He also admits to Maria that he is having trouble assimilating: "I'm becoming a very contentious man because I'm an American Jew living in your nation. I honestly hadn't remembered about either. I moved to England after that and started attending fancy dinner parties " (84). At some point, Philip tells her straight out that he thought Christianity was overpowering in England. He would have told her how happy he was to be among the Jews in New York. Philip's Jewish features stick out in a powerful and vibrant way.

Making a Narrative

The claim that novelists and other writers generally draw inspiration for their work from their own experiences is not too controversial. Some writers write only about themselves, while others draw a great deal of inspiration from their own experiences. Some of these writers expressly write autobiographically in their works. One such writer whose works are inseparable from him is Philip Roth. The main theme of Philip Roth's whole body of work is the connection between life and literature, which is most apparent in the novels in which his alter ego Nathan Zuckerman makes appearances. Both Philip Roth's protagonist and his alter ego are represented by the character Nathan Zuckerman, who makes regular appearances in his works. Through Zuckerman, Roth explores issues of identity, desire, and the complexities of the Jewish-American experience.





Novelist Zuckerman often finds himself enmeshed in the existential and moral dilemmas that his characters confront as he grapples with the tensions that occur between life and art. Roth investigates the essence of narrative in general and the role of the writer in society via the lens of Zuckerman. In all of Roth's books, Zuckerman is a guy seeking self-awareness while navigating the turbulent post-war American landscape and dealing with personal problems. The boundaries between autobiographical and creative writing are often blurred in Philip Roth's novels, which typically combine reality and fiction. The main characters in Roth's books typically have the same professions, experiences, ages, cultural backgrounds, and origins as the writer.

Each novel is unique because the author employs a variety of strategies to increase the impact of their work. Symbols and motifs are effective devices that writers use to express a great deal of meaning in a small amount of pages. There may be underlying meanings in objects, people, themes, recurring words or phrases, and a host of other things. Scholars have carried out investigations to uncover the implicit significance of these symbols and patterns. As a result, it has long been customary in the world of literature to examine the meanings concealed behind these themes and symbols. The purpose of this chapter is to identify the narrative style and devices used by Philip Roth in his books.

Phenomenal storyteller Philip Roth skilfully wove the complex networks of stories that explored the darkest recesses of the human brain. His narrative approaches are notable for their unrelenting examination of identity, frequently obfuscating the boundaries between the real and the imagined. Through a sharp sense of reflection, Roth draws readers into the thoughts of his characters as they struggle with their wants, anxieties, and flaws. Through the use of literary devices like metafiction, stream-of-consciousness, and unreliable narration, he skilfully conveys the complexity that underlies the lives of his characters. Through narratives that pulse with an innate intensity that surpasses.

Philip and Maria play a game called "reality shift" (62) in the storey to pass the time and keep themselves busy. It involves moving to a different area and speaking from a fictional character or another's perspective afterwards. In a particular episode, Maria is shown pretending to be Philip Zuckerman's biographer and conversing with him to find out more about Zuckerman. In her capacity as a biographer, Maria gains knowledge from a discussion she had with Nathan Zuckerman regarding the life narrative of the reclusive writer E. I. Lonoff. The biographer is working on Nathan Zuckerman's life in order to get rapid cash.

In this way, Philip has attempted to draw attention to the problems that postmodern writers—especially biographers—face. It is the writer's job to tell the story of the individual self, and this young man cannot find consistency in his subject's ceaseless changes. All biographers, though, are impacted by this problem. Everyone experiences an unending change of the self; nobody chooses to go through it. "The entire game of nature is becoming somewhat else, and the punishment of remaining still is death," wrote Emerson (524).

A little scene in *Deception* does a good job of explaining Roth. Philip, a well-known American author of Jewish descent who resides in London, urges his partner to take part in "reality shifts," or the impersonation of fictional characters, as a way to resolve the problem. He says that Philip's character, Zuckerman, passes away at 44 years old and that the young biographer, who the lover is supposed to be, has already started writing Zuckerman's biography. After spending five years working on a critical biography titled *Between Worlds: The Life of E. I. Lonoff*, he thought the job would be simple and quick, but it seemed like it will be harder than he expected. The biographer's worst nightmare, that "everyone tells him a different account," is what binds him (Zuckerman 515).





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CONCLUSION

The novel's author doesn't come across as a sensible individual. The fact that the man is only seen in the distance worries the biographer about his endeavour even after extensive research. The primary focus of the writer's argument is not his upbringing in Newark, but rather the "awful ambiguity of the 'I,' the process by which a writer develops a storey of himself" (515). It should be observed that in the reality shift between Philip and his sweetheart, the problem of all the distinct personalities that arise from Zuckerman's acts is not even addressed. But this is a crucial point because Roth and Philip note that the biographer finds it hard to see how all of Zuckerman's impersonations relate to one another.

The plot revolves around the protagonists' quest for fulfillment and meaning in their relationships, which usually leads them down a confusing path riddled with conflicting emotions and moral dilemmas. The protagonists, who stay nameless and are just called "He" and "She," start a passionate, enigmatic, and longing love. But beyond the appearance of their strong friendship, there's a web of deception and self-delusion as they battle their own desires and concerns. By exploring his characters' most personal psychological domains, Roth exposes the weaknesses, anxieties, and deepest thoughts of his characters. He illustrates the nuances of human emotion and how people deal with the difficulties of love and connection via his inner monologues and private conversations.

The novel "Deception" in social interactions is just an investigation into the nature of reality and illusion. The main characters constantly struggle with telling the truth and lying to each other while trying to make sense of their objectives in the context of their circumstances. Roth urges readers to look at the sincerity of human connection in addition to considering how we construct and comprehend reality in our interactions.

The book tempts readers to try and discern reality from fiction, but this endeavour is bound to fail from the start. In the postmodernist universe, reality and the observation of these facts are inextricably linked, according to Roth. Derek Parker states that "we could end up running in circles if we indulge in the game of ferreting out 'the real' from the imagined" (88). "[Given the nature of autobiographies, it doesn't matter," he asserts (88). Because of this, the realities themselves are ambiguous, susceptible to modification, and amenable to several explanations. Because it highlights how fictitious modern life is, the storey is therefore incredibly genuine and accurate. Consequently, Roth challenges the assumptions and advances the study of how individuals shape their reality. Philip focused on the way those storey structures—which heavily rely on the imagination—play a major impact in how individuals comprehend reality.

The narrative's fragmented dialogue and structure have been enhanced by the author's metafictional observations. This actually signifies that these lines should be interpreted as part of the notebook and the early chapters. In addition, in the final chapter of the novel, the main character Philip speaks with his imagined and actual English mistresses. There are recordings of hypothetical discussions in this chat. Deception thus criticises the reader for making an effort to discern between the real and the imagined, as well as between multiple ontological levels within the narrative.

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English Language: The Need of the Hour for Engineering Graduates Employability - Students' and Employers' Voices

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

In this dynamic era, Top information technology services firms no longer assume that individuals with conventional managerial pedigrees will succeed. Hence the priority falls on soft skills in the selection process. An increasing number of job offers require speaking a second language that employers find attractive in potential hires. This article studies how language has become an employability factor in the interview selection process of engineering colleges of Kurnool, Andhra Pradesh. Hence the results revealed that the students with good language skills have a higher probability of clearing the interviews compared to the students with poor language skills. The conclusions/outcomes disclosed that the proficiency in English language is considered a significant skill set influencing employability. This study used a qualitative approach. This research used a stratified sampling method for data collection. Data was collected through semi-structured interviews with 80 final-year Engineering undergraduates (both selected and rejected) from two private Engineering colleges who appeared for campus recruitments at Kurnool in Andhra Pradesh. Six employers' perspective on the significance of language in hiring a fresher at the interview was taken through a questionnaire. The conclusions collected would be discussed in the further part of the paper.

Keywords: Employability skills, qualitative, language skills





INTRODUCTION

Amid the contemporary globalized era, the English Language has evolved into a vital resource for efficient communication across various professional domains. The ability to effectively communicate in English is notable for engineering graduates who aspire to enter the globalized job arena. This research paper aims to explore the perspectives of both students and employers regarding the impact of English language skills in promoting the employability of engineering graduates. Engineering education equips students with the technical knowledge and skills required in their specific domains. Nevertheless, the demand for engineering professionals goes beyond technical expertise. Employers increasingly prioritize the importance of soft skills, embracing communication, teamwork and adaptability. Within the range of skills proficiency in English is held in high regard as it fosters effective collaboration, illustration of ideas and interaction with heterogeneous stakeholders in multinational companies.

In the last couple of decades, Andhra Pradesh has been synonymous with an active IT sector. Now arrives the most critical aspect: employability. According to NASSCOM survey conducted in 2019 out of approximately 1.5million produced by India annually, only 250,000 secure employment. The National Employability Report for Engineers 2019 published by SHL, reveals that the employability rate for engineers in IT services companies is merely 16.25% and 3.4% for IT products. It is reported that students from Bihar, Jharkhand, Delhi, Haryana and West Bengal exhibit the highest employability in IT services roles. Odisha, Telangana, Uttarakhand and Uttar Pradesh form the next tier in employability. Chhattisgarh, Karnataka, Punjab and Rajasthan fall in the third category. Tamil Nadu, Gujarat, Andhra Pradesh, Madhya Pradesh and Maharashtra were in the bottom 25 percentile brackets. According to India's Skills reports Andhra Pradesh ranks seventh in terms of employability. To perceive the worth of English language skills from multiple perspectives, this study brings together the voices of both engineering students and employers. By considering the data collected through the questionnaires we aim to provide a comprehensive analysis of the role of English language proficiency in determining the employability of engineering graduates.

This research employed a mixed methods approach, combining quantitative surveys and qualitative interviews. A questionnaire was sent to employers from different multinational companies to gain insights into their expectations in terms of English language proficiency among job applicants and their assessment of the impact on employability. It also intends to know how integral language skill in the workplace is. Additionally, semi-structured interviews with 80 students from two Engineering colleges in the local area were conducted online aiming to determine the language skills' role in deciding their employability status.

The English Language is the combination of four crucial skills which in turn must be precisely imbibed in every interviewee. They are Listening, Speaking, Reading and Writing: if we first talk about listening skills during the interview they are essential to fully understand the interviewer's questions and instruction, so active listening demonstrates your attentiveness and helps you to provide relevant and well-thought-out responses. It can help an individual adapt her answers accordingly.

Speaking Skills help the interviewee express his/ her thoughts experiences and qualifications during the process of selection. To be confident in conveying the ideas, a graduate must make sure their speaking skill should be concise and must have appropriate language, tone and relevant style of communication so that it must match the interviewers.

Reading Skills are essential before an individual attends his interview. This skill of no doubt helps an interviewer answer any kind of questions posed by an interviewer.

Writing Skills: It is an acceptable fact that writing is the first step by which a person's attitude and ability is lucidly seen that is in terms of email writing, Resume making or so on. We are aware of how written assessments or follow-





up emails will leave a great impact on an individual's selection. Strong writing skills enable you to convey ideas concisely in fact focus must be on proper grammar and punctuation which showcase your professionalism Honing LSRW can help a graduate get through the process of an interview. Objectives which every graduate must acquire:

- ◆ Practice active listening, good eye contact avoid interruptions.
- ◆ Take so many mock interviews and seek feedback from experts
- ◆ Scan and skim for at least few minutes to improve comprehension, learn new vocabulary and reach out to industry trends
- ◆ Improve writing skills by journalizing and so on.

The findings of this study will contribute to the current and pre-existing knowledge repository by providing insight into the specific English language requirements in the engineering employment arena. The results will assist educational institutions, notably the Training and Placement team in framing English language skills building syllabus that cater for the needs of engineering students ultimately progressing their employability prospects. Eventually, this research paper aims to reinforce the call for engineering graduates to place emphasis on English language learning as a means to upgrade their employability. And also how language education can be integrated into engineering programs to bridge the gap between technical skills and industry needs.

The questionnaire used in the survey is sourced from a report titled "**English at Work: a global analysis of language skills in the workplace**". This report was conducted by Cambridge English Language Assessment which offers a detailed comparison of English Language proficiency in different countries specifically focusing on the workplace.

METHODOLOGY

Semi structured interviews were conducted with a sample of 80 students from two different Engineering colleges.

Introductory questions

Introductory questions were asked to assess candidate's communication skills, including how well they express themselves and their ability to articulate their thoughts clearly.

Ex: Can you please introduce yourself?

How would you describe your strengths and areas for development?

Follow-up questions

Follow-up questions were asked to explore the candidate's responses in more detail and gain deeper insights into their skills and experiences.

Ex: Candidate's response: "One of my strengths is adaptability."

Follow-up question: "Adaptability is valuable in our dynamic work environment. Can you share an instance where you had to adapt to a challenging situation, and how did your adaptability contribute to a successful outcome?"

Spirals and probes

Spirals and probes serve to dig deeper into the candidate's responses, which allowed to gain a more comprehensive understanding of the candidate's skills

Ex: What skills do you think are most important for this position?

Behavioral interview questions

Behavioral questions were asked in order to assess soft skills like communication, teamwork, leadership, and problem-solving, which are essential for success in many roles.

Ex: Tell me about a situation where you had to make a tough decision with limited information. How did you approach the decision-making process?





Scenario-Based Questions

These questions helped to gauge the candidate's ability to respond in English.

Ex: You are a customer service representative, and a customer is upset about a product issue. How would you handle this conversation?"

Assessment criteria employed to evaluate English language proficiency are as follows:

Fluency: The ability to speak English smoothly and without hesitations or significant pauses.

Pronunciation: The accuracy and clarity of the candidate's pronunciation in English.

Grammar and Syntax: The candidate's use of proper grammar and sentence structures in spoken English.

Vocabulary: The range and appropriateness of the candidate's vocabulary in English.

Listening and Following Instructions: Assessing the candidate's ability to listen carefully to instructions and follow them accurately in various scenarios.

Conversation Management: Evaluating how well the candidate participates in conversations, asks relevant questions, and responds appropriately to different conversational topics.

Functional Language Use: The candidate's ability to use English language skills in practical situations relevant to the job role, such as in customer interactions, presentations, or negotiations.

Appropriateness of Language: Evaluating whether the candidate uses language appropriately for the context, such as using formal language in professional settings and informal language in casual settings.

FINDINGS

From semi structured interview

English language proficiency is crucial for engineering graduates' employability:

The major finding of this study is that students who were proficient in English reported more confidence during interviews. Approximately 85% of the students who demonstrated a high level of proficiency in English language succeeded in the interviews during campus recruitment. Based on the insights gathered from semi structured interview it can be inferred that the students' English language skills play a vital role in students' success in campus recruitments and in shaping their employability.

From questionnaire

Employers' expectations and requirements:

Based on the responses received from the six employers' it is evident that the English language proficiency plays a crucial role at workplace and significantly impacts the hiring process. They prospect string English language skills as a critical asset, enabling effective communication, successful client interactions and participation in international projects. Employers' often assess candidates' language abilities during job interviews and consider them as a decisive factor in the hiring process.

Educational institutions and the role of language training:

The findings suggest that educational institutions need to address the gap between students' English language skills and employers' expectations. Institutions should incorporate comprehensive English language training programs within the engineering curriculum to equip graduates with necessary language skills for the job market. These programs should focus on developing technical vocabulary, improving oral and written communication skills and providing opportunities for real-world language practice.

Limitations

- **Sample Size:** The samples for data collection are limited to 80 students from two engineering colleges.
- **Language Domains:** Language proficiency assessments might not fully cover all language domains, such as receptive skills (listening and reading) and productive skills (writing), leading to an incomplete assessment of overall language proficiency.





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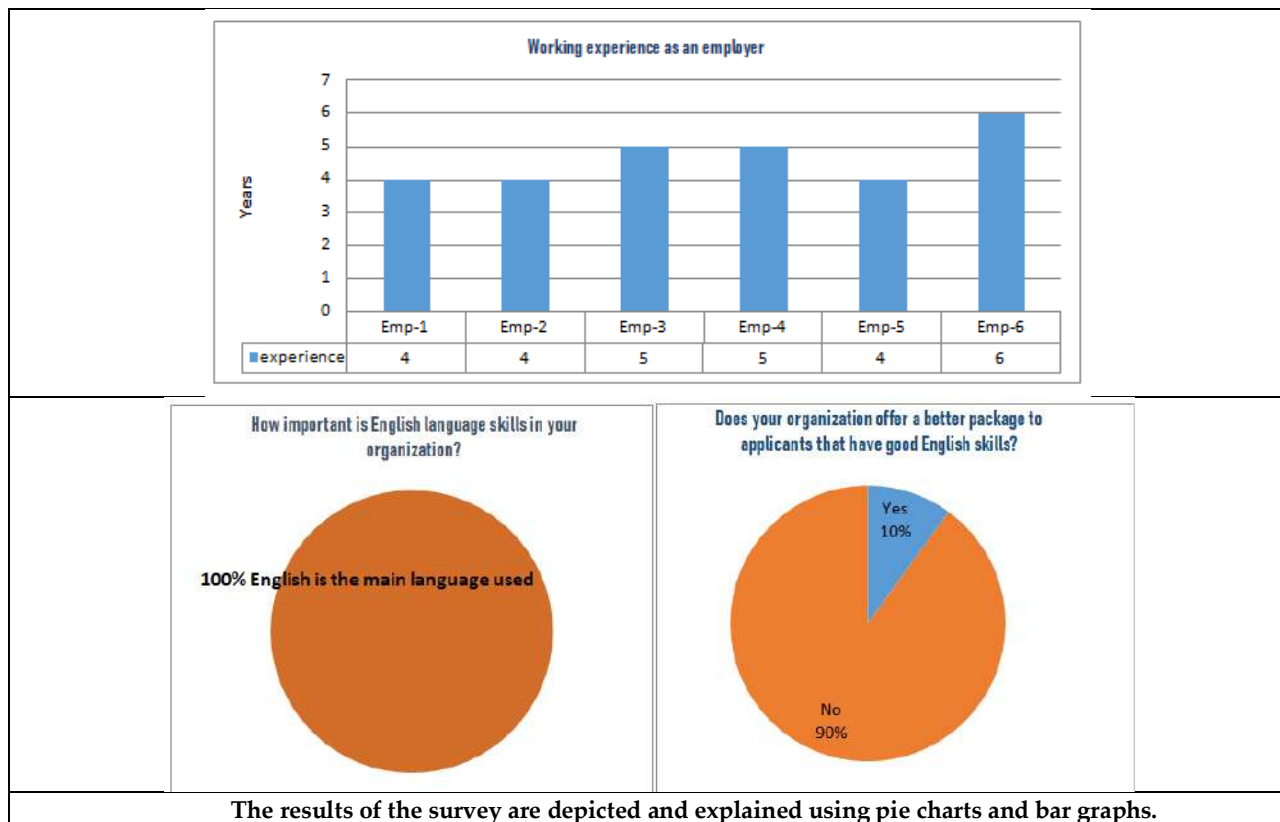
- **Limited Scope:** Mightfocus on specific aspects of language skills, such as pragmatics or cultural appropriateness
- **Sample model:** semi structured interview where the focus is only on English language proficiency

CONCLUSION

By recognizing and addressing the need for English language proficiency in engineering graduates, stakeholders can contribute to the overall success and employability of graduates in today’s globalized job market. This research provides valuable insights for future endeavors encouraging further investigation into specific language skills required in different engineering disciplines, the effectiveness of language training programs, and the impact of language proficiency on career progression and job performance.

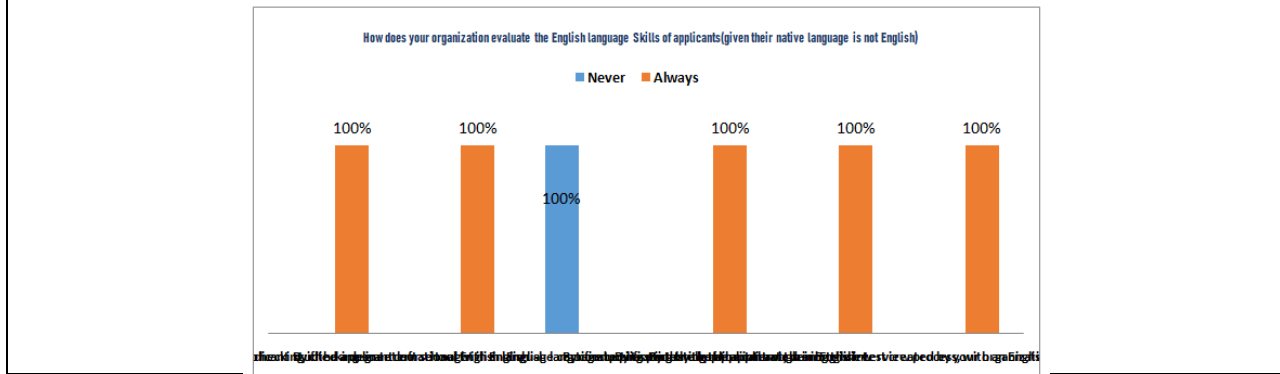
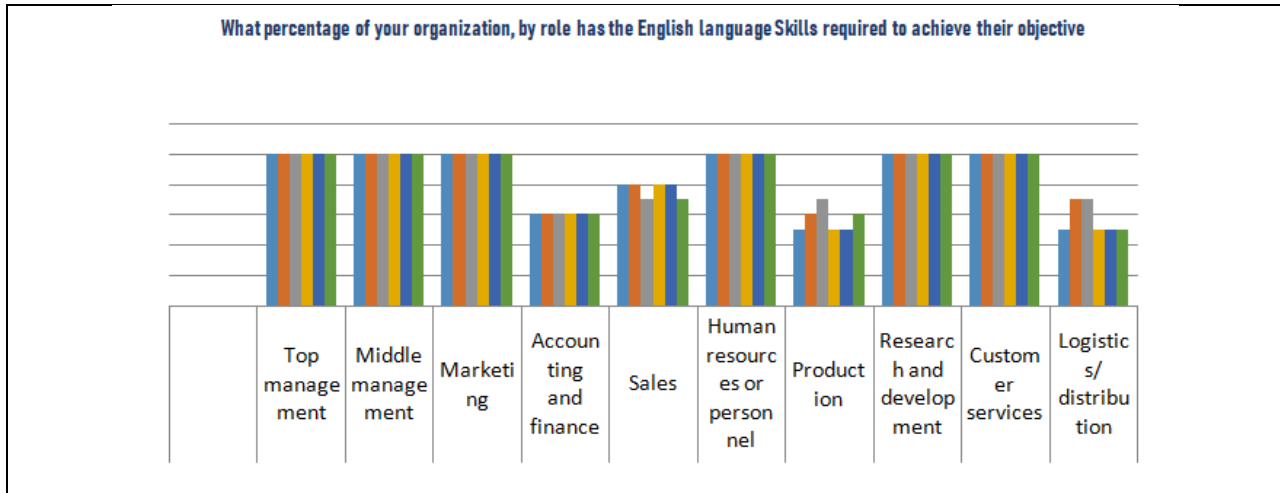
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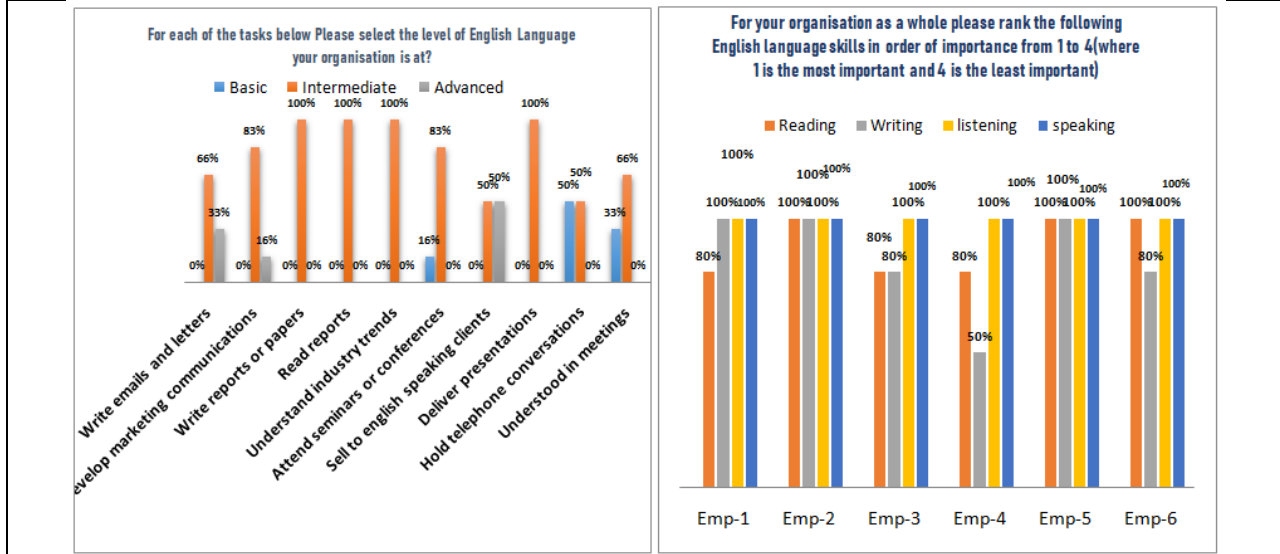


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Majority of the roles need the English language skills at work place

- ❖ Consider English language certifications
- ❖ Larger number of employers conduct interviews in English
- ❖ Assess English language through Standard English language tests during the interview.

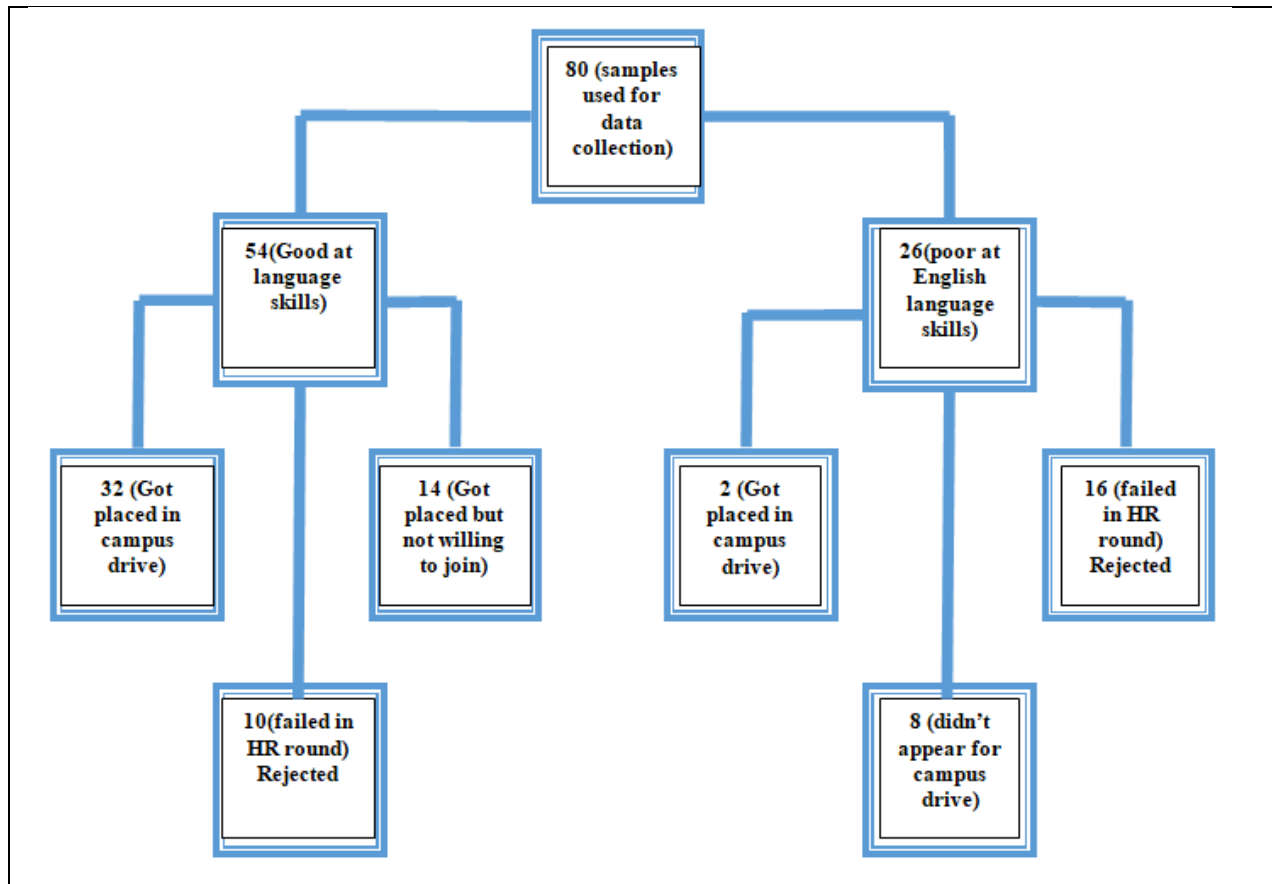


- ❖ Larger number of employers' top priorities is speaking, listening and writing.





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The Colossal Influence of Collective Unconsciousness in American Society in Stephen King's Novel *The Dead Zone*. A Study

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This paper investigates the complicated web of the collective unconsciousness rooted within the American psyche, using Carl Jung's archetypes and collective unconsciousness as a theoretical framework. Drawing inspiration from the rich and evocative narratives of renowned author Stephen King, the research seeks to illuminate the archetypal elements and collective symbols that resonate within the collective American mind. By examining King's literary work, *The Dead Zone*, the study explores how these narratives act as mirrors reflecting the deeper, shared fears, desires, and cultural motifs that pervade the American collective unconscious. Through an incorporation of Jungian theory and other textual analysis, this interdisciplinary approach bridges the realms of psychology and literature, offering a nuanced understanding of the collective unconsciousness in the context of American society, as illuminated by the dark and fantastical worlds crafted by Stephen King.

Keywords: shared fears, cultural motifs, American collective unconscious, collective symbols

INTRODUCTION

Stephen King's novels have a combination of fearful elements with psychopathic characters and deep-rooted history. The research paper aims to bring out racial memory as a primordial element of collective unconsciousness present in American society in Stephen King's novel *The Dead Zone*. The memories and tendencies a person inadvertently occupy from his older generations, play a greater role in shaping his basic personality traits as Jung believes.



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The collective unconscious is not so much a 'geographical location', but a deduction from the alleged ubiquity of archetypes over space and time. For Jung, the psychological archetypes which dredge out of the darker part of human mind the depth of consciousness, is the symbol of once-primitive thoughts. The actions that happen in the dream are within the layer of depth unconsciousness of one's inner selves. In the complicated needlepoint of human consciousness, the concept of the collective unconscious, as proposed by Swiss psychiatrist Carl Jung, serves as a profound lens through which to examine societal dynamics and individual behavior. This research paper delves into the depths of the collective unconsciousness, seeking to unravel its influence on the mindset of the American general public and the resultant political movements that shape the nation's destiny. By understanding the shared symbols, archetypes, and latent memories that reside within the collective unconscious, it aims to illuminate the underlying currents guiding the collective psyche of the American people and influencing their political unity.

The Colossal Influence of Collective Unconsciousness in American Society.

The American author Stephen King a well known horror writer of the era has used history and political situation of America as a background for his horror novels. The new land paves way for a new form of literature. The society and its collective emotions acts as a major part in the American soil. Thus, psychologist Bernard Rime explains about the group psyche, from his point of view the synchrony with others through actions, and common feelings also bring people together, whether through religious ceremonies, concerts, or protests. Strikingly related psychosocial consequences arising from several interpersonal and group contexts are proposed in recent studies. American Physical Society member Bernard Rime, an emeritus professor of psychology at the Universite Catholique de Louvain in Belgium, has used theories from sociology and psychological science to examine the mechanisms that allow us to encounter this blurring of individual borders in so many contexts.

Rime argues that interactions of synchrony and mutual emotion cause a change between two simultaneous neural "modes" in individuals, building on these sociological hypotheses.

The "individual" executive mode, well-documented by experimental psychology, underlies purposeful activities and includes executive functions such as management of concentration, setting goals, cognitive flexibility, and retrieval of information. Rime claims that the "communal" mode, which psychological research has generally ignored, encompasses our long-standing links to family members, friends, culture, and society, as well as the collectively transmitted cultural awareness extracted from these relationships.

Adding some points to him in 1893, Emile Durkheim, a French sociologist, published his theory of collective consciousness, explaining how two types of consciousness exist within each person: an individual consciousness that stresses our uniqueness and distinctiveness, and a collective consciousness that contains the mutual ideals, thoughts, and convictions that are universal to the whole community or society.

By engaging in collective emotions through social media, individuals were able to synchronize their thoughts and emotions, stimulating a sense of social belonging and shared beliefs. "In line with a central tenet of Durkheim's model, these effects were mediated by participants' perceived emotional synchrony with other people," Garcia and Rimé write. "Our findings support the conclusion that collective emotions after a disaster are associated with higher solidarity, revealing the social resilience of a community."

Team sports and group physical activity is proving to be a rich area for studying the impact of shared emotion and social support on the body. "In team sports, and group physical activity more generally, the social and the physiological are functionally and inextricably interlinked," explains Emma Cohen, a professor of cognitive anthropology. "Movement, emotion, and performance bind together at the individual level, but also at the collective level." (Cohen 67)

The paper analyses the novel *The Dead Zone*, the hero Johnny Smith is a school teacher who gets involved in a car accident. He wakes up from a five-year coma after the accident. In the due time he has lost his love life – his sweetheart is married to another man while he was in coma. But he discovers a new ability after the coma, that he





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can see people's future and past when he touches them. He helps many people by the power he possesses. He is faced with many problems due to this power. People treat him as a superstitious person. Once Johnny shakes the hand of an ambitious and amoral politician, Greg Stillson and realizes the evil intentions in Stilton's mind. He must decide if he should take drastic action to change the future. Eventually, he decides to change the future by preventing Stillson from reaching the position he desires.

Gregory Ammas Stillson is a full time politician elected as a Mayor of Castle Rock now seriously working for becoming a US Senatorial Candidate. Apart from that the most important thing about Mr Stillson is that he is a terrorist. He is highly skilled and over ambitious and he uses his eloquence to attract people, the most common weapon used by every politician in the world. He is so loved by the town's people; it helps him to gain more power. Other aspects of his charisma such as his high intelligence and trustworthy nature make him reach the summit of his political power. His only goal is to become the US President so he will be able to start a nuclear strike against Russia. Johnny knows this incident by his power. Johnny takes the drastic measure to assassinate him in order to avoid the nuclear war. He tries to shoot Stillson at the time of a public rally. He misses the target. To escape from the bullets, Stillson grabs a child and uses it as a human shield. Even though subdued by the guards Johnny is satisfied that his effort has found its mark – he foresees the future - in which Stillson's reputation and political career is ruined after the publication of a photograph showing his cowardly act of protecting himself by using a toddler as a human shield. In the final moments of his life Johnny is happy that he has helped the world from an impending danger and doomsday.

The political portrayal of Stillson by King closely resembles the views expressed by Douglas E. Winter in his *The Art of Darkness*;

"conspiratorial totalitarianism", where candidates for high office are decided not by the exercise of free choice, but "by factors as diverse as video images . . . media access and dirty tricks, untimely remarks . . . In such a system [the individual] becomes an observer, and choice seems a meaningless myth" (Winter 47)

But Johnny simple common sense and intuition tells him that Stillson is a person to be watched out. This realization comes to Johnny even before he shakes his hands with Stillson in the New Hampshire Rally. He is convinced that Stillson poses a greater threat to the world than he is to America and he begins to collect information about Stillson from all the possible sources. Stillson and their brief encounter becomes a recurring nightmare to Johnny and he becomes obsessed with the idea of eliminating the threat. An utter despair is the feeling he experiences during these bad dreams.

The sudden blackness. The feeling of being in a tunnel filled with the glare of the onrushing headlight, a headlight bolted to some black engine of doom. The old man with the humble, frightened eyes administering an unthinkable oath of office. ... The only clear image in these dream-replays came near the end: the screams of the dying, the smell of the dead. And a single tiger padding through miles of twisted metal, fused glass, and scorched earth. (TDZ 407)

These images and the thoughts about Stillson suffocate Johnny and they point to only one conclusion. Stillson is pure evil, some instances in his life in the past have shown how cruel and rude he could be. A dog has been beaten to death by him, a disobedient little boy has been bullied by him and a senator has been terrorized by him for not obeying his orders. Just evil and malevolent is the nature Stillson secretly possesses. But Johnny's realization and its confirmation while shaking his hands with Stillson sets the stage for the final encounter. A bad man he is and must be stopped at any cost. As a person awakened from a five year coma to see his life disarrayed – future does not hold Johnny anything great or exuberant to cling to. He finds this as an opportunity to add some meaning to his existence. As a commoner he feels that his certain death in the near future – due to his medical situation – would yield a better satisfaction if it is spent for a noble cause – like sacrificing his life while eliminating a world threat.





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When backed with such an intention he does not find it very difficult to reach in his decision. “Kill Greg Stillson”. The author has skillfully portrayed the transformation of Johnny’s life from an easy going, lovable, mediocre school teacher to a maniacal, depressed and melancholic killer of some sort. A believable explanation and justification for this transformation is presented – a tale that a reader could easily relate to. Jonny’s thoughts, reactions, motivations and impulses are very real to the reader like he is the one taking the full blast of the heat of Johnny’s misfortune.

King is master in presenting his ideas in simple terms – nothing too complicated about his character’s thoughts and actions. An organic development and growth in the circumstances – a natural growth – can be seen in his narrative process. The reason for the universal acceptance of his characters is the archetypal feelings involved in the character formation. For Johnny, this growth is to carry his wounded yet illuminated self all along – living as alien in the society in which he was a part of the mainstream. For Stillson, it is his growth from the meager existence to the most powerful position of the powerful nation – the presidency of USA. For the heroine Mrs. Bracknell, living the life of double jeopardy – as a faithful wife to one man and as a devoted lover to another. These feelings and the dilemmas encountered by them and the final road they all reach is so natural which is easily recognized and empathized by everyone irrespective of the race, nationality or the age group one belongs to. This can be linked to the collective unconscious of the general mass. Likewise, the initial love and admiration of the people surrounding Stillson turns in to acute hate and disgust in the due course. The same parameter can be employed to measure the intensity of love and the intensity of hate people express on the same person in a matter of days. This is the result of the collective unconsciousness. Love and admiration for the savior of the masses whereas, fear and disgust for the child murderer. The cowardly act of using a child to protect himself shatters the confidence of the people in him as the new Messiah. The following excerpt from the novel, the testimony of the photographer, Mr. Stuart Clawson who took the picture of Stillson in his cowardly act shows the change in the mindset of the people towards him;

R: You just snapped the photo when Stillson picked up the child?

Cohen: Young man, I’d like to suggest that you won the most important footrace of your life when you outran those two thugs.

C: Thank you, Sir. What Stillson did that day... maybe you had to be there, but ... holding a little kid in front of you, that’s pretty low. I bet the people in New Hampshire wouldn’t vote for that guy for dog-catcher. Not for...(TDZ 235)

Thus, comes the end of a charismatic egoist with a strong will to reach his goal. The findings on the effect of collective unconscious in the mass psychology are very relevant in today’s world. New tools supported by the modern technology have helped in reaching cemented conclusions about mass psychology in these days. Spread of the hate politics through mass media and social media platforms by the politicians plays a crucial role in the shaping up of the collective unconscious, thus achieving a desired goal –like winning an election or formulating a favourable opinion about a particular subject.

An interesting study conducted by Paolo Gerbaudo, a senior lecturer in digital culture and society at King’s College London shows that this trend has far reaching consequences in mobilizing political movements using the unethical practice of spreading hate and disgust through the effective use of media platforms. According to Gerbaudo, the attempts to use social media platforms such as Facebook and Twitter by political personalities like Matteo Salvini, the former Minister of the Interior of Italy, to induce deep resentment among the general public against minority communities such as migrants and immigrants, women, and the LGBTQ community have been very fruit bearing in terms of his ascension to power. His media Salvini method included making his Facebook page a place to paste hate messages – and the viewers were encouraged to add emojis at the comment section. Two of the most popular emotions extensively used by the users were that of ‘Furious’ and ‘Ha-ha’ – denoting anger and insult. It expressed the tell-tale signs of the general attitude of Salvini’s followers -these communities are to be hated or to be humiliated – nothing more nothing less. The comments sections were added for the convenience of the readers to post their opinions – thus giving an extra leverage to the real issue by adding more and more hateful messages under the original message. Those who have only a vague idea about the issue suddenly becomes the experts by reading the





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comments posted by the others which is often misleading and magnifying. Even the ones with a favorable attitude towards the marginalized become extremists because of the feeling of belonging to the community. They favor them because they don't want to be considered as pariah, so they take sides with the major group. They don't find many others supporting these 'weirdos'. As the end result of all these manipulations, a new political movement is achieved by transforming the hatred of a small group into mass movement. Most of the time the hatred expressed by the far-right followers are more complex than the views they express in the contemporary scenario. It is primordial. The hatred is rooted in them for generations – race supremacy, pride about the intellectual capacity and social status. Not just based on feelings of instant toxic emotions but a deep rooted conviction. This conviction is more and more hardened by joining in the bandwagon of the similar minded people united under the social media platforms. The mouthpiece speakers are considered as semi gods and lauded – praising the achievements blindly. These are not simple places where the hate is communicated but where the hate is originated and nurtured.

CONCLUSION

The theories of Bernard Rime, Emile Durkheim, Garcia and Rime, Emma Cohan, Douglas E Winter, Paolo Gerbaudo and Matteo Salvini states that the primitive thoughts and collective unconsciousness of the people of the land had a great influence over their geographical and historical incidents. The present study of archetypes in the King's novels has formulated a theory that could be practiced for the well-being of the future generations – harness the potential of the collective unconscious to produce better minded citizens in the future by inducing them with images of positive emotions and attitudes. As a nation marked by its diversity, the United States stands as a captivating case study for exploring the interplay between individual and collective mental landscapes. This research endeavors to dissect the intricacies of the American mindset, drawing connections between the shared unconscious elements that contribute to a collective identity and the subsequent political mobilization that arises from this unity.

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Artistic Values in J.M.Coetzee's *Disgrace*

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Art is a product of a human mind to convey a select idea or emotion in a conducive form of the artist. Selectivity is the key factor of an art because the artist, in order to convey his intention clearly, selects the idea or the subject and the style with due care. The artist, then, attends to the clarity of his creation. If he fails in clarity, the purpose of his creation will be lost. Hence, he applies his intelligence to shape and hove for accuracy. Later, he integrates the subject and style to present it beautifully to the reader or audience. Thus, art conveys the taste of an artist. J M Coetzee, a Noble Prize winner, is a South African writer. He uses various narrative techniques in his text to make the reader engaging. Literature is an evergreen art, thanks to the writers like him who show novelty in every work they write. *Disgrace* is his most famous novel for which he has been awarded with the Booker Prize. This paper discusses the basic artistic values and tries to trace down it from the novel *Disgrace*.

Keywords: Artistic values, exposition, symbols, narration and myth

INTRODUCTION

The creation of an artist has to be recreated by the reader or spectator to understand and appreciate it. It is considered that any work of art is complete on its own. It has the harmony in it so one cannot alter with addition and subtraction with it which may lead to destruction of it. Art has that finality which is not possessed by science. Science consents the alteration in order to grow as well as glow for centuries to come. Sometimes, the work of art may be irrelevant from the life of the spectator. Unfamiliar ideas, affairs and emotions can, in all possibility, emerge as dominant elements shut off from human interests. Here, art expects the spectator or the reader to exalt from the





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ordinary and enter into its own sphere. Hence, art need not reflect or 'imitate' life. It can become a dream as both art and dream are expressions of emotions and thus, symbolic. Anyhow, one cannot accept the consideration of art as a dream because art is a conscious attempt to present the emotions, may be, symbolically but dream remains unconscious. Some consider art as illusion but it is revelation of reality. The aspects of strangeness and other-worldliness of an art cannot hold the artist responsible. It is the artist's imagination that reveals itself and he revels in it.

Faculty of imagination is greater in artists than in ordinary men. Therefore, the spectator has to free his mind from all his impediments to comprehend the artist. Art becomes an expression also. Art is essentially a form of expression is a common notion; it may be a symbol and when it is so, it implies four factors: the symbol, the person who makes the symbol, the person who interprets it and an image of feeling of which symbol is an expression. Art expresses feeling also and it expresses pleasure, unpleasure, sadness, happiness, disgust, terror, grief and depression. Art communicates feelings of an artist through certain external signs. The signs may be words, paint, music, etc., for example lyrical poetry of Wordsworth. *Daffodils*, Wordsworth describes a routine action of appreciating beauty. Sometimes he remains without thinking and at some other times he is 'pensive' when the poet is in such an unhappy mood the happy daffodils flashes through his mind and opens his 'inward eye to get a spiritual vision which later becomes bliss'. Now the daffodils have become an ideal company and so his heart starts to dance along with the cheerful daffodils. Therefore, art is an expression of intense feeling which makes the artist restless until the feelings take the form of art. When art becomes objectification of subject or subjective reality it projects virtue.

Literature is one of the forms of art is different from other forms such as painting and music because its emphases on thought content. Music and painting can create a mood but cannot arise any thought. Since art is the virtue of the intellect, it demands to communicate with the entire universe. For example, Shakespeare entertains as well as portrays with great insight human psychology, human impulses and motivations. His characters are easily comprehensible because they reflect actual human beings. Bernard Shaw pictures social evils and drives to reform the society. Charles Dickens also attacks the social evils of his time.

Victor Hugo, Maxim Gorki, Bulzac Tolstoy, Keats, Tennyson, George Eliot, Thomas Hardy, D.H. Lawrance, T.S.Eliot and many other literary personalities are glorified even today, because of their sublimity. Longinus finds five principle sources of the sublime: grandeur of thought, capacity for strong emotion, appropriate use of figures, nobility of diction and dignity of composition. These five can be brought together with the comment of language. Grandeur of thought for Longinus is the stately thoughts of the lofty minds.

Aristotle's 'cathartic effect' as well as Longinus's 'capacity for strong emotion' aim at moral upliftment of the reader or spectator. Appropriate use of figure of speech elevates the style of writers. The chief figures that Longinus consider have the capacity of sublimity are: rhetorical question, asyndeton, hyperbaton and periphrasis. These can produce grandeur by satisfying a basic demand of human nature as one hears something new from the routine and at the end it gives a pleasant surprise and these figures Longinus thinks, "is effective only when it appears in disguise". Therefore, dignity of composition can exalt the soul and sway the heart of men with its natural power of persuasion and pleasure. Quintilian asserts that style is the product of both nature and art. It prefers language of daily life. Since, his treatise is primarily prose, like Aristotle he trusts in everyday subject and language of daily life. However, by language of daily life, he does not mean the language of the masses. He prefers the language of educated men. Therefore, the insistence lays on choice of words and their arrangement. Only when the words are chosen carefully they can be arranged properly. Apart from popular words of common usage of educated men newly coined words may be used where the popular words cannot serve the purpose but sparingly. Archaic words can also be used to impart dignity to style.



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Rhythmic prose is different from rhythm of verse where each line has a metrical composition. In prose, the rhythm is subtle. Longinus and Quintilian were ruling English literary trends until the romantic emergence. Romantics brought changes and developed literature on the whole. They opposed all regimentation in literature and proposed to 'please always and please all'. Wordsworth and Coleridge ascertained that language of the middle and the lower classes can provide poetic pleasure. Wordsworth considers the language of the layman is more permanent and philosophical. Wordsworth accepts that good prose can also sound as poetry because common men cannot spare time for metrical composition.

John Maxwell Coetzee, South African writer, literary critic, essayist, linguist and translator, was born in 1940 at Cape Town. He is the son of Zacharias Coetzee who was an attorney and partly government employee and Vera Coetzee, a school teacher. Having born in an educated family, his family members talk only in English but Coetzee, inspired by his mother tongue, speaks Afrikaans with other relatives. He studied at St Joseph's College and completed his bachelor of arts with honors in English and Mathematics from University of Cape Town. He moved to the University of Adelaide in Australia where he is currently working as a professor of English now. Coetzee, being a prolific writer, introduces himself as a writer to the literary world with his first novel *Dusklands* (1974). In the year 2003, to glorify literary contribution, he was honoured with the Nobel Prize for Literature. Coetzee in his novels delves into the themes of racism, imperialism, colonial impacts on culture and the sufferings of groundlings. Coetzee, interested in politics, projects the limitations of African society in his novels and criticizes them with his literary talents.

Coetzee's novel *Disgrace* (1999) traces the life of David Lurie, the protagonist, professor of English, a twice divorced man. The novel exhibits the inordinate sexual desires of David who seduces his own student, Melanie and is expelled from his institution. The setting of the novels is the country land of Salem in Eastern Cape where the cruel apartheid system prevails all over the land. Lucy, the daughter of David Lurie who lives in Salem, a village of Eastern Cape, is brutally gang raped by three strangers. Moreover, they severely attacked David and loot everything from their home. When policemen investigate Lucy about the incident, she shadows the rape event and only tells about her and robbery. After this event, there is a rift between the father- daughter relationship. David starts to spend his time with Bev Shaw, the friend of his daughter, in her Animal Welfare Clinic.

Later, David repents to Mr. Issac, father of Melanie, for seducing his daughter. In the meantime, David comes to know that Petrus, neighbour of Lucy, is the one who has assigned the strangers to molest his daughter in order to occupy her land as well as marry her. David smites Pollux, one of the strangers and reason for his daughter's pregnancy. At end of the novel, David accepts his life as disgraced and he does not want to change it anyway. He continues his job in the Animal Welfare Clinic. The sub plot of the novel deals with David's project on the love affairs of Byron and his mistress Teresa Guiccioli.

Coetzee uses Oedipus myth as exposition to introduce the background of the story. Coetzee uses exposition in *Disgrace* as a literary device in order to introduce backdrop details on characters, events, settings and other information to the readers. Coetzee pictures one Professor David Lurie to take advantage of one of his students and so disgraced to calamity. David is considered as a fallen angel as he has been thrown out from the university. He is compared to Lucifer and he would have been apologized by the committee if he had asked for it. His racist thought never let him to ask apology and accepts his fall. As Oedipus, he has been arrogant during the liaison and he is self-centric egoist person. Being a Professor, he failed to be professional but romantic which leads to his tragic fall. Every Thursday afternoon, he visits Soraya, a prostitute. Though the sexual relationship is complacent, he never tries to change his temperament, especially his sexual temperament.

David is employed at the Cape Technical University teaching Romantic poets initially and now teaches communication skills. He has published three books on Opera, Eros (God of love) and Wordsworth. Opera is a musical drama set for singers and instrumentalists; Eros is a God of love, son of Aphrodite; Wordsworth is a





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romantic poet and the writing the history of Wordsworth projects the degradation of a romantic poet to historian as he teaches communication skills. Through this Coetzee establishes Lurie's temperament, not an effective teacher because of his sluggishness. He gloats even at the time of inquiry which leads to his resignation. At the end of the novel he becomes undignified. David Lurie drives home the humiliation of David. His degradation, thus conceived by Coetzee is not lesser than Oedipus. Coetzee undertakes the myth of Origen to underline the character of Coetzee and his disgrace. Origen in *Ecclesiastical History* 6.8 of Eusebius mentions Origen's castration. He was a theologian who taught women Greek literature to support his family.

David Lurie is faithless and self-indulgent. His relationship with Soraya breaks up immediately after Lurie meets Soraya's family that is Soraya with her two children. His snake totem does not leave him ideal. He picks up a relationship with Dawn, another prostitute. Unable to forget Soraya or having expected Soraya in Dawn, Lurie cuts a sorry face in sexual relationship with Dawn. He is scolded by Dawn and her masturbation at the end of intercourse makes him repulsive. Coetzee analysis his mind,

He ought to give up, retire from the game. At what age, he wonders, did Origen castrate himself? Not the most graceful of solutions, but then ageing is not a graceful business. A clearing of the decks, at least, so that one can turn one's mind to the proper business of the old: preparing to die. (Coetzee 9)

Impotent and ineffective but an insatiate David Lurie selects his student Melanie as the next tool for his sexual escapade. This poor and unethical move has ensued the loss of her playful smile "The pentameter, whose cadence once served so well to oil the serpent's words, now only estranges." (Coetzee 16) The rhythmical and metrical pattern of language that has served as a cadence, as a tone, to seduce girls now has turned out to be disaffected. It is an extension of snake totem and concentration of Origen. The words once lit up the emotions of, now estranges in spite of that Lurie's temperament never changes. The seduction process continues in the classroom also a simple thought. A man looking at Alps mountain becomes a complicated imagery.

Lurie teaches *The Prelude Book six* that talks about the early literary face of simplicity of Wordsworth. Critics consider the first face as glorious because of Wordsworth's inductive surrender to nature. Face of the mountain that has taken Wordsworth over to different worlds of thought, is the theme in the class of David Lurie. Mont Blanc, a potential World Heritage Site known for its unique beauty. The meaning of Mont Blanc is White Mountain. A simple idea of Wordsworth that the scenic beauty of nature, Mont Blanc, the white mountain takes Wordsworth to different worlds is speculated for a long time in the class room by David Lurie: Especially an ordinary verb Usurp meaning take over, is meditated throughout, to suggest Melanie that like Mont Blanc, she takes Lurie over to distant spheres of the cosmos. David Lurie conveys that 'mere sense-image' of Melanie imports to his memory the 'great archetype' and 'pure ideas'. The sense-image is related to 'being in love' and students are advised to keep the sense-image 'alive in the archetypal, goddess like form'. In yet another class, David gives a lecture on Byron. Here, Coetzee prefigures the fate of David Lurie as Byron. Byron did face many allegations for his affairs. He had his affair with Mary, wife of the English poet Percy Bysshe Shelley and with Claire Clairmont, a stepsister of Mary. Even Byron involved affair with his own half-sister Augusta and others named Lady Oxford, Lady Caroline Lamb and Lady Byron whose name was Anne Isabella Milbanke.

As Byron had too many affairs so does David Lurie. He is twice- divorced; he has affairs with Soraya, Dawn, Melanie Issac and Bev Shaw. Being highly impulsive, David has little concern for morality. He wants to understand and sympathize Byron. Unconsciously in the course of lecture David speaks about solitude. His unethical temperament leaves him shameless and so he never admits his rape nor eager to hear the verdict of the inquiry committee. David escapes to the town of Salem, Eastern Cape. There, Coetzee parallels Melanie's rape to the gang rape of Lucy, David's daughter. David is attacked and the rape becomes a privacy matter for Lucy. By saying the rape can be brought to the public notice in another time, in another place, Lucy refers to Melanie's rape. Lucy goes to the extent of marrying Petrus who is doubted to have relationship with the attackers. Thus, Coetzee proves the





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distinction in cultural assimilation of the city 'Cape Town' and the village "Salem, Eastern Cape". The alterity becomes a very powerful mode of transferring Coetzee's ideas as the novel progresses to the end. Many pages are dedicated to opera now the story is not about Byron but about Teresa, Byron's old lover. Gradually the elegy becomes comic as David's life has turned from romantic to tragic.

Coetzee mentions the Casanova myth when David Lurie receives a letter during his final face of tenure in the university. Unable to control his sexual desire David Lurie has an affair with his own student Melanie Isaac. It is soon learnt by her lover Ryan and her parents. They complain to the university authorities that David Lurie has raped Melanie. When the inquiry goes on, the university advises David Lurie to undertake counseling. A pamphlet is issued in due course.

On campus it is Rape Awareness Week. Women Against Rape, WAR, announces a twenty-four-hour vigil in solidarity with 'recent victims'. A pamphlet is slipped under his door: 'WOMEN SPEAK OUT'. Scrawled in pencil at the bottom is a message: 'YOUR DAYS ARE OVER, CASANOVA'. (Coetzee 43)

Coetzee mentions Casanova who is more than a womanizer of Venice. A good example of Casanova is 'Don Juan', a Spanish legend popular for his seduction. David Lurie is no less a Casanova than a Don Juan through whom Coetzee demonstrates the sin of womanizing. David Lurie is forced to resign and at the end of the novel he becomes an employer of Bev Shaw's Animal Welfare Club. David Lurie is the architect of his own destiny - the Disgrace caused to him because he failed to realize the moral truth that womanizing is a sin. Coetzee's narrative techniques of using exposition and myth add artistic values to the novel *Disgrace*.

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Enhancing Vocabulary Learning through Gamification - A Study of Quizizz's Effectiveness in EFL Classrooms

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

Learner engagement is important in EFL classrooms to ensure effective learning, active participation and cultivate motivation towards learning. There are various strategies that can be employed to boost learners' engagement such as the use of game-based learning for vocabulary instruction. This study aims to analyze the effectiveness of Quizizz as a teaching and learning tool to teach vocabulary in EFL classroom. The analysis was conducted with 40 participants, and they were divided into two groups, a control group, and an experimental group. Before the study commenced, a pretest on vocabulary was conducted for both groups to assess the participants knowledge. Following the pretest both the groups had two distinct types of teaching. The control group received traditional vocabulary instruction while the experimental group was taught using Quizizz, a game-based learning tool. After completing 10 sessions of teaching vocabulary the two groups took a posttest on vocabulary to measure their progress. The results showed that there were significant differences between the pretest and the posttest scores favoring the experimental group. This study was conducted to explore how Quizizz can enhance EFL learners' engagement and learning. The findings of the study show that educators can achieve better learning outcomes by integrating Quizizz into their teaching process. Furthermore, this study shows that participants are motivated to utilize Quizizz as an effective learning tool even beyond the confines of the classroom.

Keywords: EFL classroom, Effective Learning, Effectiveness, Motivation, Strategies, Vocabulary



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INTRODUCTION

Acquisition of vocabulary skills plays an important role in improving language proficiency, especially in the field of teaching English as a Foreign Language (EFL). Possessing strong vocabulary skills are essential for learners as it enables them to expand knowledge in all aspects of language proficiency, be it listening, speaking, reading or writing. In the fast-paced modern world, both the educators and the learners are actively seeking various educational tools to simplify the learning process. Teaching vocabulary using traditional methods in EFL classrooms has limitations and there is a necessity for innovative teaching methods to motivate and engage learners. These limitations in traditional teaching emphasize the importance of finding engaging strategies for vocabulary learning. Traditional approaches to vocabulary instruction often face challenges in engaging and motivating learners effectively. Recognizing the importance of learners engagement in learning a language, educators are increasingly using innovative methodologies as a supplementary tool in the classroom that integrate technology and gamification to enhance learning. One such tool that has gained attention among learners and educators is Quizizz. It is a gamified platform that offers interactive quizzes and diverse learning experiences.

This study aims to investigate the effectiveness of Quizizz as a gamification tool for enhancing the vocabulary learning in English as a Foreign Language (EFL) Classrooms. The integration of technology and gamification in education has become increasingly popular due to its easy-to-use application, ability to encourage active participation, create a collaborative learning environment, and maintain learners' interest in learning, which are often lacking in traditional teaching methods. This research aim is to bridge the gap in vocabulary learning and contribute to the advancement of more engaging and effective vocabulary learning practices in EFL classrooms. As an EFL learner, it is important to have strong vocabulary skills for learning and understanding a language. It helps the learners to improve their reading and writing skills. Also, it helps the learners to communicate effectively.

Gamification is an innovative approach that aims to increase users' engagement and motivation and provide sustainable experiences (Bozkurt and Durak). Gamification is a fun way of learning by adding game elements to it and it makes learning more engaging and interactive. It speeds up the response time of the learners, stimulates creativity and focus. The interactive tool allows the learners to work out their best strategy and experiment through trial-and-error methods. Apart from helping team building, the game based interactive tool also allows the learners to find a solution to a problem by visual memory and critical thinking resulting in building of confidence and new skills.

Quizizz is a game-based learning tool that allows educators to customize interactive quizzes, and lessons as per their learners and classroom needs. It makes learners feel like playing a game while learning vocabulary with points, leader boards, and immediate feedback. This tool makes the learners feel more enjoyable and remember what they learn. This research is to evaluate the effectiveness of Quizizz on EFL learner's vocabulary learning. This study aims to explore the effectiveness of Quizizz as a gamification tool for making vocabulary learning more engaging in EFL classrooms. By exploring the effectiveness of Quizizz in transforming traditional vocabulary instruction methods and its ability to create more enjoyable and successful learning practices.

The methodology included in this study is a pretest-posttest design to collect data on the impact of Quizizz on vocabulary learning. The participants' initial vocabulary proficiency will be assessed by conducting a pretest to both control and experimental group. Following the pretest, the experimental group participants will engage in vocabulary learning activities using Quizizz for the planned session and the control will be taught vocabulary by the traditional methods. Posttest will be conducted after the completion of the learning activities to both control and experimental group to measure the outcome of the results. By comparing the pretest and posttest results, the study aims to evaluate the effectiveness of Quizizz as a game-based learning tool for enhancing vocabulary learning in EFL classrooms. The study's intended result is to demonstrate the effectiveness of Quizizz as a gamification tool for improving vocabulary instruction in EFL classrooms. It is expected that the participants who use Quizizz will show



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an increase in vocabulary proficiency compared to their pretest high level of confidence. Also, it is expected that the participants will demonstrate a high level of interest, enthusiasm, engagement and enjoyment in learning vocabulary.

LITERATURE REVIEW

In recent times, the integration of technology in educational environments has become a popular approach to improve vocabulary learning, especially in English as a Foreign Language (EFL) classrooms. Gamification involves implementing elements of game design in contexts outside of gaming to motivate learners through interactive and enjoyable experiences (Li et al.). According to Suzanne Holloway, to enhance participation, engagement, loyalty and competition, gamification employs game design principles and mechanics with non-game environments. Many studies have shown that using gamification in language learning has positive effects on language learning outcomes and can transform traditional teaching methods. In terms of vocabulary learning, researchers have explored the effectiveness of various gamified platforms, and Quizizz is a popular tool because it is easy to use, the educators can customize their lessons and it offers interactive engaging quizzes. Using an integrated approach in EFL classrooms has many benefits including achieving higher test scores, enhancing critical thinking, and positive atmosphere toward learning (Yimwilai).

Many studies have examined the integration of Quizizz as a gamification tool in the field of education. According to Handoko et al. Quizizz has a positive impact on learners' engagement and learning. Authors' findings indicated that learners preferred Quizizz over traditional teaching methods and it positively influenced their performance when Quizizz was used as an assessment tool. Researchers Permana et al. in a study aimed to examine learners' perceptions of Quizizz as a formative tool in classrooms. The findings showed that Quizizz was user-friendly, allowed for customization and positively impacted learners' learning experience. Many researchers have conducted studies to explore the impact of Quizizz gamification features on learners' learning experience and motivation level. According to Pitoyo et al. the gamification features of Quizizz including leaderboards, music, time limit, and test reports had a positive impact on learners' engagement, motivation and learning experience.

These findings strongly support that Quizizz serves as a valuable gamification tool in educational settings. It has a positive impact on learners' engagement, motivation and learning. The integration of Quizizz's gamification features has created a dynamic and interactive learning environment that captivate learners' attention and interests. It can be an effective tool for gamifying education and impactful learning experiences for learners.

Benefits of Quizizz**Enhances Learners' Involvement**

Quizizz can enhance learners' engagement by utilizing game-based learning, where learners can actively participate in real-time quizzes and compete with each other. The interactive approach to learning is fun and engaging and motivates learners to participate actively in their learning. Leaderboards are one of the ways to promote learners' involvement and provide a visual representation of learners' performance and encourage healthy competition among learners.

Immediate Feedback

Immediate feedback is another benefit of using Quizizz. Quizizz offers the advantage of immediate feedback enabling learners to know their results after answering each question. Feedback helps learners to determine the area of improvement. This kind of feedback is important for formative assessment as it allows educators to adapt their teaching strategies based on learners' performance feedback. Positive feedback builds the learners sense of being valued. It also aids in boosting positive habits and inspires the learners for better performance. Additionally, it provides educators with detailed reports of learners' performance.



**Hasheenaa Bagem and Geetha Yadav****Personalized Assignments**

Educators can use Quizizz to tailor lessons and assignments according to their learners' needs and their classroom. This platform allows educators to create customized assignments that include a variety of questions such as multiple choice, fill in the blanks, true or false, and more. Moreover, it also helps novices in developing the ability to become self-directed learners. By providing these advantages, Quizizz supports educators in developing and designing teaching materials that are relevant to their classrooms which promotes active student participation.

Collaborative Learning

Quizizz supports both individual and team-based learning and develops a collaborative learning environment. It helps the learners understand an extensive range and depth of the subject knowledge. Learners can work in teams to discuss answers, to solve questions and to learn from one other. It promotes peer interaction, communication, memory retention and enhances the overall learning experience.

Data-driven Insights

Quizizz provides educators with data on learners' performance, including individual or group reports. The data is obtained rapidly providing accurate results to plan and evaluate learners' performance. This data can also be used to find solutions to the shortcomings of the learners. This enables educators to identify the strengths and weaknesses of individual learners, allowing them to adopt their instructions and provide support accordingly.

Flexibility and accessibility

This game-based learning app Quizizz can be accessed on various electronic devices like laptops, tablets, and smartphones. It offers the flexibility of various class formats including remote, hybrid and offline learning environment. This allows learners to practice language skills both inside and outside the classroom.

Research goals, questions and approach

The study aims to explore the impact of Quizizz on various aspects of teaching and learning, including learning performance, classroom atmosphere, and the views of both learners and educators. The study aims at:

- i) To examine the effectiveness of Quizizz in teaching vocabulary
- ii) To examine the effectiveness of Quizizz on the achievement of learners' learning

RESEARCH DESIGN

The sample for this study consisted of learners who are enrolled in language learning educational programs. The study's intended participants were 40 learners from University of Technology and Applied Sciences, Al Musanna, Oman. A total of 40 participants were selected by random sampling and divided into two groups, a control group and an experimental group. Both groups participated in a pretest and a posttest to assess their vocabulary learning progress through a set of 10 questions that included multiple-choice and cloze test formats. The pretest was conducted in the same week for both the groups and focused on the vocabulary items from their Reading and Listening books. The participants from the experimental group had not previously used Quizizz. However, to familiarize themselves with gamification technology, the participants in this group took part in the Kahoot! Sessions. Between the pretest and posttest assessments, vocabulary lessons were taught to control group and experimental group using traditional teaching methods and Quizizz platform respectively. The experimental group was engaged in ten consecutive sessions, where vocabulary was taught using Quizizz. A posttest was administered after the final intervention to measure the effectiveness of Quizizz on vocabulary learning.

As part of the study, the researcher used Quizizz, a gamification tool, to teach the experimental group some concepts. The participants from the experimental group were given multiple-choice tests and fill in the blank tests. The tests required learners to make guesses, choose the correct answers for the multiple choice, and fill in the blanks with correct answers. Learners from the experimental group engaged in several activities using Quizizz platform which



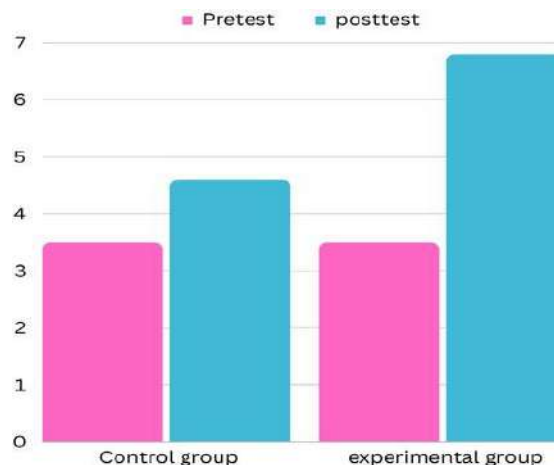
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consists of 36 multiple-choice and 32 fill in the blanks exercises focused on vocabulary from their reading and listening materials. After all the learners had responded and made their selections, the quiz results were displayed revealing the highest scorer and the winner of the game. The control group received traditional teaching methods for vocabulary instruction. They were given explanations of vocabulary and PowerPoint presentations were used to help them to understand better. The same set of vocabulary items which were taught to the experimental group was also taught to the control group in each session. Both groups took the immediate posttest after learning all the vocabulary from their Reading and listening material to assess their comprehension of the vocabulary. The main purpose of the posttest was to assess the effectiveness of Quizizz on the improvement of learners' understanding of the vocabulary.

Analysis

This analysis examined the pretest and posttest scores of a control group that did not undergo any experimental intervention. The focus was to assess changes in scores between the two tests. The pretest scores ranged from 2 to 5 with an average score of 3.6 and in the posttest, the scores ranged from 4 to 6 with an average score of 4.6. This shows an overall increase in the average posttest score compared to the pretest score. It is important to note that the improvement may not be attributed to any specific intervention or treatment. It can be other factors, such as the participant's familiarity with the vocabulary or practice effects. It is also important to consider the variations in individual scores during this analysis. Some participants maintained the same score while others showed improvement in their scores. The changes in scores are likely due to random fluctuations or individual differences without an experimental intervention. To summarize, the pretest and posttest results of the control group show minimal variation in scores. The experimental group received a pretest, posttest, and experiment conducted using the gamified tool Quizizz. The pretest scores for this group ranged from 2 to 5 with an average of 3.5 and in the posttest, the scores ranged from 5 to 9 with an average score of 6.8. The data suggests that the intervention involving the Quizizz tool had a positive impact on the participants in the experiment group. There was an improvement in their posttest scores compared to their pretest scores. This shows that the intervention helped in enhancing their performance in the assessment.

Integrating gamification through Quizizz played an important role in boosting participants engagement, motivation and active involvement. This approach created a more enjoyable and effective learning environment leading to improved test scores. However, it is important to consider individual variations within the experimental group. Although the average scores showed an increase, it is important to note that the improvement varied among individual participants. Participants prior knowledge, learning styles and individual effort might have influenced these variations. To summarize, the experimental groups' pretest and posttest results demonstrate a significant improvement in their performance after the implementation of Quizizz. This suggests that incorporating gamification in the learning process can be an effective strategy for enhancing learner engagement and learning.



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The analysis of both the control group and experimental group shows the notable difference in the outcomes. The control group which did not receive any intervention demonstrated a degree of slight variability in the scores. On the other hand, the experimental group which underwent the intervention using Quizizz, showed a significant improvement in scores. The above chart shows that the experimental group's engagement with the Quizizz contributed to enhanced learning outcomes compared to the control group.

CONCLUSION

According to the findings of the current study, the group of learners who used Quizizz to learn vocabulary performed better than the control group that didn't use it. Both groups got similar scores in the pretest, but after the intervention the experimental group showed higher scores. This study suggests using Quizizz as a learning tool improved the learners' vocabulary learning. The findings of this study examined the impact of using Quizizz's, a game-based learning tool on vocabulary learning. The results showed that integrating Quizizz as a method of instruction is successful and useful for vocabulary learning. The overall findings of this study emphasize the importance of integrating Quizizz as a supplementary to traditional resources while learning vocabulary. Research has consistently shown that game-based teaching and learning should be given priority in any language program due to its positive and significant impact on vocabulary learning. Therefore, using games in the learning process can help to reduce anxiety, feel more comfortable and become motivated to learn more. The use of gamification techniques and interactive tools appears to have a positive impact on learners' performance and highlights the advantages of integrating these approaches in the educational environment.

However, further research should be conducted to explore the impact of game-based training on various English Language skills. In this study, data collection relied only on pretest and posttests. Therefore, it is recommended that future research may include qualitative tools such as interviews to gather more reliable and comprehensive data.

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Enhancing Communication by Listening: Techniques and Approaches with Media and Technology

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This research seeks to emphasize the significance of using contemporary technologies to enhance English communication skills via media. The article explores many methodologies and strategies that could enhance the listening abilities of those learning English via contemporary media. Several ways include using internet platforms for English language listening and engaging in video conversations via mobile devices or computers. Participating in listening to audio content via movies, television, radio, and CD-ROM. This research also investigates the importance of auditory comprehension in acquiring the English language. The conclusion offers concrete suggestions and emphasizes the advantages of using Modern Media in the English as a Foreign Language (EFL) classroom. Listening is the intentional and concentrated act of hearing sounds with complete attention. Based on a poll, individuals allocate about 40 to 50 percent of their time to listening, between 25 and 30 percent to speaking, 10 to 15 percent to reading, and 9 percent to writing. Hence, the study report focuses on augmenting communication by tackling listening abilities and offering remedies for enhancement. This study seeks to clarify the importance of communication via media. The 21st century has seen a greater mobility and tangibility of civilization. Mobile devices are being utilized more and more for activities including education, entertainment, personal communication, and distant employment. Students enjoy using their mobile devices to access a variety of online listening resources





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and participate in English-language conversations. They find comfort in apps such as Facebook, WhatsApp, and Emo. The article discusses the various tools for listening skills,

Keywords: Media-mediated listening, Media's role in communication, Modern Media, Communication's Expansion, Listening tools, Communication.

INTRODUCTION

English is a global language or a lingua franca. It facilitates the exchange of communications between individuals and nations. The English language has achieved global reach and development to a degree that cannot be disregarded. English use in India has seen a significant surge. ELT in India has failed to revolutionize the conventional teaching approach prevalent in the majority of educational institutions. Students learn English only to achieve a passing grade on exams, while professors instruct with the sole objective of fulfilling this prescribed goal. Modern Media may be defined as the mass communication methods that are distinctive of the present era, namely those that are associated with newly created or sophisticated technologies. Postmodern media, a successor to modern media, encompasses mass media platforms that provide individuals with the ability to fulfill their requirements at any time, in any location, and on any digital device. "Postmodern originated in the contexts of aesthetics and art criticism, though it has since been disseminated widely in criticism of other cultural forms, particularly contemporary media." (Bignell30).

Another significant description of Modern Media may be described as the diverse use of pictures, words, sounds, and textual data. The nested properties of contemporary media components distinguish them from conventional media components, such as hardcopy documents and newspapers. The majority of media categorized as "new media" are digital, often possessing characteristics such as manipulability, networkability, high density, compressibility, and interactivity. Contemporary media only includes conventional formats like TV shows, movies, magazines, books, or printed publications if they use digital interactive technologies. Modern media refers to the process of demoralization in the development, publication, dissemination, and consumption of media information.

Empirical Literature

Seo et al. (2021) conducted a study on the impact of artificial intelligence (AI) on learner-instructor interaction in online learning. They found that adopting AI systems in online learning can enable personalized learner-instructor interaction at scale. However, there is a risk of violating social boundaries. While AI systems improve communication quality and provide just-in-time, personalized support, concerns about responsibility, agency, and surveillance remain.

Kosmas (2023) proved that it is possible to Improve students' learning performance through Technology-Enhanced Learning (TEL). The researchers found significant results which were observed in students' cognitive performance, motor skills, academic performance in language, and emotional state. These improvements led to increased motivation to participate in the learning process. Mahanty and Mishra (2023) stated that Web-based simulation instruction, blended learning, online applications, smart phones, Computer Assisted Language Learning (CALL), WhatsApp groups, movie clips, audio-visual cassettes, and different websites have facilitated the listening and speaking skills of English language learners. Chichekian and Benteux (2022) argued that Intelligent Tutoring Systems (ITSs) impact metacognitive strategies by prompting students to apply self-regulation skills and monitor their progress when learning. These systems enhance learning processes and self-awareness. Mohamed (2023) identified that AI-powered language models, such as ChatGPT, have been applied in language learning scenarios. They contribute to language tutoring, generation, and translation, thereby enhancing students' language skills.

Sangeetha (2023) conducted research on the effectiveness of using speech recognition technology in language learning. The study found that integrating speech recognition tools into language courses improved students'





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pronunciation accuracy and overall listening comprehension. Al-Seghayer (2022) explored the impact of computer-assisted language learning (CALL) on listening skills. The findings revealed that CALL programs, especially those incorporating multimedia elements and interactive exercises, significantly enhanced students' listening abilities. Chen (2023) investigated the use of automatic speech recognition (ASR) systems in language classrooms. The study demonstrated that ASR technology helped learners focus on specific phonetic features, leading to better pronunciation and comprehension. Hasan et al (2020) studied the effectiveness of mobile language learning apps in improving listening skills. The research highlighted that personalized content, real-world contexts, and interactive features in mobile apps positively impacted students' listening proficiency. Nguyen (2023) examined the role of virtual reality (VR) in language education. VR simulations and immersive environments enhanced students' listening comprehension by providing authentic contexts and multisensory experiences.

The role of media in facilitating communicative learning

The media in English Language development provides a connection between human resources and non-human resources. These are the many tools used by instructors and students throughout the process of teaching and learning. Institutional resources contribute to the pedagogical effectiveness of English Language instructors. They facilitate effective communication between instructors and learners by enhancing the teachers' ability to convey topics more effectively. They provide learners with opportunities for practical application. They incite cognitive processes and foster discourse among pupils. They motivate kids to attain greater levels of accomplishment.

Today, listening is receiving widespread attention. Schools and colleges across the nation have established training courses in the area, and many others are about to do so. Industries have instituted their management training programs in listening; governmental groups and agencies, at both the federal and lower levels, have asked for such training; religious groups have turned their attention to listening; and an International Listening Association has become active. (Holtand Winston07).

This application amuses and facilitates learning via the use of mainstream culture. Experience authentic British and American accents via audio recordings and challenge oneself with engaging tasks such as interpreting meanings, completing missing sections, and picking the appropriate words or sounds. The program developed by Miracle Fun Box is well-suited for enhancing proficiency in both listening and speaking abilities. If we look at the world tourism sector, 74 percent of travelers move from one non-English-speaking country to another non-English-speaking community. This, as Graddol (2007) suggests, necessitated 'a large demand for either foreign language learning or the increasing use of English as a lingua franca.' Countries like Malaysia made basic proficiency in English a requirement for all foreign employees. Similarly, countries such as Mongolia, Chile, South Korea, and Taiwan are planning bilingualism with English being one of the languages. This has necessitated a fresh look at whether the language facilitates the users to use it as a common code globally. "Language," as Lado (1965) puts it, 'in its most common pervasive, representative and central manifestation involves oral-aural communication.' Today, English is widely used as a language of communication. (Jayashree 11).

Speaking about vocabulary, the application primarily emphasizes often-used terms for English examinations such as IELTS and TOEFL. Engaging in many English listening examinations will enhance an individual's auditory comprehension and facilitate the acquisition of essential vocabulary. Additionally, there are opportunities for amusement via interactive activities like sentence construction games, vocabulary exercises, and word chains. Users have the option to access the classes without an internet connection and may save their preferred lessons for easy reference. As multimedia technology (such as interactive videodiscs, CD-ROMs, CD-Is, etc.) becomes more readily available to instructors and learners of different languages, its capacity to improve listening skills becomes a viable choice. Multimedia enables the seamless integration of many elements such as text, pictures, audio, and motion video in a wide array of combinations. In the 21st century, civilization has become more mobile and tangible. Increasingly, mobile devices are being used for tasks such as remote work, personal communication, entertainment, and education. Students get pleasure from using mobile devices, finding solace in applications like Facebook, WhatsApp, and Emo for engaging in English conversations and accessing a wide range of online listening materials. Students get



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comprehensive recognition for using mobile devices not just to enhance their listening skills but also to improve their spoken communication. There are four abilities (hearing, speaking, reading, and writing): persons who know a language are called speakers as if speaking comprised all other types of learning. She believes speaking is the most important of these four. "The primary goal of most, if not all, language learners have to improve their ability to communicate verbally" (Butarbutar4). Moreover, it offers the FL student a substantial amount of exposure to genuine language.

The basic skill in communication is active listening.

We engage in active listening more often than we engage in speaking. By using this listening skill effectively, we may acquire proficiency in the instruments of communication. Listening may be challenging due to the inherent tendency of the human mind to readily get distracted. An individual who exercises mental discipline and practices active listening gains a multitude of additional talents and experiences several advantages.

"An overall view of the concept of mental discipline can help us to discover its development characteristics and find a suitable research entry point" (PingChunCao2) Listening is the cognitive act of discerning and comprehending the spoken words and phrases of a language's speaker. Frequent use of linguistic skills is seen. Proficient listening skills enable learners to actively engage in familial, professional, and societal interactions. Insufficient listening skills hinder one's ability to differentiate between different portions of speech, preventing them from offering an appropriate response to convey apologies, invitations, empathy, refusals, understanding, and engagement under the given scenario. Internet forums and websites provide many opportunities to improve their English listening skills. "Concentration and urgency for remembering are demanded by the structure of the lessons. The lessons stress memory—lengthening memory span and strengthening" (Morley10)

The Significance of Active Listening

In our contemporary society driven by advanced technology, effective communication has become more vital. However, individuals are devoting progressively less time to actively engage in attentive listening with one another. The act of really listening is becoming scarce, despite its vital role in fostering relationships, resolving issues, promoting comprehension, resolving conflicts, and enhancing precision. Active and attentive listening in the workplace leads to a reduction in errors and more efficient use of time. "Initial interactions constitute a significant context for the study of listening skills. Every relationship begins with a first encounter. Further, a great deal of our instrumental goals are accomplished in first-time conversations with salespeople, customers, doctors, therapists, potential employers, yoga instructors, and the like. In first encounters, people attempt to solve a variety of information seeking, relationship, and impression management problems" (Weger15)

Strategies to improve listening skills

Select a single episode from a podcast that individuals find captivating or enjoyable. Allocate a week to regularly engage with that particular episode daily, while simultaneously engaging in activities such as driving, commuting by bus, or doing household chores. During the first two days, make note of any words or phrases that provide difficulty in comprehension and proceed to search for their meanings. Ensure to halt the audio playback, and thereafter resume it to perceive the challenging vocabulary. With a few days' practice, individuals should be able to audibly perceive and understand these words. Additionally, it might be advantageous to memorize certain chunks of podcasts and engage in the repetitive practice of reciting them. Identify the disparities between oneself and the speaker. By the last day, individual levels of comprehension will have significantly increased compared to the first day.

Simultaneously engage in reading and listening.

Employing two sources of information concurrently is an additional approach to enhancing one's listening skills. Consequently, it is essential to acquire knowledge about the English language from an alternative resource while engaging in listening activities. The most straightforward method to do this is by watching a video with English subtitles in the English language. One will be perusing and audibly perceiving the words in this fashion, which will facilitate his/her comprehension and enhance memory recall.





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Explore various dialects by watching films and listening to podcasts.

Effectively improve an individual's ability to understand a certain English accent, it is essential to consistently practise and refine an individual's listening abilities with audio materials that include that particular dialect. To improve individual comprehension of American English, consider immersing oneself in American television programs, podcasts, or news broadcasts for a duration of one month. By the conclusion of these 30 days, the ears of the listeners will have been used to the accent to facilitate comprehension.

Repetition and rephrasing of sentences, accompanied by audio recordings.

Experience uninterrupted audio playback from the selected source. Direct individual's attention to comprehending the overall framework and primary concepts. Upon the first act of listening, make a record of significant aspects, unusual vocabulary, and noteworthy sentences that caught individuals' attention. Now, please replay the audio source. On this occasion, focus on the specific aspects of those components that were not obvious during the first hearing. Upon the second round of listening, succinctly recapitulate the main concepts conveyed in the audio using phrasing.

Artificial Intelligence (AI) has several applications in the field of communication.

Enhancing one's listening ability is crucial for improving pronunciation and communication proficiency. To enhance listening proficiency, one might engage in watching television shows, films, and videos. Another method to enhance listening proficiency is by using conversational artificial intelligence such as ZenoChat, which has a text-to-voice functionality. Text Cortex is an artificial intelligence assistant that provides many features to enhance an individual's language proficiency. TextCortex is accessible as both a web application and a browser extension. It seamlessly integrates with over 4000 websites and applications, allowing individuals to use TextCortex at any location and at any time to enhance his/her language proficiency. "Duolingo provides translation to help beginners learn a language and to help students become independent language learners" (Hazar 449). Furthermore, if one is seeking additional avenues to enhance individuals' language proficiency, Duolingo provides the option of engaging in voice conversations with actual individuals for a certain duration.

CONCLUSION

Modern media, as a technological advancement, considerably enhances the development of listening skills. It has a significant impact on enhancing one's listening ability. The researchers propose that English educators use the aforementioned instruments of modern media to inspire their pupils and engagingly instruct them. Various studies highlight the benefits of utilizing Modern Media for learning English and enhancing listening skills. These advantages include (a) the use of text and visuals to aid in language comprehension when presented alongside auditory content, (b) the enhancement of language processing through the combination of different media, making the input more immediate and noticeable for language acquisition, and (c) the motivational aspect of videos as a valuable tool for language instruction. An examination of the utilization of technologically advanced media aids in the instruction and acquisition of English, particularly in second language contexts, reveals that these aids offer significant advantages in the learning process. They promote a learner-centred approach that considers the specific needs of individual students, in contrast to the traditional instructional methods that revolve around the teacher as the sole authority of knowledge. Providing instruction to educators on the use of multimedia tools for teaching English as a second language. It is expected that as instructors become proficient in using these tools for teaching, the pupils will be more knowledgeable in that area.

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MELTS (Motivational English Language Teaching Sources) for Building Language Acquisition of Gen Z Tertiary Level Engineering Students: A Study

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Received: 24 May 2024

Revised: 03 Jun 2024

Accepted: 06 Jun 2024

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ABSTRACT

This paper advocates incorporation of MELTS (Motivational English Language Teaching Sources) in the English language curriculum for effective language acquisition and learning. This is primarily suitable for the Indian context. To substantiate the argument, a survey was carried out among the engineering aspirants of two colleges in South Tamil Nadu, India. The objective were (1) to analyze whether the social media platforms are used by students for learning English after the college hours and (2) to register their opinions on introducing modern contents like songs and stories in the English language curriculum. The result of the survey favours MELTS to be included in the English curriculum. Hence, exploitation of any suitable content into a productive ELT means is the key area of discussion. Further, the teaching fraternities of English are appealed to always go the extra miles in creating fun English learning materials (Chetan Bhagat, 2012.p114.) and thereby making an essential base for language acquisition and learning. Revamping English Language curriculum from time-to-time has been a constant initiative in the English academia and ELT research studies. In the line of creating and discovering many ELT contents, exploitation of social media contents has become a new add-on research in today's language learning scenario.

Keywords: Revamping English Curriculum, Motivational English Language Teaching Sources, innovative elt practices, exploitation of social media platforms for elt. and appeal to the English teachers.





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INTRODUCTION

Student motivation is an important focus of research in education for preferred “academic excellence”, (Zulfiqar Ali, 2010) and thereby it is obvious that the inclusion of motivational sources is essential in the English curriculum. Though the syllabi prescribed by university and autonomous institutions are excellent with teaching modules that are good enough to cater the language needs of the learners, notable aversions are found among the L2 learners in general. The syllabi may be competent to cater the language learning but not inspiring enough to keep the learners to be highly motivated towards language acquisition. The present learning generation belongs to ‘netizens community’ who wish to have more and more active English classes beyond books and classrooms. Motivational agents should be a primary part of every elt classes. Due to the competitive academic scenario, students get overwhelming academic commitments which over the period raise as uninteresting chores. Though students go ahead with those unavoidable responsibilities, a psychological burden due to these stereotypical academic routine makes them mentally so down. Both learning and teaching become pressure than pleasure. To address such challenges, inclusion of motivational sources/contents are ideal and they can positively build an active language learning ambience.

Background Study

The literature review is carried out to zero in on the research articles and studies that are in favour of motivational means and methods essential for English language acquisition and learning. M. Ryan and Edward L. Deci (2000) have coined the terms called intrinsic motivation and extrinsic motivation. Zulfiqar Ali, (2010), and Shabaz Khan, et al.(2013) defend student motivation is an important focus of research in education for preferred academic excellence. This places a clear call to the teaching fraternity to create or design an out and out student oriented curriculum. Saeed & David Zyngier (2012) highlight that intrinsic motivation produces authentic learning. Yes! Intrinsic motivation is vital for kindling the learning interest among L2 learners. Chetan Bhagat (2012.p114) in his book “What Young India Wants” underlines the need of “creating fun English learning materials” in the Indian English classroom context. Khan Shahbaz, et.al, (2013) emphasize on uninteresting contents or obsolete factors that can obviously demotivate students learning condition and this is the key area of discussion in the paper. Wong, R. (2013) underlines the need of enhancing student motivation which can stimulate the mind to language acquisition in a productive manner and it is quite obvious that the motivated learners are sure to produce the expected outcome. Alrabai, F. (2014) calls for teachers’ in-class motivational intervention. Teachers need to keenly watch the attention habit of every student and put him/her on the right track of learning when they tend to deviate from the learning track. Elana Enache, (2015) advocates maintaining the learners’ interest as one of a primary goals and this is the crucial area to be monitored by every teacher. Bhuvaneshwari R & Poomathi P, (2015) highlights the effective use of mobile to motivate students. Needless to underline the role of mobile phones in students’ life today. They are indeed the six fingers that should be productively exploited for effective learning. Kim Bower, (2017) introduced the term called Content and Language Integrated Learning (CLIL) which focuses on formulation of blended elt sources. Khansir Akbar Ali, et al. (2018) argues that motivation as a learning strategy. Afroza Mili, (2020) puts the emphasize on songs and stories in ESL classrooms as motivational agents that hold relevant and crucial value in learning a second language”

Survey

Social media platforms utilization by college students

The following is a short survey conducted with 535 First Year B.E./B.Tech (academic year 2023- 2024) students of Kongunadu College of Engineering and Technology, Trichy, Tamil Nadu, India. 401 students belong to English medium and 135 are from Tamil medium. They belong to the following disciplines: IT, CSE, ECE, AI & DS, EEE, AGRI, BME and MECH. The objective of the survey is to find out how they use their social media platforms like WhatsApp, YouTube, Facebook, and Twitter.

Title: The influence of social media on enhancing English language skills (LSRW) among the First Year (2023-2024) students of Kongunadu College of Engineering and Technology, Trichy.





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The questionnaire

1. Videos, talk shows, and various other interesting texts/content that you view in socialmedia platforms mostly capture your attention. Have you ever realized that these contents could be helpful in honing your English communication skills?
2. Besides viewing the social media platforms for entertainment, how often do you use them for language learning purposes?
3. Which one of the following social media platforms do you find the most effective for improving your English skills?
4. Do you follow English language learning pages or accounts on social media?
5. How confident are you in your English language skills after using social media for learning?
6. Have you ever participated in online English language challenges or contests on socialmedia?
7. Have you noticed an improvement in your vocabulary through social media engagement?
8. Do you interact with native English speakers on social media to enhance your languageskills?
9. How often do you share English language content on your social media profiles?
10. Has social media helped you improve your English writing skills?
11. Do you feel that using social media for English language learning is a productive use of your time?
12. Do you think that social media content encourages you to speak in English more often?
13. Have you ever taken online English language courses or lessons recommended on socialmedia?
14. What type of English content do you find most engaging on social media?
15. Do you use language learning apps or tools promoted on social media?
16. Has social media helped you build your confidence in speaking English in public?
17. How often do you watch live English-speaking events or webinars on social media?
18. Have you ever received constructive feedback on your English language skills through social media interactions?
19. Do you believe that social media can replace traditional language learning methods for engineering aspirants?
20. How do you manage your time between social media and other language learning activities?
21. Have you used social media to connect with other engineering aspirants for English language discussions?
22. Are you eager to use any attractive content from media like silver screen stories, etc. for developing your English communication skills ?
23. Which is your favorite topic to deliver a one-minute talk on?
Topic 1: Leo - review; Topic 2: Technology Today - Your view
24. My choice for learning English is - a BOOK or MOBILE for learning English or a faculty?

The following diagrams are a few responses by the students showing their utilization of social media platforms both for entertainment and learning aspects.

SUMMARY

Students actively utilize social media platforms at their leisure mostly for entertainment aspects. But they also pay attention to contents pertaining to English learning activities. Que. 1 makes it clear with 67% responses that the youngsters are well aware the contribution of social media contents in developing their English skills. In Que.2, it is learned that students use social media for language learning purposes daily and weekly in a positive manner. In Que.3, 61.5% votes YouTube as the favourite platform for English learning endeavour. At the same time only 23 % regularly follow English learning pages. Que.4 writing skill also could be considerable developed through social media. Students seem to have gained confidence after using social media shows Que.5. Surprisingly, there is a notable development in vocabulary skill due to the usage of social media registered in Que.7 with 74%. Using social media platform for English learning has been very productive only and if the students are guided properly





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it is quite easy to make them learn the language. Que.12 presents a positive response on the role of social media in developing Speaking

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Authors Note

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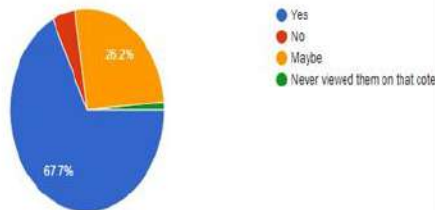




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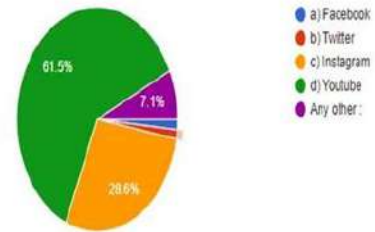
1. Videos, talk shows, and various other interesting texts/content that you view in social media platforms are mostly capture your attention. Have you ever realised that these contents could be helpful in honing your English communication skills ?

535 responses



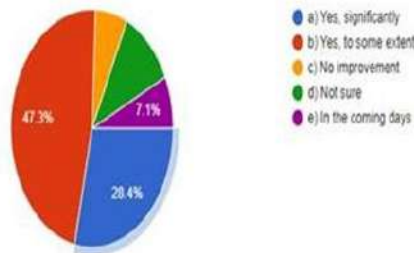
3. Which one of the following social media platforms do you find the most effective for improving your English skills?

535 responses



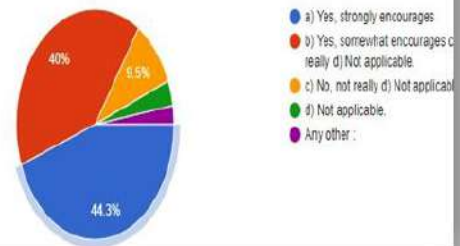
10. Has social media helped you improve your English writing skills?

535 responses



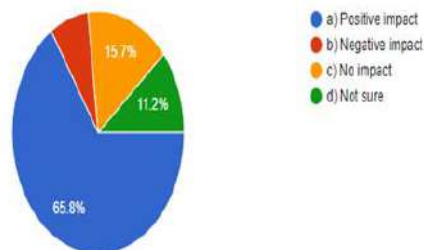
12. Do you think that social media content encourages you to speak in English more often?

535 responses



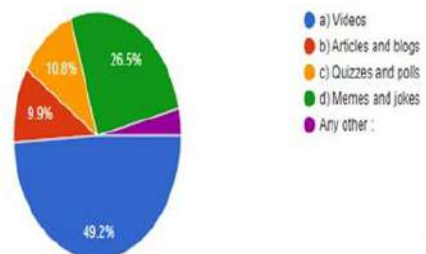
14. How do you perceive the impact of social media on your grammar skills?

535 responses



15. What type of English content do you find most engaging on social media?

535 responses

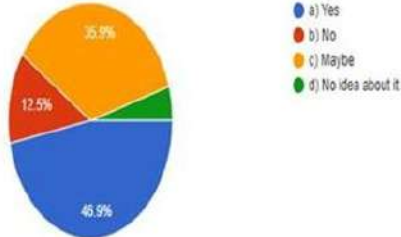




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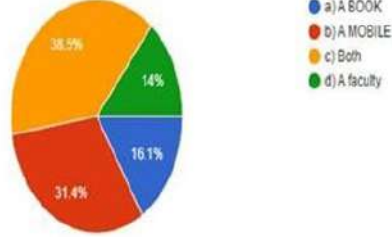
21. Are you eager to use any attractive content from media like silver screen stories, etc. for developing your English communication skills ?

535 responses



24. Which one will you pick up first - a BOOK or a MOBILE for learning English or a faculty ?

535 responses





Diasporic Dynamics: Unraveling Cultural Displacement and Identity in Jhumpa Lahiri's *The Namesake*

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

As globalisation opens doors for many to seek opportunities abroad, the dream of a better life can come with a hidden burden. Navigating a new culture, language, and customs can create a clash of identities, leaving immigrants feeling like outsiders. Jhumpa Lahiri, herself the child of immigrants, explores this complexity in *The Namesake*. Characters like Ashoke and Ashima grapple with nostalgia for their homeland even as they build a new life, highlighting the sense of disconnection that haunts them. The novel further delves into the identity crisis faced by both generations the first struggles with language barriers, cultural norms, and fitting in, while the second deals with reconciling their personalities with a culture that feels both familiar and foreign. This paper will explore the multifaceted experience of migration, particularly the theme of diaspora in *The Namesake*, analysis the challenges immigrants face.

Keywords: Diaspora, Colonialism, Migration, identity, dilemma, immigrant, diaspora, and alienation

INTRODUCTION

Over the past few centuries, there has been a notable flow in literature both within racial and ethnic communities within academic circles, all centered around the profound concept of diaspora. The term "Diaspora" finds its roots in the Greek word "diasperio," which denotes the act of distribution. It is a compound term, with "sperio" representing the act of sowing or scattering like seeds, and "dia-" signifying movement from one end to another. The genesis of diaspora can be traced back to the earliest chapters of human history, particularly in the biblical narrative of Adam and Eve's expulsion from the Garden of Eden, marking the commencement of this enduring journey of diasporic



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experiences. Millions of people moved around the world in the 1900s. Some were forced to leave because of bad weather or wars. Others, like people in Russia or India and Pakistan when they became separate countries, moved looking for a better life. When people move somewhere new, they are called a diaspora. This can happen because they are forced to leave or because they want to. These groups bring their old traditions with them and mix them with the new ones, creating a whole new culture.

Colonialism adds another layer to the idea of diaspora. Europeans moved all over the world, sometimes for a short time, to stay forever. This led to colonies being built. As these colonies got bigger, they needed more workers than the people already living there. Thus, diaspora became intertwined with the enslavement of Africans, their forced migration, and subsequent resettlement in regions like the British colonies. “Diasporic Consciousness” is a term of profound complexity, encompassing a range of sentiments and experiences. It includes the notion of living in exile, a deep sense of loss, the realization of being an outsider, an enduring longing for one’s homeland, a constant sense of dilemma, the weight of exile’s burden, dispossession, and the necessity of relocation. The initial step taken to leave one’s homeland is an act of courage, laden with risks, as it is a prerequisite for any hope of a better future. Immigrant’s lives are rarely linear, they traverse centuries of history within a single lifetime, experiencing numerous relocations and transformations. They face a persistent sense of uprootedness and a feeling of not truly belonging in their host countries. Despite their sincere efforts to assimilate, they often find themselves on the periphery, perpetually viewed as outsiders. Diasporic communities emerge from a fusion of narratives recounting journeys from the old country to the new, with first-generation immigrants tending to hold onto memories of their homeland more fervently than their children, who are born in the host country.

In his collection of essays and criticism from 1981-1991, Salman Rushdie eloquently describes immigrants as individuals who straddle two cultures and often find themselves caught between two worlds. “They endure a triple disruption, encompassing the loss of their roots, linguistic displacement, and social dislocation” (Rushdie 5). This predicament can be likened to that of Trishanku, an epic character from the Ramayana, who was neither accepted in heaven nor on earth, ultimately settling in a liminal space between two realms. Trishanku’s plight serves as a poignant metaphor for modern-day emigrants who navigate the complex and contested terrain of their universal native identity.

Even when they move far away, immigrant groups hold onto their roots. They keep speaking their home languages, practicing their religions, and celebrating their traditions. They tell stories and remember their history to keep their unique cultures alive, even in their new homes. However, this pursuit can lead to a profound sense of being “individuals without an anchor, without a horizon, colorless, stateless, and rootless - a race of angels” (Hall 226).

The diaspora phenomenon has significantly enriched the world of literature. Many Indian writers residing abroad or in foreign lands have channeled their experiences into creative writing. This marks a notable shift from earlier times when Indian writers seeking insights into creative writing often relied on interactions with foreign visitors to India. Indian diaspora writers have explored themes such as the loss of identity, feelings of isolation, the sense of constant change, adaptability, and movement. The theme of diaspora holds a prominent place in Indian literature, contributing to a broader understanding of cultural dynamics between different countries. It provides valuable insights into diverse customs and traditions, enriching our knowledge of global multiculturalism.

Literature, as a reflection of culture, serves as a powerful source for understanding the world’s current affairs and multiculturalism. It offers a unique blend of facts and captivating narratives that engage readers and raise awareness about contemporary society. Moreover, the study of diaspora themes in literature raises essential questions about the distinction between one’s homeland and foreign land. Thus, literature, as a cultural creation, becomes an invaluable tool for comprehending global realities and the complexities of multicultural societies. Jhumpa Lahiri, an Indian-American author born in London, made a huge splash with her first book. *Interpreter of Maladies*, a collection of short stories, won the Pulitzer Prize in 2000, a first for a South Asian writer. Translated into 29 languages and a bestseller everywhere, the book launched her award-winning career. Jhumpa Lahiri’s literary work appears to convey a fundamental message, the differences among human cultures are primarily shaped by human desires and



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experiences. Her writing style, characterized by its simplicity and clarity, predominantly explores the lives of Indian immigrants in America, individuals caught in the complex web of cultural influences, and their quest to find a place in their new homeland. Lahiri's unique ability to juxtapose historical cultural conflicts with contemporary cultural dynamics and to give voice to a diverse array of characters has garnered widespread attention and acclaim.

Jhumpa Lahiri, renowned for her Pulitzer Prize-winning short stories, expanded her literary repertoire with her debut novel, *The Namesake*, which was published in 2003. Originally conceived as a novella published in *The New Yorker*, it transformed into a full-length novel. The narrative centers around the fictional Ganguli family, spanning over three decades. Ashoke and Ashima, the parents, both hailing from Calcutta, make the life-altering decision to migrate to America following their marriage. Their two children, Gogol and Sonia, were born and raised in the United States. The novel delves into the complexities of navigating two divergent cultures, marked by distinct social, religious, and philosophical differences. It serves as a profound exploration of cultural identity, integration, and assimilation, using Gogol's struggle with his name as a poignant entry point.

Gogol, named after a Russian writer his dad loved, hated his name. He didn't like being named after someone who wrote a story his dad thought saved him from a train crash. Even when he turned 14, he didn't care about the book of stories his dad gave him by the same author. As Gogol grew up, he went to college, fell in love with Maxine, and moved to New York to be an architect. But things weren't always easy, especially after his dad died. Later, he enters into a relationship with Moushmi, introduced to him by his mother, and they marry, though their union faces its own set of challenges. Ultimately, Gogol's journey leads him to a profound reconciliation with his name and his cultural heritage. The role of fate, particularly the loss of his father, plays a pivotal role in reshaping his perspective. This transformative journey culminates as he returns home for a Bengali Christmas and rediscovers his father's gift a collection of Gogol's short stories bringing the narrative full circle.

Jhumpa Lahiri's first novel follows the journey she started with her award-winning short stories, the experiences of Indian immigrants. These immigrants often face challenges due to cultural differences and feeling alone in a new country. Immigrant families, across generations, struggle with figuring out who they are in this new culture. Language barriers, different foods and clothes, and even personal identity all play a role in this confusion. For Gogol, this struggle is clear even in his name, which he doesn't feel connected to. The feelings of missing their old home, loneliness, and not feeling like they truly belong anywhere are strong and deep. Ashima feels out of place because of the move itself, stuck between two worlds. Gogol and his sister Moushmi have an even more complex issue - they're a mix of cultures, which makes them feel even more isolated. Ashoke and Ghosh gave up their old life to find a new one, but they'll always feel like they're not quite settled anywhere.

Jhumpa Lahiri, a writer of the Indian diaspora, delves deep into the issues of identity, nostalgia, alienation, and the clashes between divergent cultures. Drawing from her own experiences as an Indian immigrant, she skillfully portrays these challenges through her characters. Lahiri's recurring theme revolves around the bittersweet experiences of emigrants from India to America. Her narratives predominantly feature characters who immigrate to foreign lands, where they find themselves caught in the clash of cultures. Although they may be initially enthralled by their new surroundings, they are unable to escape the haunting loss of their original homeland. Gogol's vehement disdain for his name epitomizes this struggle: "But instead he takes a deep breath and tells the people in the courtroom what he has never admitted to his parents. I hate the name Gogol. I've always hated it" (Lahiri 102). By this point, Gogol detests everything associated with his name, considering it both absurd and obscure.

The novel *The Namesake* explores the struggles of immigrants living between two cultures. The parents, Ashima and Ashoke, miss their Indian life and customs, while their children, Gogol and Moushmi, feel like outsiders in both America and India. Even though they try to fit in, they still feel a sense of loneliness and never quite feel at home, no matter where they are. This is shown by Gogol not even liking his Indian name. *The Namesake* delves into the depths of cultural displacement. For example, Ashima's distress surfaces when Gogol informs her that he has rented a room for three months, and she struggles with the distance her children now maintain:





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Having been deprived of the company of her own parents upon moving to America, her children's independence, their need to keep their distance from her, is something she will never understand. (Macwan 122)

When people move to new countries, they often write stories about their experiences. These stories can be sad because they miss their old home, but they can also be creative and teach us about different cultures. Novels like *The Namesake* show how Indian families living abroad connect back to India while also building new lives in other places, like America. This mixing of cultures helps us understand each other better and creates a more peaceful world.

Through *The Namesake*, Lahiri lays bare the trauma and hardships of migrating to a foreign land, offering a stark message to those who harbor dreams of a better life abroad. Lahiri keenly observes that many individuals, in their pursuit of a luxurious life overseas, often overlook the profound impact of displacement, which requires a remarkable adaptability to new climates and cultures. Conversely, the issue of one's identity cannot be neatly resolved by a mere name on record. Identity quandaries faced by individuals take shape through introspection and self-discovery. For those born in their homeland, the question of identity seldom arises, as they are nurtured within the familiar embrace of their society. They are sons and daughters of a place where their social status is defined. Their identity is seldom a matter of concern because they are known and recognized by the people in their society. However, for those born in foreign lands, the question of identity becomes an ever-present companion. They feel like complete strangers in their new environment, where differences in skin color, language, and culture form a complex blend that compels them to embark on a journey of self-discovery. For second-generation immigrants, the crisis of identity persists throughout their lives. Gogol's quest to find his identity embodies the essence of diasporic awareness. When people move to new countries, it can be a chance for them to learn and grow as individuals. It can also help them figure out who they are in this new world. These stories of people moving around are like a history book, showing how a culture changes and grows over time.

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Assessment on alignment of Learning Outcomes and Analysis in the Foundation Program of Muscat College: Analysis in English Language Teaching and Learning Process

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Teaching and learning are two sides of the same coin -Education. However, what aligns teaching – learning and creates a bridge between them is assessment. Every educator, regardless of the module he/she teaches is fully aware of as assessment is the most important tool with which to measure teaching and learning. Assessment, whether it is formative or summative, is very helpful in determining how far the teaching-learning process has been successful. Assessment not only helps in demonstrating the areas of excellence, but it also directs us towards the points of weaknesses. This is helpful in reflecting on specific strategies and methods that need to be continued and improved upon, and those ways and strategies that need to be discontinued to allow more suitable and result-oriented approaches to be developed. Assessment as a feedback tool is highly important to identify high achievers and subsequently reward them- be it a student or a member of teaching faculty. Additionally, assessment as a feedback tool also demonstrates a link with the curriculum and provides appropriate feedback on the curriculum devised for a particular level of the foundation program. Armed with this feedback, curriculum can be changed, improved, or adapted as per the needs of the learners.

Keywords: Analysis, ELT, Learning Outcomes, Feedback, Curriculum, Assessment.



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INTRODUCTION

The importance of Assessment

It is an undeniable fact that assessment greatly influences the learning process. However, a more important aspect to consider is, to what extent is the teaching-learning process influenced by assessment and if this influence is negative or positive. Assessment provides feedback to students on how far they were successful in learning and improving their language skills, to teachers, as to how fruitful their teaching strategies and methods were in the classroom including specific curriculum designed to achieve desired results. Assessment offers students information on how well the learning has taken place and this is called “feedback”. Additionally, it offers students ideas on how to improve next time, which is “feed forward”. It also provides students with information on how their course learning outcomes contribute to the achievement of higher-level program outcomes, which is “feed up”. Here comes into picture the very vital curriculum, the course material, and the tools of assessments. It is worth mentioning that course books chosen as well as the assessment tools designed must be based on certain specific learning outcomes of a particular course that are aligned with the learning outcomes of the program. The narrative begs a question, “do students really learn what we teach in the classroom”. The answer might surprise and create resentment in us as teachers, but the fact is, if students are really learning all that is taught to them in the classroom, then we would not need assessment at all. We could just pile up all the learning experiences and the exchanges that took place between the teacher and the student and the students themselves in a portfolio and be done. However, the reality is further from the truth. It is impossible to predict with certainty if learning has taken place, no matter how well the material is designed and implemented during the instruction. Here comes assessment as a bridge between teaching and learning to find out if the teaching-learning activities that students were engaged in resulted in the achievement of intended learning outcomes.

Assessments in ELT

Having established the need for assessment, it is imperative to identify the type of assessment that is needed based on the learning outcomes intended for achievement. Broadly, there are three different types of assessments which are usually employed to gauge the level of the students in any ELT setting. They are diagnostic, formative, and summative assessments. Diagnostic tests as the word suggests are the tests that identify a students’ current knowledge in a specific learning skill of Language Teaching, whereas formative assessment is the feedback that is taken during the process of instruction and while the teaching learning is taking place. On the other hand, summative assessment is the feedback given after the learning has been completed which pretty much sums up the process of teaching and learning.

Diagnostic Tests

Diagnostic tests identify the key skilled areas and capabilities of a student and give educators a broad picture of a students’ strengths and weaknesses. Awareness of a students’ abilities and learning level helps in planning the instructional material and activities suitable to the level of the student. The GFP in the Language Centre of Muscat College uses standardized tests from Pearson called Pearson Level Test as the diagnostic tests based on which students are placed into different levels. These tests are composed of questions that target individual as well as integrated language skills of a student. Questions in this test range from gap filling to completing reading comprehension questions and describing a picture as well as responding to spoken prompts. The scores of Level Test are based on the Pearson Global Scale of English (GSE) 10-90 as well CEFR A1-C2. The scores are given in a descriptive manner enumerating the performance of the students in each skill as well as in GSE range and CEFR score.

Once the students are placed in a group as per their performance in the level test, instruction is easily delivered by following the learning outcomes that are spelled out for that specific level. The language center of Muscat College delivers the General Foundation Programme in three levels, English 1, English 2, and English 3 with the duration of each level being ten weeks.



**Nuzhath Fatima****Formative Assessment**

Formative assessment is one of the most important components of assessments at Muscat College Language Center. As we all know, the main aim of formative assessment is to measure a students' progress while the learning is taking place. Additionally, it also provides valid feedback on the instructional process as well as the instructor. Formative assessment leads to the identification of areas in teaching and learning that need improvement. These areas might be the methods of teaching, activities employed during this process, and strategies used to impart instruction. If a weakness is noticed, then it is easy to fix the gap by changing the method of teaching utilizing a variety of activities to gauge the effectiveness of teaching. In addition to collecting feedback, another important component of formative assessment is the evidence that is collected. For the feedback to be effective and qualitatively valid, right questions need to be asked and the right time. It is commonly observed that teachers administer formative assessments and have a meeting to discuss the implications of the data collected. By this time, the teaching "has moved on" to another item of language learning or to a different unit in the course book. To overcome this, we at the Language Centre of Muscat College plan and carry out formative assessment activities spread over the semester, so that, students' feedback is timely available to make necessary modifications in the teaching strategies and course material can be adapted where needed to fix the deficiencies as we progress into the semester.

Muscat College Language Center uses a variety of well-prepared formative assessment tools which are in complete alignment with our learning outcomes which in turn aligns with the learning outcomes specified by the Oman Academic Standards (OAS).

In addition to periodic feedback from students on teaching instruction and the instructor, we also include peer tutoring, discussions between the teacher and the student during office hour, one-to-one tuition to explain and clarify any difficulty in a specific language item, and other teaching-learning related issues. Formative assessment also includes power point presentations on specific topics related to the coursebook, group discussions, debate, and essay writing on a variety of genres depending on the level being taught. Power point presentations and group discussions incorporate the learning outcomes of developing cooperative and collaborative learning among the students, while encouraging critical thinking and problem-solving abilities. Essay writing on topics of current issues promotes professional, ethical, and social responsibility among the learners while encouraging the spirit of teamwork. Research carried out by students towards the completion of their ESP projects helps in not only developing their research and writing skills but also enhances their domain knowledge and allows students to assume responsibility as a global citizen. Additionally, it inculcates an attitude of accountability in students whereby they adhere to the principles of academic integrity and claim the rightful ownership of their work.

Summative Assessment

Summative assessment is the feedback which sums up the teaching and learning process. It takes place after the completion of teaching-learning and provides valuable information on how far the learning process was successful. At this stage of assessment, no formal learning will take place except maybe the completion and submission of assignments and projects. Summative assessments are usually developed around an established set of standards or expectations that are formulated in the form of rubrics. Having a set of well-drafted rubrics helps the instructor to be objective in his/her assessment of students' work whereas the same rubrics provide students with a specific criterion with which to work on a particular project. Summative assessments usually test the acceptable level of knowledge gained by the student so that he/she can progress to the next level. Typically, summative assessment is given at the end of a semester, or a term and the intended outcome is to assess how effectively teaching learning has taken place. It must be noted that summative assessment is more product based as it evaluates the final product, be it in the form of student's learning or teaching strategies, whereas formative assessment is process based as it assesses the process of teaching learning.

The foundation programme of Muscat College uses the standardized Pearson Benchmark Test as summative assessment for all the levels. We have sort of become the pioneers in administering the online benchmark test as a tool for our summative assessments. In addition, the reliability and validity of these tests is well established in the educational circle. The level of the test to be administered to a specific group of students is decided on the learning



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outcomes the test assesses with the learning objectives put forth for that group or level. For example, for EN3 students we administer test B1 where there is absolute alignment between the outcomes assessed to the objectives of the course.

The above data is from the benchmark results of test takers who were assigned the B1 test. As is seen, the results of this test are very comprehensive in the form of a graph and table which is followed by a written description of a students' performance. This gives us a complete picture as to where a particular student is with regards to his/her level of English. This is also helpful to us in making a comparative study of the improvements that a student has made in learning the language since taking the diagnostic test. For most students with few exceptions, a comparison between the results of diagnostic test and the benchmark test shows a satisfactory level of improvement in the language learned.

CONCLUSION

An EFL classroom is a diverse, and complex setting. This diversity is what lends a classroom its dynamism in terms of students with extremely varied learning preferences and styles, teachers with different educational backgrounds and teaching styles influencing the classroom setting and the students' learning and behavior. Every teacher wants to know the magic formula that works in a classroom. But the fact of the matter is that every activity that is used in the classroom works by enriching students' knowledge of the language. However, not everything works for everyone and in every classroom. The complexity of a classroom makes it difficult for one prescription that works as a success formula. A strategy that worked wonders in the context of one classroom might be disastrous in another classroom setting. Hence, it is the discretion of a teacher to adapt teaching strategies and testing methods that best suit their own teaching styles to benefit students maximally as per their learning styles. Proponents of formative assessment spell out innumerable advantages of this type of assessment whereas those who back summative assessment preach the benefits of summative assessment. Each has its own benefits and drawbacks. Some aspects of formative assessment are workable while some other aspects of summative assessment work for others. It is entirely up to teachers to choose the type of assessment to be employed and how best to adapt it for their teaching style, students' learning preference, learning outcomes to be achieved, curriculum and the context provided. There can never be one successful model of assessment, but a combination of both types will help in bringing back to the learner and the learning set up which forms the crux of any educational setting.

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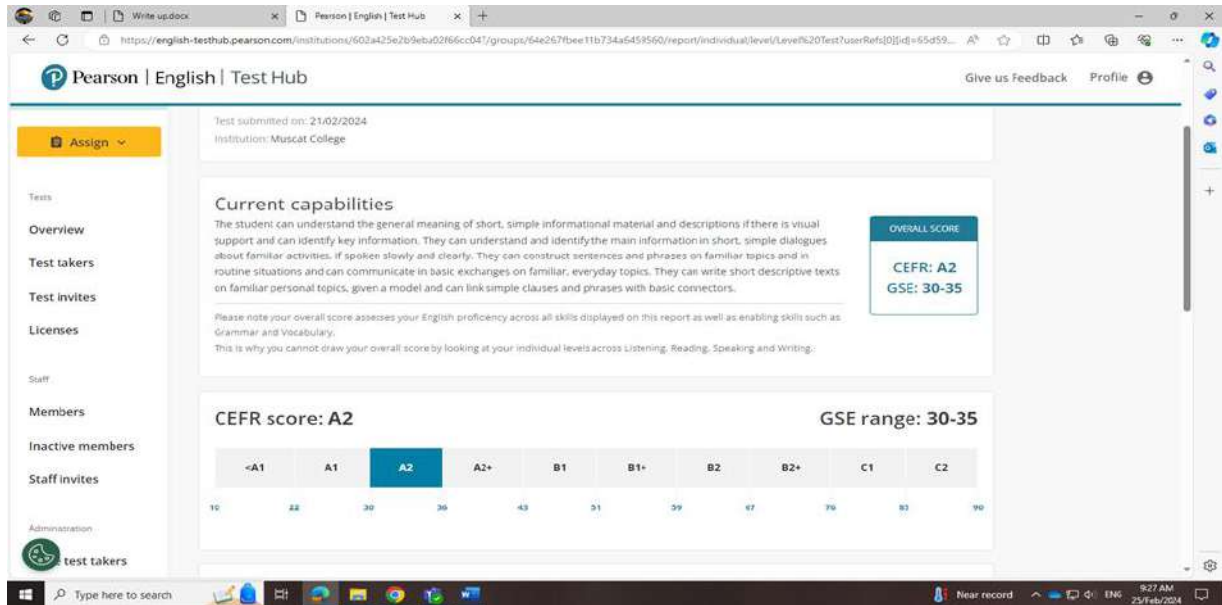


Fig.1. The Pearson Level Test results of a test taker, in graphical data

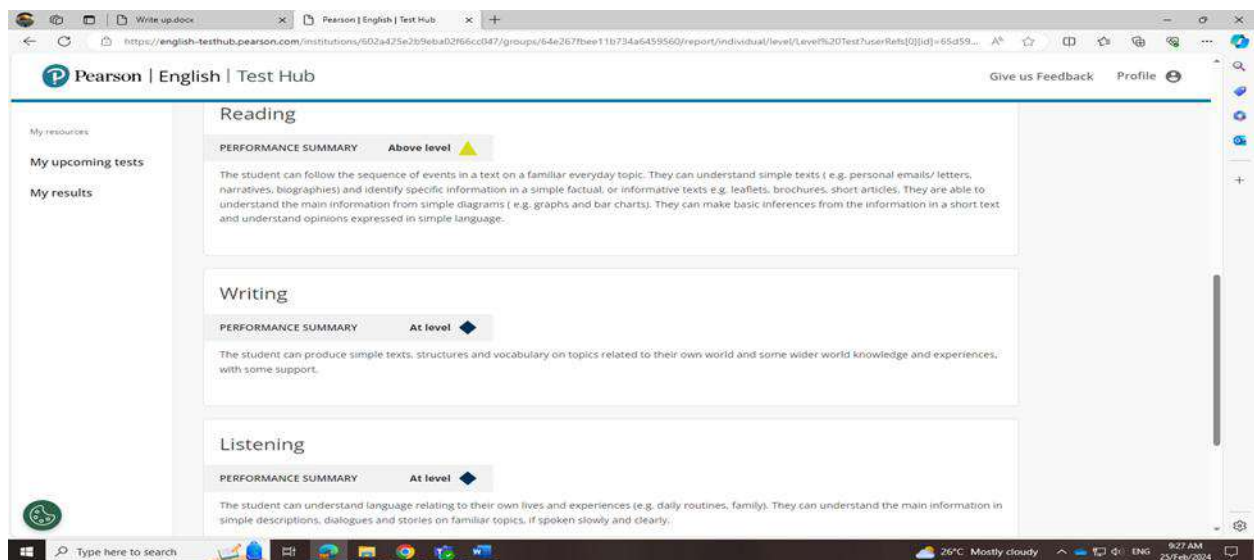


Fig. 2. The Pearson Level Test results of a test taker with detail description of all the skills





Nuzhath Fatima

Muscat College
The Language Centre
Course Outline 2023-2024

Module Code & Title	CEFR Level	Contact Hours/Semester	Assessment Methods	Reference Materials
EN3-English Level 3	B1+	Full-time: 200 Part-time: 120 Independent Study Hours: 45	Formative and Summative	<ul style="list-style-type: none"> Course Book -New Language Leader-intermediate Supplementary material & Authentic Materials

Learning Outcomes - Teaching weeks – 10 weeks

- Listen to a conversation between two or more speakers and be able to answer questions in relation to context.
- Be able to transfer specific information from a listening text into a table/diagram.
- Read and respond to a 1-2 pages (350-450 words) text in a given time frame.
- Match vocabulary by guessing the meaning through context.
- Be able to extract information to answer different types of questions.
- Be able to analyze a text or an article.
- Produce texts of 250 words showing control of the organization and layout as well as grammar and vocabulary.
- Produce a written report showing evidence of research, note-taking, paraphrasing and summarizing.
- Be able to look at data in graphs and write a report describing them.
- Prepare and deliver a talk of at least 3 minutes. Speak clearly and confidently, make eye contact and use body language to support the delivery of ideas.
- Be aware of plagiarism and how to avoid it.
- Discuss different types of sources in presentation and writing.
- **The able to work in a team, share ideas and express opinions**
- **Actively participate in a discussion, share ideas and express opinions**
- **Acquire and be able to use 21st Century Skills (Problem solving, Critical Thinking, Negotiating and Decision making, professional skills)**

Fig. 3. An example of the learning outcomes of module EN3

Muscat College
The Language Centre
Continuous Assessment Criteria EN3

Assessment	Learning Outcomes	Programme Graduate Attributes and College Generic Graduate Attributes	Teacher	Marks awarded	Week Assessed
Progress Test	<ul style="list-style-type: none"> • Learning Outcomes of Units 5-7 (Intermediate) • Academic Word List (Sublists 1,2,3,6,7,8) 	<ul style="list-style-type: none"> • Communication and IT skills • To utilize analytical thinking skills in different contexts 	T1/T2	5	Week 4
Essay Writing Problem and Solution Essay	<ul style="list-style-type: none"> • Use context-specific vocabulary and grammar correctly. • Write essay showing control of layout, punctuation, spelling and appropriate linkers. 	<ul style="list-style-type: none"> • Communication and IT skills • Evaluative and analytical thinking • Omani Culture and values • Domain Knowledge and skills with Global perspective • Revise the learning outcome of the course-book 	T1/T2	5	Week 6
ESP Group Project	<ul style="list-style-type: none"> • Note-taking skills and organizing skills. • Writing and research skills • Teamwork 	<ul style="list-style-type: none"> • Domain Knowledge and skills with Global perspective • Academic Integrity 	ESP T	10	Week 8 (Submission)
Presentation Skills	<ul style="list-style-type: none"> • Speaking skills • Develop vocabulary. • Self-confidence 	<ul style="list-style-type: none"> • Domain Knowledge and skills with Global perspective • Evaluative and analytical thinking • Communication and IT skills 	T1/T2	10	Week 3 Week 5 Week 7

- All continuous assessments will be based on a specific rubric which assesses the desired learning outcome(s).
- Continuous assessments will carry a total of 30 marks and final exams will carry a total of 70 marks.
- Submissions must be uploaded onto Moodle and documented with references.

EN3 Coordinator

Fig.4. An example of assessment activities based on learning outcomes of module EN3





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Fig.5. The Pearson Benchmark Test results of a group of test takers, in graphical data

NAME	LEVEL	OVERALL	LISTENING	READING	SPEAKING	WRITING	REPORTS
SAADAH ALHASHAR	B1	51	55	39	58	49	
ALZAHRAA ALSUBHI	B1	NA	BL	BL	BL	BL	
RETAL AL LAMRI	B1	NA	52	NS	58	BL	
SONDOS RASHID AL RIYAMI	B1	55*	58	BL	58	52	
HANOOF ALALAWI	B1	58*	58	BL	58	57	
RAGHAD AL-TAMIMI	B1	50	53	40	58	38	
SHURDOQ ALHUMADI	B1	39*	52	NS	42	40	

Fig. 6. The Pearson Benchmark Test results of a group of test takers in numerical data





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END ALQUMASHOUH	A	16	19	15	27	13
SHAHAD ALKHALIM	A	NA	BL	13	NS	16

Listening: 16

PERFORMANCE SUMMARY
The student can identify everyday objects, people or animals in their immediate surroundings or in pictures from short, basic descriptions, if spoken slowly and clearly. They can understand simple questions asking for basic information about objects in their immediate surroundings or in pictures.

RECOMMENDED ACTIVITIES
Extend the range of vocabulary and language they can use to describe the world around them (e.g. family, pets etc). Introduce them to listening tests beyond a few sentences.

SUGGESTED GSE LEARNING OBJECTIVES
Can understand very basic common classroom instructions.
Can understand the time of day when expressed in full hours.

Reading: 14

PERFORMANCE SUMMARY
Students at this level can generally recognise familiar names, words and very basic phrases. They can recognise basic plural forms of nouns (e.g. cars, books).

RECOMMENDED ACTIVITIES
Organise activities where students have to recognise words; could be done as a group activity; words can be written on the board, students are given cards with words on them and they have to pick the right one. Have them read aloud to increase knowledge of words.

SUGGESTED GSE LEARNING OBJECTIVES
Can recognise familiar names, words and very basic phrases on simple notices.
Can identify very common food and drink on a menu.

(A descriptive analysis of students' performance)





Adaptive Multiband Patch Antenna with Circular Slots, Applications in WLAN, WiMax and UWB

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

This paper presents an innovative adaptive multiband patch antenna with circular slots for wireless applications. The antenna design is straightforward, featuring a defected ground structure (DGS) formed by circular slots of varying radii, a 50-ohm feeding line serving as the radiator, and a rectangular slit coupled to the circular slots on the ground plane. Furthermore, reconfigurable multiband resonances are achieved by strategically placing PIN diodes at the circular slots on the defected ground plane and toggling them as needed. The proposed antenna features three tunable resonant frequency bands at 2.5, 3.5, and 5.7 GHz, suitable for WLAN, WiMax and UWB applications. Designed on an FR4 substrate, the antenna design is compact, measuring $28 \times 16 \times 0.8 \text{ mm}^3$. Its ability to reconfigure resonant frequency bands across a wide spectrum makes it well-suited for various wireless communication applications.

Keywords: WLAN, Wi Max, ultrawide band (UWB), defected ground structure (DGS), PIN diodes

INTRODUCTION

The adaptive antenna is a more attractive design choice than fixed antennas due to its ability to offer variable radiating properties, such as resonance for wireless communication systems. This additional level of control enables field adjustments to meet specific standards, compensate for manufacturing defects, and Resilient systems against evolving standards. Tuning sensitive wireless configuration devices often involves using a varactor diode or a tuned resistance. Recently, adaptive antennas have large attention for their possible uses in communications, electronic





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surveillance and countermeasures. In Adaptive antennas, switching allows for the alteration of the radiating element's shape. Antennas capable of supporting multiple wireless protocols will be essential for future cognitive communication systems. [1]-[5]. Multiband antennas are extremely beneficial in contemporary wireless applications because they are able to function across multiple frequencies with a single antenna. However, fixed multiband antennas often require sophisticated filters with strict criteria to enhance their ability to reject out-of-band interference. These filters can significantly increase the complexity of any communication system due to their size. Adaptive antennas offer a solution by improving out-of-band noise rejection, potentially overcoming these limitations. Adaptive antennas are capable of dynamically adjusting their operating frequencies, pattern, polarization and other properties in response to external stimuli. Depending on the application, adaptive ability may involve multiple distinct features. Adaptive antennas can generally be classified into three categories, beginning with reconfigurable frequency. The primary goal is to optimize the antenna's operational frequency, creating a compact terminal with an adaptable antenna appropriate for several applications [6]-[10]. Newly, there has been concentration in frequency reconfiguration, driven by revolutionary concepts in wireless communication such as cognitive radio, which utilizes wideband sensing and programmable narrowband transmission. The second category of reconfigurability involves altering the pattern while sustaining the same frequency range to meet specific system requirements. The third category focuses on polarization reconfigurability, allowing switches from linear to circular polarization. Various switching technologies enable reconfigurability, including optical switches, field-effect transistors, PIN diodes, and RF MEMS switches [11]-[15]. The antenna design under consideration covers essential frequency bands required for Wireless Local Area Network (WLAN), Worldwide Interoperability for Microwave Access (WiMAX) and Ultra-Wideband (UWB) applications. This antenna can resonate at three frequencies simultaneously. Adaptive antennas proposal substantial advantages for modern communication systems by providing versatility in operating frequency, polarization and radiation pattern. The radiation of an antenna can be utilized for signal localization, interference avoidance and noise mitigation, thereby enhancing communication security. These antennas play crucial roles in radar systems, satellite communications, wireless communications and related industries driven by the increasing demands in these fields [16]-[20].

The Microstrip Patch Antenna (MPA) was initially conceptualized in the 1950s and became practical in the 1970s. It consists of a radiating patch, a dielectric substrate, and a ground plane. Figure 1 illustrates the basic construction of the MPA. The radiating patch, printed on the dielectric substrate, forces the EM waves to radiate at a specific frequency. The patch can take various shapes and sizes, such as rectangular, circular, slotted, triangular, and more. The substrate and patch dimensions are chosen according to the frequency of operations and the features of the dielectric substrate material utilized. The antenna's physical attributes, including patch length and width, substrate length and width, feed location, and feed length, can be considered using various mathematical equations. Each dielectric solid has its own characteristics, dielectric constants, and conduction properties, which affect the fringing waves in the patch antenna. Common dielectric materials include FR4 Glass Epoxy, Bakelite and Roger RT/Duroid, selected based on the antenna application and cost. Various feeding techniques, such as microstrip line, proximity coupling, inset feed, aperture coupling, and coaxial probe feed, accustomed to deliver the signal to the antenna for transmission via EM waves. This paper introduces a miniaturized adaptable multiband antenna design. The designed antenna features a tunable resonant frequency with good matching ($S_{11} \leq -10\text{dB}$) across 2.5, 3.5, and 5.7 GHz. A DGS is employed on the reverse side of the substrate using circular slots of varying radii. Positive-Intrinsic-Negative diode (PIN) are utilized as switches within these circular apertures in the ground plane to achieve different resonant bands. Specifically, the antenna offers tunable band-pass characteristics centered at 2.5 GHz (for WLAN), 3.5 GHz (WiMAX), 5.7 GHz (WLAN), and 6.5 GHz (C-band).

ANTENNA DESIGN

Antenna Components

The physical arrangement of the antenna design under consideration is illustrated in Figure 2. This design is simulated on a low-cost FR4 substrate through a relative permittivity of $\epsilon_r = 4.4$ and a depth of 0.8 mm. The antenna takes a compacted total size of $28 \times 16 \text{ mm}^2$. The antenna's feeding line is located on the top side of the laminate, while the ground plane is positioned at the underside of the substrate. The radiating component is a 50-ohm fed





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microstrip antenna with dimensions of 18.4 x 1.6 mm². It features a rectangular profile achieving impedance matching across a broad range of frequencies. The antenna design under consideration demonstrates effective impedance matching across the 2 GHz to 7 GHz spectrum. The design parameters are detailed in Table I.

Design of DGS

DGS refers to Defected Ground Structure, where the metal ground plane of a microstrip circuit is intentionally altered to improve its performance. The fundamental component of DGS is a resonant gap or slot in the ground metal, strategically positioned beneath a transmission line to optimize coupling with the line. Figure 2(c) illustrates the arrangement of a ground structure for a multiband antenna. Achieving resonance across multiple frequency bands is facilitated by integrating a ground plane with intentional defects on the reverse side. The antenna element, originally designed for wideband operation, is tuned to operate across several narrow and wide frequency bands using circular slots in the DGS. These circular slots have radii R1, R2, and R3, and are supplemented by a rectangular-shaped slit coupled to the circular slots on the ground plane. The overall arrangement of the defected ground plane enables triple-band operation with central frequencies at 3.5 GHz, 5.8 GHz, and 6.5 GHz.

MULTIBAND ADAPTABILITY

The range of frequencies in which operation is desired is determined by the effective dimensions (length and width) of the resonant structure and the precise positioning of this structure. Through the use of equations(1) and (2), one can derive the resonance characteristics needed for the preferred ranges of frequencies.

$$W_{1,2,3} = \frac{c}{2f_o \sqrt{\epsilon_r + 1}} \quad (1)$$

$$L_{1,2,3} = \frac{c}{2f_o \sqrt{\epsilon_r}} \quad (2)$$

Adaptability is facilitated by employing three PIN diodes for switching purposes at the circular slots of the ground plane. The following three scenarios are provided:

Situation I

When switches S1 and S2 are in the 'OFF' state, and SW3 is in the 'ON' state, the outer circular slot with radius R3 in the defected ground exhibits capacitive behavior, while the radiating patch introduces inductive effects. This configuration forms a band-pass filter for WLAN 2.5 GHz, as showed in Figure 3.

Situation II

Dual-band operation for WiMAX and C-band frequencies is accomplished as in Figure 3, when switches S1 and S3 are in the 'OFF' state, and switch S2 is in the 'ON' state. This configuration enhances the capacitive impact of the slot on both sides of the connection.

Situation III

Triple-band operation is achieved by activating switches S1 and S2 while deactivating S3. The operational bands, namely WiMAX, WLAN, and C-band, are illustrated in Figure 3.

OUTPUT DISCUSSION

S-parameter and VSWR

The proposed design is simulated on an FR4 laminate with a depth of 0.8 mm, ϵ_r of 4.4, and a tangent of loss of 0.02, as represented in Figure 3. The outcomes specify that the antenna achieves good return loss ($S_{11} < -10$ dB) across multiple resonant frequency bands, specifically 2.5 GHz, 3.5 GHz, and 5.8 GHz, employed in WLAN, WiMAX, and UWB applications. In Figure 4, the designed antenna's Voltage Standing Wave Ratio (VSWR) is displayed., demonstrating that it meets the required criteria ($VSWR < 2$) for the bands that resonate.





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CONCLUSION

This paper presents a miniaturized multiband antenna with the capacity to be reconfigured suitable for WLAN, WiMAX, and UWB applications. Multiband operation is enabled through a defected ground structure (DGS). Furthermore, the antenna offers tunability and reconfigurability across WLAN, WiMAX, and C-band frequencies, with central frequencies of 2.5 GHz, 3.5 GHz, 5.7 GHz, and 6.5 GHz respectively. These features highlight the suitability of the antenna that was created specifically for use in portable wireless communication.

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Table 1: Parameters

Parameters					
Parameter	L	P _w	G _L	W	P _L
Value(mm)	28	1.6	3	16	18.4
Parameter	R ₁	R ₂	R ₃	G _w	-
Value(mm)	2	3.1	2.7	4.8	-

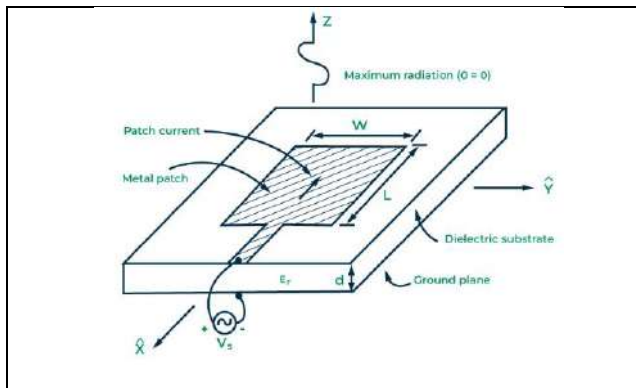


Fig.1 Construction of MPA

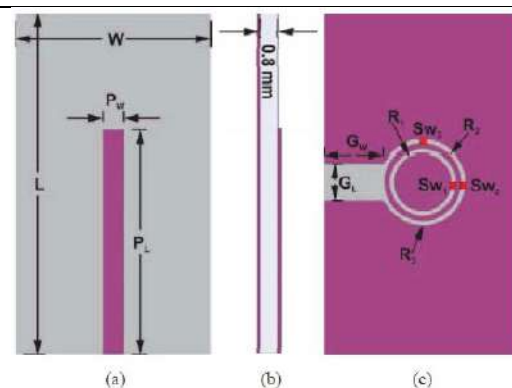


Fig.2 Geometric arrangement of the multiband antenna design (a) Front view (b) Side view (c) Back view

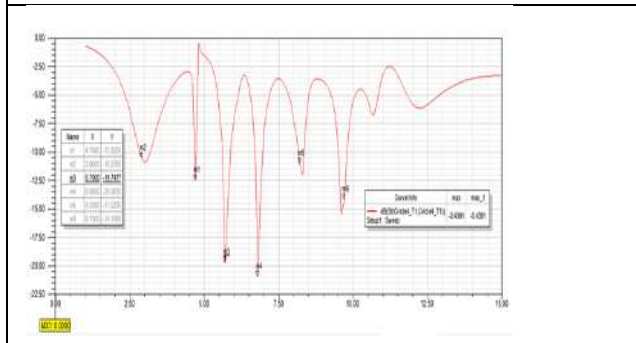


Fig.3 S11 parameters of proposed antenna

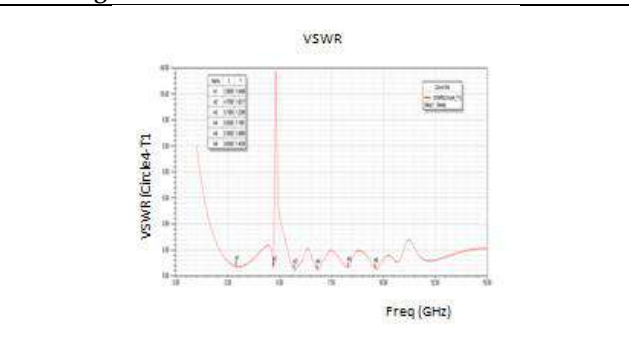


Fig.4 VSWR of proposed antenna

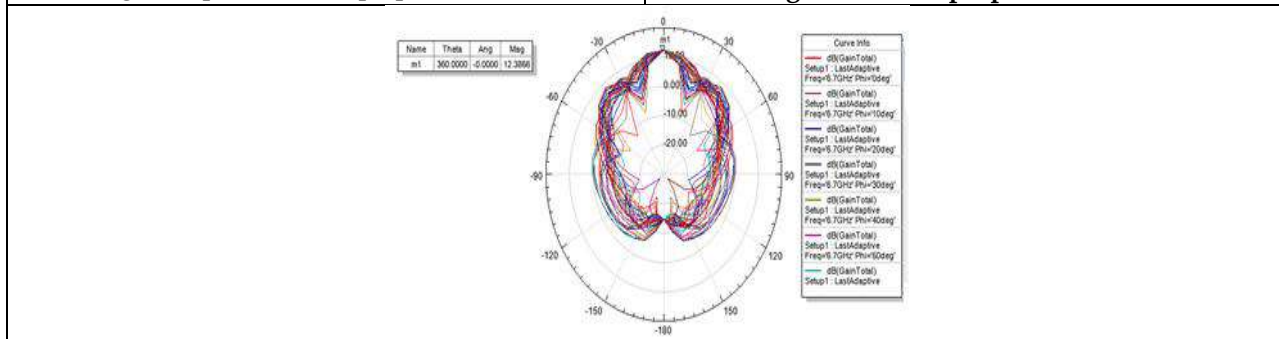


Fig.5 Radiation Pattern





Comprehensive Evaluation of Indoor Environmental Quality Parameters in Areas of Different use

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 29 Jul 2024

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ABSTRACT

Now a day's the quality of indoor environmental(IEQ) is considered to be great concern for its adverse impact on the human health. In India, there aren't many research on the interior air quality of institutional buildings. Children spend around 40% of their time in the institutional room for this reason concentration of interior air quality parameters great effects than outdoor concentration. This study examines on the institutional building Navsari, Gujarat during pre-monsoon season. Data on the quality of the indoor air was gained from five places classroom, canteen, laboratory, seminar hall and staff room of the institutional building. The target pollutants were two comfort parameters and five common indoor air quality parameters. In all the location PM_{2.5} (7µg/m³ -21µg/m³), PM₁₀ (8µg/m³ -24µg/m³), and PM₁ (5µg/m³ -15µg/m³), formaldehyde (0.019mg/m³- 0.027mg/m³), carbon dioxide (521ppm – 533ppm) was recorded lower than the standards. Excluding seminar hall all the location concentration of carbon monoxide (11ppm-15ppm) was recorded much higher and the concentration of TVOC (0.3mg/m³) also higher at classroom, staff room and seminar hall. Additionally, the temperature and relative humidity levels exceeded the Indian Society of Heating, Refrigerating and Air Conditioning Engineers' (ISHRAE) recommended limits.

Keywords: Indoor environmental quality, Institutional room, Comfort Parameters, TVOC, PM, Formaldehyde



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INTRODUCTION

Air pollution, both indoor and outside, is frequently taken into consideration the main motive of environmental health problems. Even few years returned, the troubles connected to air pollution outside were nicely publicized since the prominence of main pollutant resources like site visitors, commercial, creation, combustion assets and etc. However, in latest years, public issues on indoor air first-class (IAQ) have drawn an amazing deal of attention, as the isolation of indoor from outside surroundings end up out of the ordinary with the great deliver of tight-sealed buildings and the related sick building syndrome (SBS) [1]. Air pollution has emerged as a first-rate situation in the India in latest years both because the fact it is now clean that massive portions of the Indian urban population are uncovered to some of the best pollutant stages within the global and also because new studies round the area at the health results of various air pollutants have multiplied confidence in estimates of the dangers posed by air pollutants exposures. The state of affairs in country China and several of other developing international locations is comparable[2]. The significance of a suitable first-rate of indoor air in occupied spaces can't be overemphasized. Among the phenomena that have giant effect at the health of an average human is the satisfactory of the air we breathe both outside and indoor[3]. More emphasis is right here being laid on the indoor air pleasant because examine has verified that a common human spends at least 90% of his time indoor. Often times, some health signs had been said via occupants of sure homes for no without difficulty identifiable reason in place of their being exposed to the bodily situations inside the buildings. Such fitness signs and symptoms consist of inflammation of the eyes, nostril and throat, lethargy, complications, nausea, dizziness, bronchial allergies, itchy eyes, itchy nostril, dry pores and skin, among others[4]. Although the excellent of the indoor air might not be the singular purpose for such commentary, Nonetheless, it's been discovered that indoor air constitutes a dominant or crucial avenue of exposure for these fitness signs [5]. This pattern is perceptible now not most effective in loose going for walks building but additionally inside mechanically ventilated areas. While a filtering mechanism for the outside air that enters indoor areas may additionally lessen the health risks of these contaminants in routinely ventilated areas, in free going for walks buildings, concentration often reach uncontrollable degrees especially whilst outside conditions aren't beneficial. A perfect indoor air which has none acknowledged contaminants at dangerous concentrations as decided via recognize authorities. The collection of these indoor air contaminants is nearly inexhaustible. fortunately, a number of investigations demonstrated that numerous organic materials have been discovered in indoor air at exceptional ranges of concentration that can generate a health problem[6]. Each of those contaminants has different resources from the indoor spaces. These resources variety from indoor finishing materials, furniture, disinfectants, household home equipment furthermore activities being accomplished within the area.

This consequently suggests that throughout specific varieties of buildings and one kind of climatic regions, the nice of the indoor air as compared with stipulated requirements may range, and that these variations can be very extensive to generate extensively numerous bodily fitness consequences in occupants[7]. Airtight homes have grown rapidly so one can conserve energy, to decrease the infiltration of outdoor air and to make movement of inside air in occupied quarter. Although such improvement became a success in sure respects, it became also hampered by means of other elements like the degradation of air excellent [3]. The scale of publicity to indoor air pollutants can be regulated via interplay among their indoor supply strengths and the entrapped time in indoor environments. As people commonly stay in indoors for as much as 22 h per day, people are at a chance of destructive health consequences via their exposure over a sustained duration [8]. Indoor air pollutants are generally released from numerous indoor things like waxes, paints, furnishing, clothing, building materials, etc. Indoor environment was hence favorable to emit a massive amount of air pollutants consisting of particulate depend (PM), formaldehyde (HCHO), bio-aerosol, carbon monoxide (CO), carbon dioxide (CO₂) and many others [9]. The provision of diverse creation techniques has been the main reason to sell the maximum intake of synthetic constructing material. In addition, improper control system also led to increases in indoor air pollution (IAP) from indoor resources and air flow systems. If the heating, ventilation, and airflow (HVAC) system is not properly maintained it can directly increase the indoor air pollution. Biological contamination also can proliferate in wet components of the system at some stage in the constructing. As most indoor air pollution at once has impact on the respiratory and cardiovascular



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systems, certain elements of the population (like young and aged) can suffer from respiratory sickness extra critically [5]. Air quality at these facilities is of unique problem, as children can be affected greater sensitively by means of modifications in air pleasant because of their weaker resistance[10]. However, indoor air troubles are not continually effortlessly recognizable to take preventive measures.

MATERIAL AND METHODS**Study area or Site Location**

The measurement of indoor quality of air took place for the different group of student's age between 18 to 28 years for institutional building. The investigation took place in the Navsari city which is located in the state of Gujarat, India. The institutional building is located far from the urban area having greenery around the college campus and also more no. of trees, gardens, small plants available in the college campus. There are no major origins of air pollution available around the institutional campus. An assessment was conducted for pre-monsoon season. It is the point in time at which every semester student has attended the college[11]. A sample of the inside air was conducted at five locations Classroom, canteen, laboratory, seminar hall and staff room.

Target Pollutants

The target pollutants were two comfort parameters and five common quality of indoor air parameters. Comfort parameters are Temperature(T), Relative Humidity (RH) and common parameters of indoor air quality are Particulate matter (PM_{2.5}, PM₁₀, and PM₁), Carbon Dioxide (CO₂), Carbon Monoxide (CO), Formaldehyde (HCHO) and Total Volatile Organic Compound (TVOC).

Sampling

Assessments were taken one day a week for a one location during the regular classes' hours. Which is from 9:00 am to 4: pm for 7 hours periods in a day[2]. In the three locations classroom, canteen and staff room there are natural ventilation system during the class's hours. In the laboratory and seminar hall they had to provide mechanical ventilation arrangement (Air conditioning system). The application of a real-time monitoring system to measuring the quality of the indoor air parameters. Intelligent air quality detector was accustomed to quantify a level of pollutants with range Particulate matter PM_{2.5}, PM₁₀, and PM₁ (0-999 µg/m³), CO₂ (0-5000ppm), CO (0-2400ppm), HCHO (0.000-1.999 mg/m³) VOC (0.000-9.999 mg/m³), Relative humidity (20% - 85%) and Temperature (-20 °C - 50 °C). Sampling equipment was placed in the middle of every location, not closer than 1m to the wall, at the height of the breathing zone about 1.5 meter above the ground to get a reliable measurement. Before the measurement start calibration of the instruments was done according to the instrument manual [12]. All the comfort and common parameters of indoor air quality like Particulate matter (PM_{2.5}, PM₁₀, and PM₁), Carbon Dioxide (CO₂), Carbon Monoxide (CO), Formaldehyde (HCHO) and Total Volatile Organic Compound (TVOC) are measured in every 30-minute interval [13].

Analysis

The readings have been analyzed and for different location in institutional building like Classroom, canteen, laboratory, seminar hall and staff room the graph of concentration versus time periods are plotted [14]. The various standards of indoor environment quality like World Health Organization (WHO), "Environmental Protection Agency" (EPA), "Occupational Safety and Health Administration" (OSHA), "National Institute of Occupational Safety and Health" (NIOSH), "American Society of Heating Refrigerating and Air-Conditioning Engineers" (ASHRAE), "Indian Society of Heating, Refrigerating and Air Conditioning Engineers" (ISHRAE) have been utilized for the health risk caused due to the gases for longer duration will be correlated [15].





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RESULTS AND DISCUSSIONS

Indoor air temperature varied in the different season[16]. Summer has the highest indoor temperature and lowest in the winter also the indoor temperature varied with the different location in particular one area. As show in fig. 1, During the sampling periods the result in educational building average temperature varies between 30°C and 32°C. In the educational building highest indoor temperature found in the canteen area which was a 32 °C and lowest in the class room and the staff room. This was above the ISHRAE Standards. The study observed that the minimum and maximum indoor relative humidity in the different locations was 85% in the seminar hall and 62% in the canteen respectively. Excluding the seminar hall all another location relative humidity above the ISHRAE standards. The indoor concentration levels of particulate matters of three different sizes in the occupied spaces were assessed. These were PM10, PM2.5 and PM1. Figure 2 displays the range of minimum and maximum concentration level of PM10, PM2.5 and PM1 in different location of educational building[17]. It was noted that the maximum level of all the particulate matters found in the canteen (21µg/m³, 24µg/m³ and 15µg/m³) due to maximum moments of students and lower concentration found in the staff room (7µg/m³, 8µg/m³ and 5µg/m³). But all the locations rage of particulate matter within the WHO standards. Figure 3 represented the concentration in ppm versus different location like classroom, canteen, laboratory, staff room and seminar hall in the educational building. It clearly shows that maximum concentration of carbon dioxide in the seminar hall around 533ppm as compared to the other locations which are more specious with less students and well ventilation system[14]. As stated by the ASHRAE 62 standards maximum exposure of CO₂ in the indoor air is 1000 pmm for the duration of 8-hr exposure. This study has demonstrated that in all the location the CO₂ Concentration was below the 1000ppm. so, the health effects as a result of this parameter are negligible. According to this study, the maximum and minimum concentration value of carbon monoxide in the study location was 15 ppm and 8 ppm respectively are appeared in figure 4. The concentration was higher in the canteen as a result of the cooking activities and lower in the seminar hall. As per the WHO standards maximum exposure of CO is 9ppm for the duration of 8-hr exposure as stated by the findings of the above investigation excluding seminar hall all the location the concentration of the carbon monoxide higher than the WHO standards. It tends to generate health effects like headache, breathing issues etc.[18]. The formaldehyde concentration during the sampling time in all the location below the WHO standards as shown in figure 5. But in all the location higher concentrations of HCHO found in the staff room around 0.027mg/m³ as a result of the paper products, wood furniture and storing some cleaning product. Therefore, it may be practical to provide opening to more windows in the staff room during the institute hours [19] Figure 6 clearly shows that in the classroom, staff room and seminar hall higher level of TVOC around 0.3mg/m³ available inside the air as a result of the wood furniture, computer, markers, cleaning products, deodorants etc.[20] As per the WHO the limitation of TVOC in the interior air is higher for the 8-hr exposure condition. Therefore, it may be practical to apply well ventilation to overcome this situation.

CONCLUSIONS

Many non-residential buildings are where students and working adults spend the bulk of their hours. Maintaining the quality of indoor air (IAQ) in the institutional building is crucial for both staff and students to be able to work at their best and concentrate. According to research, ventilation and occupant density are key factors in regulating the amount of indoor environment quality in a structure. Also, from the preceding results, it can be clearly seen that different human activities mostly increase the amount of gas parameters. In this investigation, the amount of the both comfort parameters are higher in all study location as per the standards. Concentration of particulate matters of three different sizes, HCHO and CO₂ lower in all the locations. Amount level of TVOC found higher in canteen, seminar hall and classroom and for the concentration of CO excluding seminar hall it found higher in all the location as per the standards. These finding provide certain guidance in improvement of IEQ in institutional building.

ACKNOWLEDGMENTS

Not applicable



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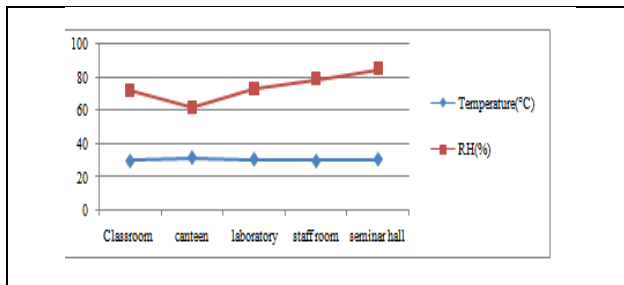


Figure 1: Indoor Temperature(°C) and Relative humidity (%) change with different location

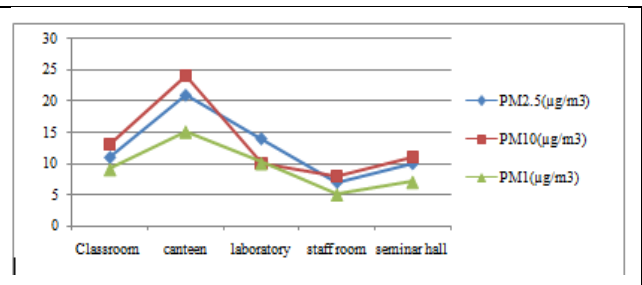


Figure 2: PM concentration at different location

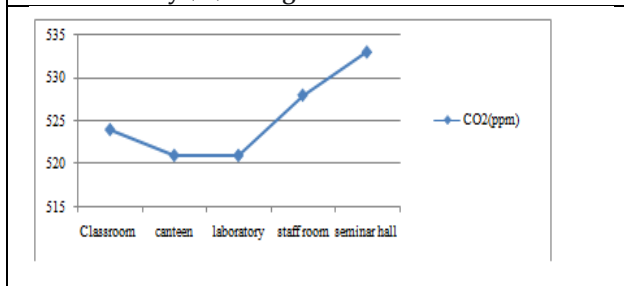


Figure 3: CO₂ concentration at different location

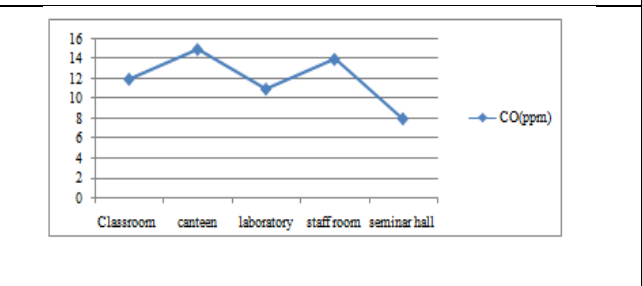


Figure 4: CO concentration at different location

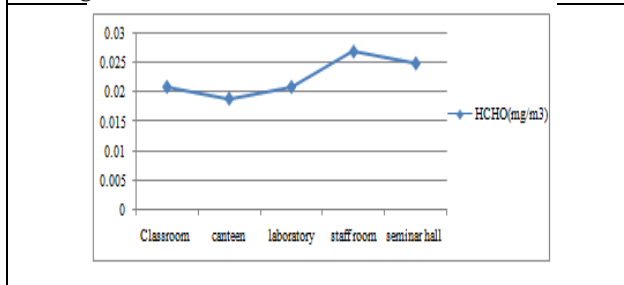


Figure 5: HCHO concentration at different location

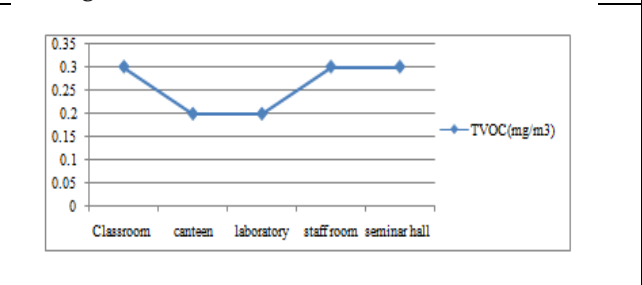


Figure 6: TVOC concentration at different location





RESEARCH ARTICLE

Cutaneous Reaction of Dashang Lepa and its Ayurved Management - A Case Report

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 25 Jul 2024

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ABSTRACT

Dashanglepa one of the mixtures of ten very effective and common indigenous drugs for local application in many superficial inflammatory conditions as described in many Ayurvedic texts. In this study a report of rare case of cutaneous adverse drug reaction (ADR) in the form of skin rash seen after the local application of *DashangaLepa*. A 65-year-old male patient developed skin rashes over knee joint following the local application of *DashangaLepa*. Rashes resolved after immediate stopping the use of drug and application of *Panchtiktaghrita*. No such drug reaction was noticed by any other patient during treatment.

Keywords: Cutaneous adverse reaction, *Dashanglepa*, Inflammation, Skin rash, *Panchtiktaghrita*.

INTRODUCTION

Adverse drug reaction is harmful or seriously unpleasant effects occurring at doses anticipated for therapeutic effect and which call for reduction of dose or withdrawal of the drug or indicate caution in future use of the same drug. *Dashanglepa* is a polyherbal preparation and used as a topical treatment in conditions like *Vishavisphota* (skin eruptions due to poison), *visarpa* (herpes), and *Dushtavrana* (non-healing wound).^[1]This formulation is found to be safe and dermatological manifestations are extremely rare. In this article a patient who has applied *DashangaLepa* on both the knee joints. This kind of reaction with *DashangaLepa* was rare and unexpected. Rashes resolved after application of *Panchatiktaghrita* which contains 5 active compounds that give the formulation its anti-inflammatory





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and antimicrobial properties. These are *Azadirachta indica* (stem bark), *Tinosporacordifolia* (stem), *Adhatodavasica* (root), *Solanumxanthocarpum* (root) and *Trichosanthesdioica* (aerial parts). Recurrence of such a type of reaction is avoidable by properly detecting and reporting such an event. Dashanglepa is mentioned in many Ayurvedic texts [2, 3, 4, 5].

MATERIAL AND METHOD

Dashanglepa is a powdered form herbal preparation made by ten indigenous drugs. [6] These drugs and their properties are

1. *Shirish* (*Albizzialebeck* Benth.) Kashaya Laghu, Ruksha Ishad-Ushna Katu Tridosahara.
2. *Madhuyasthi* (*Glycyrrhizaglabra* Linn.) Madhura Guru, Snigdha Sheeta Madhura Vata-Pittashamak. *Tagar* (*Valerianawallichii* DC.) Tikta, Katu, Kashaya Laghu, Snigdha, Ushna, Katu, Kapha-Vatashamak
3. *Raktachandan* (*Pterocarpussantalinus* Linn.) Tikta, Madhura Guru, Ruksha Sheeta, Katu, Kapha-Pitta shamak.
4. *Ela* (*Eletteriacardamomum* Linn. Maton) Katu, Madhura, Laghu, Ruksha, Sheeta, Madhura, Tridosahara.
5. *Jatamansi* (*Nardostachysjatamansi* DC.) Tikta, Kashaya, Madhura, Laghu, Snigdha, Tikshna, Sheeta, Katu, Kapha-Pittashamak. *Haridra*
6. (*Curcumalonga* Linn.) Tikta, Katu, Laghu, Ruksha, Ushna, Katu, Kapha-Vatashamak, Pittarechak. *Daruharidra* (*Berberisaristata* DC.) Tikta, Kashaya, Laghu, Ruksha, Ushna, Katu, Kapha-Vatashamak.
7. *Kushta* (*Saussurealappa* C.B. Clarke) Tikta, Katu, Laghu, Ruksha, Ushna, Katu, Kapha-Vatashamak. *Hrivera* (*Pavoniaodorata* Willd.) Tikta, Katu, Kashaya, Laghu, Snigdha, Sheeta, Katu, Kapha-Vatashamaka.
8. *Dashanglepa* is used as *Vranasophaghna* (anti-inflammatory) remedy for local application. [7]

CASE REPORT

A 65-year-old male patient with a *VataKaphaj* (constitution) was admitted for complaints of osteoarthritis and mild swelling over bilateral knee joints. The patient was advised to apply *Dashanglepa* for 7 days continuously. After 7 days patient complained of pain and swelling got reduced. After seven days patient discharged and advised to continue local application of *Dashanglepa* along with oral medication for next 7 days. After 5 days, patient came with the complaints of skin eruption, redness and cracking of skin on both the knee joint, also complaining itching at local part. After careful history taking patient has not applied any other medication over knee joints or no any history of burning by hot lepa or water. A *lepa* (semisolid paste) was prepared by mixing the *Churna* (Powder) of *DashangaLepa* (purchased from a Good Manufacturing Practices (GMP) certified company) with warm water. Presentation of condition was on 12th day morning, after the application of *DashangaLepa*, with itching, redness and rashes on and around the site of the application. The application of *DashangaLepa* was stopped immediately. The rashes were treated with a local application of *Panchtiktagrita*^[8] twice daily. No change was made in other treatment. Within 7 days of treatment, the patient was completely relieved from the skin eruption, itching, rashes, and redness. Informed consent was obtained from the patient for documentation and publication. A copy of the written consent is available for review with the Editor-in-Chief of this journal.

DISCUSSION

Adverse drug reaction to *DashangaLepa* is very rare. This case report elaborates a case of skin rash on the site of application of *DashangaLepa*. Skin eruption is a commonly seen as a cutaneous adverse drug reaction. [9] There has been a temporal relationship towards an association between the suspected formulation and the event. Causality Assessment Scale and Naranjo's Adverse Drug Reaction (ADR) Probability Scale; the scores of which are Possible and Probable (Score 8) with *DashangaLepa* administration, respectively and severity was moderate. No such reaction was noticed by any other patient on the application of *DashangaLepa* and this point towards the susceptibility of the patient toward the reaction. The technique of preparation of the *Lepa*, which the physician has followed is bit a different from the standard reference. As per classics all the 10 ingredients need to be powdered and made into a *Kalka* (semisolid paste) form and during application it is to be mixed with *Ghritha* (Ghee). *Ghritha* has an





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antidotal effect in *Pittaprakriti*.^[10] Here *Ghritha* may help in preventing the toxic effects of the formulation and moreover. Many of ingredients of *DashangaLepa* have not been reported for their toxicity. However, Veleriane alkaloid, which is an active chemical constituent of *Tagara (Valerianawallichi)* and *Jatamanshi (Nardostachysjatamansi)* has been reported to produce allergic reactions and contact dermatitis.^[11] Furthermore, Costus oil (*Kushta*) has been seen to result in allergic contact dermatitis when used externally. Hence, in this case, we believe that the event may have occurred because of improper selection of the treatment vehicle or sensitivity of some ingredients of the *DashangaLepa*. The present case shows that such rare and unpredictable adverse reactions are possible with Ayurvedic medications and the physicians need to be more vigilant to try and understand such reactions, so as to prevent its recurrence. This may be a good example for an unexpected or idiosyncratic reaction. Such unpredictable adverse reactions are not necessarily due to errors or negligence. It is difficult to predict host susceptibility to such a response and thus, it becomes very important to document, evaluate and report such reactions. Such reports show the importance of the establishment of a pharmacovigilance cell in all Ayurvedic hospitals, so that information regarding ADR related to Ayurvedic formulations can be generated to study the ADR of Ayurvedic single herbs and formulations effectively.

Conflict of interest: None

Acknowledgement: Authors are thankful to the authorities of the Parul Institute of Ayurveda and Research, Parul University, Vadodara (Gujarat), India, for providing working facilities.

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Critical Review on Medicinal Value of Indian Mushroom

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

For thousands of years, traditional medicine has employed edible mushrooms, which are prized for their immense health benefits. The beneficial effects of Indian mushrooms on human health are the topic of this review paper. Some of the biological substances contained in mushrooms have been shown to help human health. Among the bioactive components of Indian mushrooms include tri-terpenoids, low molecular weight proteins, glycoproteins, polysaccharides, and compounds that modulate immune response. A small number of studies have shown that mushrooms can promote the body's detoxification process, lower inflammation, boost immunity, prevent cancer, and limit the formation of tumor cells in addition to helping to balance blood sugar. They also offer defense against several microbes, including viruses, fungus, and bacteria. There is mounting evidence that a variety of illnesses may be treated with mushrooms.

Keywords: edible mushrooms, human health, Indian mushrooms, biochemical compounds, illness.





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INTRODUCTION

Numerous fungal species have therapeutic use in addition to plants. Mushrooms are used as medicine in traditional medicine practices (Patel et al., 2012). They were considered the "food of the gods" by the Romans. As a health food and "elixir of life," mushrooms are highly valued in Chinese culture (Valverde et al., 2015). Although there are more than 2,000 varieties of mushrooms in the wild, only around 25 are commonly used as food and very few are grown for profit. Because of their nutritional, therapeutic, and organoleptic qualities, edible mushrooms are prized as a delicacy. Furthermore, it is well-known for having therapeutic qualities and for having bioactive substances (Colunga et al., 2020). Mushrooms contain several types of vitamins that have the beneficial effect of lowering the risk of numerous diseases in humans. Studies have shown that mushrooms are effective in preventing cancer, lowering cholesterol, stress, sleeplessness, asthma, allergies, and diabetes. It might also be used as a substitute biosorbent to get rid of artificial dyes from aqueous settings. The mushrooms are usually large enough to be seen with the unaided eye, and they are joined laterally on the surface. It has a large number of bioactive components, including phenols, proteins, and polysaccharides. In an effort to enhance consumer health, mushrooms have also been utilized as dietary supplements and prebiotics more recently due to the availability of these active components (Yu et al., 2023).

Oyster mushroom (*Pleurotus species*)

The oyster mushroom was first recorded in 1775 by the Dutch naturalist Nikolaus Joseph Freiherr von Jacquin. Kadam and associates, 2023). The oyster mushroom (*Pleurotus species*) is one of the most widely cultivated types of mushrooms in the world. It is the second-largest mushroom farmed for commercial reasons in the world, after *Agaricus bisporus*. Of all the mushroom species, oyster mushrooms make up more than 200 categories (Lesa et al., 2022). There are several benefits to cultivating oyster mushrooms as opposed to other edible mushrooms. Lallawmsanga et al. in 2019. In temperate and tropical forests, it grows naturally on decaying and dead timber logs, often on the dying trunks of deciduous or coniferous woods. It is called "dhingri" in India. Oyster mushrooms grow best in the months of March/April through September/October.

Different species of oyster mushroom

- *Pleurotus ostreatus*
- *Pleurotus florida*
- *Pleurotus sajor-caju*
- *Pleurotus sapidus*
- *Pleurotus eous*
- *Pleurotus membranaceus*
- *Pleurotus flabellatus*

Medicinal value and properties of oyster mushroom (*Pleurotus species*)

It is estimated that between 6% and 10% of edible oyster mushrooms contain therapeutic qualities. Because of these qualities, these mushrooms are used as valuable natural ingredients in pharmaceutical goods. Numerous bioactive compounds with significant pharmacological properties are present in it, including those that modulate immune response, inhibit HIV-1 reverse transcriptase, promote eye health, inhibit protein synthesis, inhibit a proteolytic enzyme, are antibacterial, anti-inflammatory, anticancer, antihyperglycemic, antiatherogenic, anticancer, anti-hypercholesterolemic, antitumor, and antiviral (Lesa et al., 2022). The stimulatory activity of the dietary oyster mushroom extract allows for the isolation of specific components that have direct or indirect antiviral activities. Viral nucleic acid synthesis, viral enzyme adsorption, and viral uptake into mammalian cells can all be directly inhibited by them. Polysaccharides and other complex compounds have immune-stimulating properties, which leads to indirect effects of antivirals. "Ubiquitin," an antiviral protein, was extracted and identified from the oyster mushroom fruiting body. Water-soluble sulphated derivatives of water-insoluble β -glucans that were isolated from *P. tuberculum sclerotia*, "known as the king tuber oyster mushroom," demonstrated anti-herpes simplex virus activity against both type-1 and type-2 (Patel et al., 2012 & Anjana and Savita 2017 & Lesa et al., 2022). Natural antioxidant





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qualities and strong free-radical scavenging activity were present in medicinal mushrooms. Comparing Pleurotus fruiting bodies to other commercial mushrooms, a higher content of antioxidants was found. Owing to the presence of β -glucan, a carbohydrate component, it demonstrated enhanced antioxidant characteristics, which appeared to be the cause of the antioxidant activity. Some studies have found that the purification. Compared to the original crude extracts of mushrooms, mushroom polysaccharides exhibited reduced antioxidant activity (Anjana and Savita 2017). The research conducted in 2020 by Gashaw et al. to determine the antimicrobial activity of Pleurotus spp. (P. Ostreatus and P. Florida) demonstrates the development of inhibition against five pathogenic bacteria: Salmonella typhi, Bacillus subtilis, Escherichia coli, Streptococcus faecalis, and Pseudomonas aeruginosa. Sutthisa et al.'s 2023 study shows that oyster mushroom extract has the potential to be antimicrobial against P. Aeruginosa and S. marcescens, but it also suggests that greater extract concentrations could be required to completely suppress or destroy these dangerous bacteria. According to a 2009 study by Jedinak et al., P. Ostreatus, or oyster mushroom, was found to be the most effective in suppressing the growth of colon cancer (HT-29, HCT-116) and breast cancer (MCF-7, MDA-MB-231) cells while having no effect on the growth of normal colon FHC and epithelial mammary MCF-10A cells. Using flow cytometry, it was possible to determine that P. Ostreatus's suppression of cell proliferation was linked to the G0/G1 phase cell cycle arrest in MCF-7 and HT-29 cells.

According to a review updated in 2021 by Mishra et al., extracts from various Pleurotus species have been shown to suppress the cell cycle, cause apoptosis, and restrict the development of cancer cells in vitro and in vivo. It has been discovered that gold and silver nanoparticles made from Pleurotus extracts are strong anti-cancer agents with little negative effects on healthy cells. Bioactive macromolecules, including β -glucan, are powerful immunomodulators that trigger the activation of natural killer cells and macrophages in opposition to tumor cells. Oyster mushrooms are used in dermatology and cosmetology because they contain components that are anti-aging, anti-wrinkle, skin-whitening, and moisturizers. According to Taofiq et al. (2016), the mushroom pleuran (β -glucan) employed in skin-based atopic dermatitis cream has demonstrated promising outcomes. Manikandan (2011) said that Pleurotus species, or oyster mushrooms, are a good option for heart patients and the treatment of cardiovascular disease because of their low-fat content, increased production of unsaturated fatty acids, and lack of cholesterol. The high potassium and low salt contents of mushrooms help to maintain human blood circulation and promote salt balance.

Milky mushroom (Calocybe Indica)

Introduction

After Button and Pleurotus Mushrooms, Milky mushroom (*Calocybe indica*) has become the third commercially grown mushroom in India. A genus of mushrooms known as milky mushrooms have a white or milky appearance, medium to large fruiting bodies, an elongated, thick stipe, and, when dried, are claimed to smell like milk powder (Gosh and Acharya 2022). *Calocybeindica's* crown is white, umbrella-shaped, or convex in shape, with an average diameter of 10 to 14 cm. They smell strongly of farinaceous material. In tropical regions of Africa, China, Malaysia, Singapore, Indonesia, and India, *calocybe indica* flourishes.

Nutrients in milky mushroom

Milky mushroom (*Calocybe indica*) has become the third commercially grown mushroom in India subsequent to button and oyster mushrooms. Thymine, riboflavin, nicotinic acid, pyridoxine, biotin, and ascorbic acid can all be found in abundance in milky mushrooms. The vitamins C, D, E, B complex, and A are all abundant in them. All of the mineral salts that the human body needs, including potassium, sodium, phosphorus, iron, and calcium, should also be added. People who suffer from hyperacidity and constipation can benefit greatly from it because of its alkaline and increased fiber content (Maurya et al., 2020).

Medicinal value and properties of Milky mushroom (*Calocybe indica*)

Numerous bioactive compounds with potent antibacterial activity against both Gram-positive and Gram-negative bacteria are found in milky mushrooms. It has been demonstrated that numerous extracellular secretions from the



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mushroom mycelium suppress both viruses and bacteria. The production and binding of catechin and hexadecenoic acid to the bacterial cell wall is the mechanism by which the antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* is mediated. The majority of researchers and inflammatory disorders believe that one of the reasons of inflammation is protein denaturation, which can be inhibited and autoantigen synthesis suppressed by a methanolic extract of *Calocybe indica*. A methanolic extract of milky mushrooms contained flavonoids and polyphenols, which may be the source of their anti-inflammatory qualities (Shashikant et al., 2022). A 2016 experimental study by Anju and Ukkuru demonstrates the potential of milky mushrooms to cure hyperglycemia, hyperlipidemia, and elevated blood sugar. According to this study, two separate individuals with high blood sugar, hyperlipidemia, and hyperglycemia who received a milky mushroom supplement in their diet without taking any medicine for treatment showed progressive improvement after 45 days of observation. Polysaccharide-derived milky mushrooms have strong anticancer activity against various tumor metastasis cells. They also showed enhanced efficacy when combined with chemotherapy (Natraj et al., 2022). The inhibitory or cytotoxic properties of water and methanolic extracts are compared using conventional tamoxifen for the MCF-7 cell line and vincristine for the MHH-ES-1 cell (Gosh et al., 2015).

Button mushroom (*Agaricus bisporus*)

Introduction

One of the biggest genera of macrofungi, *Agaricus* has a number of edible species with great nutritional and therapeutic potential. Over the past six to seven decades, there has been a steady increase in both the production and consumption of this particular mushroom. With the highest production of *A. bisporus*, China comes in first. *A. Bisporus*, commonly known as button mushrooms, are an excellent dietary source that contain a number of significant bioactive substances. *A. Bisporus* has a lot of potential in terms of nutrition, medicine, and appearance.

Nutrients in button mushroom

When compared to several other commonly consumed species, *A. Bisporus* is comparatively rich in lipids, proteins, and carbs. Aspartic acid, serine, glycine, threonine, glutamine, valine, cysteine, alanine, leucine, isoleucine, lysine, histidine, proline, arginine, tyrosine, and norleucine are among the many types of amino acids that are abundant in *A. Bisporus*. Stearic acid, palmitic, linoleic, caprylic, oleic, erucic, and eicosanoic acid were the main fatty acid contents among the 13 samples (Ushman et al., 2021).

Medicinal value of button mushroom

A. Bisporus has a somewhat larger capacity for antioxidants than other significant edible mushrooms. Brown and white *A. Bisporus* also contain ergothioneine, which functions as an antioxidant. Serotonin is another significant biochemical substance with strong antioxidant potential, according to Sarikaya & Gulcin. Owing to its antioxidant properties, serotonin derived from mushrooms may be able to avert Alzheimer's. A class of fat-soluble vitamins called tocopherol is a significant antioxidant that is used by the body for numerous processes. β -tocopherol was discovered to be abundant in White *A. Bisporus*. According to Manikandan (2011), oligosaccharides and fermentable fibers from mushrooms function as prebiotics in the intestine, anchoring good bacteria in the colon. This fiber supports regular bowel movements and digestion. The button mushroom is a rich source of antioxidants, including vitamin C, D, and B12. It also contains dietary fiber, polyphenols, and folates, all of which have inhibitory effects on diabetes and cardiovascular diseases. The polysaccharides found in mushrooms have a strong anticancer effect, inhibiting cancer cell types. It may affect cancer cells by boosting immunity within cells. By enhancing the body's antioxidant defense system and halting the spread of malignant cells, lectins proved efficient against lung cancer cells. Arginine stops tumor cells from growing. However, their impact on colorectal carcinoma, sarcoma, gastric cancer, and prostate cancer was not statistically significant (Ushman et al., 2021). Because it reduces estrogen production and aromatase enzyme activity, it is beneficial in the case of breast cancer (Bushan et al., 2018). Manikandan (2011) claimed that white button mushrooms have the potential to prevent breast and prostate cancer. Fresh mushrooms have the ability to detect the activity of chemicals called 5-alpha-reductase and aromatase, which





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are involved in the establishment of malignant tumors. Polysaccharides obtained from button mushrooms also have the potential to lessen the negative effects of chemotherapy and radiation. The development of button mushroom-produced nanoparticles has several advantages for the treatment of viral, bacterial, fungal, and malignant diseases. This kind of nanoparticle synthesis by edible and medicinal mushrooms is affordable and suitable for use in nanomedicine because so many fruiting bodies are generated globally (Bushan et al., 2018). Both plasma and LDL cholesterol are decreased by it. According to a 2010 study by Jeong et al., rats fed button mushroom powder that were hypercholesterolemic showed much lower levels of total plasma cholesterol and low-density lipoprotein (LDL) than control rats. Furthermore, compared to normal hypercholesterolemic rats, greater HDL concentrations were seen in hypercholesterolemic rats administered ABP.

CONCLUSION

Indian mushrooms have gained significant importance in the modern era due to their abundance of bioactive chemicals, which are utilized to treat a wide range of serious illnesses and lower the expense of more expensive therapies. However, because people are not as aware of the benefits of mushrooms as they should be, they are not a common food in our diets. As a result, there is a need to raise public awareness of mushrooms, as well as to deepen our understanding of the subject and expand research. Investigation into the Indian mushroom's possible mechanisms of action in relation to several diseases that impact human health is necessary. The current state of research on the bioactive components of Indian mushrooms is inadequate. The fungus has a variety of potential uses, including nutritional and physiological advantages that call for more research.

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Analyzing the Interaction among Academic Self-Efficacy Beliefs, Metacognitive Awareness, and Openness Trait in High School Students

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

This research paper conducts a comprehensive analysis of the interaction between Academic Self-Efficacy Beliefs (ASEB), Metacognitive Awareness (MA), and the personality trait of Openness in high school students. The study aims to explore how these factors influence each other within the context of academic performance and confidence. Utilizing data from a sample of high school students, the study employs various measures including the Academic Self-Efficacy Scale, Metacognitive Awareness Inventory, and assessments of Openness trait. Statistical analyses are conducted to examine the correlations and interactions among ASEB, MA, and Openness. The findings shed light on the intricate relationship between these variables, highlighting the role of the Openness trait in shaping academic self-efficacy and metacognitive awareness. This thorough examination contributes to a deeper understanding of how personality traits intersect with cognitive and motivational factors in the academic domain. It provides valuable insights for educators and researchers seeking to enhance student learning experiences and outcomes.

Keywords: Metacognitive Awareness Inventory, and assessments of Openness trait.



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INTRODUCTION

In the realm of education, understanding the factors that contribute to academic success and student well-being remains a central focus for educators and researchers alike. Among these factors, Academic Self-Efficacy Beliefs (ASEB), Metacognitive Awareness (MA), and personality traits have garnered significant attention due to their potential impact on student learning outcomes and overall academic experience. This research aims to delve into the intricate interplay among these variables, with a specific focus on the personality trait of Openness, within the context of high school students. Numerous studies have highlighted the importance of Academic Self-Efficacy Beliefs in predicting academic achievement and performance across various educational settings (Zimmerman, 2000; Bandura, 1997). Defined as individuals' beliefs in their ability to succeed in academic tasks, ASEB influences students' motivation, persistence, and goal-setting behaviors (Pajares & Schunk, 2001). Similarly, Metacognitive Awareness, which refers to the knowledge and regulation of one's cognitive processes, has been linked to academic success by facilitating effective learning strategies, problem-solving skills, and self-regulation (Flavell, 1979; Schraw & Moshman, 1995). Moreover, researchers have increasingly recognized the role of personality traits in shaping individuals' academic attitudes, behaviors, and outcomes (Poropat, 2009; Trapmann et al., 2007). Of particular interest is the trait of Openness, characterized by curiosity, creativity, and willingness to explore new ideas and experiences (McCrae & Costa, 1997). Studies have suggested that Openness may influence learning approaches, information processing styles, and receptiveness to academic challenges (Chamorro-Premuzic & Furnham, 2003; Paunonen & Ashton, 2001). In a study conducted by Koyuncuoğlu (2023), the connections among metacognition, general self-efficacy, and academic achievement among university students were explored, alongside an examination of the mediating function of general self-efficacy in these associations. The results indicated favorable correlations between academic success and both metacognition and general self-efficacy. Moreover, it was revealed that general self-efficacy played a partial mediating role in the link between metacognition and academic success. Overall, recent literature underscores the importance of considering the interaction among ASEB, MA, and Openness trait in understanding student learning and academic success in high school settings. These studies provide valuable insights into the complex interplay of cognitive, motivational, and personality factors that contribute to student outcomes, offering implications for educators and policymakers aiming to support student development and achievement. While previous research has examined the individual effects of ASEB, MA, and personality traits on academic performance, limited attention has been paid to their combined influence and interactive effects, especially concerning Openness trait. Therefore, this study seeks to fill this gap by conducting a thorough examination of the interaction among Academic Self-Efficacy Beliefs, Metacognitive Awareness, and Openness trait in high school students. By elucidating the complex dynamics among these variables, this research aims to provide insights that can inform educational practices and interventions aimed at promoting student success and well-being.

Method

This research will utilize a cross-sectional approach to investigate the correlations among academic self-efficacy beliefs, metacognition awareness, and the personality trait of openness among high school students. Data will be gathered through a quantitative survey administered to the participants.

Participants

The study will involve high school students from varied backgrounds and academic environments. To ensure diversity, a purposive sampling method will be employed, aiming for representation across genders and academic achievement levels. The target sample will comprise around 100 students aged between 14 and 16 years old.

Instruments

The survey tool will incorporate standardized assessments for evaluating academic self-efficacy beliefs, metacognition awareness, and Openness personality traits. Academic self-efficacy beliefs will be gauged using the scale devised by P. Muhammed Ashraf and Abdul Gafoor K. (2006). Metacognition awareness will be measured





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through the Metacognitive Awareness Inventory for Adolescents (MAIA), and Openness personality traits will be assessed using the NEO Five-Factor Inventory (NEO FFI).

RESULT AND DISCUSSION

	Variables	N	M	SD	1	2	3
1	Openness	100	33.9	7.9	-	.090	.533**
2	Academic Self Efficacy	100	87.6	24.2		-	.148
3	Metacognition	100	21.8	6.5		.148	-

Table 01 indicates the correlation values of the openness personality traits with metacognition and academic self-efficacy beliefs. The findings from the analysis reveal a noteworthy association between Openness and metacognition, with a correlation coefficient of .533, significant at the 0.01 level. This indicates that individuals characterized by a propensity for exploring new experiences tend to exhibit a greater capacity for reflective thinking and strategic planning in their learning endeavors. Moreover, a positive correlation of 0.90 is evident between Openness and academic self-efficacy belief, suggesting that individuals possessing a high degree of openness tend to harbor stronger convictions regarding their capability to achieve academic success. The correlation coefficient of .148 between metacognition awareness and academic self-efficacy beliefs indicates a positive but relatively weak association between these two variables. This suggests that there is a discernible relationship between students' awareness of their cognitive processes (metacognition) and their beliefs in their ability to succeed academically (academic self-efficacy). However, the strength of this association is modest, implying that while there is some connection between metacognition and academic self-efficacy, other factors may play a more significant role in shaping students' confidence in their academic abilities.

CONCLUSION

The analysis underscores the significant role of personality traits, particularly Openness, in shaping key cognitive and motivational factors among students. The strong positive correlation between Openness and metacognition highlights how individuals inclined towards novel experiences tend to engage in reflective thinking and strategic planning, enhancing their learning processes. Moreover, the robust association between Openness and academic self-efficacy belief underscores the importance of personality traits in fostering confidence and conviction in academic pursuits. However, the relatively weak correlation between metacognition awareness and academic self-efficacy beliefs suggests a nuanced relationship between cognitive awareness and academic confidence. While students with higher metacognitive awareness may exhibit a positive inclination towards their academic abilities, other factors may contribute more substantially to their overall confidence level. These findings emphasize the complex interplay of individual characteristics, cognitive processes, and beliefs in shaping students' academic experiences. Understanding these dynamics can inform educational practices aimed at fostering a conducive learning environment and supporting students in realizing their academic potential. Further research could delve deeper into the nuanced interactions among personality traits, metacognition, and academic self-efficacy to elucidate their implications for student success and well-being.



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A Review on Acne: Information on Causative Agent, Etiology and Treatment

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Received: 21 Feb 2024

Revised: 03 Mar 2024

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ABSTRACT

One of the most prominent skin conditions affecting youngsters is acne. It is a pilosebaceous unit disease. Acne is caused by Propionibacterium acnes colonization and blocked sebaceous glands. Consideration should be given to the patient's kind of acne, degree, competence to use the treatment and psychological response. Most of the treatment for moderate acne is topical medication. More than 85% of teenagers suffer from acne, making it one of the most common skin conditions. Acne typically develops during puberty and gradually disappears when a person is 20 years old, though some people experience acne well into their 40s and 50s. Acne is rarely dangerous and is frequently written off as a self-limiting condition. Despite appearing purely aesthetic, its effects can extend far beyond the skin's surface and burden the patients with a heavy emotional and psychological burden. Despite appearing cosmetic, its effects can penetrate far deeper than the skin's surface and cause patients to experience severe emotional and psychological distress. The alteration in the appearance of the skin could result in a modified body image, which is known to provoke emotions such as rage, shame, anxiety, melancholy, embarrassment, bullying and stigmatization among peers, low self-esteem, social retreat, feelings of inadequacy and inferiority, functional and interpersonal issues, and suicidal thoughts. According to estimates, the decline in quality of life is comparable to that caused by epilepsy, asthma, diabetes, or arthritis.

Keywords: Acne, Propionibacterium, self-limiting, inflammation, psychological.





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INTRODUCTION

The body parts where acne is most prevalent are the face, forehead, chest, shoulders, and upper back. Some causes include genetics, hormonal fluctuations, Stress, excessive humidity, and the use of greasy or oily personal care products. Although it may occur at any age, acne affects teens most.

Reasons for Acne

Four main factors cause acne.

- Excessive production of oil (sebum)
- Oil and skin cells clogging hair follicles
- Bacteria
- Inflammation

Certain things may aggravate or induce acne

Changes in hormones. Both boys and girls have an increase in androgens throughout puberty. They cause the sebaceous glands to expand, which increases sebum production. Midlife hormonal changes, particularly in women, can result in breakouts. [1-2]

Specific medicines. Examples include corticosteroids, testosterone, and medications containing lithium.

Diet. According to studies, eating certain foods, such as carb-heavy foods like bread, bagels, and chips, may worsen acne. More study is required if adhering to dietary limitations will help those with acne.[2]

Stress. Although Stress does not cause acne, it might exacerbate it if you already have it.

Medications. Certain medication induces acne aggregation and severity. Here are a few medications that induce acne production (**table 1**)

More Common	Less Common
Anabolic steroids (danocrine, testosterone)	Immune suppressive agent (Azathioprine)
Bromides	Cyclosporine (Sandimmune, Neoral)
Corticosteroids (prednisolone, deltasone)	Disulfiram
Corticotropin	Phenobarbital
Isoniazid	Quinidine
Lithium	Tetracycline
Phenytoin	Vit B6, B12 &D2

Mechanisms involved in acne development:

The Sebaceous glands

Sebaceous glands contain the receptors which are involved in inducing sebum production.[3] Recent research describes that histamines activate histamine receptors, the hormonal DHT receptor is activated by androgens and the other three newly identified triggering receptors are activated by dietary sources.[3-5]. The connection between Diet and acne-triggering factors is further proved and reported in a case-control study in recent times.[6].

Body mass index also greatly impacts the production of acne in people and this generation, mainly in adults. [7] Additionally, although the evidence is insufficient, a population-based study of adolescent acne and BMI found a possible association between obesity and acne in 18- to 19-year-old women.[7] However, this relationship has yet to be proven.



**Srikala Kamireddy et al.,****Development of inflammatory lesions: comedogenics**

Inflammatory lesions develop from comedones that result from an abnormal keratinization pattern of sebaceous follicles.¹ Comedogenesis was once thought not to be part of the inflammatory process. Still, detailed immunohistological studies after the development of inflammatory acne lesions have shown that it is the first step to the inflammatory process, i.e., lesion formation.^[8] Microcomedone is currently believed to be the earliest type of subclinical acne lesion.

Controversy regarding the initial cellular infiltration in inflammatory acne lesions has continued since the first histological studies 30-40 years ago. The results of some early studies concluded that lymphocytes are an inflammatory cell type^{20,21,22}.^[8-9] Kligman's 1974 study¹⁰ concluded that the initial stage was neutrophil infiltration, followed by microscopic destruction of the sebaceous follicle wall and subsequent follicle formation.^[9]

P. Acne species

Studies on antibiotic resistance have shown the relationship between *P. acnes* and inflammatory acne. However, it has not been proven that this bacterium causes the disease or contributes to the development of inflammation. There is no relationship between the number of viable bacteria in the follicles and the level of inflammation, and some inflammatory lesions lack viable *P. acnes*. However, viable species cells stimulate the immune system by producing many enzymes. ^[10]

Immune system

Innate immunity is our first line of defense against pathogens (pathogen-associated molecular patterns (PAMPs)) and threats (danger-associated molecular patterns (DAMPs)). PAMP and DAMP responses are mediated by germline-encoded pattern recognition receptors (PRRs). Among the PRRs, certain members of the Nod-like receptor (NLR) family, including NLRP1, NLRP3, NLRC4, and AIM2, can mediate responses to PAMP and DAMP reactions and then accumulate to form high-molecular-weight caspase-1 activation. Activation and secretion of the proinflammatory cytokines IL-1 β and IL-18 are regulated by molecular platforms called inflammasomes. ^[11]Based on the findings that dysregulation of inflammation and IL-1 β is associated with a rare genetic autoinflammatory syndrome of pyogenic arthritis, pyoderma gangrenosum and acne called PAPA syndrome and, in addition, acne characterized by neutrophilic infiltration of the skin, which is in transgenic specificity of mice with a mutation in the NLRP3 gene corresponding to a mutation associated with human Muckle-Wells syndrome, we hypothesized that inflammation and IL-1 β might be directly involved in the pathogenesis of acne.

Treatment**Pharmacological treatment****Topical retinoids**

Retinoids were first shown to be useful in treating acne in the 1970s; they are derivatives of vitamin A that prevent the formation of comedones by normalizing the exfoliation of the follicular epithelium. ^[12] The three most important topical retinoids are tretinoin, adapalene, and tazarotene. Tretinoin has long been considered the gold standard against which new products are compared. A meta-analysis of five randomized, multicenter trials involving 900 patients confirmed a reduction of total lesions of 53% with tretinoin 0.05% gel and 57% with adapalene 0.1% gel.

Tretinoin is available as a liquid (0.05%), cream (0.025%, 0.05%, and 0.1%), and gel (0.01% and 0.025%). Redness, peeling, and swelling of the skin caused by tretinoin are dose-dependent side effects. ^[13] Adapalene 0.1% is available as a cream, gel and solution, all of which have comparable efficacy. Tazarotene is available as a cream or gel at a concentration of 0.1%.

Oral antibiotics

Antimicrobial and anti-inflammatory properties are common to systemic antibiotics used to treat acne vulgaris. They reduce follicular *P. acnes*, which prevent the synthesis of inflammatory cytokines caused by bacteria.^[14] Minocycline and doxycycline inhibit cytokines and matrix metalloproteinases involved in inflammation and tissue degeneration; tetracycline and erythromycin inhibit leukocyte chemotaxis activity and bacterial leukocyte. Chemotaxis. ^[15]



**Srikala Kamireddy et al.,**

Tetracycline, doxycycline, minocycline and erythromycin are the most commonly used systemic antibiotics for treating acne vulgaris. [16]

Topical antimicrobials

Clindamycin, erythromycin, tetracycline, and benzoyl peroxide are some of the topical antimicrobial agents currently available. Since azelaic acid has shown antibacterial activity against follicular P acnes, it can also be included in this category. [17] Our discussion focuses on five carefully designed, randomized, double-masked studies investigating topical antibiotics' effectiveness in treating acne. The most extensive studies have been done on the newer dosage forms.

Non-pharmacological treatment

Milk and its products: The oemogenic effect of milk and milk products is still controversial. However, the most likely reason for the comedogenic effect is the presence of insulin-like growth factor (IGF)-1 and hormonal components in Milk produced during pregnancy in cows. Substantial evidence indicates that excessive consumption of whole Milk (> two glasses per day) is associated with moderate to severe acne, with no association between consumption of low or fat-free dairy products or yogurt/cheese. [18] Adilson and That found that hormonal imbalance (decreased estrogen content) and changes in physiologically active molecules (glucocorticoids, transforming growth factor [TGF]-) caused by the processing of skimmed Milk make it more comedogenic than whole Milk. [19]

Omega 3 fatty acids: An important dietary modulator of inflammation is the consumption of omega-6 and omega-3 polyunsaturated fatty acids. [20] Compared to the hunter-gatherer diet, rich in fish, wild animals and wild flora, the traditional Western Diet has a higher ratio of omega-6 to omega-3 fatty acids.

Staying hydrated: Dry skin has a higher risk of irritation and damage, exacerbating acne. Keeping hydrated also helps wounds heal, and new cells form properly.

CONCLUSION

Here, we conclude that systemic treatment for acne remains a milestone, particularly in treating moderate- to severe scarring kinds of the illness, despite the interest in developing topical treatments for acne in recent decades. Developing new systemic acne medications is based on past triumphs and failures and developing future information. Inflammation appears to be rediscovered as one of the pathogenic causes of acne, and anti-inflammatory principles appear to be the newest trend in systemic and topical acne treatments. Also, changes in lifestyle modifications and food habits have a great impact on acne-triggering as well as suppressing acne.

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Coprological Prevalence of Gastrointestinal Parasites in Some Wild Herbivore Animals at Girnar Wildlife Sanctuary, Junagadh, Gujarat

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

The present study was undertaken to observe prevalence of gastro-intestinal parasites (GIP) in wild herbivore at Girnar Wildlife Sanctuary, Junagadh, Gujarat. A total of 224 samples were collected of Nilgai, Sambar and Spotted Deer. Collected samples were analysed by direct Smear, sedimentation and floatation methods. The overall prevalence of GI parasites was reported 33.03% (n=224) in wild herbivores. The parasitic prevalence was highest 42.04% (n=88) in Spotted Deer followed by 28.12% (n=96) in Nilgai and 27.5% (n=40) in Sambar. The highest prevalence was recorded for *Strongyle spp.*, (14.73%), followed by *Trichuris sp.* (09.38%), *Strongyloides sp.* (4.46%), *Paramphisopmum sp.* (2.67%) and *Coccidia oocyst* (2.23%). Parasites plays important role in host behaviour as they exhibit behavioural strategies for clearing or avoiding parasites in their natural habitat. For the conservation of wildlife, it will crucial to understand the relationship between parasites and host behaviour.

Keywords: Herbivores, Gastrointestinal parasites, Prevalence, Faeces, Wildlife





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INTRODUCTION

Wild animals are integral parts of biological world. Continuous observation of wild animals is necessary to access the impact of wild animals on natural environment [1]. India is unique in having immense natural beauty and possessing a rich and diverse wildlife. Wild animals suffer from a wide range of various infectious agents like bacteria, viruses and parasites from time to time. A number of factors threaten the existence of wild animals in our country including wildlife diseases, in particular those arising from gastrointestinal parasites [2]. India is unique because of its great natural beauty and diverse, abundant wildlife. Wild animals can be infected with a variety of infectious diseases from parasites, viruses and bacteria [3]. Animals are living in a natural state uniformed parasites are always present but usually in small number with balanced system, but change in environment, stress, nutrition and water intake level might increase sensitivity of animal with parasite infection [4]. Survey of faecal material for parasitic prevalence plays an important role in wildlife management. Data on parasitic diseases in wild animals are relatively scarce in India. Keeping in view the importance of parasitic infections in wild herbivores, the study has been conducted to investigate the occurrence of various gastrointestinal parasitic infections in different species of herbivore; Nilgai (*Boselaphus tragocamelus*), Spotted Deer (*Axis axis*) and Sambar (*Rusa unicolor*) at Girnar Wildlife Sanctuary, Junagadh, Gujarat, India. However, no systematic study was carried out on GI parasites of wild animals in natural habitat in Gujarat.

MATERIAL AND METHODS

Study site

Girnar Wildlife Sanctuary, Gujarat, Western India (Latitude North 21°25' and 21° 35' and meridians of Longitude East 70° 30' and 70° 40') is well known for its rich biodiversity, which covers 178.8 km² area (Data derived from PCCF-Gujarat Forest Department, website: <https://forests.gujarat.gov.in>) (Figure 1). Forest type of this region is mixed deciduous forest along with thorny scrub forest. The study was conducted with appropriate permissions granted by the Forest Department of Gujarat state under permit number WLP/RTC/28/C/356-357/2021-22 in accordance with Indian Wildlife Protection Act, 1972.

Collection of Samples

The present study was carried out for one year (Jan-Dec, 2022). Dropped fresh faecal samples of Nilgai (*Boselaphus tragocamelus*), Spotted Deer (*Axis axis*), Sambar (*Rusa unicolor*) were collected randomly in poly zip locked bag. A total of two hundred twenty-four (n=224) samples were collected. Sample bags were marked by date, host animal and area of Girnar wildlife Sanctuary. The labelled samples were kept with ice bag gel in icebox and transported to the laboratory for further microscopic examination.

Microscopic examination

Collected faecal samples were analysed by qualitative examination using direct smear, sedimentation and floatation technique. Stoll's dilution method was used for a quantitative examination to determine the number of eggs per gram (EPG) of infection. The level of severity of infection was graded into categories on EPG of faeces viz; below 500 (+), 500 to 1000 (++) and more than 1000 (+++) [5].

RESULT AND DISCUSSION

The overall 33.03% prevalence was recorded in wild herbivores viz., Nilgai, sambar and spotted deer (Table 1). *Strongyle spp.*, *Trichuris sp.*, *Strongyloides sp.*, *Paramphistomum sp.*, and *Coccidia oocyst* were recorded in herbivore animals (Figure 2). The findings are quite similar with prevalence (38.17%) of GI parasites in herbivore animals of Van Vihar National Park [6]. The average temperature and humidity condition of sanctuary might be favourable to the survival of eggs and free-living stages of parasites. The similar study was also reported at Kanpur Zoological



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Park, Uttar Pradesh with 25% prevalence of GI parasites in Herbivore animals [7]. Prevalence of GI parasites in captive herbivores documented at Nandankan Zoological Park [8] and Bir Moti Badh Mini Zoo [9] 41. 26% and 68% respectively. Eggs of *Trichostrongylus sp.*, *Strongyloid sp.*, *Balantidium coli* and *Coccidia* in captive herbivore animals of Municipal Zoo at Rajkot [10]. The Parasitic infection could be higher in captivity as wild animals are enclosed in captive areas, also environmental conditions could be through contaminated water or fodder and even zoo workers have played a role as vectors or transmitting parasites through their shoes, hands, food or any working tools [11].

The parasitic prevalence was highest 42.04% in Spotted Deer, followed by 28.12% in Nilgai and 27.5% in Sambar (Table 1). The highest parasitic prevalence was recorded 39.45% in Sambar and 36.84% in Nilgai at Van Vihar National Park, Bhopal [6]. Herbivores around forest of Jabalpur were also infected by GI parasites and the prevalence was 90% in Sambar, 86.67 % in Nilgai and 80% in Spotted Deer [12]. The variation found in number of parasites may be due to the distribution of animals, variation in topography and climatic factors. Also, Nilgai and Sambar have much better physical conditions in comparison to Spotted deer. The host immune level also affects the prevalence of infection, which caused weak natural defence and the ability of parasitic worms to prevent defensive-specific host. The weaker host body's resistance, the more it is likely to be infected [13].

The highest prevalence was recorded for nematode infection of *Strongyle spp.* (14.73%), followed by *Trichuris sp.*, (9.38%), *Strongyloides sp.*, (4.46%), trematode infection of *Paramphistomum sp.*(2.67%), and *Coccidia oocyst* (2.23%) for protozoa. Eggs of *Strongyle sp.*, *Fasciola sp.*, and *Trichuris sp.* were recorded in herbivores at Barnawapara Wildlife Sanctuary [14]. *Strongyle sp.* (41.67%) had the highest occurrence among wild herbivores at Madumalai wildlife Sanctuary [15], followed by *Amphistomes sp.* (15.63%), *Fasciola sp.* (13.54%), *Strongyloides sp.* (11.46%) and *Ascaris sp.* (5.29%). Highest prevalence of *Strongyle spp.*, (67%) were also recorded in herbivores of Bir Moti Bagh mini Zoo, Punjab [9]. *Strongyle sp.*, and *Strongyloid sp.* infections were wide spread in herbivores due to direct life cycle and survivability of the infective larval stage (L3) [16] and they are also prevalent in livestock. *Strongyloides spp.* and *Strongyle sp.* were also recorded in livestock of Junagadh District area [17]. While life cycle of *Trichuris sp.* is direct; eggs with characteristic bi-polar plugs are passed in the faeces and take two or three weeks to become infective stage [18].

In ungulates, behavioural strategies may be found for parasitic control like defecating in clumps and avoid foraging close to faeces. But parasite larvae may be found on grass and other plants at a level above to ground where the parasite larvae could be picked up [19, 20]. In this study, incidence of *Paramphistomum sp.* (2.67 %) was recorded during post monsoon, in which metacercaria is infective stage. When eggs come out through the faeces, it may enter to the suitable snail (intermediate host) and miracidium develops inside the body. Infection may occur when animals eat grass or drink water containing metacercaria [21]. Oocysts of *Coccidia* were also found from faeces of Nilgai and spotted deer, which can survive for long periods under suitable environmental condition [18]. Seasonal variation also effects on prevalence of parasites. In present study prevalence was highest in month of October-December.

Herbivores of Girnar Wildlife Sanctuary shares some common parasites that may be due to human dominated landscape in fringe area of sanctuary. Domestic animals sometimes share the same grazing land with wild animals. Hence, chances of interspecies transmission take place due to the interaction of animal in a common environment [22]. The infection of these parasites might be due to the existence of suitable microclimate for the survival and propagation of free-living larval stages of parasites at several places [6]. The nematodes and some coccidian oocyst parasites have a direct life cycle, they do not involve any intermediate host and they are transmitted by feco-oral route through contaminated feed, water, and soil [2]. However, wild herbivores of Girnar Wildlife Sanctuary had low intensity or parasitic load of GI parasites but that should not be neglected as parasites are important component of ecology as well as health of wild animals.





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CONCLUSION

The overall prevalence of GI parasites in wild herbivore animals was recorded 33.03%. Among different helminthic infections, the prevalence of nematodes was higher than trematodes. The occurrence of GI parasites in free-ranging herbivores might be due to the presence of infective stages of parasites in grazing land or water sources, as these parasites have a direct life cycle. The present study suggests regular screening of faecal samples in free-ranging wild animals and observation of sickness behaviours such as lethargy, avoid social interactions and feeding as a link between parasites and host behaviour, it will help in regular health monitoring and thus it will help in wildlife conservation.

ACKNOWLEDGEMENT

The authors are grateful to PCCF, Wildlife and Chief Wildlife Warden, Gujarat State, Gandhinagar for the permission granted to work in Girnar Wildlife Sanctuary. Also the authors would like to thank CCF Junagadh, DCF Junagadh, Forest staff of the Department. The authors would like to express an immense amount of gratitude towards the Principal Dr. R.P Bhatt for providing laboratory facilities and all staff members of Bahauddin Government Science College, Junagadh. The authors acknowledge Namrata Hun and Usha Zala, for their help throughout the fieldwork. Also, the first authors express their sincere thanks to SHODH - ScHeme of Developing High Quality Research for its financial support in the form of stipend.

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Table 1: Prevalence of parasitic infection in Wild Herbivores

Host	Number of Examined samples	Number of positive samples (%)	GI Parasites				
			Trichuris sp. (%)	Strongyloides sp. (%)	Strongyle sp. (%)	Paramphistomum sp. (%)	Coccian oocyst (%)
Nilgai	96	27 (28.12)	08 (8.33)	04 (4.16)	13 (13.54)	-	02 (2.08)
Sambar	40	11 (27.5)	04 (10)	01 (2.05)	06 (15)	-	-
Spotted deer	88	37 (42.04)	09 (10.23)	05 (5.68)	14 (15.91)	06 (6.82)	03 (3.41)





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Total	224	74 (33.03)	21 (9.38)	10 (4.46)	33 (14.73)	06 (2.67)	05 (2.23)
Intensity of Infection			+	+	++	+	+

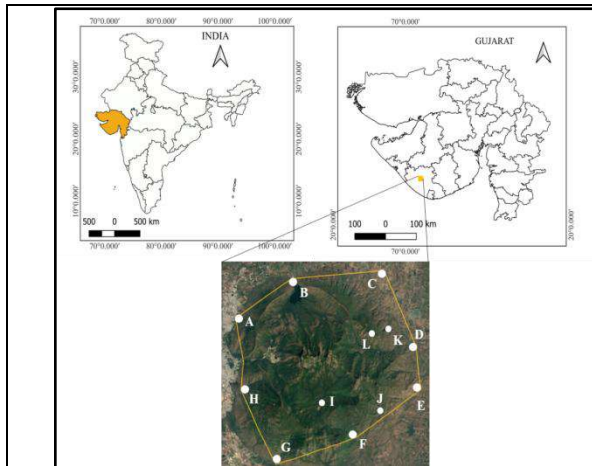


Figure 1: Map of Girnar Wildlife Sanctuary, Junagadh, Gujarat, India (1 and 2) and satellite image of the study area with sampling location as follow (3): A. Indreswar, B. Jambudi, C. Paturan, D. Patvad, E. Ratanpara, F. Ramnath, G. Dungarpur, H. Khodiyar, I. Bordevi, J. Mathureshwar, K. Surajkund, L. Kala gadba.

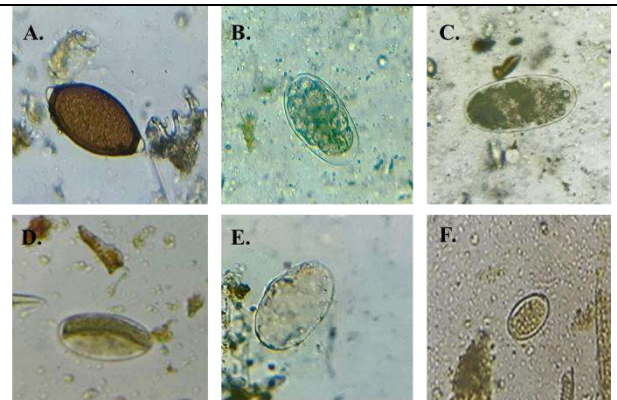


Figure 2: Photomicrographs (400 X) of eggs/ova of GI parasites in different herbivores (A) *Trichuris* sp., (B) and (C) *Strongyle* sp., (D) *Strongyloides* sp., (E) *Paramphistomum* sp., (F) *Coccidian* oocyst





Emerging Perspectives of Cordycepin in Mitigating Osteoarthritis: A Multi-Faceted Approach

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 19 Jun 2024

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ABSTRACT

A nucleoside analogue, 3'-deoxyadenosine (cordycepin), has been isolated from the mushroom, *Cordyceps militaris*. Due to its unique medicinal efficacy and several pharmacological whereabouts, it is regarded to be an exceptionally treasured fungus. Many countries employ Cordyceps extensively due to its effectiveness in the field of medicine as an antioxidant, anticancer, anti-inflammatory, anti-aging agent, etc. Therefore, this review emphasize predominantly on the biological potential of cordycepin in relation to osteoarthritis, an ailment characterized by progressive joint degeneration. The manuscript centers around the unique therapeutic potency of cordycepin on the cytokines (IL-1 β and TNF- α), nuclear localization factor (NF- κ B), and polyadenylation factors to mitigate the severe effects of these inflammatory modulators in relation to osteoarthritis and groundbreaking preclinical analysis. PRISMA 2020 guidelines were implemented; 162 articles assessed, 60 articles finalized. A myriad of studies authenticate the significance of cordycepin in various treatments related to joint disorders and synovial inflammations in humans as well as in animal models. Cordycepin has shown a promising nutraceuticals competence. In the near future, the scientific fraternity should focus more on the incognito compounds from *C. militaris* and explore its probable targeted drug delivery process to ameliorate its bioavailability.

Keywords: *Cordyceps militaris*; Cordycepin; Cytokines; Inflammation; Osteoarthritis





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INTRODUCTION

Osteoarthritis (OA) is a chronic degenerative disease affecting the musculoskeletal system, particularly the hip and knee joints [1]. Elderly individuals, especially women, are the most affected [2]. Aging leads to changes in joint tissues, increasing susceptibility to OA. Besides aging, environmental, biochemical, and mechanical factors also contribute to joint tissue deterioration. The key theories for the degeneration of articular cartilages include abnormal metabolic processes, hereditary disorders, and developmental issues. The overabundance of cytokines in the synovial fluid, including prostaglandins (PGE-2), nitric oxide (NO), interleukin-1 (IL-1), tumor necrosis factor alpha (TNF- α), and interleukin-6 (IL-6), is believed to cause OA-related joint tissue damage [3,4]. Reduced growth factors and mesodermal tissues further decrease matrix formation and repair [5]. In addition to joints, OA also impacts subchondral bone remodeling, osteophyte formation, medial meniscus, infra-patellar fat pad (IFP), and synovial joint modifications [6]. However, our lifestyle has a great impact on treating various musculoskeletal disorders along with few non-steroidal anti-inflammatory drugs (NSAIDs) or opioids to relieve pain. As medicinal mushrooms contain high antioxidants, adopting a mushroom-rich diet can prevent more than two-thirds of cancer-related deaths [7,8]. The well-known traditional Chinese medicinal mushroom *Cordyceps militaris*, an entomopathogenic fungus that parasitizes lepidopteron insects and larvae [9], is notable for its bioactive compound, Cordycepin. Cordycepin offers numerous health benefits, including anti-viral [10], anti-bacterial [11], anti-fatigue [12], anti-hyperglycemic [13], anti-inflammatory [14], and anti-tumor [15] properties. OA is considered a significant issue due to its increasing pervasiveness worldwide mainly in the older populations. Recently trivial therapies have been into limelight that includes symptoms relieving drugs but doesn't benefit the person with a permanent remedy. While cordycepin is recognized for its anti-inflammatory effects, the key players and the precise mechanisms remain uncertain. Therefore, a thorough understanding of this nucleoside analogue is essential to identify the biology underlying the anti-inflammatory properties and the development of novel therapeutic strategies. Thus, the goal of this article was to provide an overview of cordycepin's potential as an anti-inflammatory drug in the revival of OA therapies.

METHODOLOGY

In this study, various issues related to the OA in the elderly populations and implementing the nucleoside analogue, cordycepin as a remedial integrant were specified for review using "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) 2020 guidelines [16]. The subsequent inclusion requirements guided the choice of studies: (i) articles related to the cause of inflammation in OA and the use of natural herbal medicines having the inherent potency as therapy which were barely investigated were adopted, and (ii) articles with full text availability in English were selected for the review. Studies whose full texts are not available were excluded from this Review. Papers were searched in NCBI, PubMed, Google Scholar and Scopus databases using the keywords "*Cordyceps militaris*", "cordycepin", "anti-inflammation", "osteoarthritis", "cytokines", "nuclear localization factor", "polyadenylation factors" and "articular cartilage". Over the course of over six decades, a comprehensive literature survey was conducted, resulting in the identification of 162 studies from various databases that were deemed appropriate for review. Of these, 37 were determined to be duplicates and thus excluded, 35 studies were excluded due to the unavailability of full text, 30 articles were removed because the information provided was insufficient, and overall 60 papers were finalized for review. The flow diagram constructed using the PRISMA tool reveals identified records, screening process and selected studies for systematic review (Figure 1).

Cordyceps: A Medicinal Herb

C. militaris is a well-known entomopathogenic fungus, named from two Latin words "*cord*" and "*ceps*" meaning 'club' and 'head', respectively [17]. It typically falls under the family Cordycipitaceae and order Hypocreales within the phylum Ascomycetes [18]. Cordyceps predominantly occupies insect intestine during winter, and its fruiting bodies sprout out during summer, hence the name "winter-worm summer-grass". Highly host-specific and rare, it has been a treasured mushroom traditionally used as a medicine in India and China since long back. Cordyceps are also known as Himalayan Gold because it is often being harvested in high-altitude subalpine regions of grassy lands



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of Himalayas approximately 14,000 feet including Nepal, China and Tibet [19]. Of the estimated 1200 entomopathogenic fungal species, over 750 species belong to the Cordyceps genus [18].

Chemistry of Cordycepin

Cordycepin, a bioactive component of *C. militaris*, is a purine nucleoside analogue structurally identical to adenosine (Figure 2). Also known as 3'-deoxyadenosine, it replaces the OH group at the 3' position with a hydrogen atom in the ribose sugar moiety [20,21]. The cordycepin structure is portrayed by the adenine nucleotide attached to the ribofuranose moiety via a β -N9-glycosidic bond. It influences various biochemical processes, including nucleic acid synthesis [22], purine biogenesis [23], mTOR (mammalian target of rapamycin) signaling [24], apoptosis, cell cycle arrest, anti-metastasis, anti-pathogenic, antioxidant effects, inhibition of platelets aggregation and inflammatory mediator signaling [25].

Anti-Inflammatory Property of Cordycepin

OA is the most common form of arthritis, characterized by the breakdown of joint cartilage and changes in the underlying bone with symptoms such as stiffness of joints, swelling, pain, warmth, and redness. Also known as degenerative joint disease or wear-and-tear arthritis, there is currently no cure for OA. Treatments like non-steroidal anti-inflammatory drugs (NSAIDs) or opioids can alleviate symptoms but may lose effectiveness and cause side effects with long-term use. To minimize these effects, people predominantly fascinated towards a beneficial, economic and risk-free conventional herbal medications. According to reports, NF- κ B activation significantly up-regulates inflammatory mediators such as NO, COX2, TNF- α , and IL-1 β [26]. Cordycepin has been shown to suppress cytokine expressions like IL-1 β and TNF- α in LPS-stimulated macrophages, reducing nitric oxide production [25]. It also helps prevent cartilage deterioration and inflammation in OA patients by minimizing inflammatory cell infiltration and downregulating specific gene expressions [27,28]. Thus, cordycepin shows promise as an anti-inflammatory treatment for arthritis.

OA models

Elderly populations face a growing burden of diseases, notably OA, necessitating multiple animal models for studying its progression [29]. While aging mice models provide genetic coherence but take about a year to develop OA, Dunkin-Hartley guinea pigs mimic aging-related OA in less than three months, resembling human OA closely [31]. Live animal models, following ethical norms, are used to assess the therapeutic potential of cordycepin in OA. The destabilizing medial meniscus (DMM) model aids in studying OA's inception and progression, offering insights into knee joint structures and facilitating tissue studies for potential therapies (Figure 3) [32].

Effect of Cordycepin on IL-1 β and TNF- α Induced Factors

The key inflammatory cytokines, interleukin-1 beta (IL-1 β) and tumor necrosis factor alpha (TNF- α) play pivotal roles in OA-related inflammatory signaling. IL-1 β predominantly synthesized as a cytosolic precursor protein which upon proteolytic cleavage becomes active and triggers inflammatory responses via its receptors, IL-1R1 [33]. Conversely, TNF- α acts through membrane-bound receptors, TNF-R1 and TNF-R2, mediating signals upon ligand binding [34]. These cytokines, along with IL-6, IL-8, CCL5, VEGF, NO, COX-2, PLA-2, PGE-2, exacerbate inflammation in OA patients. [35]. Studies have shown elevated IL-1 β and TNF- α levels in OA tissues, leading to cartilage degradation through MMPs 1-13, and ADAMTS 4 and 5 synthesis while inhibiting aggrecan and collagen production (Figure 4) [36]. Cordycepin shows promise in mitigating these effects by reducing inflammatory mediators [37].

Effect of Cordycepin on NF- κ B Nuclear Localization

The NF- κ B is a universally expressed transcription factor involved in immune responses, inflammation, stress, cell proliferation and cell death [38]. In the absence of any signals, the NF- κ B heterodimers are positioned in the cytoplasm in an inactive form along with I κ B molecules. Upon stimulation, NF- κ B activation involves I κ B phosphorylation by I κ B kinases (IKKs) followed by 26S complex proteasomal degradation with ubiquitin tags [39]. Active NF- κ B heterodimers then translocate to the nucleus, promoting the expression of cytokines, proteases,



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immunomodulatory molecules, and chemokines [40]. Articular cartilage cells manifest mechanical receptors, TNF-R, TL-R and cytokine receptors that retaliate to certain pro-inflammatory proteins like TNF- α or IL-1 β , triggering the NF- κ B signaling [41]. This activation triggers the secretion of matrix metalloproteinases (MMPs) and impede chondrocyte metabolic functions [42]. In OA, NF- κ B transcription factors drive the progression of MMPs, cytokines and chemokines, leading to joint degradation [43]. Synovial cells in OA activate NF- κ B pathways, which deals with the conglomeration of cytokines (IL-1 β , TNF- α , RANKL, IL-6), chemokines (CCL5, IL-8), MMPs1-13, PGE2, ADAMTS4, ADAMTS5, few angiogenic agents (VEGF, bFGF), and provoke bone regression, neo-angiogenesis and synovitis [44,45]. OA also involves lymphocytes, mast cells, macrophages, and NK cells infiltration, causing swelling and stiffness [46]. The subchondral bone, beneath the articular cartilage, is protected by osteoblast-mediated bone formation and osteoclast-mediated bone resorption via the RANK/RANKL signaling pathway [47]. Basically, certain chondrocytes give rise to cytokines which induce the release of RANKL, leading to the activation of NF- κ B transcription factors for bone resorption to sustain the blood calcium level [48]. OA disrupts this balance, leading to osteoporosis and cartilage compaction (Figure 5). Furthermore, Li et al. (2016) found that cordycepin significantly reduced IL-1 β and TNF- α expression in LPS-induced macrophages by inhibiting I κ B phosphorylation and NF- κ B nuclear translocation [49]. Moreover, cordycepin also restricted osteoclast differentiation and abnormal bone resorption. Recent studies confirmed cordycepin's effectiveness in inhibiting NF- κ B expressions and I κ B phosphorylation in the aged mice [50]. Cordycepin appears to be a potent bioactive compound which has the zeal to hinder various pro-inflammatory mediators via NF- κ B nuclear localization.

Effect of Cordycepin on Polyadenylation in Macrophages

Polyadenylation involves adding a poly (A) tail to the 3' end of an mRNA transcript, which occurs inside the nucleus prior to translocation to the cytosol where it protects the 3' end from enzymatic degradation. In OA, inflammatory mediators accumulate in various tissues, causing abnormal amplification of 3' end of mRNA transcript by poly (A) polymerases (PAP). These polymerases add adenosine triphosphate (ATP) with the help of poly (A) binding protein (PABP) to stabilize the transcript in healthy individuals. In OA patients, inflammation leads to unstable transcripts. Hence, removing the poly (A) tail destabilizes mRNA. Kondrashov et al. (2012) found that cordycepin prevents inflammation by inhibiting polyadenylation [51]. The mRNA transcripts in the cytoplasmic are bound by poly (A) binding protein (PABPC1) at the 3' end, while translation initiation factors (eIF4E, eIF4A and eIF4G) binds the 5' end [52]. eIF4G connects the ends, forming a closed-loop complex crucial for translation initiation [53]. Few polyadenylation markers like CPSF4 and WDR33 monitor mRNA in healthy individuals, but in OA, LPS-stimulated macrophages cause marker translocation to the nucleus, producing inflammatory signals. Later, siRNA studies showed that inhibiting these markers affects NF- κ B localization [54]. Moreover, LPS induced mediators such as IL-1 β , TNF- α and NK- κ B showed analogous features to that of cordycepin assisting gene expressions in OA inflammation [55]. Consequently, it can be summarized that expressions of macrophages in respect to inflammation are greatly enhanced by involvement of nuclear polyadenylation factors at an intensifying rate which eventually gets hindered by cordycepin (Figure 6). Due to its structural similarity to ATP, cordycepin, or cordycepin triphosphate (CTP), disrupts polyadenylation in precursor mRNA, reducing macrophage inflammation in cartilage [56]. Unlike other adenosine analogs, cordycepin shortens poly (A) tails, reducing mRNA cleavage effectiveness [57]. Thus, cordycepin inhibits polyadenylation and serves as a therapeutic agent in OA.

Existing Therapies and Current Research Goals

The prevailing OA therapies include behavioral interventions, palliative drugs, NSAIDs, intra-articular jab, and joint replacement surgery [58]. However, these treatments often lack effectiveness and have unpleasant complications, prompting a need for better medical approaches as pharmaceutical companies shift to a non-research-based work cautious of investing in identifying OA-related treatments manifesting their potential in clinical trials. While identifying pro-inflammatory cytokines helps mimic OA pathogenesis *in vitro*, certain anti-inflammatory mediators used in other diseases have yet to show productive results against OA [59]. Preclinical studies, by Wang et al. (2013), highlighted MMP-13 as a crucial target for preventing cartilage erosion in OA [60]. Despite high specificity, treatments targeting enzyme catalysis or signaling pathways often fail due to inadequate side effects. As a result, many clinical aspects addressing OA therapies were discontinued, leading academia to seek novel strategies.





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CONCLUSION

Over the past few years, people have shown confidence and trust in naturally occurring food-based products such as nutraceuticals, for managing various diseases. Medicinal mushrooms, notably *Cordyceps militaris*, have demonstrated effectiveness against various serious complications and have been used in traditional Chinese medicine for centuries. *C. militaris* holds a rich source of bioactive ingredients, with cordycepin showing the greatest nutraceuticals potential. Research indicates cordycepin's efficacy in treatment of joint disorders and synovial inflammations in both rodent models and humans. Future research should focus on uncovering other innominate compounds in Cordyceps and their therapeutic potential. Likewise, it is equivalently important for the scientific community to explore the possibilities of nanobiotechnology-mediated targeted drug delivery systems for cordycepin and enhance its bioavailability. Further experimental studies and clinical trials are requisite to identify cordycepin's exact mechanisms, efficacy, and safety. Being a fungus, Cordyceps holds supreme role in the prevention and cure of various ailments caused by metabolic disorders and infectious diseases, establishing it as a novel bioactive source.

ACKNOWLEDGEMENTS

We would like to acknowledge the Council of Scientific and Industrial Research-Human Resource Development Group (CSIR-HRDG), Government of India, for providing SRF-NET fellowship to Diksha Dutta {File No. 09/1236(15458)/2022-EMR-I} which helped her in this work. The authors also acknowledge the Department of Biotechnology (DBT), Government of India for using resources of ongoing DBT project (No. BT/INF/22/SP45376/2022) in the present work.

AUTHORSHIP CONTRIBUTIONS

DD contributed to the study conception and design of the manuscript. Manuscript preparation, literature survey and data analysis were performed by AKV and DD. NSS and TB assisted in drafting the manuscript and data interpretation. MD and BB performed the proofreading of the manuscript. All authors read, revised and approved the final manuscript.

CONFLICT OF INTEREST

The author(s) declare(s) that there is no conflict of interests regarding the individual author's commitments or project support.

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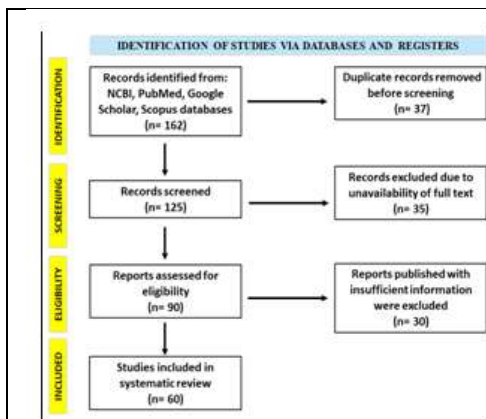


Figure 1: PRISMA flow diagram for the selection process of studies included in the present review

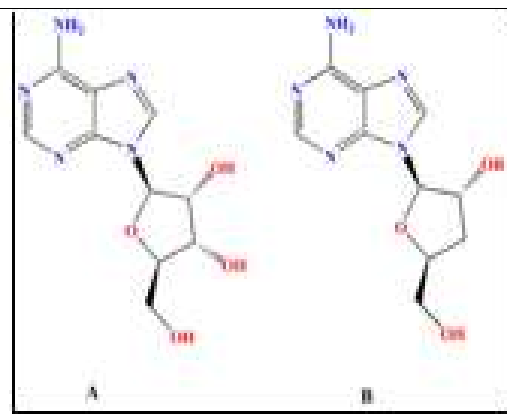


Figure 2: Chemical structure of (A) Adenosine and (B) Cordycepin

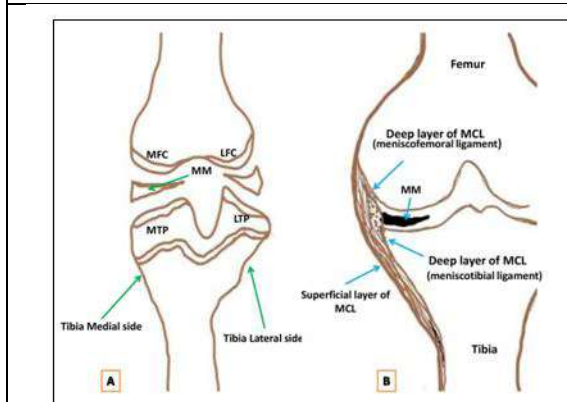


Figure 3: Pictorial representation of the knee joints in a (A) rodent (B) human [MFC: medial femoral condyle; LFC: lateral femoral condyle; MTP: medial tibial plateau; LTP: lateral tibial plateau; MM: medial meniscus; MCL: medial collateral ligament]

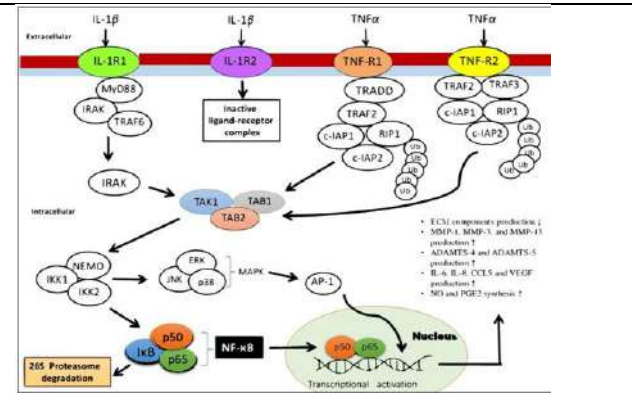
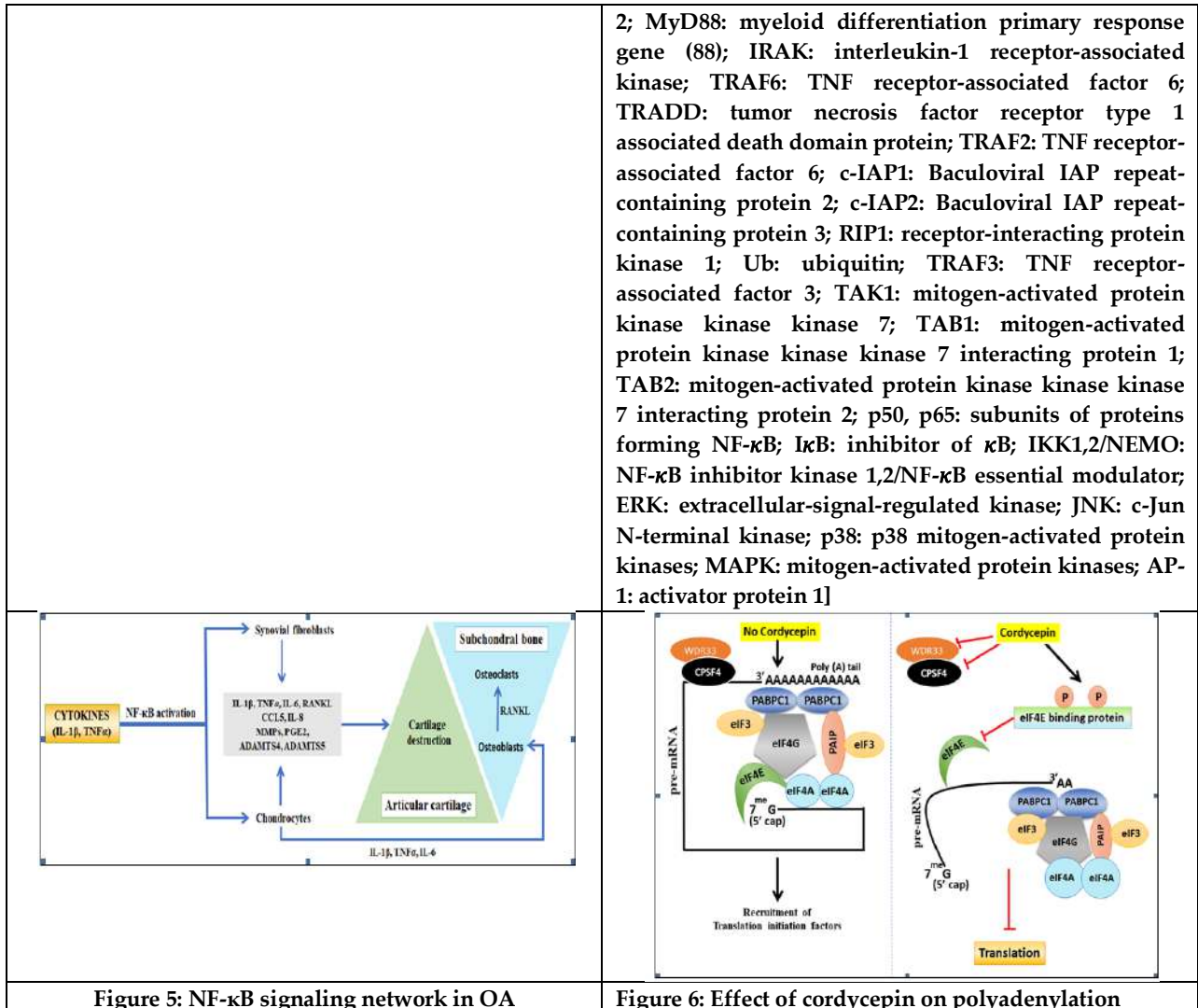


Figure 4: IL-1β and TNFα associated intracellular signaling cascades [IL-1R1: interleukin-1 receptor type 1; IL-1R2: interleukin-1 receptor type 2; TNF-R1: tumor necrosis factor receptor superfamily member 1; TNF-R2: tumor necrosis factor receptor superfamily member





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On bms α -Open Sets and bms α -Continuous Function

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

In this paper introduce binary multiset (bms) α -open, bms α -interior, bms α -closure, bms semi open and bms preopen on bms topological space and study some of their properties are given investigate the concepts of bms α -continuous and bms α -open functions and discuss their relationships with bms continuous. Also counter examples are given show their properties of these functions.

Keywords: open bms, bms α -open, bms α -closed, bms α -interior, bms α -closure and bms α -continuous function.

Mathematics Subject classification: 00A05, 03E70, 54B10, 54G20.

INTRODUCTION

The initiated a theory of notion multiset, which was first studied by Blizard[5,6] in the year of 1989. Boundary and exterior of a multiset topology Das [5] boundary exterior, Multiset topology. Dontchev [7] presented by note on some application on semi-pre-open set. [8] Levine introduced semi open and semi-continuity in topological space [1] Abd El-Monsef introduced β^* -open sets and β^* -continuity in topological space [9] Mashhour and Hasanein established the concepts of a α -continuous and α -open mapping. [10] Mashhour presented by on pre-continuous mapping and weaker pre-continuous mapping. Surekha and Sindhu introduced the new class of binary open sets in binary topological space, introduced by α gs-closed sets, α gs-open sets, α gs-closure set in 2022, [12]. [2] Andrijivic presented semi pre-open set. Biswas investigated the some mappings in Topological spaces and characterization of semi-continuous mapping. [15,16] Girish presented multiset in topological space the number of occurrences of the element





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x in the mset M . We present the mset M drawn from the set $X = \{X_1, X_2, \dots, X_n\}$ as $M = \{m_1/x_1, m_2/x_2, \dots, m_n/x_n\}$. Where m_i is the number of occurrences of the element $x_i = 1; 2, \dots, n$ in the mset M . The M -topological space was investigated by closure, interior, continuous function. [11] Priyalatha introduced the binary multiset concept for the open bms, closed bms of their properties and examples [14] Das established generalized multiset function in open, preopen, semi open, β -open function in continuous generalized ideal continuous function. [13,20] Nithayanatha Jothi introduced binary multiset topological space, a single structure which carries the subsets of X as well as the subsets of Y studying the information about the ordered pair of (A, B) of subsets of X and Y and on generalized binary topological space satisfies the condition of intersection element of subsets in binary topological space. In this paper, we introduce some new concepts in bms topological space such as bms α -open, bms α -closed bms α -continuous function, bms pre continuous, bms semicontinuous with their properties and theorem with examples are discussed.

PRELIMINARIES AND BASIC DEFINITIONS

Definition 2.1. [7] An mset M drawn from the set X is represented by a function count M or C_M defined as $C_M \rightarrow N$. Where N represents the set of non-negative integers. Here $C_M(x)$ is the number of occurrences of the element x in the mset M . We present the mset M drawn from the set $X = \{X_1, X_2, \dots, X_n\}$ as $M = \{m_1/x_1, m_2/x_2, \dots, m_n/x_n\}$. Where m_i is the number of occurrences of the element $x_i = 1, 2, \dots, n$ in the mset M . However those elements which are not included in the mset M have zero count.

Definition 2.2. [7] A domain X , is defined as a set of elements from which mset are constructed. The mset space $[X]^w$ is the set all msets whose elements are in X such that no elements in the mset occurs more than w times. The set $[X]^\alpha$ is the set all msets over a domain X such that there is no limits on the number of occurrences of an elements in an msets. If $X = \{x_1, x_2, \dots, x_k\}$ then $[X]^w = \{m_1/x_1, m_2/x_2, \dots, m_k/x_k\}$.

Definition 2.3. [7] Let $M \in [X]^w$ and $\tau \subseteq P^*(M)$. Then τ is called a multiset topological space of M if τ satisfies the following properties.

- (i) The mset M and the empty mset φ are in τ .
- (ii) The mset union of the elements of any sub collection of τ is τ .
- (iii) The mset Intersection of the elements of any finite sub collection of τ is in τ .

Definition 2.4. [7] A sub mset N of M -topological space M in $[X]^w$ is said to be closed if the mset N is open. In discrete M -topological space every mset is an open mset as well as a closed mset. In the M -topological space $PF(M) \cup \varphi$, every mset is an open mset as well as a closed mset.

Definition 2.5. [7] Given a submset A of an M -topological space M in $[X]^w$, the interior of A is defined as the mset union of all open mset contained in A and it's denoted by $\text{Int}(A)$. i.e., $\text{Int}(A) = \cup\{G \subseteq M : G \text{ is an open mset and } G \subseteq A\}$ and $C_{\text{Int}(A)}(x) = \max\{C_G(x) : G \subseteq A\}$.

Definition 2.6. [7] Given a submset A of an M -topological space M in $[X]^w$, the closure of A is defined as the mset intersection of all closed mset containing A and its denoted by $\text{Cl}(A)$. i.e., $\text{Cl}(A) = \cap\{K \subseteq M : K \text{ is a closed mset and } A \subseteq K\}$ and $C_{\text{Cl}(A)}(x) = \min\{C_K(x) : A \subseteq K\}$.

Definition 2.7. [13] Let X and Y be any two non empty sets. A binary topological space X to Y is a binary structure $M \subseteq \mathcal{P}(X) \times \mathcal{P}(Y)$ that satisfies the following axioms.

- (i) (φ, φ) and $(X, Y) \in M$.
- (ii) $(A_1 \cap A_2, B_1 \cap B_2) \in M$ whenever $(A_1, B_1) \in M, (A_2, B_2) \in M$.
- (iii) If $\{(A_\alpha, B_\alpha) : \alpha \in \Delta\}$ is a family of members of M , then $(\bigcap_{\alpha \in \Delta} A_\alpha, \bigcap_{\alpha \in \Delta} B_\alpha) \in M$.

Definition 2.8. [15] Let (M, τ) be a multiset topological space on $[X]^w$ and N sub-mset of M . We define the following definition:





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- (i) A Semi-open if $A \subseteq \text{cl}(\text{int}(A))$ with $C_{A(x)} \leq C_{\text{cl}(\text{int}(A))(x)}, \forall x \in X$.
- (ii) A semi-closed if $\text{int}(\text{cl}(A)) \subseteq A$ with $C_{\text{int}(\text{cl}(A))(x)} \leq C_{A(x)}, \forall x \in X$.
- (iii) A semi-pre-open (β – open) if $A \subseteq \text{cl}(\text{int}(\text{cl}(A)))$ with $C_{A(x)} \leq C_{\text{cl}(\text{int}(\text{cl}(A)))(x)}, \forall x \in X$.
- (iv) A semi-pre-closed (β – closed) if $\text{int}(\text{cl}(\text{int}(A))) \subseteq A$ with $C_{\text{int}(\text{cl}(\text{int}(A)))(x)} \leq C_{A(x)}, \forall x \in X$.
- (v) A pre-open if $A \subseteq \text{int}(\text{cl}(A))$ with $C_{A(x)} \leq C_{\text{int}(\text{cl}(A))(x)}, \forall x \in X$.
- (vi) A pre-closed if $\text{cl}(\text{int}(A)) \subseteq A$ with $C_{\text{cl}(\text{int}(A))(x)} \leq C_{A(x)}, \forall x \in X$.
- (vii) An α -open if $A \subseteq \text{int}(\text{cl}(\text{int}(A)))$ with $C_{A(x)} \leq C_{\text{int}(\text{cl}(\text{int}(A)))(x)}, \forall x \in X$.
- (viii) An α -closed if $\text{cl}(\text{int}(\text{cl}(A))) \subseteq A$ with $C_{\text{cl}(\text{int}(\text{cl}(A)))(x)} \leq C_{A(x)}, \forall x \in X$.
- (ix) A regular-open if $A = \text{cl}(\text{int}(A))$ with $C_{A(x)} = C_{\text{cl}(\text{int}(A))(x)}, \forall x \in X$.
- (x) A regular-closed if $\text{int}(\text{cl}(A)) = A$ with $C_{\text{int}(\text{cl}(A))(x)} = C_{A(x)}, \forall x \in X$.

ON BMS α -OPEN SETS

Definition 3.1.[11] Let U, V be two non-empty sets, $[U]^w, [V]^r$ be two multiset spaces on U and V respectively. The ordered pair (M_1, M_2) is called a binary multiset (or bms) where $M_1 \in [U]^w, M_2 \in [V]^r$ are two multisets drawn from U and V respectively.

Note 3.2.[11] We know that, the power set of a multiset M_1 (resp. M_2) is the support set of the power multiset of M_1 (resp. M_2), is symbolized by $P^*(M_1)$ (resp. $P^*(M_2)$). We can define $P^*(M_1) \times P^*(M_2) = \{(A_i, B_i) : A_i \in P^*(M_1), B_i \in P^*(M_2)\}$. According this definition, the ordered pair (A, B) is called a bms from M_1 and M_2 where $A \subseteq M_1$ and $B \subseteq M_2$. That is, the bms (A, B) is an element in $P^*[M_1] \times P^*[M_2]$.

Definition 3.3.[11] Let $M_1 \in [U]^w, M_2 \in [V]^r$ be two multisets drawn from U and V respectively. A binary topological space (briefly, bms-topology) from M_1 to M_2 is a binary multiset structure $\tau_b \subseteq P^*(M_1) \times P^*(M_2)$ that satisfies the following axioms:

- (i) $(\varphi, \varphi), (M_1, M_2) \in \tau_b$.
- (ii) If $(A_1, B_1), (A_2, B_2) \in \tau_b$, then $(A_1 \cap A_2, B_1 \cap B_2) \in \tau_b$.
- (iii) If $\{(A_\lambda, B_\lambda) : \lambda \in J\} \subseteq \tau_b$, then $(\cup A_\lambda, \cup B_\lambda) \in \tau_b$.

In this case, the structure (M_1, M_2, τ_b) is called bms-topological space (or bms-space).

Note that τ_b is an ordinary set whose elements are bms.

Definition 3.4.[11] For a bms-space (M_1, M_2, τ_b) , we have

- (i) Each element in τ_b is called an open binary multiset (or open bms) and the complement of open bms is named a closed binary multiset (or closed bms).
- (ii) A sub-bms (A, B) of a bms-space (M_1, M_2, τ_b) is said to be closed bms if the bms $(A, B)^c = (M_1 \setminus A, M_2 \setminus B)$ is an open bms.

Definition 3.5.[11] Let (M_1, M_2, τ_b) be an bms topological space and $A \subseteq M_1, B \subseteq M_2$. Then (A, B) is closed bms in (M_1, M_2, τ_b) if $(M_1 \setminus A, M_2 \setminus B) \in \tau_b$, the complement of closed Bms τ_b^c .

Example 3.6. Let $M_1 = \{2/a, 1/b, 2/c\}, M_2 = \{1/d, 3/e, 2/f\}$ be a two m-set. Consider, the bms topological space $\tau_b = \{(\varphi, \varphi), (M_1, M_2), \{2/a\}, \{3/e\}, \{1/b\}, \{2/f\}, \{2/c\}, \{2/b\}, \{1/a\}\}$ is an binary multiset topological space. Now $(\{2/a\}, \{3/e\}), (\{1/b\}, \{2/f\}), (\{2/c\}, \{2/b\}, \{1/a\})$ is an open bms. Since $(\{1/b, 2/c\}, \{1/d, 2/f\}), (\{2/a, 2/c\}, \{1/d, 3/e\}), (\{2/a, 1/b\}, \{2/a, 1/b\}, \{1/a, 1/b, 2/c\})$ are closed bms.

Definition 3.7.[11] The ordered pair $(A_1, B_1)^*, (A_2, B_2)^*$ is called bms closure of (A, B) is defined as the intersection of all closed bms containing in (A, B) denoted by $\text{cl}_b(\{A, B\})$ is bms topological space (M_1, M_2, τ_b) where $(A, B) \subseteq (M_1, M_2), \text{cl}_b(\{A, B\}) = \cap \{(G, H) \subseteq (M_1, M_2) : (G, H) \text{ is a closed bms and } (A, B) \subseteq (G, H)\}$.





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Definition 3.8.[11] An ordered pair $(A_1, B_1); (A_2, B_2)$ is called bms interior, its defined as union of binary multiset open contained in (A, B) . Its denoted by $\text{int}_b(A, B)$. It's defined $\text{int}_b(A, B) = \cup \{(G, H) \subseteq M : (G, H) \text{ is open bms an and } (G, H) \subseteq (A, B)\}$.

Example 3.9. Let $M_1 = \{1/p, 1/q\}$, $M_2 = \{1/p, 2/q, 1/r\}$ be a two m-set. We consider the bms topological space $\tau_b = \{(\varphi, \varphi), (M_1, M_2), (\{1/p\}, \{2/q\}), (\{1/p, 2/q\}, \{1/p, 1/r\}), (\{1/r\}, \{1/p\})\}$. Clearly, τ_b is an bms-topological space and the ordered pair $(M_1 \times M_2, \tau_b)$. Also the collection of τ_b and τ_b a subbms of $(A, B) = \{1/p, 1/r\}$ then $\text{int}_b(A, B) = \{1/p, 1/r\}$, $\text{cl}_b(A, B) = \{1/p, 1/r\}$.

Definition 3.10.[11] A bms (G, H) of a bms topological space (M_1, M_2, τ_b) is called bms α -open if $(G, H) \subseteq \text{int}_b(\text{cl}_b(G, H))$. The complement of bms α -open is called bms α -closed.

Definition 3.11.[11] A bms (G, H) is called bms preopen (resp. bms semiopen) in a bms topological space (M_1, M_2, τ_b) if $(G, H) \subseteq \text{int}_b(\text{cl}_b(G, H))$ [resp. $(G, H) \subseteq \text{cl}_b(\text{int}_b(G, H))$]. We will denote the family of all bms α -Open (resp. bms α -Closed and bms preopen) of a bms topological space (M_1, M_2, τ_b) by $\text{bms}\alpha\text{O}(M_1, M_2, \tau_b)$ (resp. $\text{bms}\alpha\text{C}(M_1, M_2, \tau_b)$ and $\text{bmsPO}(M_1, M_2, \tau_b)$).

Proposition 3.12. Let (M_1, M_2, τ_b) be a bms topological space, then we have (i) arbitrary union of bms α -open is a bms α -open. (ii) Arbitrary intersection of bms α -closed is a bms α -closed.

Proof. Let $\{(G_i, H_i : i \in \Lambda)\}$ be a collection of bms α -open. Then, for each $\{i \in \Lambda, (G_i, H_i) \subseteq \text{int}_b(\text{cl}_b(\text{int}_b(G_i, H_i)))\}$. Now $\cup(G_i, H_i) \subseteq \cup \text{int}_b(\text{cl}_b(\text{int}_b(G_i, H_i))) \subseteq \text{int}_b \cup \text{cl}_b(\text{int}_b(G_i, H_i))$ which is equal to $\text{int}_b(\text{cl}_b(\cup \text{int}_b(G_i, H_i))) \subseteq \text{int}_b(\text{cl}_b(\text{int}_b \cup (G_i, H_i)))$. Hence $\cup(G_i, H_i)$ is a bms α -open.

(ii) Subsequent (i) by taking complement.

Example 3.13. Let $M_1 = \{3/a, 2/s\}$, $M_2 = \{2/a\}$, $\tau_b = \{(\varphi, \varphi), (M_1, M_2), (\{2/s\}, \{2/a\}), (\{2/s\}, \{2/a\})\}$ and $\tau_b = \{(\varphi, \varphi), (M_1, M_2), (\{3/a\}), (\{1/a\}), (A, B) = (\{1/a\}), \text{int}_b(A, B) = (\{1/a\}), \text{cl}_b(A, B) = (\{1/a\})$. Since $\text{int}_b(\text{cl}_b(\text{int}_b(A, B))) \subseteq (\{1/a\})$ is a bms α -open and $\text{cl}_b(\text{int}_b(\text{cl}_b(A, B))) \subseteq (\{1/a\})$ bms α -closed.

Remark 3.14. It is obvious that every open bms (resp. closed bms) is a bms α -open (resp. bms α -closed). Similarly, every bms α -open is bms semiopen and bms preopen. Thus we have implication as shown in Figure 1. The example given below show that the converse of these implication are not true

Example 3.15. Let $M_1 = \{1/a, 2/b, 3/c, 4/d, 5/e\}$ and $M_2 = \{1/x, 1/y, 1/z\}$ and $(G, H) \subseteq (M_1, M_2)$, $\tau_b = \{(\varphi, \varphi), (M_1, M_2), (G_1, H_1), (G_2, H_2), (G_3, H_3), \dots, (G_{15}, H_{15})\}$, where $(G_1, H_1), (G_2, H_2), (G_3, H_3), \dots, (G_{15}, H_{15})$ are bms over (M_1, M_2) , defined as follows: Then τ_b defines a bms topological space on (M_1, M_2) and thus (M_1, M_2, τ_b) is a bms topological space over (M_1, M_2) . Clearly the closed bms are $(M_1, M_2)^c, (\varphi, \varphi)^c, (G_1, H_1)^c, (G_2, H_2)^c, (G_3, H_3)^c, \dots, (G_{15}, H_{15})^c$. Then, let us take (I, J)

Definition 3.16. Let (M_1, M_2, τ_b) be a bms topological space and let (G, H) be a bms over (M_1, M_2) .
 (i) bms α -closure of a bms (G, H) in (M_1, M_2) is denoted by $\text{bms}\alpha\text{cl}_b(G, H) = \cap \{(P, Q) : (P, Q) \text{ which is a bms } \alpha\text{-closed and } (G, H) \subseteq (P, Q)\}$.
 (ii) bms α -interior of a bms (G, H) in (M_1, M_2) is denoted by $\text{bms}\alpha\text{int}_b(G, H) = \cup \{(R, S) : (R, S) \text{ which is a bms } \alpha\text{-closed and } (R, S) \subseteq (G, H)\}$. Clearly $\text{bms}\alpha\text{cl}_b((G, H))$ is smallest bms α -closed over (M_1, M_2) which contains (G, H) and $\text{bms}\alpha\text{int}_b((G, H))$ is largest bms α -open over (M_1, M_2) which contains in (G, H) .

Proposition 3.17. Let (M_1, M_2, τ_b) be a bms topological space and (G, H) be a bms over (M_1, M_2) , then
 (i) $(G, H) \in \text{bms}\alpha\text{C}(M_1, M_2, \tau_b)$ iff $(G, H) = \text{bms}\alpha\text{cl}_b(G, H)$.
 (ii) $(G, H) \in \text{bms}\alpha\text{O}(M_1, M_2, \tau_b)$ iff $(G, H) = \text{bms}\alpha\text{int}_b(G, H)$.

Proof. (i) Let $(G, H) = \text{bms}\alpha\text{cl}_b((G, H)) = \cap \{(P, Q) : (P, Q) \text{ be a bms } \alpha\text{-closed set and bms } \alpha\text{-cl}_b(G, H) \subseteq$





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(P, Q) . This shows that $(G, H) \in \{(P, Q) : (P, Q) \text{ is a bms } \alpha\text{-closed and } (G, H) \subseteq (P, Q)\}$. Hence (G, H) is bms α -closed. Conversely, let (G, H) be a bms α -closed. Since $(G, H) \subseteq (G, H)$ and (G, H) is a bms α -closed and $(G, H) \in \{(P, Q) : (P, Q) \text{ is a bms } \alpha\text{-closed and } (G, H) \subseteq (P, Q)\}$. Further, $(G, H) \subseteq (P, Q)$ for all such (P, Q) . $(G, H) = \cap\{(P, Q) : (P, Q) \text{ is a bms } \alpha\text{-closed and } (G, H) \subseteq (P, Q)\}$. (ii) In Contrast(i).

Proposition 3.18. In a bms space (M_1, M_2, τ_b) , the following hold for bms α -closure.

- (i) $bms\alpha cl_b(\varphi, \varphi) = (\varphi, \varphi)$.
- (ii) $bms\alpha cl_b((G, H))$ is bms α -closed in (M_1, M_2, τ_b) for each subbms (G, H) of (M_1, M_2) .
- (iii) $bms\alpha cl_b((G, H)) \subseteq bms\alpha cl_b((I, J))$, if $(G, H) \subseteq (I, J)$.
- (iv) $bms\alpha cl_b(bms\alpha cl_b(G, H)) = bms\alpha cl_b((G, H))$.

Proof. Out from the definition.

Theorem 3.19. Let (M_1, M_2, τ_b) be a bms topological space and let (G, H) and (K, L) be two bms over (M_1, M_2) ; then

- (i) $(bms\alpha cl_b(G, H))^c = bms\alpha int_b(G, H)$
- (ii) $(bms\alpha int_b(G, H))^c = bms\alpha cl_b(G, H)^c$.
- (iii) $(G, H) \subseteq (K, L) \Rightarrow bms\alpha int_b(G, H) \subseteq bms\alpha int_b(K, L)$.
- (iv) $bms\alpha cl_b(\varphi, \varphi) = (\varphi, \varphi)$ and $bms\alpha cl_b(M_1, M_2) = (M_1, M_2)$.
- (v) $bms\alpha int_b(\varphi, \varphi) = (\varphi, \varphi)$ and $bms\alpha int_b(M_1, M_2) = (M_1, M_2)$.
- (vi) $bms\alpha cl_b((G, H) \cup (K, L)) = bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L)$.
- (vii) $bms\alpha int_b((G, H) \cap (K, L)) = bms\alpha int_b(G, H) \cap bms\alpha int_b(K, L)$.
- (viii) $bms\alpha cl_b((G, H) \cup (K, L)) \subseteq bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L)$.
- (ix) $bms\alpha int_b((G, H) \cup (K, L)) \subseteq bms\alpha int_b(G, H) \cap bms\alpha int_b(K, L)$.
- (x) $bms\alpha cl_b(bms\alpha cl_b(G, H)) = bms\alpha cl_b(G, H)$.
- (xi) $bms\alpha int_b(bms\alpha int_b(G, H)) = bms\alpha int_b(G, H)$.

Proof. Let (G, H) and (K, L) be two bms over (M_1, M_2) .

- (i) $(bms\alpha cl_b(G, H))^c = (\cap\{(P, Q) \mid (G, H) \subseteq (P, Q) \text{ and } (P, Q) \in bms\alpha C(M_1, M_2, \tau_b)\})^c = \cup\{(P, Q)^c \mid (G, H) \subseteq (P, Q) \text{ and } (P, Q)^c \in bms\alpha C(M_1, M_2, \tau_b)\} = \cup\{(P, Q)^c \mid (P, Q)^c \subseteq (G, H)^c \text{ and } (P, Q)^c \in bms\alpha O(M_1, M_2, \tau_b)\} = bms\alpha int_b(G, H)^c$. (ii) Identical to (i).
- (iii) If follows from Definition 3.7.
- (iv) Since (φ, φ) and (M_1, M_2) are bms α -closed so, $bms\alpha cl_b(\varphi, \varphi) = (\varphi, \varphi)$.
- (v) Since (φ, φ) and (M_1, M_2) are bms α -open so, $bms\alpha int_b(\varphi, \varphi) = (\varphi, \varphi)$.
- (vi) We have $(G, H) \subseteq ((G, H) \cup (K, L))$ and $(K, L) \subseteq ((G, H) \cup (K, L))$. Then by the Proposition 3.9 $bms\alpha cl_b(G, H) \subseteq bms\alpha cl_b((G, H) \cup (K, L))$ and $bms\alpha cl_b(K, L) \subseteq bms\alpha cl_b((G, H) \cup (K, L)) \Rightarrow bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L) \subseteq bms\alpha cl_b((G, H) \cup (K, L))$. Now, $bms\alpha cl_b(G, H), bms\alpha cl_b(K, L) \in bms\alpha C(M_1, M_2, \tau_b) \Rightarrow bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L) \in bms\alpha C(M_1, M_2, \tau_b)$. Then $(G, H) \subseteq bms\alpha cl_b(G, H)$ and $(K, L) \subseteq bms\alpha cl_b(K, L)$ implies $(G, H) \cup (K, L) \subseteq bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L)$. That is, $bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L)$ is a bms α -closed containing $(G, H) \cup (K, L)$. But $bms\alpha cl_b((G, H) \cup (K, L))$ is the smallest bms α -closed containing $(G, H) \cup (K, L)$. Hence $bms\alpha cl_b((G, H) \cup (K, L)) \subseteq bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L)$. So, $bms\alpha cl_b((G, H) \cup (K, L)) = bms\alpha cl_b(G, H) \cup bms\alpha cl_b(K, L)$.
- (vii) Similar to (vi). (viii) We have $((G, H) \cap (K, L)) \subseteq (G, H)$ and $((G, H) \cap (K, L)) \subseteq (K, L) \Rightarrow bms\alpha cl_b((G, H) \cap (K, L)) \subseteq bms\alpha cl_b(G, H)$ and $bms\alpha cl_b((G, H) \cap (K, L)) \subseteq bms\alpha cl_b(K, L) \Rightarrow bms\alpha cl_b((G, H) \cap (K, L)) \subseteq bms\alpha cl_b(G, H) \cap bms\alpha cl_b(K, L)$.
- (ix) Similar to (viii). (x) Since $bms\alpha cl_b(G, H) \in bms\alpha C(M_1, M_2, \tau_b)$ so by proposition 3.18(i), $bms\alpha cl_b(bms\alpha cl_b(G, H)) = bms\alpha cl_b(G, H)$.
- (xi) Since $bms\alpha int_b(G, H) \in bms\alpha O(M_1, M_2, \tau_b)$ so by proposition 3.18(ii), $bms\alpha int_b(bms\alpha int_b(G, H)) = bms\alpha int_b(G, H)$.

Theorem 3.20. If (G, H) is any bms in bms topological space (M_1, M_2, τ_b) , then following are equivalent:

- (i) (G, H) is a bms α -closed.





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- (ii) $\text{int}_b(\text{cl}_b(\text{int}_b(G, H)^c)) \supseteq (G, H)^c$.
- (iii) $\text{cl}_b(\text{int}_b(\text{cl}_b(G, H))) \subseteq (G, H)$.
- (iv) (G, H) is a bms α -open.

Proof. (i) \Rightarrow (ii) If (G, H) is a bms α -closed, then $\text{cl}_b(\text{int}_b(\text{cl}_b(G, H))) \subseteq (G, H) \Rightarrow (G, H)^c \subseteq \text{int}_b(\text{cl}_b(\text{int}_b(G, H)^c))$.
 (ii) \Rightarrow (iii) $(\text{int}_b(\text{cl}_b(\text{int}_b(G, H)^c))^c \supseteq ((G, H)^c)^c \Rightarrow \text{cl}_b(\text{int}_b(\text{cl}_b(G, H))) \subseteq (G, H)$.
 (iii) \Rightarrow (iv) It is obvious from Definition 3.11.
 (iv) \Rightarrow (1) It is obvious from Definition 3.11.

ON BMS α -CONTINUITY

Throughout in this section, the spaces (M_1, M_2) and (N_1, N_2) (or (M_1, M_2, τ_b) and (N_1, N_2, σ_b)) stands for bms topological spaces assumed unless otherwise stated.

Definition 4.2. A bms mapping $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is said to be bms α -continuous if the inverse image of each bms open subset of (N_1, N_2) is a bms α -open in (M_1, M_2) .

Example 4.3. Let $M_1 = \{1/a, 1/c\}$, $M_2 = \{1/b, 1/d\}$, $N_1 = \{1/p, 1/q\}$, $N_2 = \{1/r, 1/s\}$ be abms topological space on (M_1, M_2) , $\tau_b = \{(\varphi, \varphi), (\{1/a\}, \{1/b\}), (\{1/a\}, \{1/b\}), (\varphi, M_1), (\varphi, \{1/d\}), \{1/s\}, \{1/r\}, \{1/s\}\}$. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ be a mapping defined as follows $f(\{1/a\}) = \{1/p\}$, $f(\{1/a\}, \{1/b\}) = (\{1/p, 1/r\})$, $f(\{1/c\}) = \{1/s\}$. The inverse images of the Open bms is subbms of (N_1, N_2) is a bms α -open in (M_1, M_2) . Then f is said to be bms α -continuous but need not to be in bms continuous. The following examples shows that bms α -continuous mapping need not to be bms semi-Continuous.

Theorem 4.4. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ be a mapping from a bms space of (M_1, M_2) to bms space (N_1, N_2) . Then the following statements are true;

- (i) f is a bms α -continuous.
- (ii) for each bms singleton (S, T) in (M_1, M_2) and each open bms (L, O) in (N_1, N_2) and $f((S, T)) \subseteq (L, O)$, there exists a bms α -open (V, D) in (M_1, M_2) such that $(S, T) \subseteq (V, D)$ and $f((V, D)) \subseteq (L, O)$.
- (iii) The inverse image of each closed bms in (N_1, N_2) is a bms α -closed in (M_1, M_2) .
- (iv) $f(\text{cl}_b(\text{int}_b(\text{cl}_b(G, H)))) \subseteq \text{cl}_b(f(G, H))$, for each bms $(G, H) \in (M_1, M_2)$.
- (v) $\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}(C, F)))) \subseteq f^{-1}(\text{cl}_b(C, F))$, for each bms $(C, F) \in (N_1, N_2)$.

Proof. (i) \Rightarrow (ii) Since (L, O) is open bms in (N_1, N_2) and $f((S, T)) \subseteq (L, O)$, so $(S, T) \subseteq f^{-1}((L, O))$ and $f^{-1}((L, O))$ is a bms α -open in (M_1, M_2) . Put $(V, D) = f^{-1}((L, O))$. Then $(S, T) \subseteq (V, D)$ and $f((V, D)) \subseteq (L, O)$. (ii) \Rightarrow (i) Let (L, O) be an open bms in (N_1, N_2) such that $(S, T) \subseteq f^{-1}((L, O))$ and there exist $(V, D) \in \text{bms}\alpha S(M_1, M_2)$ such that $(S, T) \subseteq (V, D)$ and $f((V, D)) \subseteq (L, O)$. Then $(S, T) \subseteq (V, D) \subseteq f^{-1}((L, O)) = \cup(V, D) \in \text{bms}\alpha O(M_1, M_2)$. Hence $f^{-1}((L, O)) \in \text{bms}\alpha O(M_1, M_2)$ and therefore f is bms α -continuous. (i) \Rightarrow (iii) Let (H, I) be a closed bms in (N_1, N_2) . Then (H, I) is a Open bms in (N_1, N_2) . Thus $f^{-1}((H, I)^c) \in \text{bms}\alpha O(M_1, M_2)$; that is binary multiset $(M_1, M_2) - f^{-1}((H, I)) \in \text{bms}\alpha O(M_1, M_2)$. Hence $f^{-1}((H, I))$ is a bms- α open in (M_1, M_2) . (iii) \Rightarrow (iv) Let (P, J) be a bms in (N_1, N_2) . Then $\text{cl}_b(f(P, J))$ is a closed bms in (N_1, N_2) , so that $f^{-1}(\text{cl}_b(P, J))$ is a bms α -closed in (M_1, M_2) . Therefore, we have $f^{-1}(\text{cl}_b(P, J)) \supseteq \text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}(\text{cl}_b(P, J)))) \supseteq \text{cl}_b(\text{int}_b(\text{cl}_b(\text{cl}_b(P, J)))) = \text{cl}_b(\text{int}_b(\text{cl}_b(P, J)))$. (iv) \Rightarrow (v) Since (C, F) be a bms in (N_1, N_2) , then $f^{-1}((C, F))$ is a bms in (M_1, M_2) , thus by hypothesis we have $\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}((C, F)))) \subseteq \text{cl}_b(f(f^{-1}((C, F)))$ or $\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}((C, F)))) \subseteq \text{cl}_b((C, F))$; that is, $\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}((C, F)))) \subseteq f^{-1}(\text{cl}_b((C, F)))$. (v) \Rightarrow (i) Let (L, O) be a open bms in (N_1, N_2) . Let $(V, L) = (L, O)^c$, and $(E, F) = f^{-1}((V, L))$. By (v) we have $\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}((V, L)))) \subseteq \text{cl}_b(V, L) = (V, L)$, hence $\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}((L, O)))) \subseteq f^{-1}((L, O)^c)$. Therefore $f^{-1}((L, O))$ is a bms α -open in (M_1, M_2) . Hence f is a bms α -continuous function.

Corollary 4.5. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ be a bms α -continuous mapping. Then

- (i) $f(\text{cl}_b(G, H)) \subseteq \text{cl}_b(f(G, H))$, for each $(G, H) \in \text{bmsPO}(M_1, M_2)$.





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(ii) $cl_b(f^{-1}((C, F))) \subseteq f^{-1}(cl_b(C, F))$, for each $(C, F) \in bmsPO(N_1, N_2)$.

Proof. Since for each $(G, H) \in bmsPO(M_1, M_2)$ by the definition, $cl_b((G, H)) = cl_b(int_b(cl_b((G, H))))$, therefore the proof follows directly from statements (iv) and (v) of theorem 4.4.

Remark 4.7. It is clear that every bms α -continuous map is bms semicontinuous and bms precontinuous. Every bms continuous map is bms α -continuous. Thus we have implications as shown in Figure 2.

The converses of these implications are not true, which is clear from the following examples.

Example 4.8. Let $M_1 = \{1/p, 3/q, 2/u\}$, $M_2 = \{1/r, 5/s, 2/t\}$, $N_1 = \{2/a, 6/c, 1/b\}$, $N_2 = \{2/d, 1/e, 7/f\}$ and $\tau_b = \{(\varphi, \varphi), (M_1, M_2), \{1/q\}, \{1/p\}, \{2/u\}\}$ be a bms topological space (M_1, M_2) , $\sigma_b = \{(\varphi, \varphi), (N_1, N_2), \{1/f\}\}$ be a bms topological space (N_1, N_2) , then $f : (M_1, M_2) \rightarrow (N_1, N_2)$ are $bmsSO(N_1, N_2) = \{(N_1, N_2), (\varphi, \varphi), \{1/f\}, \{1/a\}, \{1/e\}, \{1/d\}, \{1/c\}\}$ define a function (M_1, M_2, τ_b) and (N_1, N_2, σ_b) . Then f is called bms semi-continuous map, since the inverse image of bms open in (N_1, N_2) in bms semiopen in (M_1, M_2) , $f(1/p, 1/t) = \{1/f\}$, $f(1/q, 1/s) = \{1/a, 1/e\}$, $f(1/r, 1/u) = \{1/d, 1/c\}$ but the f is not bms α -continuous function but also bms semiopen and bms semicontinuous.

Definition 4.6. A bms mapping $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is called bms precontinuous (resp., bms semicontinuous) if the inverse image of each open bms in (N_1, N_2) is bms preopen (resp., bms semiopen) in (M_1, M_2) .

Theorem 4.9. Let $(G, H) \in bmsPO(M_1, M_2)$ and $(I, H) \in bms\alpha O(M_1, M_2)$. Then $(G, H) \cap (I, H) \in bmsO(M_1, M_2)$.

Proof. Since $(G, H) \cap (I, H) \subseteq int_b(cl_b(G, H)) \cap int_b(cl_b(I, H)) = int_b(int_b(cl_b(G, H)) \cap int_b(cl_b(I, H))) \subseteq int_b(cl_b((G, H) \cap int_b(I, H))) \cap (G, H) = bms\alpha int_b(int_b(cl_b((G, H) \cap int_b(I, H))) \cap (G, H)) \subseteq bms\alpha int_b(cl_b((G, H) \cap int_b(I, H)) \cap (G, H)) = bms\alpha int_b(bms\alpha cl_b((G, H) \cap (I, H))) = bms\alpha int_b(bms\alpha int_b((G, H) \cap int_b(I, H))) \subseteq bms\alpha int_b(bms\alpha cl_b(bms\alpha int_b((G, H) \cap (I, H))))$. Therefore $(G, H) \cap (I, H)$ is a bms α -open of (G, H) .

Theorem 4.10. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -continuous mapping and $(G, H) \in bmsPO(M_1, M_2)$, then $f|(G, H)$ is a bms α -continuous mapping.

Proof. Let (I, H) in (N_1, N_2) be an open bms. Then $f^{-1}((I, H)) \in bms\alpha(M_1, M_2)$ and since (G, H) is a bms preopen in (M_1, M_2) , by Theorem 4.4, we have $(G, H) \subseteq f^{-1}((I, H)) = (f|(G, H))^{-1}((I, H)) \in bms\alpha O(M_1, M_2)((G, H))$. Therefore $f|(G, H)$ is a bms α -continuous map-pings.

Theorem 4.11. A bms function $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -continuous iff $f(bms\alpha cl_b(P, Q)) \subseteq cl_b(f((P, Q)))$ for every bms (P, Q) of (M_1, M_2) .

Proof. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -continuous. Now $cl_b(f(P, Q))$ is a closed bms of (N_1, N_2) . so by bms α -continuity of f is, $f^{-1}(cl_b(f(P, Q)))$ is bms α -closed and $(P, Q) \subseteq f^{-1}(cl_b(f(P, Q)))$. But $bms\alpha cl_b(P, Q)$ is the smallest α -closed set containing (P, Q) . Hence $bms\alpha cl_b(P, Q) \subseteq f^{-1}(cl_b(f(P, Q))) \Rightarrow f(bms\alpha cl_b(P, Q)) \subseteq cl_b(f(P, Q))$. Conversely, let (E, C) be any closed bms of (N_1, N_2) . Thus $f^{-1}((E, C)) \in (M_1, M_2)$ and by hypothesis $\Rightarrow f(bms\alpha cl_b(f^{-1}((E, C)))) \subseteq cl_b(f(f^{-1}((E, C)))) \Rightarrow f(bms\alpha cl_b(f^{-1}((E, C)))) \subseteq cl_b(E, C) = (E, C) \Rightarrow bms\alpha cl_b(f^{-1}((E, C))) = f^{-1}((E, C))$, Hence bms α -closed. Consequently, f is bms α -continuous.

Theorem 4.12. A bms function $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -continuous if and only if $f^{-1}(int_b(K, H)) \subseteq bms\alpha int_b f^{-1}(K, H)$ for every bms (K, H) of (N_1, N_2)

Proof. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ be a bms α -continuous. Now for any bms (E, G) in (M_1, M_2) , $int_b(f((E, G)))$ is an open bms in (N_1, N_2) ; since f is bms α -continuity, then $f^{-1}(int_b(f((E, G))))$ bms α -open, $f^{-1}(int_b(f((E, G)))) \subseteq (E, G)$. As





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$bms\alpha int_b(E, G)$ is largest bms α -open contained in (E, G) , $f^{-1}(int_b(f(E, G))) \subseteq bms\alpha int_b(E, G)$. Conversely, a open bms (I, G) in (N_1, N_2) . Then $f^{-1}(int_b(I, G)) \subseteq bms\alpha int_b f^{-1}(I, G) \Rightarrow f^{-1}(I, G) \subseteq bms\alpha int_b f^{-1}(I, G) \Rightarrow f^{-1}(I, G)$ is bms α -open.

BMS A-OPEN AND BMS α -CLOSED MAPPINGS

Definition 5.1. A bms mapping $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is called bms α -open (resp., bms α -closed) mapping if the image of each open bms (resp., closed bms) in (M_1, M_2) is a bms α -open(resp., bms α -closed) in (N_1, N_2) .

Definition 5.2. A bms mapping $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is called bms preopen (resp., bmssemiopen) if image of each open bms in (M_1, M_2) is bms preopen (resp., bms semiopen) in (N_1, N_2) . Clearly an open bms map is bms α -open and every bms α -open map is bms preopen as well as bms α -open. Similar implication hold for closed bms mappings.

Theorem 5.3. A bms mapping $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -closed if and only if $bms\alpha cl_b(f(G, H)) \subseteq f(cl_b(G, H))$ for each bms (G, H) in (M_1, M_2) .

Proof. Let $bms\alpha cl_b(f(G, H)) \subseteq f(cl_b(G, H))$. BY the definition of bms α -closure, we have $f((G, H)) = f(cl_b(G, H))$ and so $f(cl_b(G, H))$ is a bms α -closed and f is a bms α -closed mapping. Conversely, if f is bms α -closed, then $f(cl_b(G, H))$ is a bms α -closed containing $f((G, H))$ and therefore $bms\alpha cl_b(f(G, H)) \subseteq f(cl_b(G, H))$.

Theorem 5.4. A bms function $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -open if and only if $f(int_b(P, Q)) \subseteq bms\alpha int_b(f(P, Q))$ for every bms (P, A) in (M_1, M_2) .

Proof. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -open, then $f(int_b(P, Q)) = bms\alpha int_b f(int_b(P, Q)) \subseteq bms\alpha int_b f(P, Q)$. On the otherhand, an open bms (E, G) in (M_1, M_2) . Then by hypothesis, $f((E, G)) = f(int_b(E, G)) \subseteq bms\alpha int_b(f((E, G))) \Rightarrow f((E, G))$ is bms α -open in (N_1, N_2) .

Theorem 5.5. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ be a bms α -open (resp., bms α -closed) mapping. If (C, F) is a bms in (N_1, N_2) and (G, H) is a closed bms (resp., open bms) in (M_1, M_2) , containing $f^{-1}((C, F))$; then there exists a bms α -closed (resp., bms α -open) (D, F) in (N_1, N_2) , such that $(C, F) \subseteq (D, F)$ and $f^{-1}((D, F)) \subseteq (G, H)$.

Proof. Let $(D, F) = (f(G, H))_c$. Since $f^{-1}((C, F)) \subseteq (G, H)$, we have $f((G, H)_c) \subseteq (C, F)_c$. Since f is bms α -open(resp., bms α -closed), then (D, F) is a bms α -closed (resp., bms α -open) if $f^{-1}((D, F)) = (f^{-1}(f((G, H)_c)))_c \subseteq ((G, H)_c)_c = (G, H)$ and hence $(C, F) \subseteq (D, F)$ and $f^{-1}((D, F)) \subseteq (G, H)$.

Corollary 5.6. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms α -open mapping, then

- (i) $f^{-1}(cl_b(int_b(cl_b(f^{-1}((C, F)))))) \subseteq cl_b(f^{-1}((C, F)))$, for every bms (C, F) in (N_1, N_2) .
- (ii) $f^{-1}(cl_b(D, F)) \subseteq cl_b(f^{-1}((D, F)))$, $(D, F) \in bmsPO(N_1, N_2)$.

Proof. (i) $cl_b(f^{-1}((C, F)))$ is closed bms in (M_1, M_2) , containing $f^{-1}((C, F))$ for a bms (C, F) in (N_1, N_2) . By theorem 5.5, there exists a bms α -closed (E, C) in (N_1, N_2) , and $(C, F) \subseteq (E, C)$ such that $f^{-1}((E, C)) \subseteq cl_b(f^{-1}((C, F)))$. Thus $f^{-1}(cl_b(int_b(cl_b(B, C)))) \subseteq cl_b(f^{-1}(cl_b(int_b(cl_b(P, Q)))))) \subseteq f^{-1}((E, C)) \subseteq cl_b(f^{-1}(C, F))$.

(ii) Follows easily from (i).

Theorem 5.7. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms precontinuous and bms α -open mapping, then $f^{-1}(C, F) \in bmsPO(M_1, M_2)$ for each $(C, F) \in bmsPO(N_1, N_2)$.

Proof. We have $f^{-1}((C, F)) \subseteq f^{-1}(int_b(cl_b((C, F)))) \subseteq int_b(cl_b(f^{-1}(int_b(cl_b((C, F)))))) \subseteq int_b(cl_b(f^{-1}(cl_b((C, F)))))$. Since f is a bms α -open map, we have, by corollary 5.6, $f^{-1}((C, F)) \subseteq int_b(cl_b(f^{-1}(cl_b((C, F)))))) \subseteq cl_b(int_b(f^{-1}(cl_b((C, F)))))) = cl_b(int_b(f^{-1}((C, F))))$. Therefore $f^{-1}((C, F))$ is bms preopen in (M_1, M_2) .





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Theorem 5.8. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms precontinuous and bms semicontinuous, then f is bms α -continuous.

Proof. Let (C, F) be any open bms in (N_1, N_2) . Then $f^{-1}((C, F))$ is a bms preopen as well as bms semiopen in (M_1, M_2) . We have $f^{-1}((C, F)) \subseteq \text{cl}_b(\text{int}_b(f^{-1}((C, F))))$ and $(f^{-1}((C, F))) \subseteq \text{int}_b(\text{cl}_b(\text{int}_b(\text{cl}_b(f^{-1}(C, F)))) = \text{int}_b(\text{cl}_b(\text{int}_b(f^{-1}(C, F))))$. Hence f is a bms α -continuous mapping.

Theorem 5.9. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is a bms preopen mapping, then for each bms (C, F) in (N_1, N_2) , $f^{-1}(\text{int}_b(\text{cl}_b(C, F))) \subseteq \text{cl}_b(f^{-1}((C, F)))$.

Proof. It follows immediately from Corollary 5.6.

Theorem 5.10. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is bms α -continuous and bms preopen, then the inverse image of each bms α is a bms α -open.

Proof. Let (C, F) be any bms α -open in (N_1, N_2) . Then $f^{-1}((C, F)) \subseteq f^{-1}(\text{int}_b(\text{cl}_b(\text{int}_b((C, F)))) \subseteq \text{int}_b(\text{cl}_b(\text{int}_b(f^{-1}(\text{int}_b(\text{cl}_b(\text{int}_b((C, F))))))) \subseteq \text{int}_b(\text{cl}_b(\text{int}_b(f^{-1}(\text{cl}_b(\text{int}_b(C, F))))))$. By the-orem 5.8 we have $f^{-1}((C, F)) \subseteq \text{int}_b(\text{cl}_b(f^{-1}(\text{int}_b((C, F))))$. Since f is a bms α -continuous mapping, by theorem 4.4 (v), $f^{-1}((C, F)) \subseteq f^{-1}(\text{int}_b(\text{cl}_b(\text{int}_b((C, F))))$. Hence $f^{-1}(C, F)$ is bms α -open.

Corollary 5.11. If $f : (M_1, M_2) \rightarrow (N_1, N_2)$ is bms α -continuous and bms preopen mapping, then one has the following:

- (i) The inverse image of each bms α -closed and bms pre continuous, bms semicontinuous are bms α -closed.
- (ii) $f(\text{bms } \alpha \text{ cl}_b(G, H)) \subseteq \text{bms } \alpha \text{ cl}_b(f(G, H))$ for each bms (G, H) in (M_1, M_2) .

Proof. It follows immediately from the previous Theorem 5.10.

Theorem 5.12. Let $f : (M_1, M_2) \rightarrow (N_1, N_2)$ and $g : (N_1, N_2) \rightarrow (O_1, O_2)$ be two bms mapping. If f is bms preopen and bms α -continuous and g is bms α -continuous, the $g \circ f$ is bms α -continuous.

Proof. It follows immediately from 5.10.

CONCLUSION

In this paper a concept of on bms α -open and bms α -continuous function is introduced in binary multiset topological space and some of its properties are studied. Also we gave some examples and theorems of these concepts.

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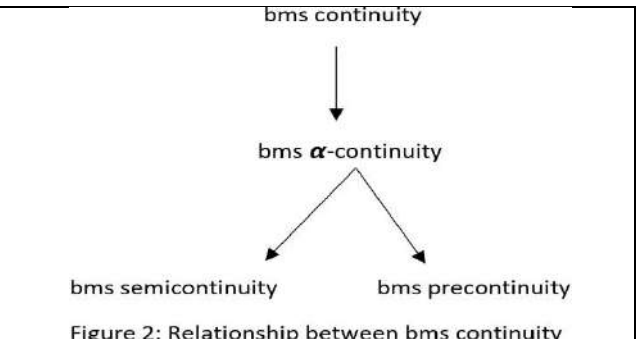
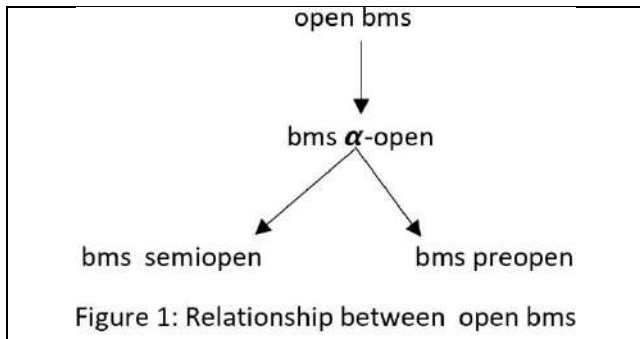
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A Systematic Review on Cell Lines and their Applications in Diabetes Mellitus Research

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Animal models are widely employed in diabetes research to study the mechanism of cellular function as many researchers have confirmed that diabetes is caused due to glucose homeostasis which lead for the discovery and purification of insulin. Cell line is a tissue or individual cell, as cell lines act as alternative method for animal studies. Numerous studies have used clonal beta cells generated from various rodents and animals (rat, mouse, hamster) insulinomas. As they act as alternative to animal or primary tissue in diabetes research or other disease research, *in vitro* medication testing and beta cell physiology studies. Choosing the appropriate cell line is quite difficult task as no one cell line fully replicate or resemble human cell features. Stable cell lines serve as good source for research. As diabetes is characterized by destruction of insulin secreting beta cells in the pancreatic islets of Langerhans. Considerably the efforts have been made to know the physiology of insulin production and secretions from the cells. In this review we discuss about the diabetes pathogenesis and various cell lines available for diabetes which are derived from various animals and human derived cell lines as this kind of therapy can help us in the treatment of diabetes and applications of cell lines in research.

Keywords: Diabetes, Cell lines, Insulin, Insulin secreting cells, pancreas.



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INTRODUCTION

Diabetes Mellitus

Diabetes mellitus is a condition that causes the body to produce less or use less insulin [1], which results in an increase in blood sugar levels this condition is defined as hyperglycemia [2]. The pancreas secretes insulin, a hormone that uses glucose as a fuel source. One of the most prevalent health issues in the globe is diabetes mellitus (DM) [1]. Diabetes is related with abnormal glucose and lipid metabolism, and one component of the illness that may be assessed is oxidative stress. Oxidative stress is defined as an "imbalance of oxidant and antioxidant levels." Superoxide anion (O_2^-), hydroxyl radical (OH), alkoxy radical (RO), peroxy radical (ROO), hydrogen peroxide (H_2O_2), and oxygen singlet (O_2) are examples of reactive oxidant species (ROS). Because of their highly reactive nature, an imbalance in favor of ROS in the human system has negative consequences, such as the breakdown of protein pathways involved with age-related muscle wasting. The mitochondria in T2D patients become dysfunctional due to a shortage of glucose within the cell to make energy, and the presence of ROS causes apoptosis and cell death [3]. Numerous novel medicines have been identified and put to use in recent years to treat diabetes mellitus. As a result, it controls blood glucose levels. Frequent urination, an increase in appetite, and an increase in thirst are all signs of diabetes mellitus. Numerous problems, including ketoacidosis and hyperosmolar hyperglycemia, are brought on by diabetes mellitus. Long-term side effects, however, can include stroke, renal damage, eye disease, and cardiovascular disease.

There are three primary kinds of diabetes mellitus, 1) Type-1 diabetes mellitus, 2) Type-2 diabetes mellitus 3) gestational diabetes mellitus. In Type-1 diabetes mellitus the inefficient synthesis of insulin by the pancreas can lead to type 1 diabetes. It stops the T-cell-mediated autoimmune assault and causes B cell insulin to stop functioning. The patient must take insulin every day to maintain their health if they have type I diabetes mellitus. According to studies, Type 1 DM patients enjoy a higher quality of life than Type 2 DM patients. Type-2 diabetes mellitus is a chronic metabolic disease known as type 2 diabetes can result from both insulin synthesis and action problems. As a result, this kind of DM is known as non-insulin dependent diabetic mellitus. Obesity, dyslipidemia, and type 2 diabetes are regarded as separate risk factors for CHD and cerebrovascular disease. Gestational diabetes mellitus, most often, this kind of diabetes mellitus develops during pregnancy in some women. There is a high likelihood that type-2 diabetes mellitus will manifest in the patient later in life if gestational diabetes mellitus is present. Medical supplies must be purchased during pregnancy, and blood sugar levels must be checked frequently. A modification in diet and the use of insulin are occasionally necessary. Skeletal muscle abnormalities and congenital cardiac defects are part of the gestational diabetes mellitus syndrome. GD can occasionally lead to placental malfunction, which harms the foetus [1,4,5].

Physiology of beta cells

A mature mammalian pancreas is made up of an exocrine and an endocrine portion, the latter of which contains clusters of cells called the islets of Langerhans that are essential for preserving the appropriate level of nutrients in the blood and cellular depots [6–8]. A human pancreas weighs 91.8 g (varying between 40.9 and 182 g based on an examination of 30 samples). It includes around one billion β cells, which translates to one gram of tissue and ten milligrams of insulin enough to control blood glucose levels for two weeks. It is estimated that a single cell produces 1 million molecules of insulin each minute and contains 10 pg of insulin packed into 10,000 granules [9]. The islets of Langerhans are made up of pancreatic polypeptide-producing PP-cells (1%), glucagon-releasing alpha cells (15–20%), somatostatin-producing delta cells (3–10%), and insulin-releasing beta cells (65–90%), which form the islet's core. The most commonly researched of these are beta cells, which control the synthesis and release of insulin by coupling food metabolism with electrical activity [6].

INSULIN

Since the peptide hormone insulin is only produced by β -cells of the pancreatic islets of Langerhans in adult mammals, these cells are crucial for preserving blood glucose homeostasis. In order to maintain blood glucose levels within specific ranges, β -cells not only generate insulin but also secrete the hormone in amounts appropriate to the



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blood glucose concentration. The development of so-called non-insulin-dependent diabetes, often known as type 2 diabetes mellitus, the most prevalent metabolic condition in men, is mostly attributed to pancreatic β -cell dysfunction [10]. Under both basal and glucose-stimulated conditions, the presence of many signals from various sources ensures proper β -cell function. These signals come from a variety of sources, including as humoral elements (hormones, vitamins, minerals, ions, etc.), nerve stimulation, and intra-islet cell-cell communication elements. While glucagon, which is secreted from pancreatic beta cells and stimulates insulin release, and somatostatin, which is secreted from δ -cells and inhibits insulin release. Recent research shows that insulin plays a beneficial role in a number of cellular functions, including the control of gene transcription, translation, Ca^{2+} flow, insulin secretion, and maybe cell survival [11–17].

Insulin biosynthesis

Insulin is produced by beta cells in response to an increase in blood nutrient concentration. The insulin gene has four exons and two introns with 1150 Da, the hormone's precursor (preproinsulin) carries a signal peptide that sends the peptide chain to the interior of the endoplasmic reticulum (ER) and consists of four peptides: an N-terminal signal peptide, a B chain, a C chain, and an A chain. The signal peptide is cleaved and disulfide bonds are formed in the ER to create proinsulin [18]. Proinsulin is transported to the Golgi apparatus and packaged into vesicles. After the C peptide is cleaved, mature insulin is produced in the vesicles and kept as zinc-containing hexamers until release [6,19].

Insulin Release

The primary physiological insulin secretagogue is glucose. When the glucose concentration was raised from 3 to 9 mM, electrical activity was recorded from a beta cell in an intact islet. Extensive experiments have revealed that a glucose concentration greater than 7 mM results in depolarization of the cell membrane from the resting potential (about -70 mV) up to a threshold from which a rhythmic electrical activity known as bursting is elicited. Bursting is composed of an active period of Ca^{2+} -dependent action potentials followed by a hyperpolarized silence phase. The duration of the active phase increases as the glucose level rises. An increase in cytoplasmic calcium concentration - $[\text{Ca}^{2+}]$ - initiates insulin secretion. The cytoplasmic ATP content is too low in the absence of glucose to keep the ATP-sensitive K-channels (KATP) closed. When the extracellular glucose concentration rises, glucose enters the cells via GLUT2 transporters, and metabolic breakdown of glucose increases ATP generation, which is responsible for cell closure. KATP in the plasma membrane depolarizes it, resulting in the opening of voltage-gated Ca^{2+} channels and an increase in external Ca^{2+} inflow. Bursts of electrical activity and Ca^{2+} influx result in insulin release [20].

CELL LINE

Cell line consist of biological tissue and an individual cell. Cell lines act as an alternative method instead of performing animal studies. It also helps in studying the particular activity of drugs. Newer drugs and toxins can be tested using various types of cell lines. Cell culturing is highly reliable as it has direct access and has easy evaluation of tissues, and it act as a tool for:

- Studying diseases
- Studying Cellular toxicity
- Studying Cellular mechanism

The study of cellular mechanisms can lead to the discovery of new molecular drug targets [21–23].

Cell line are of three types***In-vitro* cell line**

In-vitro methods or techniques play an important role in confirming a particular biological activity of a synthetic or natural compounds before animal experiment. *In-vitro* cell line studies should be supported with certain special conditions for the cells to survive. This includes:

- Media supplements
- Growth media





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- Collagen
- Other complex substances[1].

IMPORTANCE OF CELL LINES IN RESEARCH

Animal models play a crucial role in the development of new drugs and effective treatment for specific diseases.

As animals and humans are biologically similar.

Use of animal models during preclinical studies can be:

- Time consuming
- High maintenance in case of cost
- Housing and breeding facilities
- Can raise ethical concerns regarding animal handling
- There may be opposition for the use of animals in research by animal right activists.

To overcome all the above issues, the new *in vitro* techniques were implemented in drug development studies. Benefits of cell line models are:

- Reducing the usage of animal models
- Results can be obtained Rapidly
- Lowering the cost of research
- Simple and easy to follow
- Less time consuming
- It follows 3R Principles (Reduction, Refinement, Replacement) [24].

DIFFERENT TYPES OF CELL LINES USED IN VARIOUS DISEASES

Breast cancer

Breast cancer is a type of cancer which originate from the tissues of breast mostly from the milk ducts inner lining, it is most common cancer in women as it can lead to death [25]. Cell lines are extensively used for research purpose particularly in cancer as it has a greater number of advantages like handling is easy. They can be stored in cell banks for many years [26].

Prostate cancer

Prostate cancer is the second most common cancer as first stands lung cancer, it is seen in men it may lead to death [34,35]. It can be asymptomatic at early stages which can be cured with or without treatment. Mostly caused symptoms are difficulty in urination with increased frequency and nocturia and prostate hypertrophy [36].

Parkinson's disease

Parkinson's disease is a degenerative disease it causes disability in the individual. This disease was caused due to loss of neurons in the substantia nigra pars compacta (SNpc) which leads to dopamine deficiency [59].

CELL LINES USED IN DIABETES MELLITUS RESEARCH

An illness that may benefit from cell therapy is insulin-dependent diabetes mellitus (IDDM). An autoimmune illness called IDDM is brought on by a variety of largely unidentified genetic and environmental factors. The destruction of the insulin-producing cells in the pancreatic islets of Langerhans by lymphocytes, which results in an insulin shortage, is the cause of the condition. Insulin injections are currently used to treat IDDM. However, it can be challenging to calculate the precise insulin dosage, which can result in episodes of hyperglycemia or hypoglycemia. Many IDDM patients experience serious consequences over the long run as a result of hyperglycemia. If insulin delivery could be continuously modified according to evolving physiological needs, insulin delivery to IDDM patients would be much enhanced. Several organizations have tried to create insulin gene therapy. By introducing the ability to create proinsulin and convert it to mature insulin into non- β cells like pituitary cells or hepatocytes, a number of groups have sought to develop insulin gene therapy for diabetes. The main benefit of using autologous insulin-producing non- β cells is that they do not cause immunological issues such transplant rejection or



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autoimmune to β cells. But the biggest challenge with this strategy has been recreating in non- β cells the tightly controlled insulin secretion of normal cells. They not only do the islet cells make insulin, but they also include sensing and coupling mechanisms that allow them to control its release in response to variations in the blood content of a number of substances, most notably glucose. Therefore, replacing the damaged cells with intact cells is considered to be the best course of action for treating IDDM[67].

Different types of cell lines available**In vitro cell lines**

- 1) Pancreatic
 - ✓ RIN m5F
 - ✓ HIT T15
 - ✓ BRIN BD 11
 - ✓ INS 1
- 2) Adipocyte
 - ✓ 3T3 L1
- 3) Hepatic
 - ✓ Hep G2
 - ✓ H 4 IIE
- 4) Muscle
 - (a) Skeletal muscle
 - ✓ L6
 - ✓ C2C12
 - ✓ BC3H1
 - (b) Smooth muscle
 - ✓ Caco2 [68].

Insulin secreting cell lines Derived from Rodents and Insulin secreting cell lines Derived from Humans

These are the various cell line which are derived from various resources [68,95].

Applications of insulin secreting cell lines in research

- (a) It is used to study the beta cell physiology
 - ✓ Used in studying cell mechanism
 - ✓ Used in studying cell secretions
 - ✓ Used in studying about cell proliferation
 - ✓ Used in studying about cell defence
 - ✓ Used in studying about cell death
- (b) It is used to study test models
 - ✓ Used to study drug targets
 - ✓ Used to study drug screening
 - ✓ To study beta cell cytotoxicity [95].

RESULTS**Cell lines derived from rats**

This cell lines help in the studying the mechanism of insulin and somatostatin secretion. In GLP-1 (glucagon-like peptide-1) it increased the capacity and affinity to insulin binding in time to time [96]. Using rat insulinoma cell line, RIN m 5 F cell line it was observed that it shows Anti diabetic activity of plant extract (*Scoparia dulcis*)[97]. The BRIN-BD 11 cell lines have responded to various stimuli of insulinotropic including glucose, amino acids, hormones. Drugs and neurotransmitter and it is also used for screening of anti-diabetic activity of plant materials and novel insulin releasing natural products insulin secretions have been reported [98–100].



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HIT-T15 cell line was employed to study the protein kinase c effect up on change in ca^{+2} ions, results states that the protein kinase C activation leads to release of insulin by glucose induction and thus modulating K^{+} channels functioning in the cells [101]. Other study reveals that acetyl choline induced insulin released by signal transduction pathway [102]. The above cells were used to evaluate the hypoglycaemic effect of herbs. In *Tinospora crispa* it shows insulinotropic action was investigated using the above cell lines [103].

Cell lines derived from mouse

MIN6 cell lines was used for studying the importance of mitochondria DNA and ATP production in insulin secretion which are induced by glucose and leucine. It is also used to screen hypoglycemic agents through insulin action [104,105].

Cell lines derived from humans

The CM cell lines are derived from humans these cells grow slowly and lost their characteristics rapidly. The HIN-D8 cells are also human derived insulinoma they are sensitive to glucose, these cultures have shown effective insulin secretions from human derived cells (106). Endo C-beta H1 cell line by transduction of foetal pancreatic bud with SV40 under insulin promotor implanted into severe combined immunodeficiency mice for expression and formation of cell line. These cells exhibit high expressions of beta cell markers and was responsive to glucose same as primary islet cell do [91]. As islet transplantation is an evolved method for treatment of diabetes in early 1970s due to some immense research work. These include standard method for isolation of islets cell and injected with immunosuppressant drugs to prevent tissue rejection as host mechanism would not accept the isolated cells. As survival of the cell in long run can be a suspense as many factors like immunorejection, autoimmunity, drug toxicity and poor revascularisation can obstruct the transplantation as a result patient may need go through multiple transplants and insulin therapy to cover the need of the body metabolism[107–109].

CONCLUSION

Several animal models ha cell lines been made available for various diseases. As diabetes is a globally widespread disease and most common disease various animal models like rats, hamster, mouse and human derived cell lines were established for research purpose. The development of stable and functioning of insulin releasing cell lines would allow the generation of more suited models for research of human beta cell physiology while potentially providing an unlimited source of cells for anti-diabetic cell treatment many activities and experiments have been conducted to know the mechanism of cellular function, genetic, endocrine, metabolic changes underlying etiopathogenic mechanism. Many of the scientists have got positive results using the vitro cell lines and they have various applications in research. So, cell lines are an added advantage for proving *in vitro* and *in vivo* studies.

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Table :1 Cell Lines used in Breast Cancer

S. No	Cell line	Technique employed	References
1	BT20	Invasive ductal carcinoma	[27]
2	MDA-MB-231	Adenocarcinoma	[28,29]
3	MDA-MB-435	Invasive ductal carcinoma	[28]
4	MDA-MB-468	Adenocarcinoma	[28]
5	MCF-7	Invasive ductal carcinoma	[30]
6	SkBr3	Adenocarcinoma	[31]
7	T47D	Invasive ductal carcinoma	[32]
8	ZR75.1	Invasive ductal carcinoma	[33]

Table 2:Cell Lines used in Prostate Cancer

S No	Cell line	Injection site	references
1	22 Rv1	subcutaneous	[37]
2	1013L	Subcutaneous	[38,39]
3	ALVA-31	Subcutaneous	[40]
4	ALVA-41	Subcutaneous	[41]
5	ARCaP	subcutaneous prostate	[42]
6	DU-145	Subcutaneous	[43–45]





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7	SR DU-145	Subcutaneous	[46]
8	DUCaP	Subcutaneous	[47]
9	DUPro-1	Subcutaneous, Sub-renal capsule	[48]
10	LNCaP (FGC)	Spleen, prostate	[49]
11	LNCaP-C4-2 B4	Prostate, subcutaneous	[50]
12	MDA PCA 2b	Subcutaneous	[51]
13	MDA PCA 2b-hr	Subcutaneous	[52]
14	MPC-3-10	Subcutaneous	[53]
15	ND-1	Subcutaneous	[54]
16	PC-3	Subcutaneous, prostate	[53,55]
17	PC-3-1A	Intravenous	[53]
18	PC-3/MA2	Heart	[56]
19	VCaP	Intrahepatic	[57]
20	PSK-1	Subcutaneous	[58]

Table :3 Cell Lines used in Parkinson’s Disease

S No	Cell line	origin	Technique employed	References
1	SH-SY5Y	Bone marrow	Subclone of Neuroblastoma cells	[60]
2	LUHMES	Ventral mesencephalic brain region	Subclone of human mesencephalic brain	[61]
3	PC12	Adrenal medulla of rat	From rat cells	[62,63]
4	MN9D	Mouse mesencephalic cell	From mouse cells	[64]
5	Neuro 2a	From mouse neural crest	From mouse cells	[65]
6	N27	Rat mesencephalic cells	From rat cells	[66]

Table :4 Cell Lines Derived from Rat

S No	Cell line	Technique employed	Functions	References
1	RIN	Insulinoma was induced by radiation	Produces insulin	[69]
2	RINr	Insulinoma was induced by radiation	Produces insulin	[70]
3	RINm5F	Insulinoma was induced by radiation	Produces insulin	[70]
4	RINm	Insulinoma was induced by radiation	Produces insulin	[71]
5	CRI-GI	Insulinoma was induced by radiation	Produces insulin	[71]
6	INS-1	Insulinoma was induced by radiation	<ul style="list-style-type: none"> • High content of insulin • Specific beta cell function 	[72]
7	INS-1 832/13	Insulinoma was induced by radiation	Higher content of insulin	[73]
8	INS-2	Insulinoma was induced by radiation	<ul style="list-style-type: none"> • High content of insulin • Specific beta cell function 	[72]
9	BRIN-BD11	Pancreatic beta cells were prepared by electrofusion	<ul style="list-style-type: none"> • High content of insulin • Specific beta cell function • Grow faster • Easy process 	[74,75]
10	BRIN-BG5	Pancreatic beta cells were prepared by electrofusion	<ul style="list-style-type: none"> • High content of insulin • Specific beta cell function • Grow faster • Easy process 	[74]
11	BRIN-BG7	Pancreatic beta cells were prepared by electrofusion	<ul style="list-style-type: none"> • High content of insulin • Specific beta cell function 	[74]





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			<ul style="list-style-type: none"> Grow faster Easy process
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Table 5: Cell Line Derived from Hamster

S No	Cell line	Technique employed	Functions	References
1	In 111	Insulinoma was induced virally	Produces insulin	[76]
2	HIT-T15	Produced by oncogenic transfection of beta cells	Produces insulin	[69,76–78]

Table 6: Cell Line Derived from Mouse

S No	Cell line	Technique employed	Functions	References
1	Beta-TC	Produced by oncogenic transfection of beta cells	<ul style="list-style-type: none"> Produces insulin Some clones show normal glucose sensitivity 	[79]
2	NIT-1	Produced by oncogenic transfection of beta cells	Raised levels of insulin transcription	[80]
3	MIN-6	Produced by oncogenic transfection of beta cells	High insulin content and GLUT2 expression	[81]
4	Beta-HC	Produced by oncogenic transfection of beta cells	Glucose responsive and show GLUT2 expression	[82]

Table 7: Cell Line Derived From Humans

S No	Cell line	Technique employed	Functions	References
1	CM	Derived from Human insulinoma	Produces insulin	[83,84]
2	HIN-D8	Derived from Human insulinoma	No further studies were done	[85,86]
3	TRM-1	Derived from foetus insulinoma	<ul style="list-style-type: none"> Low amount of insulin was produced Nonresponsive to glucose 	[87]
4	BetaLOX5		Low amount of insulin	[88]
5	NES2Y	Derived from Human insulinoma	Requires gene transcription to induce functionally	[89]
6	NAKT-15	Transfection of human cells	Requires gene transcription to induce functionally	[90]
7	EndoC-BetaH1	Transfection of human cells	Low amount of insulin was produced	[91]
8	1.1B4	Electrofusion of human cells	Low amount of insulin was produced	[92]
9	1.1E7	Electrofusion of human cells	Low amount of insulin was produced	[92]
10	1.4E7	Electrofusion of human cells	Low amount of insulin was produced and less responsive than 1.1B4	[92]
11	1.2B4	Electrofusion of human cells	Low amount of insulin was produced and less responsive than 1.1B4	Results are unpublished
12	EndoCBetaH2	Transfection of human cells	Low amount of insulin was produced	[93]





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13	EndoCBetaH3	Transfection of human cells	Low amount of insulin was produced	[94]
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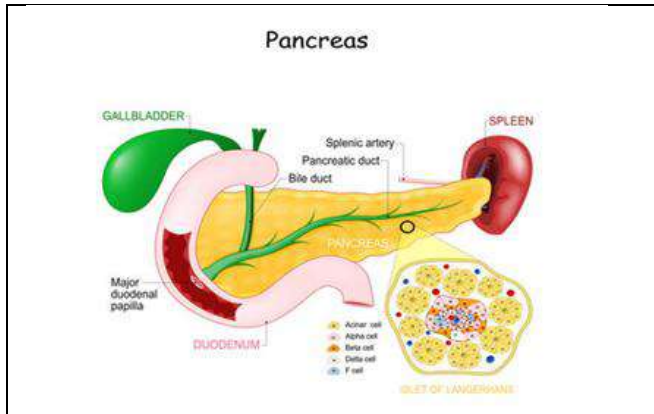


Figure: 1 Structure of pancreatic islets of Langerhans

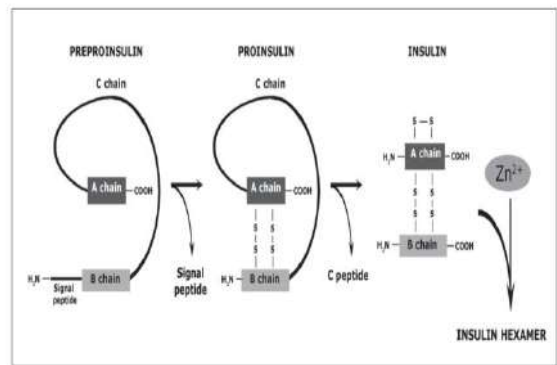


Figure: 2 Insulin Biosynthesis [6].

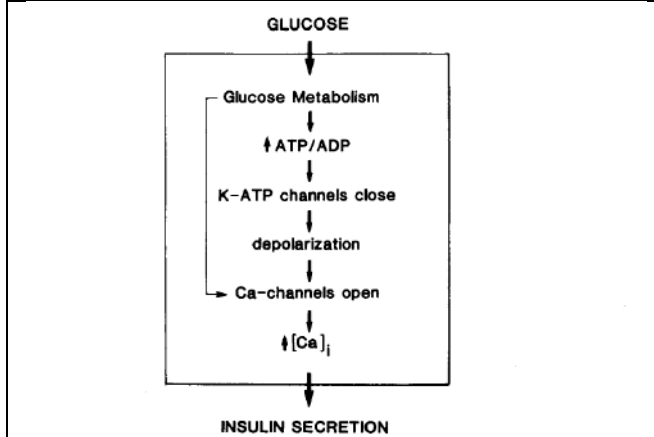


Figure: 3 Insulin Release [20].

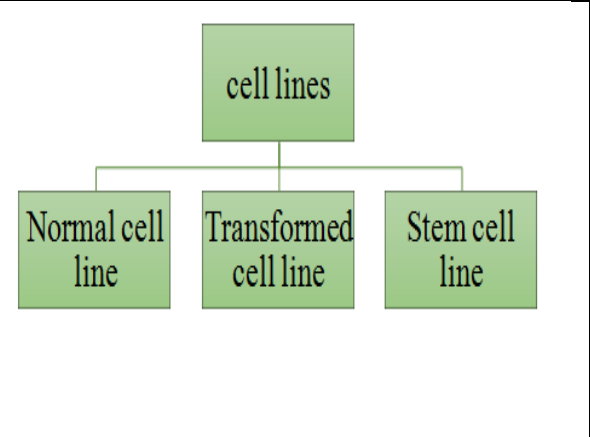


Figure 4: Types of cell line

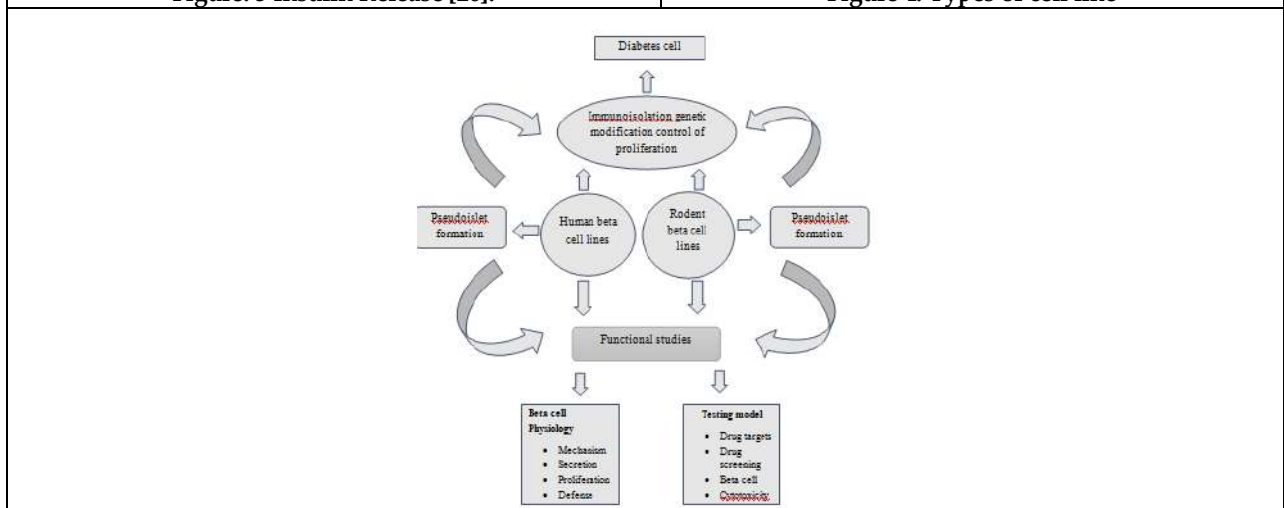


Figure 4: Uses of insulin secreting cell lines





Predominant Taxonomical Study on Macro Algae in Mandapam, Rameshwaram Region – South Coast of India

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Received: 22 Feb 2024

Revised: 03 Apr 2024

Accepted: 27 Jun 2024

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ABSTRACT

Seaweeds are commonly known as Marine macroalgae. Marine macroalgae shall thrive horizontally in an abundance of zonations, including brackish water environments, seas, estuaries, and the supra tidal (sub littoral) intertidal(littoral) and subtidal regions (sub littoral) where dead corals, rocks, stones, pebbles, and other appropriate substrata are available for their attachment. seaweed diversity was studied in the two explored coastal areas in Mandapam and Rameshwaram Island in south coast of India. The predominant diversity data were analysed with totally 30 species including 7 species of Chlorophyceae, species of 15 Phaeophyceae and 8 species of Rhodophyceae were recorded. The study areas are flourishing with 20–30 seaweed species. It is inferred that the seaweeds are well diversified in the month of December to February. The baseline data generated through this project is going to promote indigenous seaweed conservation efforts.

Keywords: Rhodophyceae, Chlorophyceae, Rameshwaram, Marine macroalgae

INTRODUCTION

Algae are Thallophytes (plants lacking roots, stems and leaves) which have chlorophyll A as their primary photosynthetic pigment which lack a sterile covering of cells around reproductive cells. Algae is derived from the Latin word meaning alga –it washes away from the plants or simply known as seaweeds. The Chinese term is



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referred as Tsau. The Hawaii term is Limu. Romans called as Fucus. In Tamil, it is called as Pasigal. Algae are extremely diverse group of organisms consisting predominant in aquatic plant kingdom. The wide spread overall view of taxonomy is essentially retrogressive. Sea water algae (marine) popularly known as Seaweeds, it can be grown in solid state such as rocks, pebbles, shells, corals and ped rocks(22). Hence it also found in coastal litters such as ropes, nets, and decaying wooden pieces in the sea, and epiphytes on other plants like seagrasses and shallow in mangroves, intertidal and sub – tidal zones and deep waters of sea, even the depth of 150 m.

Seaweeds belongs to the division thallophyta (plant bodies contain thalloid in nature).Sub kingdom Cryptogamae. Seaweeds are classified into three classes via. Chlorophyceae(green) Phaeophyceae (brown) Rhodophyceae (red). Based on this colour and type of photosynthetic pigments they can vary in size, difference ranging from unicellular organisms for instance (*Acetabularia*) to multicellular forms example (*Sargassum*, *Ulva*). In the marine resources, seaweeds is important one. In current period (raw materials) were used in many other industries such as textiles, pharmaceuticals, dairy, manure, paper, rubber products and fodder for domestic animals. Nowadays various pharmaceutical companies are concentrating in seaweeds. Marine biodiversity comprises the earth surface of about 70% of hydrosphere (aquatic habitat) it occupies 3% of fresh water and 97% of marine water. Marine ecosystem is the largest one and supports innumerable plants and animals. Taxonomically, the marine algae plants are very diverse and it include four groups. Such as macroscopic algae, microscopic free floating phytoplanktons, Mangroves, Sea grasses.

India is the 7th largest country in the world global geographical area, and it contains the coast line of 7,500 sq. km. Indian coast has a massive network of creeks, cliffs, mangroves, coral reefs, backwaters, bays, estuaries and lagoons .and it supports the marine flora and fauna. Geographically, it is divided into two major groups namely the east coast and west coast. In worldwide, 45,000 species of algae are nearly reported so far, and seaweeds represent about 11,500 species. In the seaweeds, Rhodophyceae is dominant and about 6,500 species, followed by Phaeophyceae with 2,000 species and Chlorophyceae contains 1,500 species (9). In India, a total 860 species of seaweeds have been reported and it includes of 430 Rhodophyceae, 286 Chlorophyceae and 185 Phaeophyceae (25) showing the seaweed diversity and variations. The algal resources can be explored in Mandapam, Ramanathapuram district by various persons in intensive manner. The predominant taxonomical works of the seaweeds will help to assess the conservation status of seaweed resources in our country.

The Rameshwaram is considered the icon for algal species and species diversity. The distribution of seaweeds is significantly influenced by the habit and habitat, due to tidal exposure period and human interface(24). In India, it has nearly 770 species of seaweeds have been reported from the Indian maritime environments(18). Algal diversity is rich in this Island. In this area it consists of plants and animal weed and well known for pilgrim places. The temple and the town are considered as a holy pilgrimage site for Shivas and Vaishnavas and the seaweeds is mostly used for food products and cosmetics items. Seaweeds are one among the renewable and economically valuable marine resources (3).Some algae are edible to eat and cook. The utilization of seaweed extracts in pharmaceuticals, nutraceuticals, and soil enhancers. Additionally, they contain more and more valuable as a food source or “sea vegetable” as a result of improving the advantages of consuming seaweed and its extracts: enhanced loss of weight (17). Combating mineral deficiency (11), antioxidant (12) and anti-tumour properties (26). The diversity and distribution of seaweeds along the Indian coast is not constant in all the states, they have huge or minor variations in the term of seaweed diversity.

ECONOMIC IMPORTANCE OF ALGAE

For food and energy algae is the primary source. *Porphyra* is the most important red algae used as a human food. Agar is a gelatinous, clear, nitrogen free extract from the above-mentioned genera of red algae. Agar is used in cosmetics, paper textile, leather industry, food industry and many commercial products. The alginates are used as thickeners in food industry, cosmetics and textile industry in printing pastes, production of plastics, artificial fibres, rubber industry and in latex production, gelling agents in confectionary, dental impression, powders, paints



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and ice creams. Carrageenin is used to stabilize emulsions and as remedy for cough hand clearing agent in juices, liquors, beet sugar, food industry, emulsifier in dairy products. Some seaweeds contain rich source of iron, copper, manganese, boron, and iron substances. Several brands of liquid fertilizers were prepared from the seaweeds are now available in market. Brown algae is used as anticoagulant of blood, antibiotics, laxatives, stops bleeding. Biological warfare against mosquitos. It is used in the role of water supply.

MATERIALS AND METHODS**STUDY AREA**

The present study area Mandapam and Rameshwaram belongs to Ramanathapuram district located nearly 34 km away from the central town. In this area, the algal communities are highly rich in number, and we can see various varieties of algae is not static. It changes according to the waves and tides, and climate too.

MANDAPAM- WORK AREA**FIELD SURVEY**

The study area covers the Mandapam and Rameswaram region. Three field surveys were done during the period of December to February. More information was collected from the local people. The present study mainly concentrated in the algal communities to know about the status of seaweeds including collection and preservation for future studies.

METHOD OF COLLECTION

The present taxonomic study of the algae on Mandapam coast is mainly based on collection of seaweeds through field surveys. Thirty algal specimens were collected through polythene bags. During this field surveys, the habit and habitat of the seaweeds were noted. The latitudes and longitudes of the collection areas were monitored. The seaweeds were photographed using the canon digital camera. For preservation techniques, we collected the ocean's water to preserve. In addition, collecting the filtered samples using a mixture of 4% formalin and 96% of double distilled ocean water.

RESULTS

The present study contains the algal specimens belonging to the systematic position, general characteristics and economic values of the species. And it reveals that the 30 kinds of seaweed species consist of Rhodophyceae, Chlorophyceae, Phaeophyceae and Myxophyceae that were available in Mandapam and Rameswaram coast. The diversity of coastal habit and habitat such as rocks, bedrocks, estuaries, backwaters, cliffs, calcareous and designing stones consists a wide range of algal vegetation.

Table:1 -List of Algal species

Table:2 -Preserved Specimens.

Table:3- List of algal specimens collected from Mandapam and Rameswaram region, Ramanathapuram district, Tamil Nadu. It denotes that the algal specimens, descriptive part and its economic values of algae.

The result shows that the predominant study parameters were been recorded during the month of December to February. Economically important algae are used for various process, the seaweeds can be utilized by the local fisher peoples for their business and giving the seaweeds to the industries for their financial conditions.



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DISCUSSION

The collection processes of algae encompasses series of activities, Field sampling is the first step in a sequence of actions that make up the algal gathering process. All of these proven approaches need patience, time, and adequate ability. likewise, some lab supplies are required in order to cultivate the algae. (Anderson 2005). (Friedmann & Ocampo-friedmann 1984, Flechtner et al.1998, Budel et al.2009).Approximately thirty unique seaweed species have been revealed in my research. Majorly it belonging to the class of Rhodophyceae, Chlorophyceae, Phaeophyceae and Florideophyceae that were available in the Mandapam coastal regions. Among these classes Rhodophyceae and Phaeophyceae comprises the algal flora, mostly Phaeophyceae comprises the seaweed classification. In the Mandapam coast region contain the habitats such as laid stones, estuaries, calcareous, bedrocks, backwaters and cliffs exhibit a wide range of seaweed vegetation in different seasons. During the climate conditions the P_H can be varied. It also consists of water salinity level and temperature level.

The distribution of a number of species was common, that it expanded with time, that some species were fairly spread, and that some species were randomly distributed. my present studies also show that various endemic and commercially significant seaweed species can be found along the Mandapam shoreline in the Ramanathapuram district. Out of about thirty seaweeds present on Indian shores, some indigenous taxa have been identified through an investigation Some of the fauna I have collected economically significant in the region of Mandapam, and Rameswaram Ramanathapuram district. Algae can provide a wide range of economic advantages. The people who reside in the Mandapam region can cultivate algae. Many of the pharmaceutical and cosmetics industry can be collected the algae by using the local people for their adaptability of people financial position(18).Majorly, it based on the climate factor.

The “Direct collecting method” is one of the best methods to know the algal diversity. It could be applied to all the macro and micro algae. Saunders and Hommers and reported that the wondrously diverse eukaryotes that constitute the red algae have been the focus of numerous recent molecular surveys and remain a rich source of un described and unknown species for the traditional taxonomist. We provide a comprehensive review of the literature pertaining to the antiquity, diversity, and systematics of the red algae and propose a contemporary classification based on recent and traditional evidence. The current system of red algal classification creates the illusion that this lineage is relatively limited in its diversity when compared to chlorophytes and chromophytes, the wide range of morphology observed among red algae and a wealth of contemporary ultra structural and molecular data that speak to the antiquity and diversity within Rhodophyta.

CONCLUSION

The predominant diversity of seaweeds in two stations viz. mandapam and Rameshwaram, Gulf of Mannar was investigated during 2020. Totally 30 species including 7 species of Chlorophyceae, 15 species of Phaeophyceae and 8 species of Rhodophyceae were recorded. Seaweed diversity in Rameshwaram coastal areas were satisfactory when compared with earlier reported works. An effort was made to briefly study the algae, their status, and some algae can be mentioned as rare and endemic in nature. Finally, algae were important to human, plants and animals. Most of the algae were very useful and economically important one. Basically, algae are rich in proteins, carbohydrates, oils, vitamins and minerals. The exploitation, utilization and conservation of seaweeds achieved effectively and well documented.





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ACKNOWLEDGEMENTS

The authors extend their regards to the local peoples for permitting us to perform this work. Our sincere gratitude to Department of Botany, PSG College of Arts & Science, Coimbatore, for assistance and all who assisted in our field surveys and samplings.

FUNDING

No grants/funds were received for this project.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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Table 1. List of algal species

S.NO	FAMILY	NO OF SPECIES
1.	Ulveaceae	3
2.	Halmidaceae	3
3.	Dictyotaceae	7
4.	Gracillariaceae	2
5.	Rhizophyllidaceae	1
6.	Liagoraceae	1
7.	Hypneaceae	1
8.	Sargassaceae	8
9.	Caulerpaceae	1
10.	Solieriaceae	1
11.	Corellainaceae	1
12.	Gelidiellaceae	1

Table 2. Preserved Specimens





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1. *Ulva lactuca* Linn., 2. *Halimeda gracilis* Harvey ex J. Agardh 3. *Halimeda tuna* (J. Ellis & Solander) J.V. Lamouroux 4. *Hypnea valentiae* (Turner) Montagne 5. *Ulva reticulata* Forsskal 6. *Turbinaria conoides* (J. Agardh) Kutzing 7. *Portieria hornemanii* (Lyngbye) p. Silva 8. *Stoechospermum marginatum* (C. Agardh) Kutzing 9. *Dictyota dichotoma* (Hudson) Lamouroux 10. *Gracilaria edulis* Greville 11. *Dictyota bartayresiana* J.V. Lamouroux 12. *Portieria hornemanii* (Lyngbye) p. Silva 13. *Caulerpa racemosa* (Forsskal) J. Agardh 14. *Gracilaria salicornia* (C. Agardh) 15. *Ulva flexosa* J. Agardh 16. *Padina gymnospora* Kutzing 17. *Kappaphycus alvarezii* (Doty) Doty ex Silva 18. *Jania adherans* J.V. Lamouroux 19. *Halymenia floresia* (Clemente) C. Agardh 20. *Spatoglossum variabile* Figari & De Notaris 21. *Sargassum tenerrimum* J. Agardh 22. *Sargassum plagiophyllum* C. Agardh 23. *Sargassum myriocystum* J. Agardh 24. *Sargassum muticum* (Yendo) Fensholt





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Table: 3 List of algae collected from Mandapam region, Ramanathapuram district, Tamil Nadu.

S.NO	BOTANICAL NAME Vernacular name	DESCRIPTION	ECONOMIC VALUES
1	<i>Ulva lactuca</i> Linn.,	Thallus looks like light, flat and thin yellowish green, membranous, ovate to roundish. In apical portion cells are regular. In middle portion, it is irregular. In basal region it is round.	It is used in cooking vegetable soups and salads. <i>Ulva lactuca</i> contains the cobalamin or vitamin B12.
2	<i>Halimeda gracilis</i> Harvey ex J. Agardh	Thallus is mostly large, prostrate, moderate, but slightly calcified (up to 24cm long.) and intricate populations forming thick cushion on the substratum. The upper margin segments are entire generally trilobed or slightly undulate. Attached with multiple holdfast. Branching cannot be seen in the basal portion.	It is used as fertilizers and animal feeds. It consists antifungal and anti-bacterial properties.
3	<i>Halimeda tuna</i> (J. Ellis & Solander) J.V. Lamouroux	Thallus erect, single, moderate to lightly calcified. Thallus are whitish green up to 10-20cm long. Sub cuneate to sub cylindrical. Peripheral utricles are hexagonal in surface view.	It is used as animal feed and acts against the bacterial diseases.
4	<i>Stoechospermum marginatum</i> (C. Agardh) Kützinger	Thallus erect, flat, spatulate with dichotomously branched fertile plants without midrib. Plants have large tufts, consists a length of 40cm, and 12-15cm or more in height. Numerous rhizoids from the base attaining the plants to the substratum. Thallus are brown in upper parts, and dark brown in the basal portion.	It is used as a source of alginates. It is used as fertilizer for food products.
5	<i>Gracilaria edulis</i> Greville	Thallus is reddish brown in colour. It grows up to 30cm tall, with discoid substratum. Cylindrical ending in pointed apexes. sub-dichotomous in nature, and branching pattern is 3-4 order. Branching dense, fasciate, divaricate, up to 7 orders and with long branch intervals, branches 1-1.5 mm in diameter. They form clump with attenuated base and they are attached to coral stones or to the substratum.	<i>G. edulis</i> is used as fertilizer and animal feed. It is also used in the waste water purification process.
6	<i>Portieria hornemanii</i> (Lyngbye) P. Silva	Thallus are erect, tall reddish to coralline in colour. Flattened branches. In the base portion, thallus	<i>P. hornemanii</i> is also used for human food as vegetable salads.





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		is broad. Irregular branches, divaricate, pinnate, alternate and subopposite in upper portions. Margin entire, uniaxial structure, forming arcs, branching tips are slightly pointed and curled.	It is a source of carrageenan related to lambda carrageenan, which can be 35% of dry weight.
7	<i>Dictyota dichotoma</i> (Hudson) Lamouroux	Fructiferous structures, on the middle thallus portion, leaving a narrow sterile margin on both sides. Dichotomously branched with parallel sides, forming a large or small tufts and entangled masses. Branches more profuse towards upper reaches of fronds and narrow extremities.	It is used in making the fruit juices, beer production, ice creams flavouring sauces, milk shakes, pastries, salads and extract is used in gelling agents and also stabilizers.
8	<i>Dictyota bartayresiana</i> J.V. Lamouroux	Blades are flat and slightly branched dichotomously, equal angled. Margin entire, apex acute. Sometimes, it is broadly rounded. Tetrasporangia on both sides, either it is solitary. Gametangia on both sides, either solitary or few together scattered over the whole surface.	It is used as anti -microbials, as larvicides and cytotoxins.
9	<i>Ulva reticulata</i> Forsskal	Thallus looks like reticulate or net liked, pale green in colour. It grows up to the height of 8-15 cm in length and 10-20 cm width. It is attached to the substratum. Disc like hold fast. Thallus texture is delicate and smooth. Each cell contains single parietal chloroplast.	It is used for jellies production, medicine, food and animal feed.
10	<i>Hypnea valentiae</i> (Turner) Montagne	Thallus looks like dark-red brown in colour. Thalli are 10-15 cm in height, erect and long percurrent, lateral branches with irregular radial laterals becomes gradually shorter and it have numerous fine lateral branches and few branched with the pointed tips. Several axes with sparse branches, spinous ramuli throughout the length.	It is edible and used for the salads. Chemical waste containing chromium can be removed by using the species. It is abundant and ch available. Carrageenan yielding plant.
11	<i>Turbinaria conoides</i> (J.Agardh) Kützinger	Thallus erect, yellowish brown or dark-brown in colour attached by a branched holdfast. It is compact, cone-like radially organised plant. Main axis and branches are slightly compressed. Branches dentate, turbinate, numerous. Vesicles inflated in the	It is used for fever, as a fertilizer. It is an insect repellent, pesticide and antibacterial. It has a dietary fibre content.





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		distal margin of the blade.	
12	<i>Caulerpa racemosa</i> (Forsskal) J. Agardh	The chloroplasts containing the chlorophyll are free. It consists a single cell with large number of nuclei. It possess a rhizome with creeping, cylindrical and highly branched. It is found in rocks, sand and slit- covered substrate attached by the numerous rhizoids arising from the creeping stolon.	It is edible and rich in ascorbic acid, folic acid, proteins, minerals, vitamin A and vitamin, B1. In Japan and Philippines, it is used as salads.
13	<i>Gracilaria salicornia</i> (C.Agardh)	Thallus consists of brittle, cylindrical to compressed branches 25mm in diameter. In shady places, and looks like brownish or dark green in colour. In sunny spots, it looks yellowish in nature. It grows on reefs and forms thick intertwining mats up to 6 inches. Both axes and branches are regularly or irregularly constricted. Plants often prostrate and overlapping with lateral branches.	It is used as the substitute for wild <i>G.coronopifolia</i> . It crunchiness is gaining favour.
14	<i>Ulva flexosa</i> J.Agardh	It consists of smooth and tubular thallus. Chloroplasts is present in the outer region of cells. Small rhizoidal region. It is differentiated into the branches. It is attached to the substratum by a round basal disc. Thallus may grows up to 25cm long.	It is used as a bio-indicator for metal contamination. It is used in waste water treatment in dye manufacturing, tannery, textile and cosmetic industry.
15	<i>Padina gymnospora</i> Kutzing	Thallus looks like olive brown in colour. Both sides of the thallus hairy substances are present. In TS the thallus is composed of 4-6 layers of cells in mid region it consists of 9 layers near to the base portion. It is attached by the small stupose rhizoidal base, fabelate and composed of several lobes with inrolled (slightly to moderately calcified).	It is used as fertilizer, animal feed, traditional medicine, and a source of the phycocollaid alginates. It is used as a substitute for salts for high Blood Pressure patients.
16	<i>Kappaphycus alvarezii</i> (Doty) <i>Doty ex silva</i>	The thalli are smooth, cylindrical, cartilaginous and bushy with multi axial prostrate or erect branches. Sometimes branching is irregularly pinnate, opposite or falsely dichotomous. Secondary branches are common on the older segments. Primary branches arise one at a time	It is used as a stabilizer and emulsifier in ice creams, instant puddings, chocolate milk, coffee creamer. In ancient times, Chinese have used carrageenan for gelling of milk.





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		from near the tip of non – damaged axis.	
17	<i>Jania adherans</i> J.V Lamouroux	Thallus are mostly tall, epiphytic, consisting a calcified crustose holdfast. Branches arising from the holdfast or stolon with or without secondary holdfast. It arises from the main axis or other lateral branches. It consists of globular and wedge-shaped cells.	It is used in cosmetics and natural beauty products and moisturizing the skin.
18	<i>Halymenia floresia</i> (clemente) C.Agardh	Thallus looks like slightly red, and somewhat rose-red in colour. It reaches to 15-40cm in height, 3cm broad, mucilaginous, tapered towards to the acute spines. Discoid holdfast. Inner cells are ovoid and becoming stellate. In the outer cortex, spermatangia is present.	<i>H.floresia</i> is very palatable and readily eaten by both tangs and angel fish. It is used in animal fertilizer. In animal feed and health, it includes water extraction under high pressure, while algal fertilizers prepared.
19	<i>Spatoglossum variabile</i> Figari & De Notaris	Thallus branched, filamentous, matted holdfast, linear and membranous. It consists of rough surface. In medullary part it consists of two layers of cells. Dichotomous Branches In that proliferations are present, usually present in the apical part. It consists of polygonal in shape.	N-butyl and isopropyl 3,5-dimethoxy-4-hydroxyxinnamate were isolated from <i>Spatoglossum variabile</i> .
20	<i>Sargassum tenerrimum</i> J.Agardh	Pyramidal in shape with basal adhesive disc -shaped holdfast. The axis is rounded and glabrous. It reaches up to 30-40cm height, Leaves are wide and tapering at the end and thin, translucent and linear-lanceolate, with toothed margin. The midrib is indistinct.	It is used as a natural fertilizer. It forms a source of production of animal feed, fertilizer, sodium alginate and medicine.
21	<i>Sargassum plagiophyllum</i> C.Agardh	Flask shaped receptacles are found and consists the specialized branches. It consists of highly branched thallus and toothed edges. It reproduces through the process of fragmentation. It is erect, flat or cylindrical in structure. The leaf structure is flat with dentate and distinct midrib. Margin is entire, with acute apex. It consists of air bladders. It helps to swim in water.	It is used in numerous ways such as a source of food, feed, fertilizer, medicine, antioxidant and heart related diseases.
22	<i>Sargassum myriocystum</i> J.Agardh	It consists of pyramidal in shape with basal disc or holdfast arises from the short primary axis. They are thin,	It is used for the biosynthesis of silver and gold nanoparticles by the





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		translucent and linear-lanceolate, with toothed margin. The midrib is indistinct. Leaves are tapered at the ends.	reduction of chloroauric acid.
23	<i>Sargassum muticum</i> (yendo) fensholt	Thallus is bushy, elongated, cylindrical, alternately pinnately branched, whorl of distinctly flattened sculpted leaves at the base. it looks like brown to yellowish in colour, a length up to 10 to 15 cm each. Life span consists of the is 3- 4 years. Air bladders were present and it is elliptical in manner. Basal holdfast penetrating and conical form.	In agriculture it is used as a source of nitrate and potash varieties for fertilization, pharmaceuticals, cosmetics and health fields. It also carries the process of bio-sorption of heavy metals such as cadmium.
24	<i>Sargassum vulgare</i> C.Agardh.	Leaves become crowded, partly twisted, linear lanceolate to linear, long and 2-4 mm broad with irregularly serrate margins, leaf or ribbon shaped pedicels. Reproductive branches were short up to 7 mm long. In sometimes, dichotomously branched or cylindrical receptacle.	It has commercial significance due to their physical properties such as gelling, water-retention and emulsifiers. High commercial value.
25	<i>Gelidiella acerosa</i> (Forsskal) Feldmann & G. Hamel	Thallus looks like purplish, cartilaginous in texture, formed by the several tufts. It is erect and cylindrical axis erect up to 5-7 cm high with a basal portion. It can be attached to the substratum by rhizoids on rock region, dead corals with basal creeping rhizome. In that, branches usually distichously opposite or sub opposite pinnate one.	In Philippines and Vietnam, it is used in the preparation of agar forming hard jellies. It can be eaten as vegetable or salads and with mixed rice items.
26	<i>Liagora ceranoides</i> J.V. Lamouroux	Rhizoidal filaments cut off from the basal cells. Thalli is bushy, stiff and heavily calcified. Cylindrical branches 0.5-1.5 mm diameter, stiff hair like filaments, inconspicuous hold fast and it forms hemispherical mounds.	It is used in pharmaceutical industry.





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Figure: NO OF SEEWEEDS

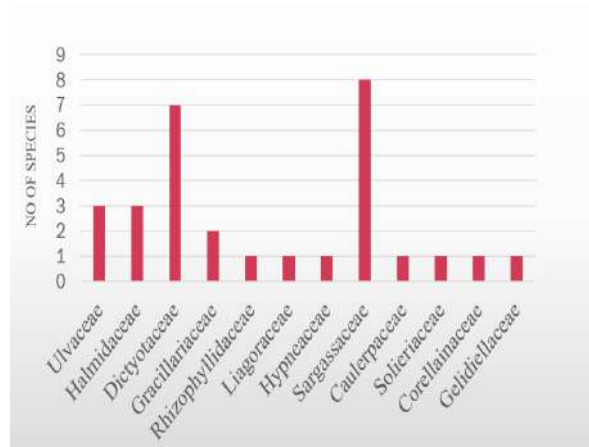


Fig 1. No. of seaweeds - family wise



Fig. 2. Study area and the sites selected in the Mandapam and Rameshwaram region.





On $n^*\mu$ -Continuous and Decomposition of Nano Continuity Maps

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Received: 21 Feb 2024

Revised: 10 Apr 2024

Accepted: 19 Jun 2024

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ABSTRACT

This research paper focuses on $n^*\mu$ -closure and $n^*\mu$ -interior under certain conditions. Then introduce $n^*\mu$ -continuous maps and $n^*\mu$ -irresolute maps. Then present contra $n^*\mu$ -continuous map and discuss some of their properties. Finally, obtained decomposition of nano continuity.

Keywords: $n^*\mu$ -closed set, $n^*\mu$ -closure, $n^*\mu$ -interior, $n^*\mu$ -continuous maps, $n^*\mu$ -irresolute maps and contra $n^*\mu$ -continuous.

INTRODUCTION

Several authors [1,2,3,4,5,6] working in the field of general nano topology have shown more interest in studying the concepts of generalizations of nano continuous maps. Nano continuous maps have been introduced in [5]. A weak form of nanocontinuous maps called ng-continuous maps have been presented in [1]. Afterwards, [7] has propounded $n^*\mu$ -closed sets. The main objective of this study is to introduce a new hybrid intelligent structure called $n^*\mu$ -continuous map. The significance of introducing hybrid structures is that the computational techniques, fuzzy and soft topological spaces. The rest of this article is organized as follows. Some preliminary concepts required in our work are briefly recalled in section 2. In section 3, 4, and 5 the concept of $n^*\mu$ -continuous maps and discuss lemma, propositions, theorems with suitable examples.





PRELIMINARIES

Definition 2.1. [8] If $(K, \tau R(U))$ is the nano topological space with respect to U where $U \subseteq K$ and if $S \subseteq K$, then

(1) The nano interior of the set S is defined as the union of all nano open subsets contained in S and it is denoted by $nint(S)$. That is, $nint(S)$ is the largest nano open subset of S .

(2) The nano closure of the set S is defined as the intersection of all nano closed sets containing S and it is denoted by $ncl(S)$. That is, $ncl(S)$ is the smallest nano closed set containing S .

Definition 2.2. A subset S of a space $(K, \tau R(U))$ is called:

(1) ng -closed set [9] if $ncl(S) \subseteq P$ whenever $S \subseteq P$ and P is nano open in $(K, \tau R(U))$.

(2) nag -closed set [10] if $n\alpha cl(S) \subseteq P$ whenever $S \subseteq P$ and P is nano open in $(K, \tau R(U))$.

(3) $n^*\mu$ -closed [7] if $ncl(S) \subseteq P$ whenever $S \subseteq P$ and P is n^*gs -open in $(K, \tau R(U))$.

(4) $n^*\mu\alpha$ -closed set [7] if $n\alpha cl(S) \subseteq P$ whenever $S \subseteq P$ and P is n^*gs -open in $(K, \tau R(U))$.

(5) $n^*\mu p$ -closed set [7] if $npclo(S) \subseteq P$ whenever $S \subseteq P$ and P is n^*gs -open in $(K, \tau R(U))$. The complement of above mentioned nano closed sets are called their respective nano open sets.

Definition 2.3. A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is called

(1) nano continuous [5] if $f^{-1}(W)$ is a nano closed set of K for every nano closed set W of V .

(2) nano α -continuous [11] if $f^{-1}(W)$ is a nano α -open set in K for every nano open set W of V .

(3) ng -continuous [1] if $f^{-1}(W)$ is a ng -closed set of K for every nano closed set W of V .

(4) nano αg -continuous [12] if $f^{-1}(W)$ is a nag -closed set of K for every nano closed set W of V .

Definition 2.4. [7] For a space $(K, \tau R(U))$ is called $Tn^*\mu$ -space if every $n^*\mu$ -closed set is nano closed.

Proposition 2.5. [7]

(1) Every nano closed set is $n^*\mu$ -closed set but not conversely.

(2) Every $n^*\mu$ -closed set is ng -closed set but not conversely.

(3) Every nano α -closed set is $n^*\mu\alpha$ -closed but not conversely.

(4) Every $n^*\mu$ -closed set is $n^*\mu\alpha$ -closed but not conversely.

(5) Every $n^*\mu\alpha$ -closed set is $n^*\mu p$ -closed but not conversely.

(6) Every $n^*\mu\alpha$ -closed set is nag -closed but not conversely.

(7) Every nano open set is $n^*\mu$ -open set but not conversely.

Definition 2.6. [13] A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is called contra nano continuous if $f^{-1}(W)$ is a nano closed set of $(K, \tau R(U))$ for every nano open set W of $(L, \tau' R(V))$.

Definition 2.7. [14] A function $f : (O, N) \rightarrow (P, N')$ is said to be nano contra g -continuous if $f^{-1}(V)$ is a ng -closed set of (O, N) for every n -open set V of (P, N')

$n^*\mu$ -interior and $n^*\mu$ -closure

Definition 3.1. For any $M \subseteq K$, $n^*\mu$ -inte(M) is defined as the union of all $n^*\mu$ open sets contained in M . i.e., $n^*\mu$ -inte(M) = $\cup\{G : G \subseteq M \text{ and } G \text{ is } n^*\mu\text{-open}\}$.

Lemma 3.2. For any $M \subseteq K$, $inte(M) \subseteq n^*\mu$ -inte(M) $\subseteq M$. Proof. The proof follows from Proposition 2.5 (7).

Proposition 3.3. For any $M \subseteq K$, the following holds.

(1) $n^*\mu$ -inte(M) is the largest $n^*\mu$ -open set contained in M .

(2) M is $n^*\mu$ -open if and only if $n^*\mu$ -inte(M) = M .





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Proposition 3.4. For any subsets M and P of $(K, \tau R(U))$, the following holds.

- (1) $n^*\mu\text{-inte}(M \cap P) = n^*\mu\text{-inte}(M) \cap n^*\mu\text{-inte}(P)$.
- (2) $n^*\mu\text{-inte}(M \cup P) \supseteq n^*\mu\text{-inte}(M) \cup n^*\mu\text{-inte}(P)$.
- (3) If $M \subseteq P$, then $n^*\mu\text{-inte}(M) \subseteq n^*\mu\text{-inte}(P)$.
- (4) $n^*\mu\text{-inte}(K) = K$ and $n^*\mu\text{-inte}(\phi) = \phi$.

Definition 3.5. For any $M \subseteq K$, we define the $n^*\mu$ -closure of M to be the intersection of all $n^*\mu$ -closed sets containing M . i.e., $n^*\mu\text{-clo}(M) = \cap\{F : M \subseteq F \in n^*\mu\text{-closed}\}$.

Lemma 3.6. For any $M \subseteq K$, $M \subseteq n^*\mu\text{-clo}(M) \subseteq \text{nclo}(M)$.

Proof. The proof follows from Proposition 2.5 (1).

Remark 3.7. Both containment relations in Lemma 3.6 may be proper as seen from the following example.

Example 3.8. Let $K = \{21, 22, 23, 24\}$, with $K/R = \{\{21\}, \{23\}, \{22, 24\}\}$ and $U = \{21, 22\}$. Then, the nano topology $\tau R(U) = \{\phi, \{21\}, \{22, 24\}, \{21, 22, 24\}, K\}$. Then, $n^*\mu$ -closed sets are $\phi, \{23\}, \{21, 23\}, \{22, 23\}, \{23, 24\}, \{21, 22, 23\}, \{21, 23, 24\}, \{22, 23, 24\}, K$. Let $A = \{22\}$. Here, $n^*\mu\text{-clo}(\{22\}) = \{22, 23\}$ and so $A \subseteq n^*\mu\text{-clo}(A) \subseteq \text{nclo}(A)$.

Proposition 3.9. For any $M \subseteq K$, the following holds.

- (1) $n^*\mu\text{-clo}(M)$ is the smallest $n^*\mu$ -closed set containing M .
- (2) M is $n^*\mu$ -closed if and only if $n^*\mu\text{-clo}(M) = M$.

Proposition 3.10. For any two subsets M and P of $(K, \tau R(U))$, the following holds.

- (1) If $M \subseteq P$, then $n^*\mu\text{-clo}(M) \subseteq n^*\mu\text{-clo}(P)$
- (2) $n^*\mu\text{-clo}(M \cap P) \subseteq n^*\mu\text{-clo}(M) \cap n^*\mu\text{-clo}(P)$

Proposition 3.11. Let M be a subset of a space K , then the following are true.

- (1) $(n^*\mu\text{-inte}(M))^c = n^*\mu\text{-clo}(M^c)$
- (2) $n^*\mu\text{-inte}(M) = (n^*\mu\text{-cl}(M^c))^c$
- (3) $n^*\mu\text{-clo}(M) = (n^*\mu\text{-inte}(M^c))^c$

Proof. (1) Clearly follows from definitions.

(2) Follows by taking complements in (1).

(3) Follows by replacing M by M^c in (1).

$n^*\mu$ -Continuous Maps and Irresolute Maps

Definition 4.1. A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is called $n^*\mu$ -continuous if $f^{-1}(W)$ is a $n^*\mu$ -closed set of $(K, \tau R(U))$ for every nano closed set W of $(L, \tau' R(V))$.

Proposition 4.2. Every nano continuous is $n^*\mu$ -continuous but not conversely.

Proof. The proof follows from Proposition 2.5 (1).

Proposition 4.3. Every $n^*\mu$ -continuous is ng-continuous but not conversely.

Proof. The proof follows from Proposition 2.5 (2).

Definition 4.4. A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is called $n^*\mu\alpha$ -continuous (respectively $n^*\mu\beta$ -continuous) if $f^{-1}(W)$ is an $n^*\mu\alpha$ -closed (respectively $n^*\mu\beta$ -closed) in $(K, \tau R(U))$ for each nano closed W of $(L, \tau' R(V))$.

Proposition 4.5. (1) Every nano α -continuous is $n^*\mu\alpha$ -continuous but not conversely.





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- (2) Every $n^*\mu$ -continuous is $n^*\mu\alpha$ -continuous but not conversely.
- (3) Every $n^*\mu\alpha$ -continuous is $n^*\mu p$ -continuous but not conversely.
- (4) Every $n^*\mu\alpha$ -continuous is $n\alpha g$ -continuous but not conversely.

Theorem 4.6. If $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is $n^*\mu$ -continuous and $g : (L, \tau' R(V)) \rightarrow (M, \tau * R(W))$ is nano continuous then $g \circ f : (K, \tau R(U)) \rightarrow (M, \tau * R(W))$ is $n^*\mu$ continuous.

Proof. Let G be nano closed set in M . Since g is nano continuous, $g^{-1}(G)$ is nano closed in L . Since f is $n^*\mu$ -continuous, $(g \circ f)^{-1}(G) = f^{-1}(g^{-1}(G))$ is $n^*\mu$ -closed in K . Therefore, $g \circ f$ is $n^*\mu$ -continuous.

Proposition 4.7. A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is $n^*\mu$ -continuous if and only if $f^{-1}(W)$ is $n^*\mu$ -open in $(K, \tau R(U))$ for every nano open set W in $(L, \tau' R(V))$.

Proof. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be $n^*\mu$ -continuous and W be a nano open set in $(L, \tau' R(V))$. Then, W^c is nano closed in $(L, \tau' R(V))$ and since f is $n^*\mu$ -continuous, $f^{-1}(W^c)$ is $n^*\mu$ -closed in $(K, \tau R(U))$. But $f^{-1}(W^c) = f^{-1}((W)^c)$ and so $f^{-1}(W)$ is $n^*\mu$ -open in $(K, \tau R(U))$. Conversely, assume that $f^{-1}(W)$ is $n^*\mu$ -open in $(K, \tau R(U))$ for each nano open set W in $(L, \tau' R(V))$. Let F be a nano closed set in $(L, \tau' R(V))$. Then, F^c is nano open in $(L, \tau' R(V))$ and by assumption, $f^{-1}(F^c)$ is $n^*\mu$ -open in $(K, \tau R(U))$. Since $f^{-1}(F^c) = f^{-1}((F)^c)$, we have $f^{-1}(F)$ is nano closed in $(K, \tau R(U))$ and so f is $n^*\mu$ continuous.

Theorem 4.8. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be an $n^*\mu$ -continuous map. If $(K, \tau R(U))$, the domain of f is an $Tn^*\mu$ -space, then f is nano continuous.

Proof. Let W be a nano closed set of $(L, \tau' R(V))$. Then, $f^{-1}(W)$ is a $n^*\mu$ -closed set of $(K, \tau R(U))$, since f is $n^*\mu$ -continuous. Since $(K, \tau R(U))$ is an $Tn^*\mu$ -space, then $f^{-1}(W)$ is a nano closed set of $(K, \tau R(U))$. Therefore, f is nano continuous.

Definition 4.9. Let $(K, \tau R(U))$ be a nano topological space. Let k be a point of K and G be a subset of K . Then, G is called an $n^*\mu$ -neighbourhood of k (briefly, $n^*\mu$ -nbhd of k) in K if there exists an $n^*\mu$ -open set S of K such that $k \in S \subseteq G$.

Proposition 4.10. Let M be a subset of $(K, \tau R(U))$. Then, $k \in n^*\mu$ -clo(M) if and only if for any $n^*\mu$ -nbhd G_k of k in $(K, \tau R(U))$, $M \cap G_k \neq \emptyset$.

Proof. (\Rightarrow): Assume $k \in n^*\mu$ -clo(M). Suppose that there is an $n^*\mu$ -nbhd G of the point k in $(K, \tau R(U))$ such that $G \cap M = \emptyset$. Since G is $n^*\mu$ -nbhd of k in $(K, \tau R(U))$, by Definition 4.11, there exists an $n^*\mu$ -open set S_k such that $k \in S_k \subseteq G$. Therefore, we have $S_k \cap M = \emptyset$ and so $M \subseteq (S_k)^c$. Since $(S_k)^c$ is an $n^*\mu$ -closed set containing M , we have by Definition 3.5, $n^*\mu$ -clo(M) $\subseteq (S_k)^c$ and therefore $k \notin n^*\mu$ -clo(M), which is a contradiction. (\Leftarrow): Assume for each $n^*\mu$ -nbhd G_k of k in $(K, \tau R(U))$, $M \cap G_k \neq \emptyset$. Suppose that $k \notin n^*\mu$ -clo(M). Then, by Definition 3.5, there exists an $n^*\mu$ -closed set F of $(K, \tau R(U))$ such that $M \subseteq F$ and $k \notin F$. Thus, $k \in F^c$ and F^c is $n^*\mu$ -open in $(K, \tau R(U))$ and hence F^c is a $n^*\mu$ -nbhd of k in $(K, \tau R(U))$. But $M \cap F^c = \emptyset$, which is a contradiction.

In the next theorem, we explore certain characterizations of $n^*\mu$ -continuous functions.

Theorem 4.11. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be a map from a nano topological space $(K, \tau R(U))$ into a nano topological space $(L, \tau' R(V))$. Then the following statements are equivalent.

- (1) The function f is $n^*\mu$ -continuous.
- (2) The inverse of each nano open set is $n^*\mu$ -open.
- (3) For each point k in $(K, \tau R(U))$ and each nano open set C in $(L, \tau' R(V))$ with $f(k) \in C$, there is an $n^*\mu$ -open set B in $(K, \tau R(U))$ such that $k \in B, f(B) \subseteq C$.
- (4) The inverse of each nano closed set is $n^*\mu$ -closed.
- (5) For each k in $(K, \tau R(U))$, the inverse of every neighbourhood of $f(k)$ is an $n^*\mu$ nbhd of k .
- (6) For each k in $(K, \tau R(U))$ and each neighbourhood N of $f(k)$, there is an $n^*\mu$ nbhd G of k such that $f(G) \subseteq N$.
- (7) For each subset M of $(K, \tau R(U))$, $f(n^*\mu$ -clo(M)) \subseteq nclo($f(M)$).
- (8) For each subset Q of $(L, \tau' R(V))$, $n^*\mu$ -clo($f^{-1}(Q)$) $\subseteq f^{-1}(nclo(Q))$.





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Proof. (1) \Rightarrow (2) This follows from Proposition 4.9. (1) \Rightarrow (3) Suppose that (3) holds and let C be an open set in $(L, \tau' R(V))$ and let $k \in f^{-1}(C)$. Then, $f(k) \in C$ and thus there exists an $n^*\mu$ -open set B_k such that $k \in B_k$ and $f(B_k) \subseteq C$. Now, $k \in B_k \subseteq f^{-1}(C)$ and $f^{-1}(C) = \cup_{k \in f^{-1}(C)} B_k$. Then, arbitrary union of $n^*\mu$ -open set is $n^*\mu$ -open, $f^{-1}(C)$ is $n^*\mu$ -open in $(K, \tau R(U))$ and therefore f is $n^*\mu$ -continuous.

Conversely, suppose that (1) holds and let $f(k) \in C$. Then, $k \in f^{-1}(C) \in n^*\mu\tau R(X)$, since f is $n^*\mu$ -continuous. Let $B = f^{-1}(C)$. Then, $k \in B$ and $f(B) \subseteq C$.

(2) \Rightarrow (4) This result follows from the fact if A is a subset of $(L, \tau' R(V))$, then $f^{-1}(Ac) = (f^{-1}(A))c$.
 (2) \Rightarrow (5) For $k \in (K, \tau R(U))$, let N be a neighbourhood of $f(k)$. Then, there exists an nano open set C in $(L, \tau' R(V))$ such that $f(k) \in C \subseteq N$. Consequently, $f^{-1}(C)$ is an $n^*\mu$ -open set in $(K, \tau R(U))$ and $k \in f^{-1}(C) \subseteq f^{-1}(N)$. Thus, $f^{-1}(N)$ is an $n^*\mu$ -nbhd of k .

(5) \Rightarrow (6) Let $k \in K$ and let N be a neighbourhood of $f(k)$. Then, by assumption, $G = f^{-1}(N)$ is an $n^*\mu$ -nbhd of k and $f(G) = f(f^{-1}(N)) \subseteq N$.

(6) \Rightarrow (3) For $k \in (K, \tau R(U))$, let C be an nano open set containing $f(k)$. Then, C is a neighborhood of $f(k)$. So by assumption, there exists an $n^*\mu$ -nbhd G of k such that $f(G) \subseteq C$. Hence, there exists an $n^*\mu$ -open set B in $(K, \tau R(U))$ such that $k \in B \subseteq G$ and so $f(B) \subseteq f(G) \subseteq C$.

(7) \Rightarrow (4) Suppose that (4) holds and let M be a subset of $(K, \tau R(U))$. Since $M \subseteq f^{-1}(M)$, we have $M \subseteq f^{-1}(nclo(f(M)))$. Since $nclo(f(M))$ is a nano closed set in $(L, \tau' R(V))$, by assumption $f^{-1}(nclo(f(M)))$ is an $n^*\mu$ -closed set containing M . Consequently, $n^*\mu\text{-clo}(M) \subseteq f^{-1}(nclo(f(M)))$. Thus, $f(n^*\mu\text{-clo}(M)) \subseteq f(f^{-1}(nclo(f(M)))) \subseteq nclo(f(M))$.

Conversely, suppose that (7) holds for any subset M of $(K, \tau R(U))$. Let F be a nano closed subset of $(L, \tau' R(V))$. Then, by assumption, $f(n^*\mu\text{-clo}(f^{-1}(F))) \subseteq nclo(f(f^{-1}(F))) \subseteq nclo(F) = F$. i.e., $n^*\mu\text{-clo}(f^{-1}(F)) \subseteq f^{-1}(F)$ and so $f^{-1}(F)$ is $n^*\mu$ -closed.

(7) \Rightarrow (8) Suppose that (7) holds and Q be any subset of $(L, \tau' R(V))$. Then, replacing M by $f^{-1}(Q)$ in (7), we obtain $f(n^*\mu\text{-clo}(f^{-1}(Q))) \subseteq nclo(f(f^{-1}(Q))) \subseteq nclo(Q)$. i.e., $n^*\mu\text{-clo}(f^{-1}(Q)) \subseteq f^{-1}nclo(Q)$. Conversely, suppose that (8) holds. Let $Q = f(M)$ where M is a subset of $(K, \tau R(U))$. Then, we have $n^*\mu\text{-clo}(M) \subseteq n^*\mu\text{-clo}(f^{-1}(Q)) \subseteq f^{-1}(nclo(f(M)))$ and so $f(n^*\mu\text{-clo}(M)) \subseteq nclo(f(M))$.

This completes the proof of the theorem.

Definition 4.12. A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is called $n^*\mu$ -irresolute if $f^{-1}(W)$ is a $n^*\mu$ -closed set of $(K, \tau R(U))$ for every $n^*\mu$ -closed set W of $(L, \tau' R(V))$.

Theorem 4.13. Every $n^*\mu$ -irresolute map is $n^*\mu$ -continuous but not conversely. Proof. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be a $n^*\mu$ -irresolute map. Let W be a nano closed set of $(L, \tau' R(V))$. Then, by the Proposition 2.5 (i.), W is $n^*\mu$ -closed. Since f is $n^*\mu$ -irresolute, then $f^{-1}(W)$ is a $n^*\mu$ -closed set of $(K, \tau R(U))$. Therefore, f is $n^*\mu$ -continuous. **Theorem 4.16.** Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ and $g : (L, \tau' R(V)) \rightarrow (M, \tau * R(W))$ be any two maps. Then,

- (1) $g \circ f$ is $n^*\mu$ -continuous if g is nano continuous and f is $n^*\mu$ -continuous.
- (2) $g \circ f$ is $n^*\mu$ -irresolute if both f and g are $n^*\mu$ -irresolute.
- (3) $g \circ f$ is $n^*\mu$ -continuous if g is $n^*\mu$ -continuous and f is $n^*\mu$ -irresolute. **Definition 4.17.** A map $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is called contra $n^*\mu$ -continuous if $f^{-1}(W)$ is a $n^*\mu$ -closed set of $(K, \tau R(U))$ for every nano open set W of $(L, \tau' R(V))$.

Proposition 4.14. Every contra nano continuous is contra $n^*\mu$ -continuous but not conversely. Proof. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be a contra nano continuous map and let G be any nano open set in $(L, \tau' R(V))$. Then, $f^{-1}(G)$ is nano closed in K . Since every nano closed set is $n^*\mu$ -closed, $f^{-1}(G)$ is $n^*\mu$ -closed in K . Therefore f is contra $n^*\mu$ -continuous.

Proposition 4.15. Every contra $n^*\mu$ -continuous is nano contra g -continuous but not conversely. **Proof.** Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be a contra $n^*\mu$ -continuous map and let G be any nano open set in $(L, \tau' R(V))$. Then, $f^{-1}(G)$ is $n^*\mu$ -closed in K . Since every $n^*\mu$ -closed set is Ng -closed, $f^{-1}(G)$ is Ng -closed in K . Therefore, f is nano contra g -continuous.





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Remark 4.16. $n^*\mu$ -continuity and contra $n^*\mu$ -continuity are independent.

Remark 4.17. The composition of two contra $n^*\mu$ -continuous maps need not be contra $n^*\mu$ -continuous.

Theorem 4.18. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be a map. Then, the following conditions are equivalent:

- (1) f is contra $n^*\mu$ -continuous.
- (2) The inverse image of each nano open set in P is $n^*\mu$ -closed in K .
- (3) The inverse image of each nano closed set in P is $n^*\mu$ -open in K .
- (4) For each point k in K and each nano closed set G in P with $f(k) \in G$, there is an $n^*\mu$ -open set U in K containing k such that $f(U) \subset G$.

Proof. (1) \Rightarrow (2) Let G be nano open in L . Then $L - G$ is nano closed in L . By definition of contra $n^*\mu$ -continuous, $f^{-1}(L - G)$ is $n^*\mu$ -open in K . But $f^{-1}(L - G) = K - f^{-1}(G)$. This implies $f^{-1}(G)$ is $n^*\mu$ -closed in K . (2) \Rightarrow (3) Let G be any nano closed set in L . Then $L - G$ is nano open set in L . By the assumption of (2), $f^{-1}(L - G)$ is $n^*\mu$ -closed in K . But $f^{-1}(L - G) = K - f^{-1}(G)$. This implies $f^{-1}(G)$ is $n^*\mu$ -open in K .

(3) \Rightarrow (4) Let $k \in K$ and G be any nano-closed set in L with $f(k) \in G$. By (3), $f^{-1}(G)$ is $n^*\mu$ -open in K . Set $U = f^{-1}(G)$. Then, there is an $n^*\mu$ -open set U in K containing k such that $f(U) \subset G$.

(4) \Rightarrow (1) Let $k \in K$ and G be any nano-closed set in L with $f(k) \in G$. Then $L - G$ is nano-open in L with $f(k) \in G$. By (4), there is an $n^*\mu$ -open set U in K containing k such that $f(U) \subset G$. This implies $U = f^{-1}(G)$. Therefore, $K - U = K - f^{-1}(G) = f^{-1}(L - G)$ which is $n^*\mu$ -closed in K .

Theorem 4.19. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ and $g : (L, \tau' R(V)) \rightarrow (M, \tau * R(W))$. Then, the following properties hold:

- (1) If f is contra $n^*\mu$ -continuous and g is nano continuous, then $g \circ f$ is contra $n^*\mu$ -continuous.
- (2) If f is contra $n^*\mu$ -continuous and g is contra nano continuous, then $g \circ f$ is $n^*\mu$ -continuous.
- (3) If f is $n^*\mu$ -continuous and g is contra nano continuous, then $g \circ f$ is contra $n^*\mu$ -continuous.

Proof. (1) Let G be nano closed set in M . Since g is nano continuous, $g^{-1}(G)$ is nano closed in L . Since f is contra $n^*\mu$ -continuous, $(g \circ f)^{-1}(G) = f^{-1}(g^{-1}(G))$ is $n^*\mu$ -open in K . Therefore $g \circ f$ is contra $n^*\mu$ -continuous.

(2) Let G be any nano closed set in M . Since g is contra nano continuous, $g^{-1}(G)$ is nano open in L . Since f is contra $n^*\mu$ -continuous, $(g \circ f)^{-1}(G) = f^{-1}(g^{-1}(G))$ is $n^*\mu$ -closed in K . Therefore $g \circ f$ is $n^*\mu$ -continuous.

(3) Let G be any nano closed set in M . Since g is contra nano continuous, $g^{-1}(G)$ is nano open in L . Since f is $n^*\mu$ -continuous, $(g \circ f)^{-1}(G) = f^{-1}(g^{-1}(G))$ is $n^*\mu$ -open in K . Therefore $g \circ f$ is contra $n^*\mu$ -continuous.

Theorem 4.20. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is $n^*\mu$ -irresolute map and $g : (L, \tau' R(V)) \rightarrow (M, \tau * R(W))$ is contra nano continuous map, then $g \circ f : (K, \tau R(U)) \rightarrow (M, \tau * R(W))$ is contra $n^*\mu$ -continuous map.

Proof. Since g is contra nano continuous from $(L, \tau' R(V)) \rightarrow (M, \tau * R(W))$, for any nano open set in m as a subset of M , we get $g^{-1}(m) = G$ is a nano closed set in $(L, \tau' R(V))$. By Proposition 2.5 (i), it implies that $g^{-1}(m) = G$ is $n^*\mu$ -closed in $(L, \tau' R(V))$. As f is $n^*\mu$ -irresolute map. We get $(g \circ f)^{-1}(m) = f^{-1}(g^{-1}(m)) = f^{-1}(G) = S$ and S is a $n^*\mu$ -closed in $(K, \tau R(U))$. Hence, $g \circ f$ is a contra $n^*\mu$ -continuous map.

Theorem 4.21. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ is $n^*\mu$ -irresolute map and $g : (L, \tau' R(V)) \rightarrow (M, \tau * R(W))$ is contra $n^*\mu$ -continuous map, then $g \circ f : (K, \tau R(U)) \rightarrow (M, \tau * R(W))$ is contra $n^*\mu$ -continuous map.

Proof. Since g is contra $n^*\mu$ -continuous from $(L, \tau' R(V)) \rightarrow (M, \tau * R(W))$, for any nano open set in m as a subset of M , we get, $g^{-1}(m) = G$ is a $n^*\mu$ -closed set in $(L, \tau' R(V))$. As f is $n^*\mu$ -irresolute map. We get $(g \circ f)^{-1}(m) = f^{-1}(g^{-1}(m)) = f^{-1}(G) = S$ and S is a $n^*\mu$ -closed in $(K, \tau R(U))$. Hence $g \circ f$ is a contra $n^*\mu$ -continuous map.

Theorem 4.22. Let $f : (K, \tau R(U)) \rightarrow (L, \tau' R(V))$ be a map and $g : (K, \tau R(U)) \rightarrow ((K, \tau R(U)) \times (L, \tau' R(V)))$ the graph map of f , defined by $g(k) = (k, f(k))$ for every $k \in K$. If g is contra $n^*\mu$ -continuous, then f is contra $n^*\mu$ -continuous.

Proof. Let G be an nano open set in $(L, \tau' R(V))$. Then, $((K, \tau R(U)) \times G)$ is an nano open set in $((K, \tau R(U)) \times (L, \tau' R(V)))$. It follows from Theorem 4.27, that $f^{-1}(G) = g^{-1}((K, \tau R(U)) \times G)$ is $n^*\mu$ -closed in $(K, \tau R(U))$. Thus, f is contra $n^*\mu$ -continuous.





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Decomposition of Nano Continuity Map

Definition 5.1. A subset D of a space $(K, \tau_R(U))$ is said to be $n^*\mu lc^*$ -set if $D = E \cap F$, where E is N^* gs-open set and F is nano closed set $(K, \tau_R(U))$.

Proposition 5.2. Every nano closed set is $n^*\mu lc^*$ -set. Proof. This is obvious.

Remark 5.3. $n^*\mu$ -closed sets and $n^*\mu lc^*$ -sets are independent of each other.

Proposition 5.4. Let $(K, \tau_R(U))$ be a nano topological space. Then, a subset D of $(K, \tau_R(U))$ is nano closed set if and only if it is both $n^*\mu$ -closed set and $n^*\mu lc^*$ -set.

Proof. Case (1) Necessity is trivial. Case (2) To prove the sufficiency, we assume that D is both $n^*\mu$ -closed set and $n^*\mu lc^*$ -set. Then, $D = E \cap F$, where E is N^* gs-open set and F is nano closed set in $(K, \tau_R(U))$. Therefore, $D \subseteq E$ and $D \subseteq F$, and so by hypothesis, $ncl(D) \subseteq E$ and $ncl(D) \subseteq F$. Thus, $ncl(D) \subseteq E \cap F = D$ and hence $ncl(D) = D$ i.e., D is nano closed set in $(K, \tau_R(U))$.

Definition 5.5. Let $f : (K, \tau_R(U)) \rightarrow (L, \tau' R(V))$ is called $n^*\mu lc^*$ -continuous map if $f^{-1}(W)$ is $n^*\mu lc^*$ -set in $(K, \tau_R(U))$ for every nano closed set W of $(L, \tau' R(V))$.

Proposition 5.6. Every nano continuous map is $n^*\mu lc^*$ -continuous map.

Proof. It follows from Proposition 5.2.

Remark 5.7. $n^*\mu$ -continuity map and $n^*\mu lc^*$ -continuity map are independent of each other.

Theorem 5.8. Let $f : (K, \tau_R(U)) \rightarrow (L, \tau' R(V))$ is nano continuous map if and only if it is both $n^*\mu$ -continuous map and $n^*\mu lc^*$ -continuous map.

Proof. Case (i) We assume that f is nano continuous map. Then, by Proposition 4.2 and Proposition 5.8, f is both $n^*\mu$ -continuous map and $n^*\mu lc^*$ -continuous map. Conversely, Case(ii) We assume that f is both $n^*\mu$ -continuous map and $n^*\mu lc^*$ -continuous map. Let W be a nano closed subset of $(L, \tau' R(V))$. Then $f^{-1}(W)$ is both $n^*\mu$ -closed set and $n^*\mu lc^*$ -set. By Proposition 5.6, $f^{-1}(W)$ is a nano closed set in $(K, \tau_R(U))$ and so f is nano continuous map.

CONCLUSIONS

Characterizations and properties of $n^*\mu$ -closed sets and $n^*\mu$ -open sets are given. A characterization of $n^*\mu$ -continuous maps and $n^*\mu$ -irresolute is given in terms of $n^*\mu$ -closed sets. Also, it is established that an contra $n^*\mu$ -continuous and to obtained decompositions of nano continuity in nano topological spaces. The results of this study may help in many researches.

ACKNOWLEDGEMENT

We thank to referees for giving their useful suggestions and help to improve this article.

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Ayurvedic Management of Pre-Diabetes: A Case Study

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Pre-diabetes is an intermediate state of hyperglycaemia with glycemic parameters above normal but below the diabetes threshold. In view of increasing prevalence of Diabetes mellitus (DM) across the globe, which is greater in India, it is important to focus on prevention of conversion of pre-diabetic population to Diabetes. Although theorized to be effective for pre-diabetes, Nisha Amalaki Yoga (NAY) has not been studied in this population. The purpose of this article is to report the results of a case in which a patient with prediabetes was treated with the NAY. A 38-year-old female was diagnosed as a case of pre-diabetes with HbA1C 6.2%. Even after 2 months of consistent lifestyle modifications, her HbA1C did not show reduction, and thus medicinal management was indicated. As patient was willing to take herbal medicine, she was started NAY capsule 1gm twice in a day along with lifestyle modification. 4 weeks later, she noted improvements in blood sugar. After 12 weeks of treatment, her HbA1C decreased to normal range (5.6%). Although human studies about management of pre-diabetes with herbal formulations are lacking, the available experimental studies have shown improvements in β -cell function and postprandial and fasting glucose levels. Furthermore, it has shown a delay in progression of prediabetes. No case reports have been found on use of NAY in prediabetes. NAY along with lifestyle modification may have a role in management of pre-diabetes and should be further studied in large sample.

Keywords: Ayurved, Pre-diabetes, Nisha Amalaki Yoga Lifestyle modification, Case study.





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INTRODUCTION

“Prevention is better than cure” this phrase is deeply rooted in Ayurvedic system of Medicine. Pre-diabetes is initial stage of Diabetes mellitus, if it is reversed in its early stage may prevent its conversion into DM(1).Pre-diabetes is an intermediate stage of dysglycemia with conversion from normoglycemia to hyperglycemia i.e. diabetes. Prediabetes is diagnosed by laboratory investigation of fasting blood glucose (FBG-100-125 mg/dl), glyated hemoglobin (HbA1C-5.7-6.4%), or 2-h postprandial blood glucose (2hBG-140-199mg/dl) (2).5-10% of pre-diabetics get converted to DM each year, while the same proportion converts back to normoglycaemia by lifestyle modification and drug-based interventions. (3)Worldwide prevalence of prediabetes is increasing rapidly and it may cross 470 million prediabetic people by 2030.(3)Insulin resistance and β -cell dysfunction-abnormalities are simultaneously occurring in Prediabetes prior to the glucose changes are detectable. (4)Multi factorial risk scores using non-invasive methods and blood-based metabolic traits along with glycemic values, could improve the estimation of diabetes risk. Lifestyle modification is the key factor of diabetes prevention, with evidence of a 40-70% relative-risk reduction in pre-diabetics. (5)The term pre-diabetes is a term used to identify individuals who are at risk for future diabetes, but it is also accompanying with a high burden of cardio-metabolic risk factors, early forms of nephropathy, chronic kidney disease, small fiber neuropathy, diabetic retinopathy and is also associated with poor outcomes.(6) The prevalence of prediabetes and diabetes increases noticeably with age.(7)*Pramehais* commonly correlated with diabetes, so *Pramehapurvarupa* (Prodromal symptoms) can be correlated with symptoms of pre-diabetes. A pre-diabetic if left untreated becomes diabetic, in the same way in Ayurveda *Pramehapoorvarupa* converts into *KaphajaPrameha*. *KaphajaMeha* getting converted into *Vataja meha in long run due to Dhatukshaya* and succeeding *Vataprakopa*.(8) *Prameha* is a chronic persistence and perpetuation of disease(*PramehoAnushanginam*). (9) It reappears again and again and continues in generations due to *BeejaDushti* (seeds-sperm, ovum affected by *Dosha* causing disease) (10) In this study, the best medicine (*Agryadraya*) mentioned by *Acharya Vagbhata* for diabetes i.e. *Nisha Amalaki Yoga*, combination of *Haridra*(*Curcuma longa Linn*)and *Amalaki* (*Emblia officinalis Gaertn*)was selected.(11) Here a case of Vadodara based patient who was diagnosed as a pre-diabetes, treated with Ayurvedic herbal drugs combination along with lifestyle modification.

PATIENT PROFILE

A 38-year-old female, a non-vegetarian, non-alcoholic, and non-smoker with no family history of Diabetes mellitus, came in the Kayachikitsa OPD of Ayurved Hospital for the management of obesity in January 2021. She presented with symptoms of *Kshudhadhikya* (polyphagia), *Trishmadhikya* (polydipsia), *Mutradhikya* (polyuria), *Daurbalya* (weakness) heaviness of body, and mild itching at vaginal region from 2 years intermittently. Considering suspicion about polycystic ovarian disease due to mild itching at vaginal region and heaviness of body, detail history of menstruation and weight gain was taken. History revealed the regularity of menses and chronic history of weight gain. There were no associated symptoms in patient, which needs further evaluation for PCOS. Thyroid profile was done by patient previously considering hypothyroidism, which was normal. She was advised to do various laboratory investigations considering suspicion of DM and metabolic syndrome (MetS) such as fasting blood sugar, post-prandial blood sugar, glyated haemoglobin, lipid profile, renal function test, liver function test, urine-routine-microscopic and complete blood count. For diagnosis of MetS, the presence of basic criteria-obesity (waist circumference > 35 inches in female and >40 inches in male)or body mass index >30 kg/m²and two of the three following criteria: high blood pressure, impaired glucose metabolism, elevated non-high-density lipoprotein (non-HDL) cholesterol level is mandatory.(12)Patient was not fulfilled basic criteria (patients waist circumference<35 inches and BMI <30) of MetS, which rule out the possibility of metabolic syndrome. Considering her fasting blood sugar level-120 mg/dl, post-prandial blood sugar-146 mg/dl, HbA1C-6.2%,patient was diagnosed as Pre-diabetes as per American Diabetic Association criteria.(13)Before inclusion in the study, patient have followed Dixit diet for 2 months along with cycling 8-10 km/day for pre-diabetic condition. Dixit diet comprise of only two meal a day i.e. fasting of 12 hours. Overall concept behind keeping only two meal a day is to regulate insulin secretion in blood, which usually increases after meals, triggers obesity, insulin resistance and type 2 DM. (14)





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Despite of lifestyle modification, her glycated haemoglobin was not reduced significantly. HbA1C was reduced to 6.2% from 6.3% i.e. still in pre-diabetic condition. So, to get desired outcome she was treated with NAY along with strict diet control and regular exercise for 3 months.

Nidana found in patient

- *Hetu* (etiology or causative factors) a) *Ahara: Madhuar, Lavana, KatuRasatmakaAhara, Navannapana* since long period (Consumption of newly prepared dhanya), *Paya- Dadhisevana* (Regular practice of milk and curd) Intake of Sweet, salty, and spicy food items.
- b) *Vihara: Asayasukham* (Habituation to sitting on soft cushions for long periods), *Swapnasukham* (excessive sleeping), *Divaswapa* (day sleep). All these causative factors closely resembles with classical description of *Nidanain* Ayurveda. (16)
- *Poorvarupa* (Prodromal symptoms): Heavyness of body, Excessive urination (on/off), *kshudhadhikya* (excessive hunger), Vaginal region itching (on/off), *Maladhikya*

AYURVEDIC MANAGEMENT

Capsule NAY was given in the dose of 1 gm twice a day for the period of 3 months. Strict diet control and regular exercise was also advised to the patient.

Outcome

Vaginal itching was subsided within 15days if treatment. *Maladhikya* was reduced completely after 1 month of treatment. After 1 month, symptoms like heaviness of body, *mutradhikya, kshudhadhikya, alasya, daurbalya* were significantly reduced. All symptoms were subsided completely after 90 days of treatment. NAY didn't show an adverse drug event during three months (90 days). Initial 75 kg weight was reduced to 70 kg, reducing the BMI from 28.6 kg/m² to 26.7kg/m². Very significant results were seen in subjective as well objective parameters. Patient felt healthy and more energetic after three months of treatment.

DISCUSSION

Pre-diabetes is an intermediary stage of hyperglycemia with glycemic parameters above normal but below the diabetes threshold. The diagnostic criteria's of pre-diabetes are not uniform according to various international professional organizations, still it remains a state of high risk for developing diabetes with yearly conversion rate of 5%-10%. (19) The universal prevalence rate of IGT in 2010 was estimated to be 343 million (7.8%) ranging from 5.8% in South East Asia to 11.4% in North American and Caribbean Countries of the nation's population (20). International Diabetes Federation projects an increase in prevalence of prediabetes to 471 million globally by 2035 (21) According to the principles of Ayurveda, *Prameha* is one of the *Astamahagada*, i.e. diseases which are difficult to treat. (22) Hence, it has been suggested that the disease may be treated in its *Purvarupavastha* (23). Hence, treating at pre-diabetes stage, which may be considered as the *Purvarupavastha*, will be more beneficial and NAY has shown very promising results in doing this. Modern science has not mentioned any specific symptoms of Pre-diabetes but Ayurveda have elaborated various symptoms such as *Mukhamadhurya, Kar-padadaha, Nidradhikya, Kshudhadhikya, Shithilangata (Laxity of body)* etc. (24) A hypothesis was made on the basis of exploration of pre-diabetic features as are identified in ayurveda as *Prameha Purvarupa*, a more realistic sensitization among pre-diabetes people may be done. After identification, these pre-diabetics can be warned and prompted for steps to prevent the disease by showing the proximity of their pre-diabetes features with clinical diabetes (25). In this study, patient was diagnosed as pre-diabetes based on investigations (Blood parameters) fasting blood sugar, post-prandial blood sugar and glycated hemoglobin. (Table 4) The patient was showing some symptoms of *Prameha Purvarupa* (Table 2). NAY is a drug combination mentioned under *Agryadravya* for *Prameha*. Various researches are available on NAY in the management of DM. Hence, this drug combination was used along with dietary and physical activities regimen for pre-diabetes. Daily dose of NAY was 2 gm in capsule form two times in day before food. Initially the patient got symptomatic





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relief in first month of treatment but bio-chemical parameters was not significantly reduced. Symptoms such as heaviness of body, excessive micturition, *kshudhadhikya* was significantly reduced after three months of treatment. FBS, PPBS and HbA1C were significantly reduced and normalized the symptoms.

Probable Mode of Action of NAY

Pharmacology

Curcuma longa linn contains curcuminoids, which improves insulin resistance, decrease glucose and insulin levels, increase adiponectin release, and reduce the levels of leptin, resistin, interleukin (IL-6) IL-1 β , and tumor necrosis factor- α patients with T2DM (26). Compounds containing *Curcuma longa* can affect glucose homeostasis and diabetic complications, and the vascular risk of patients with T2DM (27). Some studies have found that supplementation of curcuminoids improves the lipid profile and increases the total antioxidant capacity of T2DM patients. Curcumin specifically improves insulin resistance, serum glucose levels, HbA1c, lipid profile, and inflammatory biomarkers in patients with T2DM. (28) Ellagic acid in *Embllica Officinalis gaertn* exerts anti-diabetic activity through stimulation of β -cells of pancreas to secrete insulin and decreases glucose intolerance. (29)

Therapeutic properties of NAY

- a) *Curcuma longa linn*: It is having *Laghu*, *Ruksha* properties, *Tikta* (Bitter), *Katu* (Spices) *rasa*, *KatuVipaka* and Hot potency. Due to these properties, it acts as *Kaphaghna*, *Kledahara* and improves glucose intake metabolism. (30)
- b) *Embllica officinalis Gaertn*: It is good anti-oxidant and has rejuvenation properties. It acts as immunity booster, reduces stress levels, and improves glucose intake metabolism. It is *Amlapradhanadravya* (predominance of sour taste amongst five). It possesses *Guru* (heavily digesting), *Ruksha* (Dryness) and *Sheeta* (Cold) properties. It pacifies *Tridosha* and act as *Vatanulomana*. (31)

Combination of NAY is *Tridosahara* and it reduces the vitiated *Kapha*. Its act on vitiated *Kapha*, *Meda* and *Kleda*. It has capacity to improve tone of *Saptadhatus* and reduces *Dhatushaithilya* (Laxity of *dhatu*). Due to its *Deepana* and *Pachana* properties, acts on *Jatharagni* (Digestive enzymes) and *Dhatwagni*, removes *Ama* and *Kleda*. It corrects the function of *Dhatwagni*, henceforth regulates deranged metabolism. It has *Deepana*, *Pachana* and *Anulomana* properties, hence re moves *Srotoavarodha* (obstructed body channels) and improves glucose intake metabolism. *Rukshaguna* acts as *Kledshoshana* (drying of excessive moisture and regulating the excessive formation of *kleda*) and helps to break the pathology of *Prameha*. (31) (Table 7)

Importance of Diet

Non-communicable diseases remain the leading cause of death worldwide, with approximately 38 million global deaths annually. Half of these deaths can be prevented, by taking urgent measures, including changing lifestyle and adapting a healthy and balanced nutrition. (32) *Yavapradhana Ahara* is mentioned in Ayurveda for *Prameha*. (33) *Yavapradhana* diet along with other food items which are indicated in DM was advised to the patient. (Table 6) Oat, barley contains beta-glucans. Oat beta-glucans have been widely used in several clinical trials to prove its action of glucose reduction. Studies showed that oat beta-glucan lowered postprandial glycemia. (34) Beta-glucans acts by reducing blood glucose possibly by delaying stomach emptying so that dietary glucose is absorbed more gradually. (35)

Importance of Exercise

Exercise plays a key role in the management of lifestyle diseases. Aerobic type of exercise in the form of cycling and walking was advised and it was well followed by the patient. (Table 5) Insulin action in muscle and liver can be modified by acute bouts of exercise and by regular physical activity. (36) Acutely, Aerobic exercise through insulin-independent mechanisms increases muscle glucose uptake up to fivefold through. After exercise, glucose uptake remains elevated by insulin-independent (~2 h) and insulin-dependent (up to 48 h) mechanisms if exercise is prolonged. (37) The effects of a single bout of aerobic exercise on insulin action vary with duration, intensity, and subsequent diet; a single session increases insulin action and glucose tolerance for > 24 h but < 72 h. (38) Lipid profile was done before and after the treatment which was normal. Normal values of liver function test, kidney function test and urine analysis suggesting the safety of NAY. In complete blood count, hemoglobin % was improved. (Table





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4) Hence, present case study showed the combined significant effect of NAY, diet regimen and regular exercise in the management of pre-diabetes without any adverse events or adverse drug reaction.

CONCLUSION

Pre-diabetes can be correlated with *PramehaPurovaroopa*. But evidences are necessary to prove the theory. Most of the subjects with pre-diabetes do not show any symptoms but showing changes in blood investigation. Glycated hemoglobin should be done regularly to reduce accidental diagnosis of Pre-diabetes and to increase awareness in society. NAY along with dietary regimen and exercise is better choice for pre-diabetic condition. Significant reduction was noted in fasting blood glucose, post prandial blood sugar and glycated hemoglobin in present case report along with improved quality of life. There was no any adverse effect while using NAY. The clinical trial shall be conducted on large sample to establish the efficacy and safety of NAY.

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Table 1: Details of medication

SN	Name of medicine	Dose (matra)	Time of drug administration (Aushadh Sevan Kala)	Anupana
1	Nisha Amalaki Yoga	1g twice in a day	Before food	Lukewarm water

Table 2: Showing Demographic data of patient

Name:	XYZ
Age:	38 years
Sex:	Female
Address:	Vadodara
Occupation:	Doctor
Marital status:	Married
Socio- economic status:	Rich
Weight:	75 kg
Height:	162 cm
BMI	28.6 kg/m ²

Table 3: Showing Assessment of symptoms with gradation

Date	Symptoms during treatment of Pre-diabetes					
	Mukhamadhurya (sweetness in mouth)	Alasya (laziness)	Maladhikya ^a (excessive formation of waste materials)	Mutradhikya (excessive urination)	Kshudhadhikya (frequent feeling of hunger)	Daurbalya (Weakness)
04/02/2021	2	3	1	2	2	3
17/03/2021	1	1	0	2	2	2
16/04/2021	0	1	0	1	1	1
15/5/2021	0	0	0	0	0	0

Table 4: Gradation of the symptoms:(15)

SN	Symptoms	Grade	Description
1	Mukhamadhurya (sweetness in mouth)	No mukhamadhurya	0
		Feeling of sweet taste in mouth after eating sweet diet	1
		Feeling of sweet taste in mouth after eating normal items	2
		Feeling of sweet taste in mouth throughout a day	3
2	Alasya (laziness)	No alasya in daily activities	0
		Alasya in routine work but able to manage.	1
		Alasya enough to hamper routine work.	2
		Alasya in slight work or at rest requiring rest.	3
3	Maladhikya (excessive formation of waste materials)	No maladhikya	0
		Mild production of mala	1





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		Moderate production of mala	2
		Severe production of mala	3
4	Mutradhikya (excessive urination)	3 – 6 times per day, rarely at night (Urine output between 1500 – 2000 ml/24 hour)	0
		6 – 9 times per day, 0 – 2 times per night (Urine output between 2000 – 2500 ml/24 hour)	1
		9 – 12 times per day, 2 – 4 times per night (Urine output between 2500 – 3000 ml/24 hour)	2
		More than 12 times per day, more than 4 times per night (Urine output more than 3000 ml/24 hour)	3
5	Kshudhadhikya (frequent feeling of hunger)	Two meals a day	0
		Three meals a day	1
		Four meals a day	2
		Four meals a day but still feels hungry	3
6	Daurbalya (Weakness)	No weakness in daily activities	0
		Weakness in routine work but able to manage.	1
		Weakness enough to hamper routine work.	2
		Weakness in slight work or at rest requiring rest.	3

Table 5: Examination of patient

Sampraptighataka (Pathological factors)
<i>Dosha: Tridosha</i>
<i>Dushya: Rasa, Rakta, Mamsa, Meda</i>
<i>Srotasa: Anna, Rasa, Rakta, Mutra, Meda</i>
<i>Srotodushti: Atipravritti</i>
<i>Aam: Sama</i>
<i>Agni: Tikshna</i>
<i>Samutthana: Amashaya</i>
<i>Adhishthana: Bastipradesh</i>
<i>Vyaktisthsana: Sarvasharira</i>

Astavidha pariksha (8 tools for examination of patient)					
	Baseline	1stF/U	3rd F/U	5th F/U	7th F/U
	28/01/2021	04/02/2021	17/03/2021	16/04/2021	15/05/2021
<i>Nadi</i>	74/min, kapha-vataj	78/min, kapha-vataj	72/min, kapha-pittaj	70/min, kapha-vataj	78/min, kapha-pittaj
<i>Mutra</i>	Bahumutrata(9-12 times/day, 2-4 times/night)	Bahumutrata(9-12 times/day, 2-4 times/night)	Bahumutrata(9-12 times/day, 2-4 times/night)	Bahumutrata (6 – 9 times per day, 0 – 2 times per night)	Prakrit (3 – 6 times per day, rarely at night)





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Mala	Constipated(on/off)Weekly 3-4 times	Constipated(on/off)Weekly 2 times	Constipated(on/off)Weekly 1 time	Occasional	Occasional
Jihwa	Sama	Sama	AlpaSama	Nirama	Nirama
Shabda	Prakrit	Prakrit	Prakrit	Prakrit	Prakrit
Sparsha	Samsheetoshna	Samsheetoshna	Samsheetoshna	Samsheetoshna	Samsheetoshna
Drik	Prakrit	Prakrit	Prakrit	Prakrit	Prakrit
Aakriti	Sthula	Sthula	Sthula	Sthula	Sthula
Samanya Parikshana(General examination)					
BP in mm Hg	122/80	120/80	120/70	118/80	120/80
PR	74/min	78/min	72/min	70/min	78/min
RR	18/min	16/min	14/min	16/min	18/min
Temperature	97.6°F	98.2°F	97.1°F	98.4°F	97.3°F
Pallor	Present (+)	Present (+)	Present (+)	Present (+)	Present (+)
Icterus	Absent	Absent	Absent	Absent	Absent

Table 6: Showing Laboratory findings observed during treatment

Name of investigation	Observed values			
	30/01/2021	17/03/2021	16/04/2021	15/05/2021
Fasting blood sugar (mg/dl)	120	116	109	98
2H blood sugar (mg/dl)	146	124	136	109
Glycated Haemoglobin %	6.2	-	-	5.6
Lipid Profile				
S. Cholesterol	136	-	-	118
S. Triglyceride	50	-	-	55
S. HDL	45	-	-	39
S. LDL	63	-	-	86
S. VLDL	10	-	-	11
Cholesterol/HDL ratio	2.62	-	-	3.48
S. LDL/HDL ratio	1.4	-	-	2.20
Liver Function Test				
Bilirubin Total	0.3	-	-	0.3
SGOT	20	-	-	15
SGPT	12	-	-	26
Sr. ALP	52	-	-	56





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Total protein	6.0	-	-	6.5
Kidney Function Test				
S. Urea	33	-	-	19
S. Creatinine	0.9	-	-	0.5
S. Uric Acid	6.2	-	-	6.8
Urine Routine Microscopic				
Colour	Pale yellow	-	-	Pale yellow
pH	6.0	-	-	6.0
Specific Gravity	1.020	-	-	1.010
Glucose	Negative	-	-	Negative
Protein	Negative	-	-	Negative
Bilirubin	Negative	-	-	Negative
Pus cells	Occasional	-	-	1-2/ HPF
RBC/WBC	Absent	-	-	1-2/HPF
Epithelial Cells	1-2/ HPF	-	-	1-2/ HPF
Cast Cells	Absent	-	-	Absent
Crystals	Absent	-	-	Absent
Bacteria	Absent	-	-	Absent
Foreign body	Absent	-	-	Absent
Complete blood count				
Hb gm%	10.9	-	11.1	11.2
TLC	7030	-	8150	7580
N	52	-	53	52
L	41	-	40	40
M	04	-	04	05
E	03	-	04	03
B	00	-	00	00
RBC	4.86	-	4.84	4.86
PCV	35.0	-	34.0	34.6
MCV	72.0	-	70.2	71.3
MCH	22.4	-	22.0	22.2
MCHC	31.1	-	31.4	31.2
RDW-CV	15.6	-	16.4	17.4
Platelet	278000	-	285000	301000
Weight	75	73.5	71	70
BMI	28.6	28	27.1	26.7

Table 7: Exercise adopted

SN	Type of Exercise (Aerobic)	Duration	Frequency	Estimated calorie burn
1	Cycling	30 minutes	Once in a Day	250
2	Walking	1-2Km	Once in a Day	150





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Table 8: Diet advised

SN	Breakfast Carbohydrate+Fibres	Lunch Proteins+Fibre+Fat	Dinner Proteins+Fibre+Fat	Intake in calories
1	<p>Whole grains (unpolished cereals and millets), legumes, peas, beans, oats, barley</p> <p>Cup of Fruits- papaya, guava, apples, pears, oranges, mosambi can be taken in moderation</p>	<p>a. Whole grains along with whole pulses like grams, soya</p> <p>b. Chapati made of Wheat/Barley/Bajara with curry made of Green leafy vegetables</p> <p>c. Vegetable sources like pulses, soy, grams, peas as well as low fat milk, low fat curds, fish and lean meats</p> <p>d. Oils like mustard, rice bran, peanut</p>	<p>a. Chapati made of Wheat/Barley/Bajara with curry made of green leafy vegetables</p> <p>b. Oils like mustard, rice bran, peanut for preparation of various recipes</p>	1300-15 calories/day

Foods to avoid or Limit

- Fruit juice and dried fruit
 - Starchy vegetables (e.g., peas, winter squash, corn and sweet potatoes)
 - Reduced-fat dairy products, including sweetened yogurt
 - Grains (e.g., bread, pasta, rice, cereal, oatmeal, crackers, and pretzels)
 - Processed snack foods, such as potato chips.
 - Fried foods, such as doughnuts, French fries, and fried chicken.
 - Sweets (e.g., candy, cake, ice cream, pie, pastries, and cookies)
 - Sugar-sweetened beverages (e.g., soft drinks, energy drinks, sugar-sweetened coffee and tea, and sports drinks)
 - Alcoholic beverages

Table 9: Properties of *Curcuma longa* linn and *Emblica officinalis* Gaertn

Drugs	Rasa (Taste)	Virya (Potency)	Vipaka (Digestive effect)	Guna (Properties)	Doshaghata (Action on Dosha)
<i>Curcuma longa</i> linn(17)	Katu, Tikta	Ushna	Katu	Ruksha	Kaphapittaghna
<i>Emblica officinalis</i> Gaertn(18)	Madhura, Amla, Katu, Tikta, Kashaya	Sheeta	Madhura	Laghu, Ruksha	Tridoshghna





Significance of Focal Depth in Seismic Hazard Analysis of Major Dams of Chhattisgarh

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 29 Jul 2024

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ABSTRACT

Dam is a vital Civil Engineering structure. The assessment of an earth dam during an earthquake is imperative because its failure can result in noteworthy human and monetary losses and severe environmental influence. This paper presents a deterministic seismic hazard analysis for Major Dams of Chhattisgarh. Chhattisgarh comes under Peninsular India which is tectonically identified as an intraplate region of Indian plate. Due to the convergent movement of Indian plate with Eurasian plate, along major intraplate, faults may result the seismic activity in the region. For deterministic hazard analysis the linear seismic sources within a region bounded by Latitude:18° 0' 0"-24° 0' 0" to Longitude:78° 0' 0"- 85° 0' 0" was considered and the peak ground acceleration (PGA) at bed rock level for 50 & 84 Percentile were evaluated for major dams of Chhattisgarh. The attenuation relations proposed by Iyengar and Raghukanth (2004), was used in the investigation. The effects of variation of focal depth over maximum PGA (g) values at bed rock level were reported for major dams Ravishankar Sagar, Sikaser, Kodar and Sondur.

Keywords: Dam Site, Deterministic Seismic Hazard Analysis (DSHA), Faults, Peak Ground Acceleration (PGA), Seismic Parameters.



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INTRODUCTION

In seismology, the depth of focus is the depth at which an earthquake occurs. About 10 per cent of all major earthquakes are acknowledged to originate below the "crust" of the earth at depths ranging up to 700 km. For Earthquakes occurring at a depth of less than 70 km (43 mi) are classified as shallow-focus earthquakes, while those with a focal depth between 70 km (43 mi) and 300 km (190 mi) are commonly termed mid-focus or intermediate-depth earthquakes. Evidence for deep-focus earthquakes was discovered in 1922 by H.H. Turner of Oxford, England. Previously, all earthquakes were considered to have shallow focal depths. The existence of deep-focus earthquakes was confirmed in 1931 by studying the seismograms of several earthquakes, which in turn led to the construction of traveltime curves for intermediate and deep earthquakes. The most obvious indication of a seismogram that a large earthquake has a deep focus is, the small amplitude or height, of the recorded surface waves and the uncomplicated character of the P and S waves. Although the surface-wave pattern does generally indicate that an earthquake is either shallow or may have some depth, the most accurate method of determining the focal depth of an earthquake is to read a depth phase recorded on the seismogram. Occasional shallow earthquakes—those that originate within 60 km of the Earth's superficial surface are seen to affect most of the parts of the world. In fact, the large majority of earthquake foci are known to be shallow. It should be noted however that, the geographic division of smaller earthquakes is fewer completely determined than more severe earthquakes, partly because the accessibility of relevant data is needful on the distribution of observatories. As observed from the past frequently occurring earthquakes, it is becoming obvious that, due to rapid urbanization, many big cities are becoming prone to earthquake hazard. In this study the main target is to study the seismicity and to calculate the seismic hazard in the study area. Newly born Chhattisgarh state, covered by 4 major water-systems of India: Ganga, Mahanadi, Narmada and Godawari. Mahanadi is the lifeline of Chhattisgarh. Water is a catalyst for development state. All major dams are constructed on Mahanadi. Chhattisgarh has fairly good rainfall, but proper Irrigation system and water management bring the people have agro-based livelihood. For fulfil the demand of irrigation the major dams were constructed. The present study is giving emphasis on the consequence of variation of focal depth over maximum peak ground acceleration at bed rock level. Four major dams Ravishankar Sagar, Sikaser, Kodar and Sondurare considered to verify the effect of variation of focal depth over maximum peak ground acceleration for using deterministic approach.

METHODOLOGY

The first step in seismic hazard analysis is to characterize the various seismic sources in the area which may affect the site of a structure. The seismic sources are generally defined from the spatial distribution of past earthquakes or from knowledge of various faults in the area. In the deterministic approach, the focus is on the largest possible earthquake event, including all earthquake sources capable of producing damaging ground motions at a site. Faults may be earthquake sources, which are typically planar surfaces, identified through various means such as observations of past earthquake locations and geological evidences. In the present study, DSHA was applied to major dams Ravishankar Sagar, Sikaser, Kodar and Sondur of Chhattisgarh. The literature review reveals the information regarding different parameters, for assessment of seismic hazard. The hazard at the site is defined in terms of ground motion, induced at the site due to the earthquake that can occur, on the already identified sources. Different values of ground motion will be obtained from different sources at the site under investigation. In the Deterministic approach of hazard estimation, the minimum source to site distance is taken as the distance parameter in the attenuation equation. A set of possible values of PGA at the site due to the various sources is computed with the help of the attenuation equation given by Iyengar and Raghukanth (2004). The maximum of this set of values, is chosen as the quantified hazard and estimates the effect when the focal depth is increasing. The known seismic sources those which are adequately near the site as shown in Fig. 1, along with available historical seismic and geological data.





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COMPUTATION OF SEISMIC HAZARD PARAMETERS

In the context to estimate the peak ground acceleration for major dams Ravishankar Sagar, Sikaser, Kodar and Sondur of Chhattisgarh, it is indispensable to estimate seismic hazard parameters (a & b value) for particular site. The “b” Value is the measure of the frequency of the occurrence of earthquakes of different sizes. There are two techniques, currently used for determination of seismic hazard parameters (a & b-value).

- Linear Least-Squares Fit [Stepp, 1972]]
- Maximum-Likelihood Estimation (Utsu, 1965)

In Linear Least-Squares Fit, the earthquake data analysis is used to investigate the accessible data set, to assess its nature and degree of completeness. The incompleteness of the available earthquake data, makes it difficult to attain the fits of the Gutenberg-Richter recurrence law is believed to signify the true long term recurrence rate. There are many recurrence laws that help describe the uncertainty in the size of earthquakes produced by each source zone. To account for minimum and maximum magnitudes, Gutenberg-Richter recurrence law assumes an exponential distribution of magnitude, which is used with modification and is given by:

$$\text{Log } N = a - b \cdot M \quad \text{----- (1)}$$

As recommended by Stepp (1972), the problem data incompleteness can be overcome by a method of analysis, which involves the grouping of earthquake data into several magnitude classes. By taking the help of the property of statistical estimation that, variance of the estimate of a sample mean is inversely proportional to the number of observations in the sample (Stepp, 1972). The b value is obtained from Linear Least-Square Fit for major dams of Chhattisgarh. Another method is Maximum-Likelihood Estimation, that was applied over major dams Ravishankar Sagar, Sikaser, Kodar and Sonduras:

$$b = \log_{10} e / (M_{av} - M_{min}) = 0.43 / (M_{av} - M_{min}) \quad \text{----- (2)}$$

where M_{av} is the mean of the observed magnitudes and M_{min} is the minimum or threshold magnitude, for present study the value is taken as 3.0.

Estimation of Maximum Magnitude

In seismic hazard analysis, the acquaintance of estimating the maximum magnitude is used as one of the key input parameters in the seismic design. The highest potential of accumulated strain energy is signified by this, which is to be released in the region or a seismic source/fault. Alternatively, the M_{max} is an upper limit or the largest possible earthquake that may produce the highest seismic hazard scenarios of the region. For estimation of M_{max} two methods were used as Wells and Coppersmith (1994) and Gupta (2002). Wells and Coppersmith (1994) method, has given a relation between M_w and the surface rupture length (SRL), that was developed using reliable source parameters and this is further applicable to interplate or intraplate earthquakes, shallow earthquakes, and all types of faults.

$$\text{Log (SRL)} = 0.57 M_w - 2.33 \quad \text{..... (3)}$$

The above equation was used to estimate M_{max}

Gupta’s (2002) method was applied to estimate $M_{max} = M$, by equation given as below:

$$M_{max} = M = M_{obs} + 0.5 \quad \text{..... (4)}$$

$M_{max} = M = \text{Maximum Magnitude}$

$M_{obs} = \text{Observed Moment Magnitude (} M_w \text{)}$.

ATTENUATION RELATIONSHIP FOR PENINSULAR INDIA REGION

From review of literature of attenuation relationship for Peninsular India region, in the present research an attenuation relationship proposed by Iyengar and Raghukanth (2004), has been adopted. The proposed equation for peak ground acceleration (PGA), under bed rock conditions, is given as below

$$\ln Y = C1 + C2 (M-6) + C3 (M-6)^2 - \ln(R) - C4(R) + \ln(\epsilon) \quad \text{..... (5)}$$

where refer to $Y = \text{PGA (g)}$, $M = \text{Magnitude}$, and

$R = \text{Hypo-central distance Peninsular India: } C1 = 1.6858;$

$C2 = 0.9241; C3 = -0.0760; C4 = 0.0057$

Assuming Focal Depth = 10 km





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Above attenuation relationship is used to find out Peak Ground Acceleration (PGA) at bed rock level for major dam site of Chhattisgarh. For DSHA application over major dam sites like Ravishankar Sagar, Sikaser, Kodar and Sondur the total numbers of 16 faults are considered. The Maximum PGA (g) value 0.0266g for 50 Percentile was reported for Ravishankar Sagar dam for fault F12, fault length 58 km with minimum map distance of 105.192 km as shown in Table 2. When focal depth is increasing with increment of 5 km the PGA (g) values reduces as shown in Appendix I, Table 1 and variation in Fig.4(i)(a). For the focal depth 50 km the PGA (g) value reduces as reported 0.0227g. On the other-hand the Minimum PGA(g) value for having map distance 167.008 km for Sikaser Dam 0.0124g for 50 Percentile reduces and reported 0.0114g shown in Appendix I, Table 1 and variation shown in Fig.4(i)(b). For rest two dam sites the PGA(g) values reported between above stated values. For 84 Percentile the Maximum PGA (g) value 0.0423g was reported for Ravishankar Sagar dam for fault F12, fault length 58 km with minimum map distance of 105.192 km as shown in Table 2. When focal depth is increasing with increment of 5 km the PGA (g) values reduces as shown in Appendix I, Table 1 and variation shown in Fig.4(ii)(a). For the focal depth 50 km the PGA (g) value reduces as reported 0.0361g. On the other-hand the Minimum PGA(g) value for having map distance 167.008 km for Sikaser Dam 0.0197g for 84 Percentile reduces and reported 0.0182g shown in Appendix I, Table 1 and variation shown in Fig.4(ii)(b). For rest two dam sites the PGA(g) values reported between above specified values.

CONCLUSIONS

An attempt has been made to estimate the variation to estimate the variation of increment in focal depth over PGA(g) values for major dams Ravishankar Sagar, Sikaser, Kodar and Sondur of Chhattisgarh. The DSHA is used to find out the PGA (g) values at bed rock level for above stated major dams of Chhattisgarh. As the focal depth increase 5 times the PGA (g) value for 84 Percentile is decreases to 14.66 % for Ravishankar Sagar dam site having minimum map distance 105.192 km and 7.62 % for Sikaser dam site having minimum map distance 167.008 km. The present study outcome highlights the fact that fault no F12 having fault length 58 km it the nearest fault for all four major dams of Chhattisgarh and is the key fault.

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Table 1: Activity Rate and Interval of Completeness for Major Dams of Chhattisgarh

Name of Dams	Magnitude Mw	No of Events \geq Mw	Complete in interval (year)	No. of Events per year \geq Mw
Ravishankar Sagar Dam	3	107	40	2.6750
	4	64	80	0.8000
	5	21	120	0.1750
	6	7	140	0.0500
Sikaser Dam	3	91	40	2.2750
	4	53	80	0.6630
	5	18	100	0.1800
	6	6	120	0.0500
Kodar Dam	3	63	40	1.5750
	4	38	80	0.4750
	5	16	100	0.1600
	6	7	150	0.0470
Sondur Dam	3	82	40	2.7334
	4	48	60	0.8000
	5	17	90	0.1889
	6	4	110	0.0364





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Table 2: Maximum PGA(g) Values for Major Dams of Chhattisgarh

Name of Dams	Hypo-central Distance R in kM	100 years Recurrence Periods M100	Peninsular India Site PGA(g) 50 Percentile	Peninsular India Site PGA(g) 84 Percentile
Ravishankar Sagar Dam	105.667	5.944	0.0266	0.0423
Sikaser Dam	167.315	5.993	0.0124	0.0197
Kodar Dam	130.393	5.831	0.0169	0.0268
Sondur Dam	162.464	5.996	0.0132	0.0209

Table 3: Effects of Variation of Focal Depth Over Maximum PGA (g) Values at Bed Rock Level for all Major Dams of Chhattisgarh

Name of District Headquarter	Fault No.	Fault Length	Minimum Map Distance to the site D (kM)	Focal Depth F in (kM)	Hypo-central Distance R in kM	100 years Recurrence Periods M ₁₀₀	Peninsular India Site PGA 50 Percentile	Peninsular India Site PGA 84 Percentile
Ravishankar Sagar Dam	F12	58	105.192	10	105.667	5.944	0.0266	0.0423
			105.192	15	106.257	5.944	0.0264	0.0419
			105.192	20	107.077	5.944	0.0260	0.0414
			105.192	25	108.122	5.944	0.0256	0.0408
			105.192	30	109.387	5.944	0.0252	0.0400
			105.192	35	110.862	5.944	0.0246	0.0392
			105.192	40	112.541	5.944	0.0240	0.0382
			105.192	45	114.414	5.944	0.0234	0.0372
Sikaser Dam	F11	58	167.008	10	167.308	5.993	0.0124	0.0197
			167.008	15	167.681	5.993	0.0123	0.0196
			167.008	20	168.202	5.993	0.0123	0.0195
			167.008	25	168.869	5.993	0.0122	0.0194
			167.008	30	169.682	5.993	0.0121	0.0192
			167.008	35	170.637	5.993	0.0119	0.0190
			167.008	40	171.732	5.993	0.0118	0.0187
			167.008	45	172.965	5.993	0.0116	0.0185
Kodar Dam	F22	58	130.008	10	130.393	5.831	0.0169	0.0268
			130.008	15	130.871	5.831	0.0167	0.0266
			130.008	20	131.538	5.831	0.0166	0.0264
			130.008	25	132.39	5.831	0.0164	0.0261
			130.008	30	133.425	5.831	0.0162	0.0257





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			130.008	35	134.637	5.831	0.0159	0.0253
			130.008	40	136.023	5.831	0.0156	0.0249
			130.008	45	137.576	5.831	0.0153	0.0244
			130.008	50	139.292	5.831	0.0150	0.0238
Sondur Dam	F5	58	162.16	10	162.469	5.996	0.0132	0.0209
			162.16	15	162.853	5.996	0.0131	0.0208
			162.16	20	163.389	5.996	0.0130	0.0207
			162.16	25	164.076	5.996	0.0129	0.0205
			162.16	30	164.912	5.996	0.0128	0.0203
			162.16	35	165.895	5.996	0.0126	0.0201
			162.16	40	167.021	5.996	0.0125	0.0198
			162.16	45	168.289	5.996	0.0123	0.0195

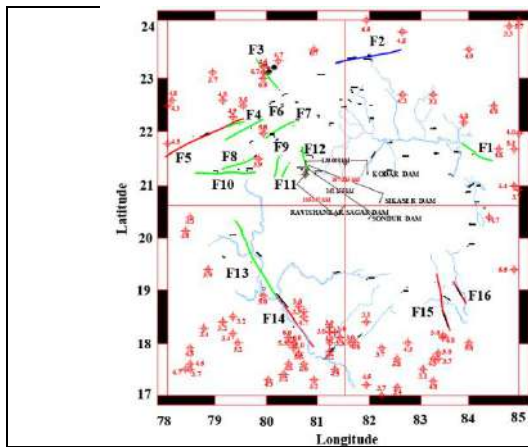


Fig. 1 Linear Seismic Source for Major Dams of Chhattisgarh

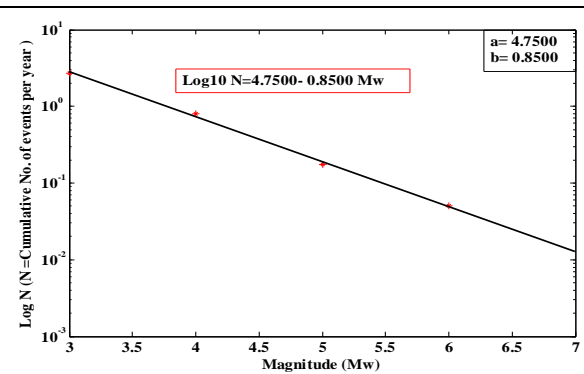


Fig. 2 (a) RavishankarSagar Dam

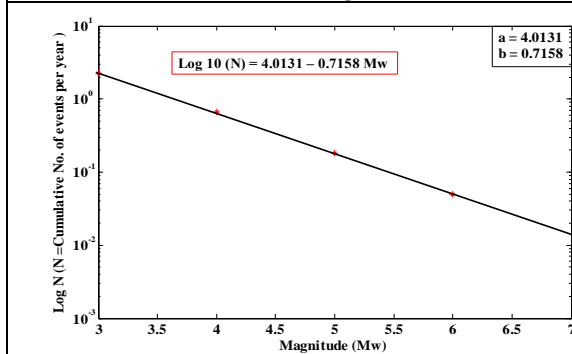


Fig. 2 (b) Sikaser Dam

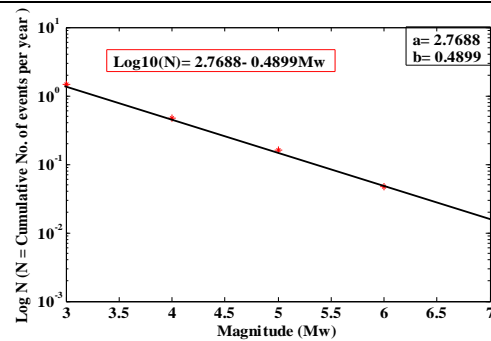


Fig. 2(c) Kodar Dam





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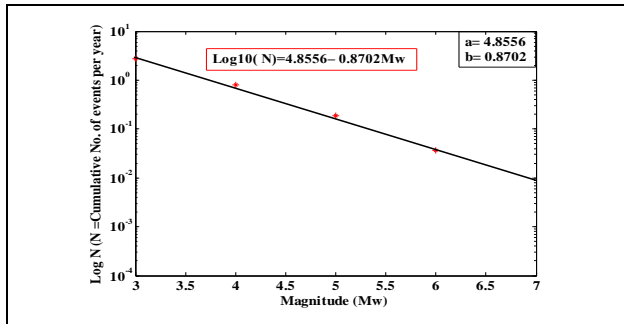


Fig. 2 Frequency-Magnitude Relationship for Major Dam of Chhattisgarh (d) Sondur Dam

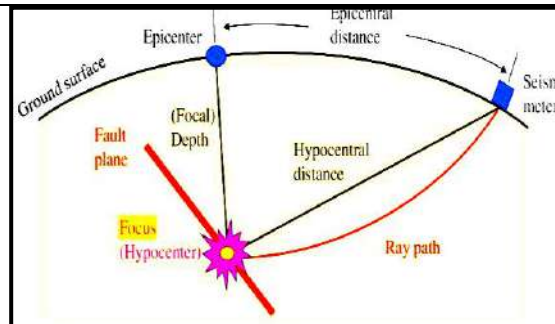


Fig.3 Source to Site Distance

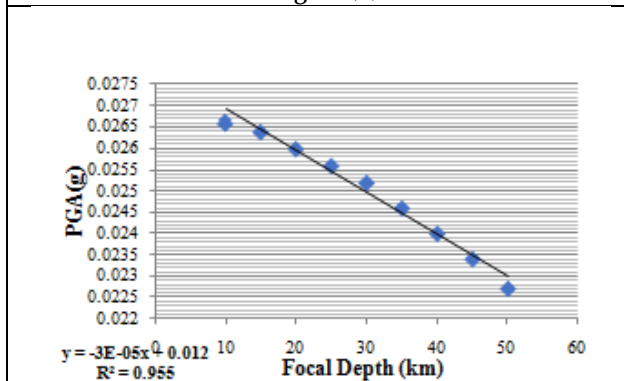


Fig.4(i) PGA (g) (50 Percentile) variation with increasing Focal Depth for Major Dams of Chhattisgarh (a) Ravishankar Sagar Dam

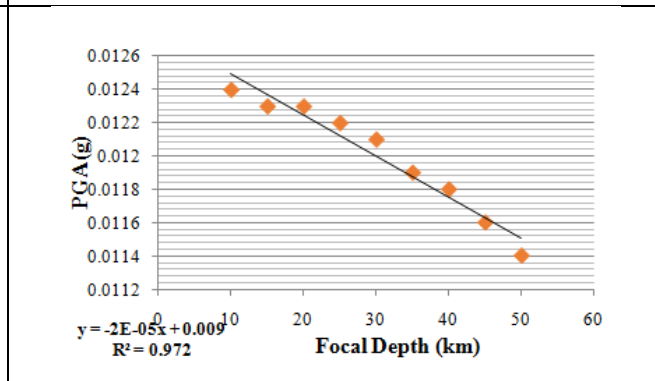


Fig.4(i) (b) Sikaser Dam

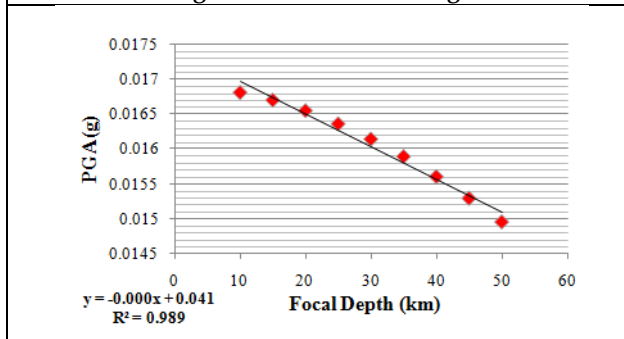


Fig.4(i) (c) Kodar Dam

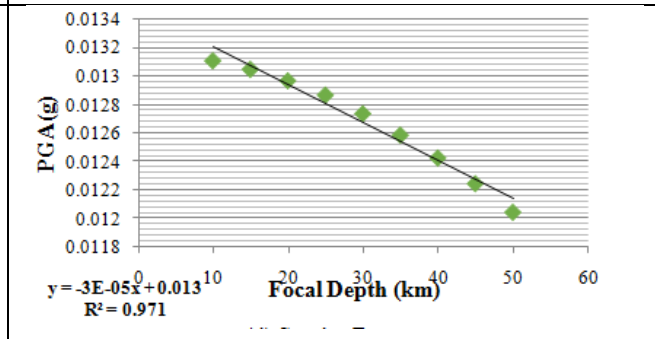
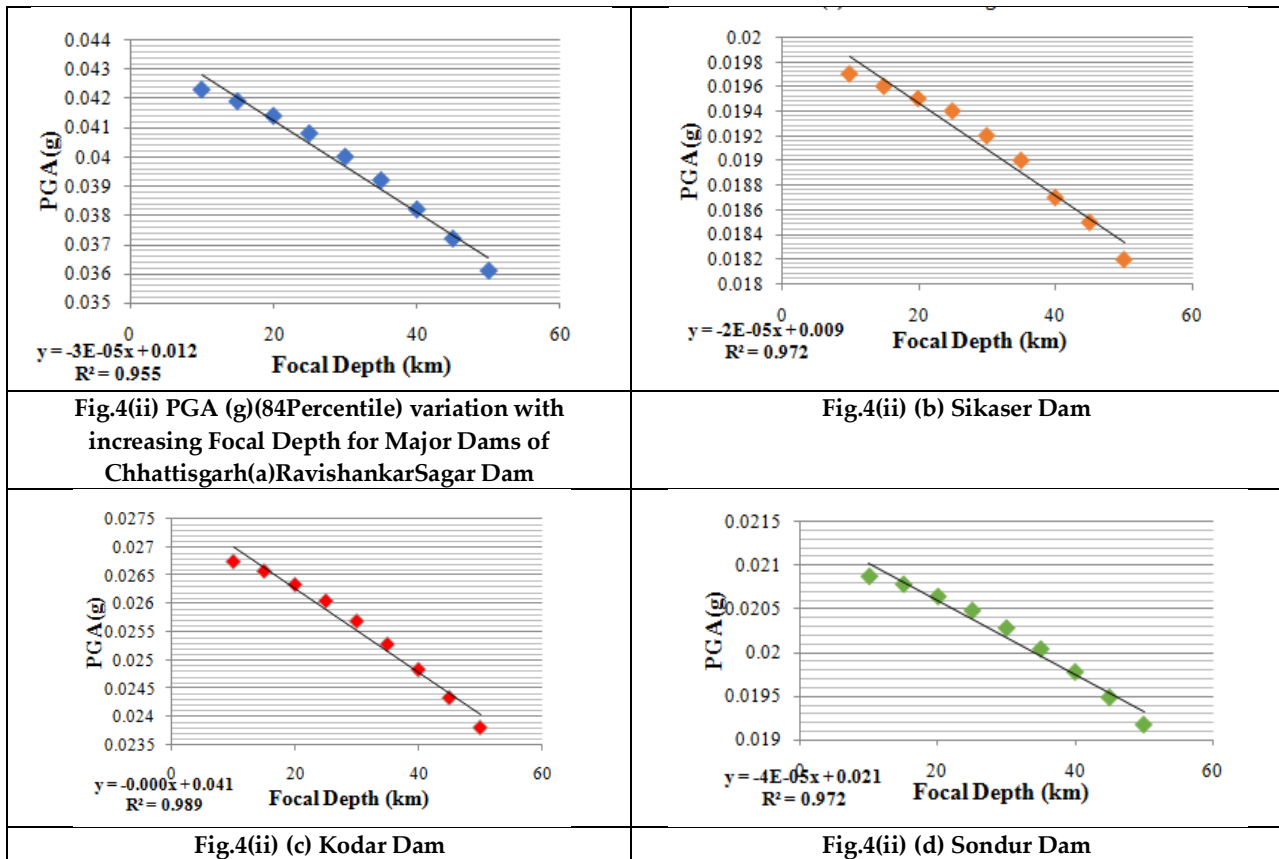


Fig.4(i) (d) Sondur Dam





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Overview of Remote Sensing Image Registration

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

Image registration plays a pivot role in various remote sensing image processing applications such as image interpolation, image segmentation, image fusion, image mosaicing etc. It is the process of finding sub-pixel accuracy between two images. The primary objective of image registration is the geometric alignment of two images and to remove geometry deformation between two images. This paper focus on the brief introduction about various methods of image registration. This paper provides a thorough overview of methods for remote sensing image registration. In the initial section of this paper, we delve into classical approaches for image registration, aiming to highlight their key characteristics and functionality. In the second part, all the traditional method is discussed we then discussed recently developed method Convolution neural network with deep learning algorithms with various feature based algorithm to boost the overall performance is discussed In the Last we compare the methods based on the registration accuracy.

Keywords: Remote-sensing, CNN, DNN, Multi-sensor image registration

INTRODUCTION

Image registration involves alignment of two images capturing the same scene but acquired at varying times or viewpoints, utilizing either the same or different sensor [1, 2, 18]. Image Registration is a key step in various image processing applications such as Image restoration, Image Segmentation, weather forecasting, agriculture monitoring, security, and surveillance military operations [1, 2, 17,18]. In image registration, one image acts as a reference image and the other as a sensed image [1,2]. The main objective of the image registration is to geometrically align the sensed image with the reference image and to remove distortion between two images [1,2]. Image registration can be



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categorized based on simultaneity into two types synchronous and asynchronous image registration [3]. Synchronous image registration involves aligning image acquired simultaneously, while asynchronous image registration pertains to the alignment of images obtained at different time intervals [3]. Single sensor images are comparably consistent, while multi-sensor images are more variant and have more transformation which lead to higher complexity of image. Image registration of multi-source images is generally more challenging than single-sensor images [3]. Typically passive optical sensors are responsible for capturing remote sensing optical images, while active Synthetic aperture radar (SAR) sensors are utilized for capturing SAR images [1]. The Synthetic aperture radar is capable of offering high resolution remote sensing images under various weather conditions. Additionally it possesses robust anti-jamming capabilities [21]. In recent years, lots of research has been done in the field of image registration on remote sensing images [3]. Image registration is performed between the images captured at different times, it is called multi-temporal image registration. When registration is performed between the images captured by different sensors is called multi-model image registration and registration is performed between the images taken from multiple viewpoints it is called multi-view image registration [1, 3, 18]. Remote sensing is spell out as the process of gaining information about an object by a visualizing system without being in physical contact with the object [1,2,18] The Earth-observing satellites and airborne-based imaging systems regularly capture images of the Earth surface by using single or multiple sensors these images are known as remote-sensing images[1,3]. In the past twenty years, manual image registration involved a process where humans visually identified ground control point(GCP) on both sensed and reference images. This approach relied on human assessment for feature detection and matching. However conducting manual image registration for remote sensing images became an arduous task due to the high-resolution nature of these image. Several challenges emerged, including difficulties in accuracy identifying points, the necessity for numerous GCPs to enhance precision, and the requirement for an expert human operator to perform this task. This problem leads to the development of a fully automated image registration. Registration methods which can be divided into two categories: area-based and feature-based [1, 2, 3,17]. Area-based method mostly works on intensity value. This method first normalized the data into grayscale images. Subsequently, computations such as cross-correlation and mutual information (mi), to identify matching points within an image [1,3]. These methods can achieve higher accuracy but also they have higher computational time [3,4]. Feature-based methods are basically divided into four steps feature detection, feature descriptor, feature matching, and lastly the sensed image is aligned with the reference image. Feature based method achieves higher accuracy compare to area based methods. Recently, deep-learning algorithms have gained significant attention within the machine-learning field for their capability to learn hierarchical representative features from data. These dl methods have also found their way into the geoscience and remote sensing community [16].

Dataset analysis based on application

Various types of input images are used in the image registration process according to the applications.

1. Multi-temporal images: same or different images captured from different sensors at different times [2,3].
2. Multi-sensor images: the same images captured from different sensors such as synthetic aperture radar (SAR), hyperspectral and multispectral optical images and panchromatic images can enhance the analysis of specific regions of an image [2]. According to available information, more than 700 remote-sensing satellites are available in space. Images taken by different sensors improve the accuracy of registration [3]. The different sensor gives different information about various bands and it can work on infrared, near-infrared, microwave, and other bands [2].
3. Multi-view images: images are taken by the same sensor from different viewpoints [2].

METHODOLOGY**Area-based image registration and overview**

Image registration using area-based method works on image intensity value. When the image is gray scale or with color intensities with a lack of significant details such as shape and structure area [2,20]. Area area-based method works on the small size of the image block of both images and compare the intensity values of both images. These



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intensity values are used to measure the similarity between the two images and to measure the similarity cross correlation (CC) and mutual information (MI) is used. Fourier based method are more suitable to remove the frequency dependent noise and non-uniform illumination variation according to time. Centre point of block of image was consider Control point for similarity measure. This leads to less accuracy and it affects many factors such as sensor used, illumination, time of acquiring image, image shadow, angle of object also affects the pixel value of image. Area based method is not more suitable for remote sensing image registration due less accuracy. Also the computational time is increased when more deformation are available. Area based image registration using deep learning approach involves training the network layer to calculate similarity and add layer to estimate the similarity. [2,7].

Feature-based Image Registration and Overview

Image registration using a feature-based method works on various salient features of images such as region, line, points, corner, contour, etc. Feature-based methods are mostly concerned with features. The feature-based image registration method is divided into four different steps:

Feature detection

feature detection is the key step in feature-based image registration to detect various features like edges, corners, etc. Harris corner detection algorithm proposed by c. Harris and j. Stephens in 1988 is best suited and gives accuracy to extract corner points from both images. [7,8,9,20] Canny edge detection algorithm is used to detect the edges of an image. The modified HARRIS corner detection algorithm is used in remote sensing image registration to reduce the computation time it ignores the low gradient value.[9,20] Laplace of Gaussian detector is applied for the line detection[8]. Region detection method using affine is introduced in 2010. Region feature has a high variance of a closed boundary. Sift can extract local features of the image with scale and rotation invariant this is the advantage of sift that makes it most popular pre-processing and key step to extract features in many sift has a disadvantage in that it gives the Unevenly Distributed Image Feature And Concerns About Local Features [2]. 91% Of Sift Feature Points are broken down by the Rotation Invariance Which Affects Registration. SURF is also used to extract the image features and it is faster than SIFT and has good results Compared to SIFT [2]. The SUSAN Corner Detection Algorithm is determined by comparing the corner point, center point and the Pixel Value of the Detected Region and It Takes More Computational Time [10]. Feature Matching: in feature matching it finds correspondence of detected features in both images are calculated based on various feature descriptor methods such as sift, surf, hog, and freak. Sift extracts invariant features [8].surf is a local robust feature detector and it uses haar response-based descriptor. Hog is used as a feature descriptor and it is used because it is more illumination invariant compared to surf [8].

A freak descriptor is a binary descriptor and it has a significant advantage of speed in generating feature vectors and matching. Transform model estimation: The transformation function is used to remove the geometry distortion between the two images [1]. The coordinates of the matching pairs are used to estimate the transformation function parameters [1]. Zitova and Flusser (2003) introduced two transformation functions such as local and global [1,8,20]. Affine, Projective, and polynomial are well-known global transformations. Global geometric difference such as rotation, scaling, and different view angles are present in input image then these types of transformation is generally used in local transformation, it calculates based on a combination of patches and it depends on the location of images[8]. In a Cartesian coordinate system, affine transformation are employed, which consist of rotation, scaling, and translation operation. Affine transformation are less susceptible for distorted images. These are globally used transformation in image registration. Projective and perspective transformation are used to remove distortion due to different projections of the sensor at varying distances [2]. Bajcsy et al[2] introduces elastic registration approach which is not using mapping function and it is less efficient in that image is considered as rubber sheet, where external forces for stretching and internal force of smoothing are applied to align both image.

Resampling and Outline Remover

In the process of model estimation, a mapping function is determined through translation. Subsequently, every point within the captured image undergoes translation according to calculated mapping function. The computational





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procedure can be intricate, posing challenges and potentially introducing imperfections into the result image [3]. This approach is known as the forward approach. On the other hand, the backward approach is widely used to compute the inverse of the mapping function. Various interpolation methods are applied such as bilateral, bilinear, bicubic, cubic B-spline, and Gaussian. Additionally, resampling employs functions like sine as described by J. Parker and R. Kenyon. [2,8]. Furthermore, the feature-based image registration method is less suitable for remote sensing image registration. Limited applicability found in feature-based method. They perform well solely on specific images with suitable feature representation. RMSC is used to measure the accuracy of the image [4,17].

DEEP LEARNING ALGORITHMS

Recently, different deep learning architectures have flourished, finding applications in diverse domains like audio recognition, natural language processing and numerous classification tasks. These architectures commonly surpass traditional methods in performance [1,16,20]. The inspiration behind this concept stems from the structure of the mammalian brain, which is organized in a deep architecture [16,18,20]. Drawing from the depth of the human brain architecture, researchers in the field of deep learning have innovated novel deep architectures as a departure from shallower designs [16,18,20]. Additionally, in visual recognition tasks, most algorithms have been outperformed by convolution neural networks (CNNs) considered the most representative supervised deep learning model. The deep structure of CNNs enables highly abstract feature detectors to be learned by the model and allows the input features to be mapped into representations that can clearly enhance the performance of subsequent classifiers [1,16].

Convolution Neural Networks

The CNNs is multi-layer architecture designed for training, consisting of several stages of feature extraction. Each stage is constructed with three layers: 1) a convolution layer, 2) a nonlinearity layer, and 3) a pooling layer. Basically one, two, or three feature-extraction stages typically compose a CNNs, followed by one or more traditional, fully connected layers, and concluding with final classifier layer [1, 7, 16, 17, 20]. Each Layer Described in the Following Section:

Convolution Layer

The convolution layer receives a three-dimension array comprising r two-dimensional feature maps of size $m \times n$ as its input. Each element is represented as $x_{i,m,n}$, and each feature map is denoted as x^i . The resulting output consists of a three-dimensional array with k feature maps of size $m \times n$, where k denotes the number of feature maps generated. This layer employs k trainable filters, also known as the filter bank w , sized $l \times l \times$ which establish a connection between the input and output feature maps. The computation of the output feature map is performed by the convolution layer $z^s = \sum_i^s * x^i + b_s$, where $*$ is a two-dimensional discrete convolution operator and b is a trainable bias parameter [16].

CNNs model [16]:

- Input layer
- Convolution layer + activation function
- Pooling layer
- Fully connected layer

Nonlinearity Layer

- The nonlinearity layer in traditional CNNs is comprised of a pointwise activation function applied to each component in a feature map. The output feature map, denoted as $[a]_{fij} = f([z]_{fij})$. The activation function f is typically chosen to be a rectified linear unit (ReLU) $f(x) = \max(0, x)$ [16].

Pooling Layer

The pooling layer is defined by executing a maximum operation over the activations within a small spatial region of each feature map, represented as PGa . To provide greater precision, one can conceptualize the pooling layer as being comprised of a grid of pooling units spaced s pixels apart. Each unit serves to summarize a small spatial region of size $p \times p$ centered at the location of the pooling unit. Following multiple feature-extraction stages, the entire network





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undergoes training through backpropagation of a supervised loss function, such as the classic least-squares output. The target output y is expressed as a 1-of- K vector, Where K represents the number of output and L significant number of layers:

$$J(\theta) = \sum_{i=1}^N \left(\frac{1}{2} \|h(x, \theta) - y\|^2 \right) + \lambda \sum_l \text{sum}(\|\theta(l)\|^2) \text{----- (1)}$$

Where, l indexes the layer number. Our goal is to minimize $J(\theta)$ as a function of θ . To train the CNN, we can apply stochastic gradient descent with back propagation to optimize the function. Recently, CNNs, have gained popularity as deep learning method and have demonstrated significant success in large-scale visual recognition. This success has been facilitated by the availability of extensive public image repositories, exemplified by ImageNet [16].in the remote sensing community, there have been recent endeavors in CNNs based remote sensing image pixel classification [1,16,19], target recognition [16], and scene understanding[16]. CNNs methods are used for image registration [2, 16, 17, 19]. CNNs have a wide scope in computer vision applications due to higher accuracy. CNNs automatically detects the correlated features from two images. CNNs consist of consecutive layers of trained convolution filters and these filters learn stratified dependent image features, which are common steps of deep learning networks. The CNNs features are built according to a neural network. So, the features that are created are directly generated design from image pixels. In cnn low-level features are trained in the first layer and high-level features are trained in deeper according to the image data set. So, the network learns the different levels of valuable contribution in remote sensing images [6,17]. Feature Extraction network such as AlexNet, VGGNet, GoogleNet remote sensing image registration based on deep learning has achieved acceptable outcome [18]. Neural Network) achieved great success in the field of computer vision because they are adept at identifying low-level and abstract features [2]. The basic framework of remote sensing data analysis is mainly divided into three main components, the input dataset, the core deep network, and the expected output data. The input and output image dataset always depends on the application. Multi-model image registration is done using CNNs which is used for image extraction in that Region-based evolution, and point-based evolution are done on various image datasets and remove the transformation using MI [3]. CNNs (convolution neural network) and DNN (Deep Shuang Wang et. al. [11] introduce DNN to extract affine transformation and with the use of a mapping function it finds image matching pair to register an image. CNNs can automatically acquire high-level or silent features than statistical methods. VGG16 also gives accuracy in registration with SIFT [12]. A full convolution neural network (FCN) is applied on multimodal images with average pooling to generate scaler matric values for SAR-optical which predicts whether the image is aligned or not. FCN which only trained, aligned, or displaced multi-model patches [15]. Still, there is a challenge in remote sensing image analysis due high Quality of RS images, time complexity, and low availability of training dataset [2].

CONCLUSION

Various work has been done in Remote sensing image registration in the last two decades but there are various challenges faced due to sensors, illumination, etc. From various kinds of literature, it has been found that area-based methods work on the image intensity value and it takes more computation time. Feature-based methods give good results but they also found challenges in remote sensing images. SIFT and SURF work as feature extractors and also generate feature descriptors and histograms of matching point pairs. SIFT also faces problems such as insufficient feature points, and a higher outlier ratio under rigid and non-rigid images. SURF is robust and faster than SIFT. To find the correct matching point pair of both images that focuses on local and global features of an image. Transformation estimation is also a challenging task in remote-sensing image registration. So, various deep learning methods are introduced such as CNN, and DNN which combine with traditional methods for better results and to reduce computational time. It is also necessary to work with other traditional deep-learning methods. All the work has been done on a single-sensor image. So, it is required to work on Multi-sensor images such as SAR, Panchromatic, and optical which have more details such as transformation, deformation, and illumination changes helps to get better results on remote sensing image registration.





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Table 1. List of Abbreviation

ABBREVIATION	FULL NAME
SIFT	Scale Invariance Feature Transform
SURF	Speeded Up Robust Feature
CNN	Convolution Neural Network
DNN	Deep Neural Network
FCN	Fully Connected Network
SUSAN	Smallest Univalued Segment Assimilating Nucleus
SAR	Synthetic-Aperture Radar
RMSC	Root Mean Square Residual Correlation
MI	Mutual Information
RANSAC	Random Sample Consensus
RELU	Rectified Linear Unit
VGG-16	Visual Geometry Group - 16

Table 2: Comparison

Author	Dataset	Methodology	Result	Conclusion
Liang Zeng et. al.[3]	SAR and Optical Image multisource image dataset from China.	Image Preprocessing, CNN is used to extract image Features and Remove Transformation using MI on a multisource image dataset.	Region-based evolution and point-based evolution is done.	The proposed method works on different image datasets which gives better outcomes.
Zhang Jun et. al[4]	<ul style="list-style-type: none"> • Multi-sensor urban areas image (april, 2000, daedalus visible and infrared) • 524 X 524 image with spatial 	Image Transfer: Deep features are extracted using CNN and it maps the features in both images such as A and B and	Proposed method compared with manual, SURF and SIFT and calculates RMSC ratio for accuracy, NOCC (number of correct	Proposed method works for multimodal images as preprocessing then the accuracy and robustness of





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	resolution 2012. • Google earth and TerraSAR-X image,2007	reconstruct the image as A' and B' and match the both image.	correspondences, and running time. Proposed+SURF (RMSC-0.2638) and Proposed+SIFT (RMSC-0.2457)	registration is effectively improved.
Dumitru, C.O. et.al[5]	Multi spectral images from Bucharest, Munich Venice and Washington.	Image indexing is done For individual sensor image and for multi spectral image.	Joint Image indexing with multi spectral sensor images is done and gives higher accuracy.	Joint indexing of multi sensor images gives higher accuracy compare to indivial sensor image for each data set.
Kinjal Parmar et. al[8]	Satellite image data set	Harris algorithm is used to detect image features HOG is used to generate feature vector and matching is done using Best bin first algorithm. RANSAC is used to remove outlier	Harris, SUSAN and SIFT is compared for feature extraction and Harris (0.863s) takes less time to extract image feature. SUSAN-(3.027s) SIFT-(3.586s)	Harris takes less time to detect features compare to SUSAN and SIFT.
Shuang Wang et. al.[11]	Landsat, Radarsat Image Dataset	DNN is used to Extract affine transformation and uses a mapping function to find image-matching pairs and then register the image.	DNN compared with all the traditional methods with various image datasets.	The proposed method gives better results and low computational cost compared to traditional methods on remote sensing datasets.
Famao Ye et. al.[12]	Landsat Thematic Mapper & color remote sensing SAR image Checkerboard mosaicked image.	CNN(VGG-16)+SIFT,PSO-SIFT	Fine-tuning the Pre-trained VGG16 model for Landsat thematic mapper and another color remote Sensing image gives better results at fc6 and can achieve pixel accuracy compared to fc7 layer. PSO-SIFT+FC6(RMSC-0.732)	PSO-SIFT +CNN (fc6) gives better result compared with PSO-SIFT, SURF, and FSC-SIFT.
Maria	Multispectral	CNN (predict rigid	10 image pairs are	Unsupervised





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Vakalopoulou et. al. [13]	high-resolution image from Quick bird satellite acquired in 2007& 2006	&deformable parameter) + it uses a 2D spatial transform for registration	used to extract the image feature and it uses affine and deformable functions to give the best result. It took half a second to extract image feature and to register on 256 X 256 image pair.	method is used
Dou Quan et. al.[14]	SAR Image Acquired by Radarsat-2 in 2008 by China	DNN to extract Image feature, RANSAC to remove outlier.	SIFT algorithm Compared with DNN gives better results as image extraction on SAR images and it removes outlier or wrong matching points using the RANSAC Algorithm.	The proposed method gives better results compared with SIFT. Also, RMSC has a small value compared to SIFT.
Stefan Hofmann[15]	SAR and optical image dataset	FCN with an average pooling was applied on both images to remove affine transformation.	FCN is trained on aligned and displaced multi-model patches.	Deep metric Predicts the alignment. Average pooling is used to create a scalar metric which describes the alignment of SAR and optical image. FCN is compared with MI and NMI registration metrics and FCN gives better Result.

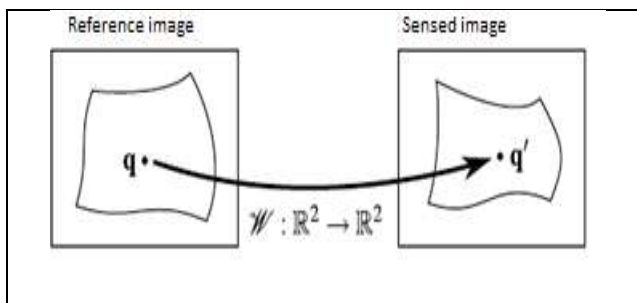


Figure 1. General Principal of Image Registration

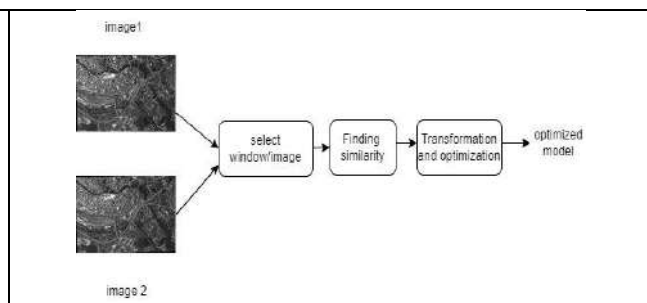


Figure 2. Basic area based image registration





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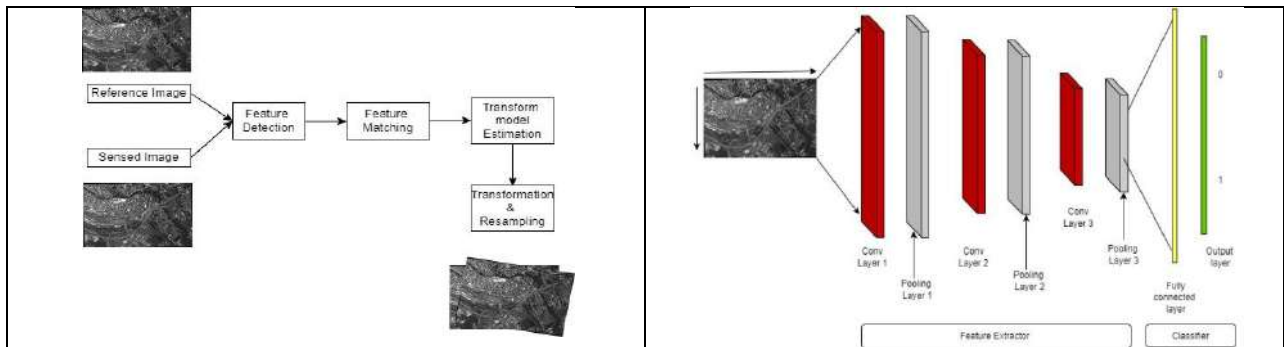


Figure 3. Feature Based Image Registration

Figure 4. Basic CNN Model

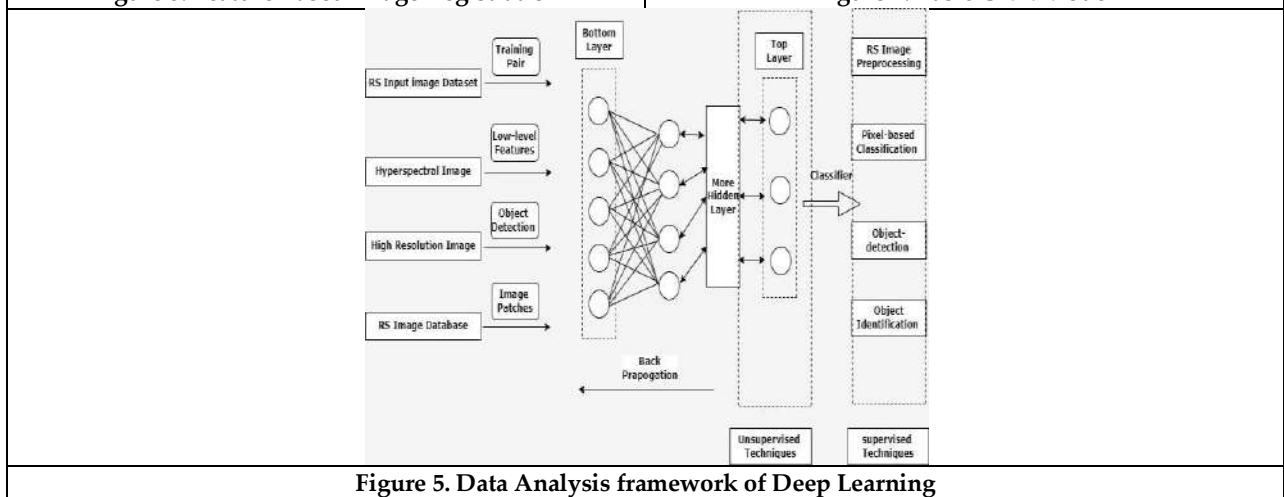


Figure 5. Data Analysis framework of Deep Learning





Soft Pre g^* - Closed Sets in Soft Topological Spaces

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 24 Jun 2024

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ABSTRACT

In this paper we introduce Soft pre g^* -closed sets in soft topological spaces which are defined over an initial universe with a fixed set of parameters. Also we investigate about the relationship of soft pre g^* -opensets.

Keywords: soft pre g^* -closed set, soft pre g^* -open set

INTRODUCTION

Molodstov [6], presented the theory of soft sets. Kannan [3], described soft generalized closed sets in soft topological spaces. Muhammad shabir and Munazza Naz [8], investigate about the soft topological spaces. Levine [4], showed on generalized closed sets in topological spaces. Selvi and Arockiarani [7], explained about soft- πg closed sets in soft topological spaces. Maji, Biswas and Roy [5], were defined the concept of soft set theory and their properties. Arockiarani and Arockia Lancy [1], were characterized soft β separation axioms. Also they are explained about generalized soft $g\beta$ closed sets and soft $gs\beta$ closed sets in soft topological spaces. Yuksel, Tozlu and Ergul [10], were showed Soft Regular Generalized Closed sets in soft topological spaces. In this paper, $\text{int}(S,E)$ and $\text{cl}(S,E)$ represents the interior of (S,E) and closure of (S,E) respectively. In this paper we introduced some new concepts in soft topological spaces such as soft pre g^* - closed sets and soft pre g^* -opensets and derive some of its properties.





PRELIMINARIES

Definition :2.1. [6] Let U be the initial universe and $P(U)$ denote the power set of U . Let E denote the set of all parameters. Let A be a non-empty subset of E . A pair (F,A) is called a soft set over U , where F is a mapping given by $F : A \rightarrow P(U)$. In other words, a soft set over U is a parameterized family of subsets of the universe U . For $\varepsilon \in A, F(\varepsilon)$ may be considered as the set ε – approximate elements of the soft set (F,A) .

Definition :2.2. [6] For two soft sets (F,A) and (G,B) over a common universe U , we say that (F,A) is a soft subset of (G,B) if (1) $A \subset B$ and (2) for all $e \in A, F(e)$ and $G(e)$ are identical approximations. We write $(F,A) \subset (G,B)$. (F,A) is said to be a soft super set of (G,B) , if (G,B) is a soft subset of (F,A) . We denote it by $(F,A) \supset (G,B)$.

Definition :2.3. [5] Two soft sets (F,A) and (G,B) over a common universe U are said to be soft equal if (F,A) is soft subset of (G,B) and (G,B) is a soft subset of (F,A) .

Definition :2.4. [5] The union of two soft sets of (F,A) and (G,B) over the common universe U is the soft set (H,C) where $C = A \cup B$ and for all $e \in C$,

$H(e) = F(e)$ if $e \in A - B$

$G(e)$ if $e \in B - A$

$F(e) \cup G(e)$ if $e \in A \cap B$

We write $(F,A) \cup (G,B) = (H,C)$

Definition :2.5. [6] The intersection (H,C) of two soft sets of (F,A) and (G,B) over the common universe U denoted $(F,A) \cap (G,B)$, is defined as $C = A \cap B$ and $H(e) = F(e) \cap G(e)$ for all $e \in C$.

Definition :2.6. [7] Let τ be the collection of soft sets over X , then (X, τ, E) is said to be a soft topological space over X if

(1) Φ, X belong to τ ,

(2) The union of any number of soft sets in τ belongs to τ ,

(3) The intersection of any two soft sets in τ belongs to τ . The triplet (X, τ, E) is called a soft topological space over X .

Let (X, τ, E) be a soft space over X , then the members of τ are said to be soft open sets in X .

Definition :2.7. [8] A subset (A,E) of a topological space X is called soft regular closed (soft r - closed), if $\text{cl}(\text{int}(A,E)) = (A,E)$. The complement of soft regular closed is soft regular open set.

Definition :2.8. [10] The finite union of soft regular open sets is said to be soft π -open. The complement of soft π -open is said to be soft π -closed.

Definition :2.9. [3] A subset (A,E) of a topological space X is called a soft generalized closed (soft g -closed) if $\text{cl}(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft open in X .

Definition :2.10. [10] A subset (A,E) of a topological space X is called a soft πg -closed in a soft topological space (X, τ, E) if $\text{cl}(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft π -open in X .

Definition :2.11. [10] A subset (A,E) of a topological space X is called a soft πsg -closed in a soft topological space (X, τ, E) if $\text{scl}(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft π -open in X .

Definition :2.12. [10] A subset (A,E) of a topological space X is called a soft gpr -closed in a soft topological space (X, τ, E) if $\text{pcl}(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft regular open in X .





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Definition :2.13. [8]A subset (A,E) of a topological space X is called a soft regular generalized closed (soft rg-closed) in a soft topological space (X, τ, E) , if $cl(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft regular open in X .

Definition :2.14. [1]A subset (A,E) of a topological space X is called a soft generalised-semi closed (soft gs-closed) in a soft topological space (X, τ, E) , if $scl(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft open in X .

Definition :2.15. [1]A subset (A,E) of a topological space X is called a soft α generalised closed (soft α g-closed) in a soft topological space (X, τ, E) , if $\alpha cl(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft open in X .

Definition :2.16. [1]A subset (A,E) of a topological space X is called a soft generalized β closed (soft g β -closed) in a soft topological space (X, τ, E) , if $\beta cl(A,E) \subset (U,E)$ whenever $(A,E) \subset (U,E)$ and (U,E) is soft open in X .

Definition :2.17. [9]Let (F_E, τ) be a soft topological space, a soft set F_A is said to be soft pre-open set (soft P-open) if there exists a soft open set F_0 such that $F_A \tilde{\subset} F_0 \tilde{\subset} \overline{F_A}$. The set of all soft P-open set of F_E is denoted by $G_{sp}(F_E, \tau)$ or $G_{sp}(F_E)$. Then F_A^c is said to be soft pre-closed. The set of all soft P-closed set of F_E is denoted by $F_{sp}(F_E, \tau)$ or $F_{sp}(F_E)$.

Proposition :2.18. [9]

- (i) Every soft openset is a soft pre-open set.
- (ii) Every soft closed set is a soft pre-closed set.

Definition 2.19.[3]A soft set (A,E) is called a soft generalized open (soft g-open) in a soft topological space (X, τ, E) iff $(F,E) \subset \text{int}(A,E)$ whenever $(F,E) \subset (A,E)$ and (F,E) is soft closed in X .

SOFT PRE g^* - CLOSED SET

Definition 3.1. A subset (S,E) of soft topological space (X, τ, E) is called a soft pre g^* closed set if $pcl(S,E) \subset (U,E)$ Whenever $(S,E) \subset (U,E)$ and (U,E) is soft g-open in X .

Theorem 3.2. Every soft preclosed set is soft pre g^* - closed.

Proof

Let (S,E) be soft pre closed set in (X, τ, E) and (U,E) be soft g-open in X , such that $(S,E) \subset (U,E)$. Then by the definition 3.1., $pcl(S,E) = (S,E) \subset (U,E)$ Hence (S,E) is soft pre g^* closed set in soft topological space (X, τ, E)

Theorem 3.3. Every soft pre g^* -closed set is soft pre g-closed.

Proof

Suppose (S,E) be soft pre g^* -closed set in (X, τ, E) .

Let (U,E) be soft open in X such that $(S,E) \subset (U,E)$. Since every soft preopen set is soft g-open, we have $pcl(S,E) \subset (U,E)$. Therefore (S,E) is soft pre g-closed.

Theorem 3.4. Every soft pre g^* -closed set is soft pre gs-closed.

Proof

Let (S,E) be soft pre g^* -closed set in (X, τ, E) .

Let (U,E) be soft open in X such that $(S,E) \subset (U,E)$. Since every soft preopen set is soft g-open, we have $pcl(S,E) \subset (U,E)$ Now $scl(S,E) \subset pcl(S,E) \subset (U,E)$ Therefore (S,E) is soft pre gs-closed

Theorem 3.5. Every soft pre g^* -closed set is soft pre rg-closed.

Proof

Let (S,E) be soft pre g^* -closed set in (X, τ, E)

Let (U,E) be soft regular open in X such that $(S,E) \subset (U,E)$. Since every soft pre regular open set is soft g-open, we have $pcl(S,E) \subset (U,E)$ Hence (S,E) is soft pre rg-closed





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Theorem 3.6. Every soft pre g^* -closed set is soft pre gpr-closed.

Proof

Let (S,E) be soft pre g^* -closed set in (X, τ, E)

Let (U,E) be soft regular open in X such that $(S,E) \subset (U,E)$.

Since every soft pre regular open set is soft g -open, we have $pcl(S,E) \subset (U,E)$ Now $pcl(S,E) \subset cl(S,E) \subset (U,E)$

Hence (S,E) is soft pre gpr-closed.

Example 3.7. Suppose that there are five trees in the Universe. Let $U = \{t_1, t_2, t_3, t_4, t_5\}$ under consideration, and $E = \{p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8\}$ is a set of parameters then $p_i (i=1,2,3,4,5,6,7,8)$ stands for the parameters “strong wood”, “medicinal use”, “beautiful flower”, “tasty fruit”, “speed growth”, “slow growth”, “small tree”, “big tree”, respectively. In this case, to define a soft set means to point out strong wood, medicinal use and so on. Consider the mapping f_E given by “trees(.)” where (.) is to be filled in by one of the parameters $p_i \in E$, For instance, $f_E(p_i)$ means “tree have (strong wood)”, and its functional value is the set $\{t \in U: t \text{ have strong wood}\}$ and so, let $A \subset E$, the soft set F_A that describes the “Best of trees” in the opinion of the forest officer say Kumar, may be defined like, $A = \{p_2, p_3, p_4, p_5, p_7\}$, $F_A(p_2) = \{t_2, t_3, t_5\}$, $F_A(p_3) = \{t_2, t_4\}$, $F_A(p_4) = \{t_1\}$, $F_A(p_5) = \{U\}$ and $F_A(p_7) = \{t_3, t_5\}$. The soft set F_A as consisting of the following collection of approximations: $F_A = \{(p_2, \{t_2, t_3, t_5\}), (p_3, \{t_2, t_4\}), (p_4, \{t_1\}), (p_5, \{U\}), (p_7, \{t_3, t_5\})\}$.

Theorem 3.8. Every finite union of soft pre g^* closed set is soft pre g^* closed set.

Proof

Let (S,A) and (S,B) be two soft pre g^* -closed sets in soft topological space (X, τ, E) .

Let (U,E) be a soft g -open set in (X, τ, E) such that $(S,A) \cup (S,B) \subset (U,E)$

Then $pcl(S,A) \subset (U,E)$ and $pcl(S,B) \subset (U,E)$ Therefore $pcl((S,A) \cup (S,B)) \subset pcl(S,A) \cup pcl(S,B) \subset (U,E)$

$\Rightarrow pcl((S,A) \cup (S,B)) \subset (U,E)$ Therefore $(S,A) \cup (S,B)$ is soft pre g^* closed.

Example 3.9. Let $X = \{a, b\}$, $E = \{e_1, e_2\}$ $X = \{(e_1, \{a, b\}), (e_2, \{a, b\})\}$. Then the soft sets are written by $F_{E1} = X, F_{E2} = \phi, F_{E3} = \{(e_1, \{a\})\}, F_{E4} = \{(e_1, \{b\})\}, F_{E5} = \{(e_1, \{a, b\})\}, F_{E6} = \{(e_2, \{a\})\}, F_{E7} = \{(e_2, \{b\})\}, F_{E8} = \{(e_2, \{a, b\})\}, F_{E9} = \{(e_1, \{a\}), (e_2, \{a\})\}, F_{E10} = \{(e_1, \{a\}), (e_2, \{b\})\}, F_{E11} = \{(e_1, \{a\}), (e_2, \{a, b\})\}, F_{E12} = \{(e_1, \{b\}), (e_2, \{a\})\}, F_{E13} = \{(e_1, \{b\}), (e_2, \{b\})\}, F_{E14} = \{(e_1, \{b\}), (e_2, \{a, b\})\}, F_{E15} = \{(e_1, \{a, b\}), (e_2, \{a, b\})\}, F_{E16} = \{(e_1, \{a, b\}), (e_2, \{b\})\}$.

Theorem 3.10. If (S,E) is a soft pre g^* closed set of X such that $(S,E) \subset (T,E) \subset pcl(S,E)$ then (T,E) is a soft pre g^* closed.

Proof

Let $(T,E) \subset (U,E)$ where (U,E) is soft g -open

Then $(S,E) \subset (T,E)$

$\Rightarrow (S,E) \subset (U,E)$

Since (S,E) is a soft pre g^* -closed set,

$pcl(S,E) \subset (U,E)$

Given $(T,E) \subset pcl(U,E)$

Hence $pcl(T,E) \subset pcl(pcl(S,E))$

$\subset pcl(S,E)$

$\subset (U,E)$

$\Rightarrow pcl(T,E) \subset (U,E)$

Therefore (T,E) is a soft pre g^* closed set.

Example 3.11. Let us consider the soft sets of F_E that are given in example 3.5., Then the topologies are written by $\tau_1 = \{X, \phi, F_{E11}\}; \tau_1^c = \{X, \phi, F_{E4}\}; \tau_2 = \{X, \phi, F_{E9}\} \tau_2^c = \{X, \phi, F_{E13}\}$ and so on.

Theorem 3.12. A soft set (T,E) is soft pre g^* -closed if and only if $pcl(T,E) - (T,E)$ contains only null soft g -closed set.

Proof

Necessity Part: Let (T,E) be a soft pre g^* -closed set.

Let (S,E) be soft g -closed such that $(S,E) \subset pcl(T,E) - (T,E)$





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Then $(S,E) \subset \text{pcl}(T,E)$ and $(S,E) \subset (T,E)^c$
 $\Rightarrow (T,E) \subset (S,E)^c$
 Then $\text{pcl}(T,E) \subset (S,E)^c$ as $(S,E)^c$ is a soft g-open set
 $\Rightarrow (S,E) \subset \text{pcl}(T,E)^c$
 Therefore $(S,E) \subset \text{pcl}(T,E) \cap (\text{pcl}(T,E))^c$
 Hence (S,E) is a null soft g-closed set.

Theorem 3.13. If (S,E) is soft g-open and soft pre g^* -closed then (S,E) is soft closed.

Proof

The Proof is obvious.

SOFT PRE g^* -OPEN SET

Definition 4.1. A subset (S,E) of a soft topological space (X, τ, E) is called soft pre g^* -open if $(U,E) \subset \text{pint}(S,E)$ whenever $(U,E) \subset (S,E)$ and (U,E) is soft g-closed in X .

Theorem 4.2. If (S,E) is a soft pre g^* -open set of soft topological space (X, τ, E) and $\text{pint}(S,E) \subset (T,E) \subset (S,E)$ then (T,E) is also soft pre g^* -open set of X .

Proof

Let (S,E) be soft pre g^* -open set in soft topological space (X, τ, E) .
 If (G,E) is soft g-closed set such that $(G,E) \subset (T,E)$
 Since $(T,E) \subset (S,E)$ we have $(G,E) \subset (S,E)$
 Since (S,E) is a soft pre g^* -open set,
 $(G,E) \subset \text{pint}(S,E)$
 Then $\text{pint}(\text{pint}(S,E)) \subset (T,E)$
 $\Rightarrow \text{pint}(S,E) \subset \text{pint}(T,E)$
 Hence $(G,E) \subset \text{pint}(S,E) \subset \text{pint}(T,E)$
 $\Rightarrow (G,E) \subset \text{pint}(T,E)$
 Then (T,E) is soft pre g^* -open set of X .

Example 4.3. Let us consider the soft sets of F_E that are given in example 3.9,

Let $F_{E9} = \{(e_1, \{a\}), (e_2, \{a\})\}$ be soft open set. Then soft pre open sets are $\phi, X, F_{E3}, F_{E5}, F_{E6}, F_{E8}, F_{E9}, F_{E10}, F_{E11}, F_{E12}, F_{E14}, F_{E15}, F_{E16}$.

Soft pre closed sets are $\phi, X, F_{E3}^c = F_{E14}, F_{E5}^c = F_{E8}$,

$F_{E6}^c = F_{E16}, F_{E8}^c = F_{E5}, F_{E9}^c = F_{E13}, F_{E10}^c = F_{E12}, F_{E11}^c = F_{E4}, F_{E12}^c = F_{E10}, F_{E14}^c = F_{E3}, F_{E15}^c = F_{E7}, F_{E16}^c = F_{E6}$.

Therefore soft pre closed sets are $\phi, X, F_{E3}, F_{E4}, F_{E5}, F_{E6}, F_{E7}, F_{E8}, F_{E9}, F_{E10}, F_{E12}, F_{E13}, F_{E14}, F_{E16}$.

Soft g-closed sets are $F_{E9}, F_{E11}, F_{E13}, F_{E14}, F_{E15}, F_{E16}$.

Soft g-open sets are $F_{E13}, F_{E4}, F_{E9}, F_{E3}, F_{E7}, F_{E6}$.

Soft pre g^* closed sets are F_{E13} and F_{E9} .

Example 4.4. Let us consider the soft sets of F_E that are given in example 3.9,

$$F_{E13} \cup F_{E9} = \{(e_1, \{b\}), (e_2, \{b\})\} \cup \{(e_1, \{a\}), (e_2, \{a\})\}$$

$$= \{(e_1, \{a,b\}), (e_2, \{a,b\})\} \subset X$$

SOFT PRE $T_{1/2}^*$ -SPACE AND SOFT PRE $T_{1/2}^*$ -SPACE

Definition:5.1. A Soft topological space (X, τ, E) is called a soft $T_{1/2}^*$ space if every soft g^* -Pre closed set is soft closed.

Theorem :5.2. Every soft $T_{1/2}$ space is soft $T_{1/2}^*$ space.

Proof : Let (X, τ, E) be a soft $T_{1/2}$ space and let (S,E) be soft g^* -Pre closed set in (X, τ, E) . By proposition 3.3, (S,E) is soft g-closed. Since (X, τ, E) is soft $T_{1/2}$ space, (S,E) is soft closed.

Theorem :5.3. For a space (X, τ, E) the following conditions are equivalent.





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- 1) (X, τ, E) is a soft $T_{1/2}^*$ space
- 2) Every singleton of X is either soft g -closed set or soft open.

Proof : (1) \Rightarrow (2) Let $x \in X$ and suppose $\{x\}$ is not soft g -closed set of (X, τ, E) . Then $X - \{x\}$ is not soft g -open. This implies X is the only soft set containing $X - \{x\}$. So $X - \{x\}$ is a soft g^* -Pre closed set of (X, τ, E) . Since (X, τ, E) is a soft $T_{1/2}^*$ space, then $X - \{x\}$ is soft closed or equivalently $\{x\}$ is soft open in (X, τ, E) **(2) \Rightarrow (1)** Let A be a soft g^* -Pre closed set of (X, τ, E) Trivially $(S, E) \subset \text{cl}(S, E)$. Let $x \in \text{cl}(S, E)$. By (2), $\{x\}$ is either soft g -closed or soft open.

Case (i) : Suppose $\{x\}$ is soft g -closed. If $x \notin A$, then $\text{cl}(A, E) - (A, E)$ contains a non – empty soft g -closed set. But this is not possible according to the Theorem 3.8. as A is a soft g^* -Pre closed set. Therefore $x \in A$.

Case (ii) : Suppose $\{x\}$ is soft open. Since $x \in \text{cl}(S, E)$, then $\{x\} \cap A \neq \phi$. so $x \in (S, E)$

Therefore $x \in (S, E)$. So in any case $\text{cl}(S, E) \subset (S, E)$. Thus

$\text{cl}(S, E) = (S, E)$ or equivalently (S, E) is a soft closed set of (X, τ, E) .

Definition:5.4. A Soft topological space (X, τ, E) is called a soft $1/2^*T$ space if every soft g^* -Pre closed set is soft g -closed.

Theorem :5.5. Every soft $T_{1/2}$ space is soft $1/2^*T$ space.

Proof : Let (X, τ, E) be a soft $T_{1/2}$ space. Let (S, E) be soft g -closed set of (X, τ, E) . Since (X, τ, E) is soft $T_{1/2}$ space, (S, E) is soft closed in (X, τ, E) . By Theorem 3.2, (A, E) is soft g^* -Pre closed.

Therefore (X, τ, E) is a soft $T_{1/2}$ space.

Theorem :5.6. If (X, τ, E) is a soft $1/2^*T$ space, then $x \in X$, $\{x\}$ is either soft closed or soft g^* -Pre open.

Proof : Suppose (X, τ, E) is a soft $1/2^*T$ space. $x \in X$ and assume that $\{x\}$ is not soft closed.

Then $X - \{x\}$ is not a soft open set. This implies $X - \{x\}$ is a g -closed set since X is the only soft open set which contains $X - \{x\}$. Since (X, τ, E) , then $X - \{x\}$ is a soft g^* -Pre closed or equivalently $\{x\}$ is a soft g^* -Pre open.

CONCLUSION

In this paper we defined g^* Pre closed sets, Pre open sets and their properties. Also we defined soft $T_{1/2}$ space and soft $1/2^*T$ space.

Acknowledgement

We sincerely thank the Head of the Department of Mathematics and the Principal of Rani Anna Government College for Women, Tirunelveli for providing the necessary help and support.

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Study of Impact of Rainfall Pattern and Irrigation Facilities on Yield of Rice in Haryana at District Level

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 20 Jun 2024

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ABSTRACT

This research explores how changes in rainfall and the availability of irrigation affect rice yields across various districts in Haryana. As rice is predominantly grown during the kharif season, it relies heavily on adequate rainfall. The analysis indicates that from 2011 to 2020, rainfall patterns were inconsistent and varied widely. An examination of the area, production, and yield of rice in different districts shows that the number of districts reporting high to moderate rice yields increased over the decade. Specifically, districts with high rice yields doubled, rising from four in 2011 to eight in 2020. The districts with moderate yield of rice decreased from nine in 2011 to five in 2020. This is because of increase in artificial means of irrigation such as tube-wells, pump-sets and expansion of canal network in these districts and hence, the impact of variation of quality and quantity of rainfall get lessened by use of irrigation facilities. The districts with poor yield had underdeveloped irrigation infrastructure. Hence, it becomes crucial to investigate alternative irrigation methods to ensure the stability of rice production and yield, and to mitigate the risks associated with variations in natural and monsoon rainfall patterns. Further, the analysis of irrigational facilities revealed a marked growth in irrigation services throughout Haryana. However, despite the overall increase in irrigation, there were regional disparities in the availabilities of irrigation amenities within the state.

Keywords: Rice, Kharif, Haryana, Irrigation, Crop diversification, Horticulture



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INTRODUCTION

The 2020 Food and Agriculture Organization (FAO) report reveals that in 2019, about 750 million individuals globally were severely food insecure, which represents almost 10% of the global population [1]. Ensuring food security is crucial for the sustainable growth of the global economy and societal well-being. Rice ranks among the top three staple crops worldwide, cultivated in 122 countries and serving as the primary dietary staple for over half the world's population [2,3]. Any future shifts in rice cultivation are poised to significantly influence global grain production trends and overall food security [4]. India holds the distinction of being the second largest rice producer globally, with the most extensive rice cultivation area, approximately 43 million hectares [5]. Rice accounts for over 40% of India's total grain output. During the 2019–2020 period, rice fields covered 43.7 million hectares, producing 118.4 million tonnes, and achieving an average yield of about 2,705 kg/ha. Notably, Kharif rice, grown during the summer monsoon season, constitutes a significant portion of the country's rice output, with production reaching 102.4 million tonnes in 2019–2020 [5]. In India, Haryana ranks as one of the smaller states with a land area of 4.4 million hectares, which constitutes 1.34 percent of the country's total geographical area. Around 80 percent of this area is cultivated, with 84 percent benefiting from irrigation, resulting in a cropping intensity of 184 percent as per the Haryana State Agriculture Policy (HSAP). Since its establishment in 1966-67, Haryana has seen significant advances in food grain production and is now a key contributor to India's central food-grain pool. The cultivation of rice and wheat significantly boosts the state's agricultural output. Additionally, the productivity of crops in Haryana is influenced by various climatic factors such as temperature, drought, and rainfall during their growth phases [6,7,8]. Given that rice requires a significant amount of water, rainfall is a critical factor that greatly influences its production [9,10]. Rainfall naturally hydrates plants, and since rice requires more water than crops such as maize, barley, and sorghum, irrigation methods like tube wells, pumps, and canal networks become essential to maintain productivity during periods of low rainfall. Variations in rice yields from year to year [5] are often attributed to fluctuations in monsoonal rains [11,12]. Additionally, rice production differences can arise from diverse irrigation systems, technological advances, and crop management strategies [13]. Variability in rainfall impacts groundwater levels, which in turn influences irrigation that predominantly relies on this groundwater source. Moreover, the cost and accessibility of groundwater differ across various districts of Haryana due to distinct irrigation infrastructures. This study, therefore, examines how patterns of rainfall and the presence of irrigation facilities affect rice production across different districts in Haryana.

METHODOLOGY

STUDY AREA

This study was carried out at the district level in Haryana, which is situated between latitudes 27° 30' and 30° 35' N, and longitudes 74° 28' and 77° 36' E, in the northwest part of India. Haryana lies in the North Western arid and semi-arid plains and receives an average annual rainfall of 545 mm, predominantly through the southwest Monsoon. The state is divided into four distinct regions: Northern, Eastern, Western, and Southern. The Northern region features hilly terrain, while the Eastern region benefits from higher rainfall and fertile soil, sloping from north to south at elevations between 700 and 900 feet. Groundwater depletion is a significant issue in both the northern and southern regions, while the central areas, including parts of Rohtak, Jhajjar, Jind, Hisar, and Sirsa, experience problems with rising groundwater levels, leading to waterlogging and salinization. The southwestern region is characterized by its dry, sandy, and barren landscape. Despite lacking perennial rivers, Haryana has developed a robust agricultural sector, supported by fertile lands and an extensive canal irrigation system, including the western Yamuna canal and Bhakhra canal systems. The map of Haryana and its location in India is shown in the figure 1.

RESULTS AND DISCUSSION

Study of area, production and yield of rice cultivation in Haryana:



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The figure 2 illustrates the area of cultivation of rice in Haryana over the years 1966-67 to 2019-20. This data shows a persistent increase from 192 thousand hectare in 1966 to 1559 thousand Hectare in 2020. Figure 3 illustrates the progression of rice production in Haryana from 1966 to 2020, where it escalated from 2.23 lakh tonnes in 1966 to 51.98 lakh tonnes in 2020, with a notable decline from 48.8 lakh tonnes in 2017-18 to 45.16 lakh tonnes in 2018-19 Figure 4 traces the changes in rice yield per hectare, beginning with 1161 kg in 1966 and rising to 2775 kg in 1991. However, the yield experienced a downturn to 2557 kg per hectare by 2001, followed by an increase to 3422 kg per hectare in 2018. Subsequent years saw a dip to 3121 kg per hectare in 2019, before rising again to 3334 kg per hectare in 2020. These figures indicate that the improvements in rice yield in Haryana have been subject to significant fluctuations over the years.

Analysis of rainfall impact on yield of rice in different districts of Haryana

The map (figure 5) shows the impact of rainfall on yield of rice in different districts of Haryana, 2011. Panchkula received low average annual rainfall and had moderate yield of rice. Being a kharif crop rice requires good rainfall. Usage of high yielding variety of seeds, technological inputs and artificial means of irrigation leads to high yield of rice even at places receiving less rainfall (table 1). Ambala and Yamuna-Nagar received high rainfall and had high yield of rice. Karnal, Mahendragarh, Rewari and Palwal received moderate average annual rainfall and had moderate yield of rice. Faridabad, Jind, Panipat and Sonapat received moderate average annual rainfall but had low yield of rice. Less technological inputs, usage of seeds with low yield and fewer artificial means of irrigation leads to less agricultural yield of rice. Hisar, Bhiwani, Rohtak and Jhajjar received low average annual rainfall and had low yield of rice. Fatehabad and Kurukshetra received low average annual rainfall but had high yield of rice. Sirsa, Kaithal, Gurgaon and Mewat received low average annual rainfall but had moderate yield of rice. In 2011, only four districts of Haryana had high yield of rice, nine had moderate yield of rice and eight had low yield of rice. The figure 6 shows impact of rainfall on yield of rice in Haryana, 2020. In the year 2020, Panchkula, Ambala, Yamuna-Nagar and Karnal received high average annual rainfall and had high yield of rice. Hisar, Bhiwani, Jhajjar and Rewari received low average annual rainfall and had low yield of rice. Fatehabad received low average annual rainfall but had high yield of rice. Sirsa received low average annual rainfall and had moderate yield of rice. Sonapat, Rohtak, Mewat and Faridabad received moderate average annual rainfall but had low yield of rice. Gurgaon, Kaithal and Kurukshetra received moderate average annual rainfall but had high yield of rice. Jind, Panipat, Mahendragarh and Palwal received moderate average annual rainfall and had moderate yield of rice.

In 2020, Haryana had eight districts with high rice yields, five districts with moderate yields, and another eight with low rice yields. The number of districts with high yield of rice increased from four in 2011 to eight in 2020. The districts with moderate yield of rice decreased from nine in 2011 to five in 2020. This is because of increase in artificial means of irrigation such as tube-wells, pump-sets and expansion of canal network in these districts (table 1 & figures 7,8,9). The table 1 highlights the progressive changes in the extent of irrigation across districts in Haryana. It indicates a positive trend towards increased irrigation coverage and improved access to water resources for agricultural purposes. Grasping these shifts can guide policymakers and stakeholders to pinpoint regions needing more aid in developing irrigation infrastructure and managing water resources, thereby boosting agricultural productivity and promoting sustainable development in the state. The research highlights that rice, as a kharif crop, relies heavily on adequate rainfall, with the amount and quality of rainfall significantly influencing the area, production, and yield of the crop. However, due to global warming, the patterns of rainfall and monsoon in Haryana are becoming erratic. The yield is also determined by the use of high-yielding seed varieties, fertilizers, pesticides, and, crucially, the irrigation facilities available in each district. The impact of rainfall variability can be mitigated by the prudent use of these irrigation systems. Thus, it is essential to invest in artificial irrigation methods to ensure the stable production and yield of rice, safeguarding against the variability caused by changes in natural and monsoon rainfall patterns.

Status of irrigation facilities in Haryana

The study of pattern of irrigational development reveals a marked growth in irrigation facilities throughout Haryana (table 1 & figures 7,8,9). This expansion can be attributed to various factors, including the implementation of irrigation projects, the construction of canals and tubewells, and the utilization of groundwater resources. However,



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despite the overall increase in irrigation, there remains a regional imbalance in the development of irrigation facilities within the state. This imbalance can be attributed to the prevailing physio-socio-economic conditions that pose restrictions and challenges to irrigation development in certain area. Mathauda et al. (2000) reported that the chemical composition of the atmosphere is getting altered [14]. The main causes of these are fuel combustion, burning of biomass, deforestation, manufacturing of synthetic chemicals. These causes are enhancing the greenhouse effect in the atmosphere. Abbas and Mayo (2021) stated that global warming is rising which in turn leads to variation in the rainfall and temperature patterns [15]. Rice being a kharif crop requires good rainfall but due to global warming and climate change the rainfall and monsoon pattern in northwest India is getting altered and disturbed. Therefore, it is very important to also invest in artificial means of irrigation to secure the production and yield of the rice crop and prevent its failure due to change in the pattern of natural and monsoon rainfall. Mahajan et al. (2009) said that it is very important to adopt water saving management practices because they lead to increase in yield and water productivity and a sustainable production of rice [16].

CONCLUSIONS

Observations of how rainfall variations affect rice yields in Haryana clearly indicate that there are shifts in climatic conditions over time. The patterns of rainfall are evolving, with its distribution becoming increasingly irregular recently. Farmers in Haryana rely on rainfall for crop cultivation, yet the recent irregularities in rainfall patterns have heightened dependence on artificial irrigation methods. This increased reliance on artificial irrigation has led to groundwater depletion and the emergence of dark zones in water levels across north-western India. In response to acute water shortages, the Haryana government has imposed restrictions on paddy cultivation in the most affected areas. The agricultural system in Haryana is under strain due to the disproportionate use of fertilizers, prevalent crop residue burning in the rice-wheat cropping system, and the limited availability of resources in each designated ecosystem. This situation underscores the necessity for crop diversification to enhance both ecological and human health. The cultivation of citrus fruits, like Kinnow, is gaining popularity in several districts, driven by benefits such as reduced reliance on monsoon rains, the creation of sustainable livelihoods, higher farmer incomes, and greater efficiency in resource usage. Horticulture, encompassing the growing of fruits, vegetables, spices, and other plantations, is emerging as a vibrant and sustainable economic pursuit for Haryana's farmers, who are being urged to diversify into crops like vegetables, fruits, cotton, maize, pulses, and more. One of the popular crop diversification schemes is 'Mera Pani Meri Virasat' to make farmers diversify to less water-consuming crops. This scheme encourages farmers to shift from water-guzzling paddy to cultivation of maize, pulses, fruits & vegetables. The government can introduce more such schemes and crop insurance policies to further motivate and support farmers to diversify crop for sustainable livelihood and sustainable agricultural practices.

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Table 1. Gross area irrigated and total cropped area by districts in the year 2011-12 and 2019-20; Source: Statistical abstracts of Haryana (2012-13 and 2020-21)

Districts	Total area under Irrigation (000 hectare)	% to net area sown	Total area under irrigation (000 hectare)	% to net area sown
	Year (2011-12)		Year (2019-20)	
Ambala	107	100	208	99.5
Bhiwani	250	67.6	425	81
*Charkhi			192	86.1
Dadri				
Faridabad	32	100	63	100
Fatehabad	217	96.9	431	99.1
**Gurgaon/	75	93.7	110	100
Gurugram				
Hisar	267	80.4	608	93.1
Jhajjar	98	73.1	237	93.7
Jind	236	99.2	467	100
Kaithal	201	100	386	100
Karnal	192	100	395	100
Kurukshetra	151	100	277	99.3
Mahendragarh	120	78.4	228	78.9





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**Mewat/Nuh	49	41.9	140	76.5
Palwal	100	91.7	195	95.1
Panchkula	14	56	37	80.4
Panipat	95	99	192	100
Rewari	110	87.3	208	100
Rohtak	112	80	227	100
Sirsa	361	92.1	733	97.7
Sonipat	169	100	303	100
Yamunanagar	116	92	217	100

*Previously in Bhiwani district, Charkhi Dadri become as 22nd district of Haryana on 1 December 2016.

** Mewat was renamed as Nuh and Gurgaon as Gurugram in 2016.

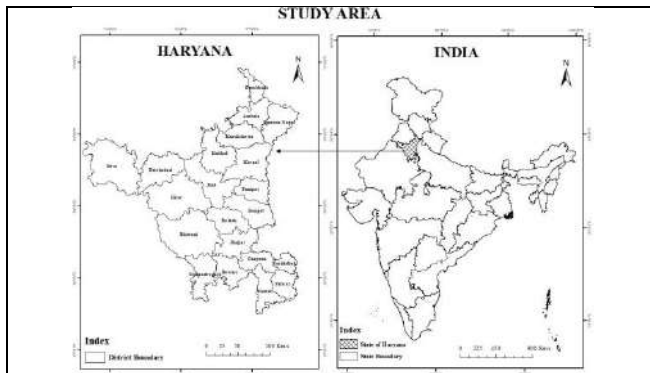


Figure 1: Haryana state and its location in India; Source: Census of India 2011

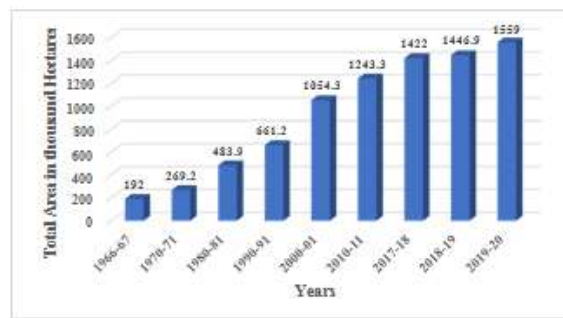


Figure 2: Area of rice cultivation in Haryana; Source: Department of Land Records, Haryana (2021-22)

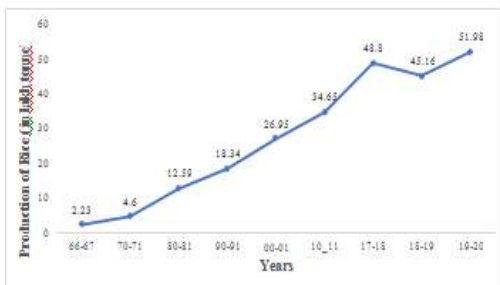


Figure 3: Production of rice in Haryana; Source: Department of Land Records, Haryana (2021-22)

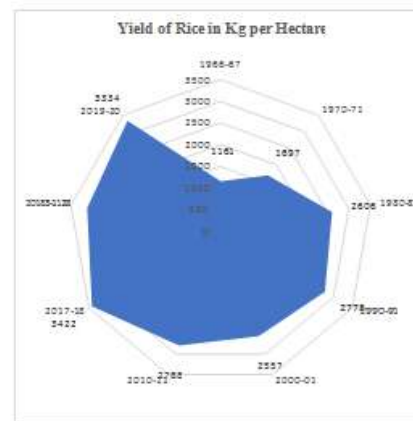


Figure 4: Yield of rice in Haryana; Source: Department of Land Records, Haryana (2021-22)





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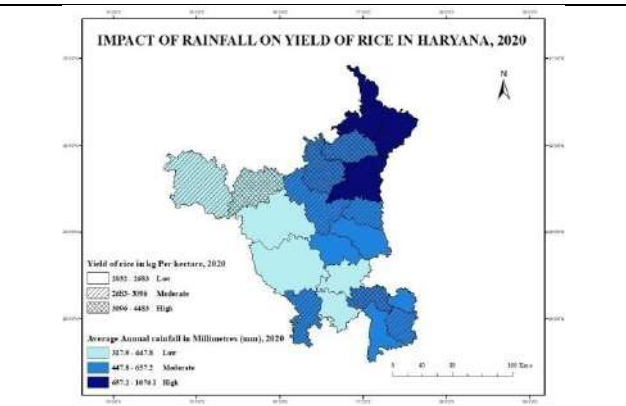
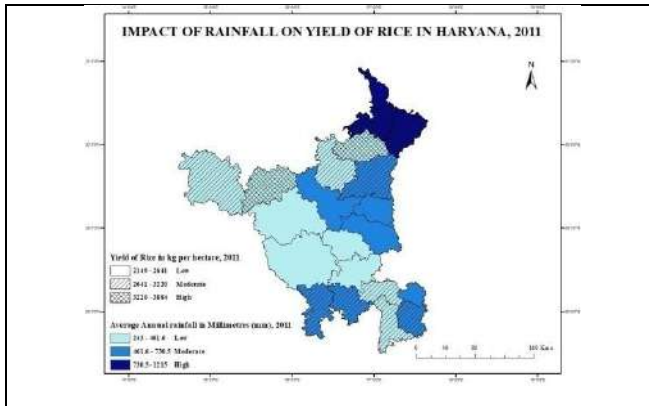


Figure 5: Impact of rainfall on yield of rice in different districts of Haryana, 2011 Source: Statistical abstract of Haryana, 2012-13

Figure 6: Impact of rainfall on yield of rice in different districts of Haryana, 2020; Source: Statistical abstract of Haryana, 2021-22

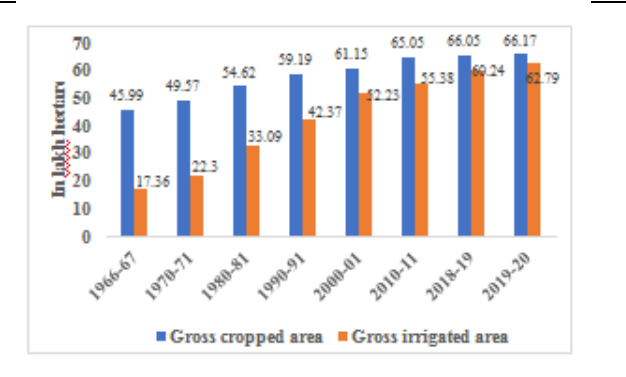
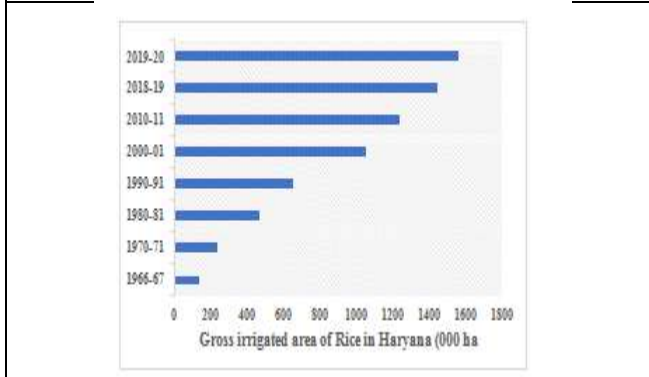


Figure 7: Expansion of gross irrigated area of Rice during the period of 1966-67 to 2019- 20; Source: Statistical abstract of Haryana, 2021-22.

Figure 8: Extent of irrigation in term of gross cropped area and gross irrigated area in Haryana during the period from 1966-67 to 2019-20; Source: Statistical abstract of Haryana, 2021-22

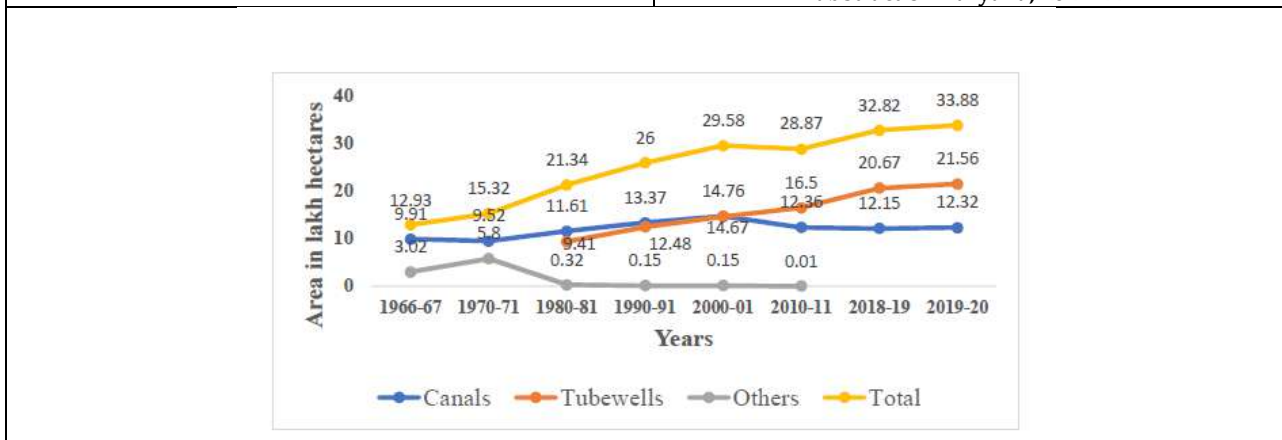


Figure 9: Net area irrigated by different sources in Haryana during the period from 1966-67 to 2019-20; Source: Statistical abstract of Haryana, 2021-22





Palindromic Antimagic Labeling of Some Classes of Graphs and its Operations

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 20 Jun 2024

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ABSTRACT

In this study, we propose the introduction of a novel classification of antimagic labeling known as palindromic antimagic. In the context of graph theory, a palindromic antimagic labeling of a graph $G = (V, E)$ with p vertices and q edges can be defined as an invertible mapping from the set of edges can be defined as an invertible mapping from the set of edges $\{e_1, e_2, \dots, e_q\}$ to the set of palindromic numbers $\{p_1, p_2, \dots, p_q\}$. This labeling also involves an injective mapping of vertex labeling, where each vertex is assigned a label equal to the sum of its incident edges. It is important to note that these vertex labels are distinct from one another. This article examines the palindromic antimagic properties of certain sets of graphs, such as the diamond and gem graph, the house, and kite graph. It provides proof that the join of these graphs, as well as the fusion of non adjacent vertices in the join graph, exhibit palindromic antimagicness.

Keywords: Palindromic Antimagic Labeling, Operations of graphs, Diamond and Gem graph, House and Kite graph.

Mathematical subject classification: 05C78, 05C76





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INTRODUCTION

In this study, we investigate the concept of a palindromic antimagic labeling for a graph

$G = (V, E)$ with p vertices and q edges, the edge set E assure an invertible mapping

$\varphi: (G) \rightarrow \{p_1, p_2, \dots, p_q\}$ where $\{p_1, p_2, \dots, p_q\}$ is a palindromic number (Numbers remain carbon copy when its terms are overturned) that launch an injective mapping

$\theta: (G) \rightarrow Z^+$ defined

$$(V(G)) = \sum_{e \in E} \psi(Z^+) \varphi(e)$$

where $\psi_G(Z^+)$ is an incidence function associated with corresponding v and those vertex labelings are incompatible with each other. Let G_1 and G_2 denote two disjoint graphs. The join of these two graphs $G_1 + G_2$ is formally described as a mathematical structure consisting of a set of vertices $(G_1 + G_2)$ and the set of edges $(G_1 + G_2)$ are

$$(G_1 + G_2) = V(G_1) + V(G_2)$$

$$(G_1 + G_2) = E(G_1) + E(G_2) + N(u) + N(v)$$

For every vertex u in G_1 , the neighbourhood of u , denoted by $N(u)$, is the set of vertices located adjacent to u in G_1 , and similarly for any vertex v in G_2 .

The fusion operation in graph theory involves merging two vertices, u and v in a graph G to create a new vertex w . This process implies reassigning any edges that were originally connected to either u or v , or both, to the newly created vertex w . Following the process, the number of vertices in graph G is reduced by one, while the number of edges in graph G remains unchanged.

A Diamond graph is a type of planar undirected graph that consists of four vertices and five edges, arranged in a manner that resembles the shape of a diamond. The structure is comprised of a fully connected graph, denoted as K_4 , with the removal of a single edge. The given structure exhibits isomorphism with the entire tripartite graph $K_{1,1,2}$. This graphical representation is occasionally referred to as a double triangle graph.

A Gem graph is a fan graph $F_{1,4}$ which acquire by join a graph K_1 and path P_4 which have the appearance of gem stone. A House graph is a type of planar undirected graph that consists of 5 vertices and 6 edges. It is formed by the union of a cycle C_3 and a cycle C_4 .

The term "House graph" is derived from its visual resemblance to a schematic illustration of a house, that includes a roof.

A Kite graph is a simple planar undirected graph with 5 vertices and 6 edges, bear semblance to Shape of kite which is achieved by linking a diamond graph and a K_1 graph via a bridge.

In 1990, Hartsfield and Ringel[4] introduced the idea of antimagic. They made the inference that every connected graph, except for K_2 , and every tree, except for K_2 , are antimagic. Additionally, they provided a proof that every path ($n \geq 3$), cycles C_n ($n \geq 3$), complete graph K_n ($n \geq 3$) are antimagic. In a publication from 1996, Joseph A. Gallian[3] conducted an in-depth investigation of the topic of Graph Labeling. In this study, Gallian provided evidence to support the assertion that the join of two graphs can exhibit graceful, harmonious, and antimagic properties. In 2004, Alon et al.[1] put up a hypothesis suggesting that dense graphs possess antimagic properties. They subsequently provided a proof demonstrating that all graphs with a maximum degree of at least $n - 2$ are antimagic. Yilma[6] expanded upon the findings on antimagic graphs that involve vertices of significant degree by providing a proof that establishes the antimagic property of a connected graph with $\Delta(G) \geq |V(G)| - 3, \forall |V(G)| \geq 9$. In a study conducted in 2013, Wang et al.[5] demonstrated that if G and H are graphs with the same order, then the graph obtained by combining G and H , denoted as $G + H$, exhibits antimagic properties. In a study conducted by Baca et al.[2] in 2015, it





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was demonstrated that some join graphs and incomplete join graphs possess antimagic properties. Let us examine the primary findings of the article.

Main Result

In this section, the major result is demonstrated through the utilization of two subsections

Palindromic Antimagic of some operations in Diamond and Gem graph

In this section, it is necessary to assign labels to the first set of base graphs, such as Diamond and Gem graphs. Consider a graph G , referred to as a Diamond graph, which consists of p vertices and q edges. Similarly, let H be a graph known as a Gem graph, with \bar{p} vertices and \bar{q} edges, the vertex set of G and H , $V(G) = \{t_a: 1 \leq a \leq p\}$, $V(H) = \{s_b: 1 \leq b \leq \bar{p}\}$ and the edge set of G and H , $E(G) = \{e_a: 1 \leq a \leq q\}$, $E(H) = \{e_b: 1 \leq b \leq \bar{q}\}$. Consequently, the edge labeling of graph G and H may be determined.

$$\begin{aligned} 1. \varphi: E(G) &\rightarrow \{p_1, p_2, \dots, p_q\} \text{ defined} \\ 2. \varphi(e_1, e_2, \dots, e_q) &= (p_q, p_{q-1}, \dots, p_1) \end{aligned} \tag{1}$$

$$\begin{aligned} 3. \bar{\varphi}: E(H) &\rightarrow \{p_1, p_2, \dots, p_q\} \text{ defined} \\ \bar{\varphi}(e_1, e_2, \dots, e_{\bar{q}}) &= (p_q, p_{q-1}, \dots, p_1) \end{aligned} \tag{2}$$

where $\{p_1, p_2, \dots, p_q\}$ is a palindromic number. The vertex labeling of graph G and H becomes

$$\begin{aligned} \theta: (G) &\rightarrow Z^+ \text{ defined} \\ (V(G)) &= \sum_{eg} \psi(Z^+) \varphi(e_a) \end{aligned} \tag{3}$$

$$\begin{aligned} \bar{\theta}: (H) &\rightarrow Z^+ \text{ defined} \\ \bar{\theta}(V(H)) &= \sum_{eg} \psi_H(Z^+) \bar{\varphi}(e_b) \end{aligned} \tag{4}$$

where ψ is an incidence function of corresponding vertex and also which is couplet disparate.

Lemma 2.1. Let G be a simple planar undirected Diamond graph with p vertices and q edges, which satisfy palindromic antimagic labeling, then for any vertex t_i in $V(G)$,

$$\frac{p+q+\delta(G)-1}{\Delta(G)-1} \leq t_i \leq \frac{p+q+\delta(G)-1}{\Delta(G)-1} + \frac{p+q+\Delta(G)+\delta(G)}{\delta(G)} \text{ and let } t_i, t_j \text{ be any two vertices of } G \text{ such that if } t_i > t_j \text{ then } \frac{p+q+\delta(G)-1}{\Delta(G)-1} - [\delta(G)]^2 \leq t_i \leq \frac{p+q+\Delta(G)+\delta(G)}{\delta(G)}. \text{ Hence } t_i \text{ is distinctive from each other.}$$

Lemma 2.2. Let H be a simple connected undirected gem graph with \bar{p} vertices and \bar{q} edges, which satisfy palindromic antimagic labeling, then for any vertex s_i in $V(H)$,

$$\frac{\bar{p}+\bar{q}+\Delta(H)+\delta(H)}{\Delta(H)-1} \leq s_i \leq \frac{\bar{p}+\bar{q}+\Delta(H)+\delta(H)}{\Delta(H)-1} + \frac{\bar{p}+\bar{q}+\Delta(H)+\delta(H)}{\delta(H)} \text{ and let } s_i, s_j \text{ be any two vertices of } H \text{ such that if } s_i > s_j \text{ then } \frac{\bar{p}+\bar{q}+\delta(H)}{\Delta(H)-\delta(H)} - \frac{\bar{p}+\bar{q}+\Delta(H)+\delta(H)}{\Delta(H)-1} \leq s_i - s_j \leq \delta(H) \left[\frac{\bar{p}+\bar{q}+\delta(H)}{\Delta(H)-\delta(H)} \right]. \text{ Hence } s_i \text{ is distinctive from each other.}$$

Theorem 2.3. The join of two palindromic antimagic labeled graph (G and H) is a Palindromic antimagic

Proof. Let G represent a Diamond graph and H represent a Gem graph. $G + H$ denotes the join of two graphs G and H , the vertex set $(G + H) = (G) + V(H)$, and the edge set

$$(G + H) = (G) + E(H) + N(t_i) + N(s_i) \text{ where } t_i \text{ and } s_i \text{ are any vertices and } N(t_i) \text{ and } (s_i) \text{ are a neighbourhood of those vertex in graph } G + H, \text{ has } |V| = p + \bar{p}, |E| = q + \bar{q} + p\bar{p}.$$

Let us call the vertices of $G + H$ the same as the vertices of G and H , which are represented by r . Edges of $G + H$ are labeled the same as edges of G and edges of H , and the edges that connect the vertices of these two graphs are named ε_1 to ε_q . Let us see how to name the edges

ε_i , name ε_1 to ε_q to the edges those incident with $(G+H)-\bar{p}$, clepe ε_{q+1} to ε_{2q} to the edges whose incident with $t_{\delta(G)}$,

clepe ε_{2q+1} to ε_{3q} to the edges which is incident with $t_{\Delta(G)}$, clepe ε_{3q+1} to $\varepsilon_{p\bar{p}}$ to the edges whose incident with $t_{\Delta(H)}$, all in clockwise order.





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In order to establish the palindromic antimagic attribute of the labeled graph $G + H$, it is necessary to assign labels to the edges of $G + H$.

$\varphi'' : E(G + H) \rightarrow \{p_1, p_2, \dots, p_{q+\bar{q}+p\bar{p}}\}$ defined

$$E(G + H) = \begin{cases} e_a = \{e_1, e_2, \dots, e_q\} = \{p_q, p_{q-1}, \dots, p_1\} \text{ by eqn (1)} \\ \bar{e}_b = \{\bar{e}_1, \bar{e}_2, \dots, \bar{e}_{\bar{q}}\} = \{p_{q+\bar{q}}, p_{q+\bar{q}-1}, \dots, p_{q+1}\} \\ \varepsilon_i = \{\varepsilon_1, \varepsilon_2, \dots, \varepsilon_{q+\bar{q}+p\bar{p}}\} = \{p_{q+\bar{q}+1}, p_{q+\bar{q}+2}, \dots, p_{q+\bar{q}+p\bar{p}}\} \end{cases} \quad (5)$$

The vertex labeling of the graph $G + H$ is determined by summing the incident edges of the corresponding vertex. Let r_{ij} represent any vertex of the vertex set $V(G + H)$ then

$$\begin{aligned} \{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} &\leq r_{ij} \\ &\leq \{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} + \{\Delta(G + H)\{\Delta(G)^{\delta(H)} q(\Delta(H) - \delta(H)) \\ &\quad + [\delta(G + H) - \bar{p}]\} \end{aligned}$$

and let r_{ij} and r'_{ij} be any vertices of $G + H$ such that if $r_{ij} > r'_{ij}$ then

$$t_{\Delta(H)} > t_{\Delta(G)} > s_{\delta(G+H)-\bar{p}} > s_{\delta(G)} > s_{\Delta(G)} > t_{\delta(G)} > s_{\Delta(H)} > s_{\bar{p}} > t_{\delta(G+H)-\bar{p}} \text{ thus,}$$

$$\begin{aligned} \left[\delta(G)^{\delta(H)} \frac{\Delta(G + H)}{\delta(H)} \right] + [\delta(G + H) - \bar{p}] &\leq r_{ij} - r'_{ij} \\ &\leq \{\Delta(G + H)\{\Delta(G)^{\delta(H)} q(\Delta(H) - \delta(H)) + [\delta(G + H) - \bar{p}]\} \end{aligned}$$

As a result, the labeling of $G + H$ is distinct from one another. Consequently, the join of two Palindromic antimagic graphs (G and H) is also Palindromic antimagic.

Theorem 2.4. The Fusion of non adjacent vertices of Palindromic antimagic labeled joining graph ($G + H$) is a Palindromic antimagic.

Proof. The objective of this theorem is to establish the palindromic antimagic property of the fusion of non-adjacent vertices in the graph $G + H$. Fusion is an operation in which two vertices are replaced by a single new vertex has $|V| = p + \bar{p} - 1$, $|E| = q + \bar{q} + p\bar{p}$. Prior to demonstrating the palindromic antimagic property, In this inquiry, we aim to determine the adjacency function of the combined graph $G + H$.

$$\begin{cases} N(t_{\delta(G+H)-\bar{p}}) = t_{\delta(G)}, t_{\Delta(G)}, t_{\Delta(H)}, V(H) \\ N(t_{\delta(G)}) = t_{\delta(G+H)-\bar{p}}, t_{\Delta(G)}, V(H) \\ N(t_{\Delta(G)}) = t_{\delta(G+H)-\bar{p}}, t_{\delta(G)}, t_{\Delta(H)}, V(H) \\ N(t_{\Delta(H)}) = t_{\delta(G+H)-\bar{p}}, t_{\Delta(G)}, V(H) \\ N(s_{\delta(G+H)-\bar{p}}) = V(G), s_{\delta(G)}, s_{\bar{p}} \\ N(s_{\delta(G)}) = V(G), s_{\Delta(G)}, s_{\delta(G+H)-\bar{p}}, s_{\bar{p}} \\ N(s_{\Delta(G)}) = V(G), s_{\delta(G)}, s_{\Delta(H)}, s_{\bar{p}} \\ N(s_{\Delta(H)}) = V(G), s_{\Delta(G)}, s_{\bar{p}} \\ N(s_{\bar{p}}) = V(G), s_{\delta(G+H)-\bar{p}}, s_{\delta(G)}, s_{\Delta(G)}, s_{\Delta(H)} \end{cases} \quad (6)$$

where $N(t_i)$ and $N(s_i)$ is a neighbourhood of those vertices. By the eqn(6) the fusion does not take place to the vertices $t_{\delta(G+H)-\bar{p}}, t_{\Delta(G)}, s_{\bar{p}}$ because $\psi_{G+H}(t_{\delta(G+H)-\bar{p}}) = \psi_{G+H}(t_{\Delta(G)}) = \psi_{G+H}(s_{\bar{p}}) = p + \bar{p} - 1$. To demonstrate the palindromic antimagicness of $G + H$ fusion, we must first label the edges as in eqn(5). The vertex labeling of new fused graphs is the sum of the edges that touch it.

Case(i):

Let $Fu_1(G + H)$ be a fused graph of $G + H$ formed by replacing the vertices $t_{\delta(G)}, t_{\Delta(H)}$ into $t_{\delta(G)}, t_{\Delta(H)}$ with $p + \bar{p} - 1$ vertices $q + \bar{q} + p\bar{p}$ edges, then for any vertex r_{ij} in $Fu_1(G + H)$, $\{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} \leq r_{ij} \leq \{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} + \{\delta(G)[(q, \delta(H)^{\Delta(G)}[\bar{p} + \bar{q} + 1]) - [\delta(G + H) - \bar{p}]]\}$. Let r_{ij} and r'_{ij} be any two vertices of $Fu_1(G + H)$ such that $r_{ij} > r'_{ij}$ then $\delta(G)[\delta(G + H) + \Delta(G + H) + \Delta(G) + \delta(H)] \leq r_{ij} - r'_{ij} \leq \{\delta(G)[(q, \delta(H)^{\Delta(G)}[\bar{p} + \bar{q} + 1]) - [\delta(G + H) - \bar{p}]]\}$. From the above inequality the vertex labelling of $Fu_1(G + H)$ is couplet disparate. Hence $Fu_1(G + H)$ is palindromic antimagic.





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Case(ii):

Let $Fu_2(G + H)$ be a fused graph of $G + H$ formed by replacing the vertices $s_{S_{\delta(G+H)-p}, S_{\Delta(G)}}$ into $s_{S_{\delta(G+H)-p}, S_{\Delta(G)}}$ with $p + \bar{p} - 1$ vertices $q + \bar{q} + p\bar{p}$ edges, then for any vertex r_{ij} in $Fu_2(G + H)$, $\{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} \leq r_{ij} \leq \{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} + (\delta(G) + 1)\{\Delta(G)[(\Delta(G))^{\delta(H)}[\bar{p} + \bar{q} + 1]] - [\delta(H) - 1] + [\delta(G + H) - \bar{p}]\}$. Let r_{ij} and r'_{ij} be any two vertices of $Fu_2(G + H)$ such that $r_{ij} > r'_{ij}$ then $[\delta(G + H) + \Delta(G) + \Delta(G)] \leq r_{ij} - r'_{ij} \leq (\delta(G) + 1)\{\Delta(G)[(\Delta(G))^{\delta(H)}[\bar{p} + \bar{q} + 1]] - [\delta(H) - 1] + [\delta(G + H) - \bar{p}]\}$. From the above inequality the vertex labelling of $Fu_2(G + H)$ is couplet disparate. Hence $Fu_2(G + H)$ is palindromic antimagic.

Case(iii):

Let $Fu_3(G + H)$ be a fused graph of $G + H$ formed by replacing the vertices $s_{S_{\delta(G+H)-p}, S_{\Delta(H)}}$ into $s_{S_{\delta(G+H)-p}, S_{\Delta(H)}}$ with $p + \bar{p} - 1$ vertices $q + \bar{q} + p\bar{p}$ edges, then for any vertex r_{ij} in $Fu_3(G + H)$, $\{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} \leq r_{ij} \leq \{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} + \{\bar{p}\bar{q}\Delta(G)^{\delta(H)+1}\}$. Let r_{ij} and r'_{ij} be any two vertices of $Fu_3(G + H)$ such

that $r_{ij} > r'_{ij}$ then $p \leq r_{ij} - r'_{ij} \leq \{\bar{p}\bar{q}\Delta(G)^{\delta(H)+1}\}$. From the above inequality the vertex labelling of $Fu_3(G + H)$ is couplet disparate. Hence $Fu_3(G + H)$ is palindromic antimagic.

Case(iv):

Let $Fu_4(G + H)$ be a fused graph of $G + H$ formed by replacing the vertices $s_{S_{\delta(G)}, S_{\Delta(H)}}$ into $s_{S_{\delta(G)}, S_{\Delta(H)}}$ with $p + \bar{p} - 1$ vertices $q + \bar{q} + p\bar{p}$ edges, then for any vertex r_{ij} in $Fu_4(G + H)$, $\{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} \leq r_{ij} \leq \{\bar{q}[\delta(G)^p \Delta(G)] + [\delta(G + H) - \bar{p}]\} + \delta(H)\{(\delta(G)[\Delta(G)q[\delta(G + H) + q]] - 1) - [\delta(G + H) - \bar{p}]\}$. Let r_{ij} and r'_{ij} be any two vertices of $Fu_4(G + H)$ such that $r_{ij} > r'_{ij}$ then $p \leq r_{ij} - r'_{ij} \leq \delta(H)\{(\delta(G)[\Delta(G)q[\delta(G + H) + q]] - 1) - [\delta(G + H) - \bar{p}]\}$. From the above inequality the vertex labelling of $Fu_4(G + H)$ is couplet disparate. Hence $Fu_4(G + H)$ is palindromic antimagic.

As a result of the preceding four cases, the fusion of non-adjacent vertices of a palindromic antimagic labeled join graph $(G + H)$ is palindromic antimagic.

2.2 Palindromic Antimagic of some operations in House and Kite graph

In this section, it is recommended to designate the next collection of base graphs as the House and Kite graphs. Let G^* , denote a House graph, with p^* vertices and q^* edges, and let H^* be a kite graph, with \bar{p} vertices and \bar{q} edges, the vertex set of G^* and H^* , $V(G^*) = \{l_a: 1 \leq a \leq p^*\}, V(H^*) = \{m_b: 1 \leq b \leq \bar{p}\}$ and the edge set of G^* and H^* , $E(G^*) = \{e_a^*: 1 \leq a \leq q^*\}, E(H^*) = \{\bar{e}_b: 1 \leq b \leq \bar{q}\}$. Consequently, the edge labeling of graph G^* and H^* is determined.

$$\begin{aligned} \varphi^*: E(G^*) &\rightarrow \{p_1, p_2, \dots, p_{q^*}\} \text{ defined} \\ \varphi^*(e_1, e_2, \dots, e_{q^*}) &= (p_{q^*}, p_{q^*-1}, \dots, p_1) \end{aligned} \tag{7}$$

$$\begin{aligned} \tilde{\varphi}: E(H^*) &\rightarrow \{p_1, p_2, \dots, p_{\bar{q}}\} \text{ defined} \\ \tilde{\varphi}(\bar{e}_1, \bar{e}_2, \dots, \bar{e}_{\bar{q}}) &= (p_{\bar{q}}, p_{\bar{q}-1}, \dots, p_1) \end{aligned} \tag{8}$$

where $\{p_1, p_2, \dots, p_q\}$ is a palindromic number. The vertex labeling of graph G and H becomes

$$\begin{aligned} \theta^*: V(G^*) &\rightarrow Z^+ \text{ defined} \\ \theta^*(V(G^*)) &= \sum_{e \in \psi_{G^*}(z^*)} \varphi^*(e_a^*) \end{aligned} \tag{9}$$

$$\begin{aligned} \tilde{\theta}: V(H^*) &\rightarrow Z^+ \text{ defined} \\ \tilde{\theta}(V(H^*)) &= \sum_{e \in \psi_{H^*}(z^*)} \tilde{\varphi}(\bar{e}_b) \end{aligned} \tag{10}$$

where ψ is an incidence function of corresponding vertex and also which is couplet disparate.

Lemma 2.5. Let G^* be a simple planar undirected House graph with p^* vertices and q^* edges, which satisfy palindromic antimagic labeling, then for any vertex l_i in $V(G^*)$, $\frac{p^*+q^*+\delta(G^*)+1}{\Delta(G^*)-1} \leq l_i \leq \frac{p^*+q^*+\delta(G^*)+1}{\Delta(G^*)-1} + \frac{p^*+q^*+\Delta(G^*)}{\delta(G^*)}$ and let l_i, l_j be any two vertices of G^* such





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that if $l_i > l_j$ then $\frac{p^*+q^*+\delta(G^*)+1}{\Delta(G^*)-1} - [\delta(G^*)]^2 \leq l_i - l_j \leq \frac{p^*+q^*+\Delta(G^*)}{\delta(G^*)}$. Hence l_i is distinctive from each other.

Lemma 2.6. Let H^* be a simple connected undirected kite graph with \tilde{p} vertices and \tilde{q} edges, which satisfy palindromic antimagic labeling, then for any vertex m_i in $V(H^*)$, $\frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\Delta(H^*)-1} - \frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\delta(H^*)+1} \leq m_i \leq \frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\Delta(H^*)-1} + \Delta(H^*)[\delta(H^*)+1]$ and let m_i, m_j be any two vertices of H^* such that if $m_i > m_j$ then $\frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\Delta(H^*)-1} - \frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\delta(H^*)+1} - \frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\delta(H^*)+1} \leq m_i - m_j \leq \frac{\tilde{p}+\tilde{q}+\delta(H^*)}{\Delta(H^*)-1} + \frac{\tilde{p}+\tilde{q}+2[\Delta(H^*)]-\delta(H^*)}{\delta(H^*)-1}$. Hence m_i is distinctive from each other.

Theorem 2.7. The join of two palindromic antimagic labeled graph G^* and H^* is a Palindromic antimagic.

Proof. Let G^* represent a House graph and H^* represent a Kite graph. The join of two graphs G^* and H^* is represented as $G^* + H^*$. The vertex set of $G^* + H^*$ is the combination of the vertex sets of G^* and H^* , denoted as $V(G^* + H^*) = V(G^*) + V(H^*)$. Similarly, the edge set of $G^* + H^*$ is the combination of the edge sets of G^* and H^* , along with the neighborhoods of any vertex l_i and m_i in the graph $G^* + H^*$, indicated as $E(G + H) = E(G) + E(H) + N(l_i) + N(m_i)$. The given graph, denoted as $G^* + H^*$, has a vertex set of size $p^* + \tilde{p}$ and an edge set of size $q^* + \tilde{q} + p^*\tilde{p}$. We shall assign the identical names to the vertices of $G^* + H^*$ as the vertices of G^* and the vertices of H^* , which will be represented by o_{ij} . The edges of $G^* + H^*$ are named the same as the edges of G^* and H^* . The edges that connect the vertices of these two graphs are labeled ε_i^* for all values of i such that $1 \leq i \leq p^*\tilde{p}$. In this discussion, we shall examine the process of assigning labels to the edges in graphs. We will name the edges ε_i^* , name ε_1^* to $\varepsilon_{\tilde{p}}^*$ to the edges whose incident with $l_{\delta(H^*)}$, clepe $\varepsilon_{p^*+1}^*$ to $\varepsilon_{p^*[\delta(G^*)]}^*$ to the edges whose incident with $l_{\delta(G^*)}$, naming $\varepsilon_{[p^*(\delta(G^*)+\delta(H^*))]}^*$ to $\varepsilon_{[p^*(\delta(G^*+H^*)-\Delta(G^*))]}^*$ to the edges whose incident with $l_{\delta(G^*+H^*)-\Delta(G^*)}$, baptite $\varepsilon_{[p^*(\delta(G^*+H^*)-\Delta(G^*))+\delta(H^*)]}^*$ to $\varepsilon_{[p^*(p^*-\delta(H^*))]}^*$ to the edges whose incident with $l_{(p^*-\delta(H^*))}$, name $\varepsilon_{[p^*(p^*-\delta(H^*))+\delta(H^*)]}^*$ to $\varepsilon_{p^*\tilde{p}}^*$ to the edges whose incident with $l_{\Delta(G^*+H^*)-\Delta(H^*)}$. All of these names will be assigned in a clockwise direction.

To establish the palindromic antimagic property of the labeled graph $G^* + H^*$, it is necessary to provide labels to the edges of $G^* + H^*$.

$$\varphi''': E(G^* + H^*) \rightarrow \{p_1, p_2, \dots, p_{q^*+\tilde{q}+p^*\tilde{p}}\} \text{ defined}$$

$$E(G^* + H^*) = \begin{cases} e_a^* = \{e_1^*, e_2^*, \dots, e_{q^*}^*\} = \{p_{q^*}, p_{q^*-1}, \dots, p_1\} \text{ by eqn (7)} \\ \tilde{e}_b = \{\tilde{e}_1, \tilde{e}_2, \dots, \tilde{e}_{\tilde{q}}\} = \{p_{q^*+\tilde{q}}, p_{q^*+\tilde{q}-1}, \dots, p_{q^*+1}\} \\ \varepsilon_i^* = \{\varepsilon_1^*, \varepsilon_2^*, \dots, \varepsilon_{q^*+\tilde{q}+p^*\tilde{p}}^*\} = \{p_{q^*+\tilde{q}+1}, p_{q^*+\tilde{q}+2}, \dots, p_{q^*+\tilde{q}+p^*\tilde{p}}\} \end{cases} \quad (11)$$

The vertex labeling of the graph $G^* + H^*$ is sum of the incident edges of the corresponding vertex. Let o_{ij} represent any vertex of the vertex set $V(G^* + H^*)$ then

$$p^*[(\Delta(H^*)\delta(G^*)(\tilde{p} + q^*)) + \delta(H^*)] \leq o_{ij} \leq p^*[(\Delta(H^*)\delta(G^*)(\tilde{p} + q^*)) + \delta(H^*)] + \{\delta(G^*)[p^*(\Delta(G^*) - \delta(H^*))](q^* + \delta(H^*)^{\delta(G^*)}) + \delta(H^*)\} + \delta(H^*)$$

and let o_{ij} and o'_{ij} be any vertices of $G^* + H^*$ such that if $o_{ij} > o'_{ij}$ then

$$l_{\Delta(G^*-H^*)-\Delta(H^*)} > l_{p^*-\delta(H^*)} > w_{\delta(H^*)} > w_{\delta(G^*)} > w_{\delta(G^*-H^*)-\Delta(G^*)} > l_{\delta(G^*-H^*)-\Delta(G^*)} > w_{p^*-\delta(H^*)} > w_{\Delta(G^*-H^*)-\Delta(H^*)} > l_{\delta(G^*)} > l_{\delta(H^*)} \text{ thus,}$$

$$\delta(G^* + H^*) \leq o_{ij} - o'_{ij} \leq \{\delta(G^*)[p^*(\Delta(G^*) - \delta(H^*))](q^* + \delta(H^*)^{\delta(G^*)}) + \delta(H^*)\} + \delta(H^*)$$





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Therefore, the distinction between the labeling of $G^* + H^*$ is evident. The join of two Palindromic antimagic graphs, designated as $(G^*$ and $H^*)$ results in an entirely Palindromic antimagic graph.

Theorem 2.8. The Fusion of non adjacent vertices of Palindromic antimagic labeled join graph $(G^* + H^*)$ is a Palindromic antimagic.

Proof. This theorem aims to establish the palindromic antimagic property of the fusion of non- adjacent vertices in the graph $G^* + H^*$. The fusion of graph $G^* + H^*$ has $|V| = p^* + \tilde{p} - 1$, $|E| = q^* + \tilde{q} + p^*\tilde{p}$. Prior to demonstrating the property of palindromic antimagicness, We aim to determine the adjacency function of graph $G^* + H^*$,

$$\begin{cases}
 N(l_{\delta(H^*)}) = l_{\delta(G^*)}, l_{\Delta(G^*-H^*)-\Delta(H^*)}, V(H^*) \\
 N(l_{\delta(G^*)}) = l_{\delta(H^*)}, l_{\delta(G^*-H^*)-\Delta(G^*)}, l_{\Delta(G^*-H^*)-\Delta(H^*)}, V(H^*) \\
 N(l_{\delta(G^*-H^*)-\Delta(G^*)}) = l_{\delta(G^*)}, l_{p^*-\delta(H^*)}, V(H^*) \\
 N(l_{p^*-\delta(H^*)}) = l_{\delta(G^*-H^*)-\Delta(G^*)}, l_{\Delta(G^*-H^*)-\Delta(H^*)}, V(H^*) \\
 N(l_{\Delta(G^*-H^*)-\Delta(H^*)}) = l_{\delta(G^*)}, l_{\delta(H^*)}, l_{p^*-\delta(H^*)}, V(H^*) \\
 N(m_{\delta(H^*)}) = V(G^*), m_{\delta(G^*)}, m_{\delta(G^*-H^*)-\Delta(G^*)}, m_{p^*-\delta(H^*)} \\
 N(m_{\delta(G^*)}) = V(G^*), m_{\delta(H^*)}, m_{\delta(G^*-H^*)-\Delta(G^*)} \\
 N(m_{\delta(G^*-H^*)-\Delta(G^*)}) = V(G^*), m_{\delta(H^*)}, m_{\delta(G^*)}, m_{p^*-\delta(H^*)} \\
 N(m_{p^*-\delta(H^*)}) = V(G^*), m_{\delta(H^*)}, m_{\delta(G^*-H^*)-\Delta(G^*)}, m_{\Delta(G^*-H^*)-\Delta(H^*)} \\
 N(m_{\Delta(G^*-H^*)-\Delta(H^*)}) = V(G^*), m_{p^*-\delta(H^*)}
 \end{cases} \tag{12}$$

where $N(l_i)$ and $N(m_i)$ is a neighbourhood of those vertices. In order to determine the palindromic antimagic attribute of the fusion of $G^* + H^*$, it is necessary to assign labels to the edges in accordance with equation (11). The vertex labeling of newly fused graphs is determined by summing the edges incident to each vertex.

Case(i):

Let $Fu_1(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $l_{\delta(H^*)}, l_{\delta(G^*-H^*)-\Delta(G^*)}$ into $l_{\delta(H^*)}, l_{\delta(G^*-H^*)-\Delta(G^*)}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_1(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{\delta(G^*)[\delta(G^*)\Delta(H^*)((\Delta(H^*)^{\Delta(G^*)}\delta(G^*)) - \delta(H^*))]\} +$

$(\tilde{q} + p^*)\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_1(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $\delta(G^*) \leq o_{ij} - o'_{ij} \leq \{\delta(G^*)[\delta(G^*)\Delta(H^*)((\Delta(H^*)^{\Delta(G^*)}\delta(G^*)) - \delta(H^*))]\} + (\tilde{q} + p^*)\}$.

From the above inequality the vertex labelling of $Fu_1(G^* + H^*)$ is couplet disparate. Hence $Fu_1(G^* + H^*)$ is palindromic antimagic.

Case(ii):

Let $Fu_2(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $l_{\delta(H^*)}, l_{p^*-\delta(H^*)}$ into $l_{\delta(H^*)}, l_{p^*-\delta(H^*)}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_2(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{\delta(G^*)[\delta(G^*)\Delta(H^*)((\Delta(H^*)^{\Delta(G^*)}\delta(G^*)) - \delta(H^*))]\} +$

$(\tilde{q} + p^*)\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_1(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $\Delta(H^*) \leq o_{ij} - o'_{ij} \leq \{\delta(G^*)[\delta(G^*)\Delta(H^*)((\Delta(H^*)^{\Delta(G^*)}\delta(G^*)) - \delta(H^*))]\} + (\tilde{q} + p^*)\}$.

From the above inequality the vertex labeling of $Fu_2(G^* + H^*)$ is couplet disparate. Hence $Fu_2(G^* + H^*)$ is palindromic antimagic.





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Case(iii):

Let $Fu_2(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $l_{\delta(G^*), l_{p^*-\delta(H^*)}}$ into $l_{\delta(G^*), l_{p^*-\delta(H^*)}}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_2(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{[\tilde{p}^{\delta(G^*)}\delta(G^*)\Delta(H^*)(\tilde{q} + \delta(H^*))] + (q^* - \tilde{p})\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_2(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $\{(q^* + \delta(H^*))p^*\} \leq o_{ij} - o'_{ij} \leq \{[\tilde{p}^{\delta(G^*)}\delta(G^*)\Delta(H^*)(\tilde{q} + \delta(H^*))] + (q^* - \tilde{p})\}$. From the above inequality the vertex labeling of $Fu_2(G^* + H^*)$ is couplet disparate. Hence $Fu_2(G^* + H^*)$ is palindromic antimagic.

Case(iv):

Let $Fu_4(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $l_{\delta(G^* - H^*)-\Delta(G^*), l_{\Delta(G^* - H^*)-\Delta(H^*)}}$ into $l_{\delta(G^* - H^*)-\Delta(G^*), l_{\Delta(G^* - H^*)-\Delta(H^*)}}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_4(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{\delta(G^*)^{\delta(H^*)+1}[\delta(G^*)^{\delta(H^*)+1}[(\delta(G^*)p^*\Delta(H^*)) + \delta(H^*)]] - (q^* - \tilde{p})\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_4(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $\{\Delta(G^* + H^*) + \delta(G^* + H^*) + \tilde{p}\} \leq o_{ij} - o'_{ij} \leq \{\delta(G^*)^{\delta(H^*)+1}[\delta(G^*)^{\delta(H^*)+1}[(\delta(G^*)p^*\Delta(H^*)) + \delta(H^*)]] - (q^* - \tilde{p})\}$. From the above inequality the vertex labeling of $Fu_4(G^* + H^*)$ is couplet disparate. Hence $Fu_4(G^* + H^*)$ is palindromic antimagic.

Case(v):

Let $Fu_5(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $m_{\delta(H^*), m_{\Delta(G^* - H^*)-\Delta(H^*)}}$ into $m_{\delta(H^*), m_{\Delta(G^* - H^*)-\Delta(H^*)}}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_5(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq$

$o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{\delta(G^*)[p^*\delta(G^*)^{\Delta(H^*)+\delta(H^*)}\Delta(G^*)^{\delta(H^*)}] + (q^* - \tilde{p})\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_5(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $(q^* + \tilde{p}) \leq o_{ij} - o'_{ij} \leq \{\delta(G^*)[p^*\delta(G^*)^{\Delta(H^*)+\delta(H^*)}\Delta(G^*)^{\delta(H^*)}] + (q^* - \tilde{p})\}$. From the above inequality the vertex labeling of $Fu_5(G^* + H^*)$ is couplet disparate. Hence $Fu_5(G^* + H^*)$ is palindromic antimagic.

Case(vi):

Let $Fu_6(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $m_{\delta(G^*), m_{p^*-\delta(H^*)}}$ into $m_{\delta(G^*), m_{p^*-\delta(H^*)}}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_6(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{(\delta(G^*)^{\delta(H^*)+1}\tilde{p}[(\delta(G^*)\tilde{p}(q^* + \delta(H^*))) + \delta(H^*)]) + (q^* - \tilde{p})\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_6(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $(q^* + \tilde{p}) \leq o_{ij} - o'_{ij} \leq \{(\delta(G^*)^{\delta(H^*)+1}\tilde{p}[(\delta(G^*)\tilde{p}(q^* + \delta(H^*))) + \delta(H^*)]) + (q^* - \tilde{p})\}$. From the above inequality the vertex labeling of $Fu_6(G^* + H^*)$ is couplet disparate. Hence $Fu_6(G^* + H^*)$ is palindromic antimagic.





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Case(vii):

Let $Fu_7(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $m_{\delta(G^*)}, m_{\Delta(G^* - H^*) - \Delta(H^*)}$ into $m_{\delta(G^*)}m_{\Delta(G^* - H^*) - \Delta(H^*)}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_7(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{[\delta(G^*)^{\tilde{p}}[(\delta(G^*)\Delta(H^*)(q^* + \delta(H^*)) + \delta(H^*))]] + (\tilde{q} - p^*)\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_7(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $(\tilde{q} + p^*) \leq o_{ij} - o'_{ij} \leq \{[\delta(G^*)^{\tilde{p}}[(\delta(G^*)\Delta(H^*)(q^* + \delta(H^*)) + \delta(H^*))]] + (\tilde{q} - p^*)\}$. From the above inequality the vertex labeling of $Fu_7(G^* + H^*)$ is couplet disparate. Hence $Fu_7(G^* + H^*)$ is palindromic antimagic.

Case(viii):

Let $Fu_8(G^* + H^*)$ be a fused graph of $G^* + H^*$ formed by replacing the vertices $m_{\delta(G^* - H^*) - \Delta(G^*)}, m_{\Delta(G^* - H^*) - \Delta(H^*)}$ into $m_{\delta(G^* - H^*) - \Delta(G^*)}m_{\Delta(G^* - H^*) - \Delta(H^*)}$ with $p^* + \tilde{p} - 1$ vertices $q^* + \tilde{q} + p^*\tilde{p}$ edges, then for any vertex o_{ij} in $Fu_8(G^* + H^*)$, $\{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} \leq o_{ij} \leq \{\tilde{p}\delta(G^*)^{\Delta(H^*)}(\Delta(G^* + H^*) + \tilde{p})\} + \{(\delta(G^*)p^*[\tilde{p}\delta(G^*)\tilde{p}(p^* + q^* + \delta(G^*)) + \delta(H^*)]] + (\tilde{q} - p^*)\}$. Let o_{ij} and o'_{ij} be any two vertices of $Fu_8(G^* + H^*)$ such that $o_{ij} > o'_{ij}$ then $(\tilde{q} + p^*) \leq o_{ij} - o'_{ij} \leq \{(\delta(G^*)p^*[\tilde{p}\delta(G^*)\tilde{p}(p^* + q^* + \delta(G^*)) + \delta(H^*)]] + (\tilde{q} - p^*)\}$. From the above inequality the vertex labeling of $Fu_8(G^* + H^*)$ is couplet disparate. Hence $Fu_8(G^* + H^*)$ is palindromic antimagic.

Therefore, based on the aforementioned eight cases, it can be concluded that the fusion of non-adjacent vertices of a Palindromic antimagic labeled join graph $(G^* + H^*)$ results in a Palindromic antimagic graph.

CONCLUSIONS

This article presents a conclusion regarding the join operation applied to two palindromic antimagic labeled graphs, G and H . Additionally, it explores the fusion of non adjacent vertices within these graphs and establishes that the resulting graphs likewise exhibit palindromic antimagic properties. Furthermore, consider two additional graphs, G^* and H^* . In this study, we propose the introduction of a novel concept known as palindromic antimagic labeling. By combining this idea with graph operations on certain classes of graphs, we are able to identify numerous open problems. It is evident that these findings can be further developed and extended to various additional classes of graphs.

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Contra Continuity Via Soft Lattice Topological Spaces

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

A novel mathematical method for analyzing uncertainty is the generalization of soft sets in soft lattices. Extension of a soft lattice L and a set of fixed parameters A is Soft L -topological spaces. The mapping of soft L -topological spaces continuity has also been researched. It is known how to invoke the function $f: L_1 \rightarrow L_2$ is Contra-Continuous if the pre-image of every open set is closed. By using this fundamental idea, we create the Soft L -contra continuous and relate it to the Soft L -kernel set of Soft L -topological Spaces. We have now seen several soft L -kernel set notions. We also achieved novel interactions between such notions. The logic of Soft L -contra continuous mapping in Soft L -topological spaces is also investigated in this study.

Keywords: Soft sets, soft lattice, Sub lattice, soft L -mapping, soft L -continuous, soft L -contra continuous.

INTRODUCTION

Molodtsov[8], first put forward the system of soft theory in 1999 as a framework for mathematics that addresses doubtfulness while illustrating hurdles in science and technology cases such as the field of physics, science of computers, economics, and other disciplines. Maji et al.,[7] 2003 the core concepts of soft theory were developed and debated. Shabir and Naz,[14] 2011 began the study of soft topological spaces (on short SLTS). Following the





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presumption of soft sets, soft lattices (on short SL) as a layout has emerged. F. Li [6] investigated, outlined, and provided the fundamental principles of soft lattices. Additionally, E. Kuppuswamy [9] used soft sets to lattices in 2011. As a supplement to what F. Li has done, E. Kuppuswamy has taken a new approach to SL. Operations on SL and their characteristics were examined in 2013 by V. D. Jobish, K. V. Babitha, and Sunil Jacob John [5]. Numerous theorems about different kinds of unions, intersections, and complements are established, notably De Morgan’s Laws. Modern topology heavily relies on the concepts of soft theory. In 2016, soft continuous mappings (on short SCM) emerged by Cigedem Gunduz Aras, Ayse Sonmez, and Husey in Cakalli. Numerous writers have investigated some of its characteristics. With their qualities, H. Hazra, P. Majumdar, and S. K. Samanta defined the continuity of soft mapping (on short SM) in 2012. Yang et al. pioneered the idea of SCM between two STS. for the first time in 2015. Soft lattice topological spaces (on short SLTS), which are declared over a SL L with a given set of parameters A and are also a generalization of STS, were recently developed in 2021 by Sandhya S. Pai and T. Baiju [10]. The thoughts of soft lattice continuous mapping (on short SLCM) (soft L-continuous mapping) in SLTS was also covered indepth, along with the concepts of SL-open and closed sets (on short SLO and SLC), SL-closure, SL-interior point, and SL-neighborhood (on short SLN), in the year 2022. Then, in 2023[1], we keep looking into a SL-interior, SL-exterior, and SL- border in the work extension of SL-sets which is essential for more study on soft lattice topology. Dontchev [3] first presented the contra continuous functions in 1996. Contra-open and Contra-closed were familiarised by Baker in 1997[2]. In the final analysis, we argued soft lattice contra continuous conclusions in SLTS in this study. On specified SLTS, we additionally conversed SL contra-open and SLT contra-closed mapping, and some intriguing results resulted. The basic point of the theory of SLTS will be strengthened as a result.

PRELIMINARIES

Definition 2.1: [12] Consider (L, θ, A) be a STS, G_A^L be a SL and $x \in L$. G_A^L is stated as SLN of x if \exists a SLO set $F_A^L \ni x \in F_A^L \subseteq G_A^L$.

Proposition 2.1:[12] Consider (L, θ, A) be a SL- space. The set $\theta_a = \{f(a) \mid F_A^L \in \theta\} \forall a \in A$ conveys a topology on L.

Definition 2.2:[12] Consider (L, θ, A) be a SLTS and Z be a non-empty subset of L. Then $\theta_Z = \{ZF_A^L \mid F_A^L \in \theta\}$ is stated to be the soft relative lattice topology on Z and (Z, θ_Z, A) is called a SL-subspace of F_A^L .

Definition 2.3:[12] We have F_A^L as a SL which is a SL- point expressed (l_a, A) for the element $a \in A$, $f(a) = \{l\}$ and $f(a') = \emptyset \forall a' \in A - \{a\}$.

Definition 2.4:[12] Let $\gamma_g: L_1 \rightarrow L_2$. Then

- 1) The SL-set mapping induced by γ_g , denoted γ_g^{\rightarrow} is a SM from $S_{L_1}(X)$ to $S_{L_2}(Y)$ that maps F_A^L to $\gamma_g^{\rightarrow}(F_A^L) = (\gamma_g^{\rightarrow}(F^L), A)$, where $\gamma_g^{\rightarrow}(F_A^L)$ is defined by $\gamma_g^{\rightarrow}(F^L)(\zeta) = \{\gamma_g(l) \mid l \in (F^L)(\zeta)\} \forall \zeta \in A$.
- 2) The inverse SL-set mapping induced by γ_g denoted by the notation γ_g^{\leftarrow} , that maps G_A^L to $\gamma_g^{\leftarrow}(G_A^L) = (\gamma_g^{\leftarrow}(G^L), A)$, where $\gamma_g^{\leftarrow}(G_A^L)$ is defined by $\gamma_g^{\leftarrow}(G^L)(\zeta) = \{l \mid \gamma_g(l) \in (G^L)(\zeta)\} \forall \zeta \in A$.

Example 2.1:[12] Suppose $L_1 = \{U_1, U_2, U_3\}$, $L_2 = \{W_1, W_2, W_3\}$, $A = \{Q_1, Q_2\}$. The γ_g is conveyed by $\gamma_g(U_1) = W_1$, $\gamma_g(U_2) = W_3$, $\gamma_g(U_3) = W_2$.

- 1) If $F_A^L \in S_{L_1}(X)$ is defined by $\{\gamma(Q_1) = \{U_2\}, \gamma(Q_2) = \{U_1\}\}$, then $\gamma_g^{\rightarrow}(F_A^L) = (\gamma_g^{\rightarrow}(F^L), A) = \{\gamma_g^{\rightarrow} f(Q_1) = \{W_3\}, \gamma_g^{\rightarrow} f(Q_2) = \{W_1\}\} \in S_{L_2}(Y)$.
- 2) If $G_A^L \in S_{L_2}(X)$ is defined by $\{g(Q_1) = \{W_2\}, g(Q_2) = \{W_1\}\}$, then $\gamma_g^{\leftarrow}(G_A^L) = (\gamma_g^{\leftarrow}(G^L), A) = \{\gamma_g^{\leftarrow} g(Q_1) = \{U_3\}, \gamma_g^{\leftarrow} g(Q_2) = \{U_1\}\} \in S_{L_1}(X)$.

Proposition 2.2: [12] Let us consider $\gamma_g: X \rightarrow Y$, $F_{1A}^L, F_{2A}^L \in S_{L_1}(X)$. then

- 1) $\gamma_g^{\rightarrow}(\phi_A^L) = \phi_A^L$





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- 2) $F_{1A}^L \subset F_{2A}^L \Rightarrow \gamma_g^{\rightarrow}(F_{1A}^L) \subset \gamma_g^{\rightarrow}(F_{2A}^L)$
- 3) $\gamma_g^{\rightarrow}(F_{1A}^L \cup F_{2A}^L) = \gamma_g^{\rightarrow}(F_{1A}^L) \cup \gamma_g^{\rightarrow}(F_{2A}^L)$
- 4) $\gamma_g^{\rightarrow}(F_{1A}^L \cap F_{2A}^L) \subset \gamma_g^{\rightarrow}(F_{1A}^L) \cap \gamma_g^{\rightarrow}(F_{2A}^L)$

Proposition 2.3: [12] Let us consider $\gamma_g: X \rightarrow Y, G_{1A}^L, G_{2A}^L \in S_{L_2}(Y)$. then

- 1) $\gamma_g^{\leftarrow}(\phi_A^L) = \phi_A^L, \gamma_g^{\leftarrow}(L_2) = L_1$
- 2) $G_{1A}^L \subset G_{2A}^L \Rightarrow \gamma_g^{\leftarrow}(G_{1A}^L) \subset \gamma_g^{\leftarrow}(G_{2A}^L)$
- 3) $\gamma_g^{\leftarrow}(G_{1A}^L \cup G_{2A}^L) = \gamma_g^{\leftarrow}(G_{1A}^L) \cup \gamma_g^{\leftarrow}(G_{2A}^L)$
- 4) $\gamma_g^{\leftarrow}(G_{1A}^L \cap G_{2A}^L) \subset \gamma_g^{\leftarrow}(G_{1A}^L) \cap \gamma_g^{\leftarrow}(G_{2A}^L)$
- 5) $\gamma_g^{\leftarrow}(G_{1A}^L)^c = (\gamma_g^{\leftarrow}(G_{1A}^L))^c$.

Proposition 2.4: [12] Consider $\gamma_g: X \rightarrow Y, F_A^L \in S_{L_1}(X)$ and $G_A^L \in S_{L_2}(Y)$. Then

- 1) $\gamma_g^{\leftarrow}(\gamma_g^{\rightarrow}(F_A^L)) \supseteq F_A^L$. If γ_g is injective, then $\gamma_g^{\leftarrow}(\gamma_g^{\rightarrow}(F_A^L)) = F_A^L$.
- 2) $\gamma_g^{\rightarrow}(\gamma_g^{\leftarrow}(G_A^L)) \subseteq G_A^L$. If γ_g is surjective, then $\gamma_g^{\rightarrow}(\gamma_g^{\leftarrow}(G_A^L)) = G_A^L$.

SOFT LATTICE CONTRA CONTINUOUS

Definition 3.1: Let (L_1, θ_1, A) and (L_2, θ_2, A) be two SLTS, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$, where $\gamma: L_1 \rightarrow L_2$ and $g: A \rightarrow A$ be a mapping. If the Inverse-image of each SLO set F_A^L over L_2 is SLC set in L_1 , then γ_g is soft L-contra continuous (on short SLCC) function.

Theorem 3.1: Let us consider the two SLTS (L_1, θ_1, A) and (L_2, θ_2, A) . The mapping γ_g is called a SLM from $L_1 \rightarrow L_2$ denoted by $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$. For each SLN (G_A^L) of $(\gamma(L_1), A)$, \exists a SLC (F_A^L) of $(l_a, A) \ni \gamma_g(H_A^L) \subseteq G_A^L$, if and only if γ_g is said to be SLCCM at (l_a, A) .

Proof: To prove: γ_g is SLCC. Consider G_A^L be a SLO set over L_2, \exists SLC set $(l_a, A) \in F_A^L \ni \gamma_g(F_A^L) \subseteq G_A^L, F_A^L \subseteq \gamma_g^{-1}(G_A^L). \gamma_g^{-1}(G_A^L) = \cup_{\gamma_g^{-1}(l_a, A) \in G_A^L} \{F_A^L \mid F_A^L \text{ is SLC in } L_1\}$. Hence, $\gamma_g^{-1}(G_A^L)$ is SLC in L_1 . As a result, γ_g is SLCCM at (l_a, A) .

Conversely, let us G_A^L be a arbitrary SLN in L_2 containing $(\gamma(l_a), A)$. Then $(l_a, A) \in \gamma_g^{-1}(G_A^L)$ is a SLC and $\gamma_g(\gamma_g^{-1}(G_A^L)) \subseteq G_A^L, \gamma_g(H_A^L) \subseteq G_A^L$ where, H_A^L is a SLC in L_1 .

Theorem: 3.2: Let $\gamma_g: L_1 \rightarrow L_2$ be a function. Then as a result of are equivalent.

- (1) γ_g is a SLCC function.
- (2) On every SL-point (l_a, A) and each SLC set G_A^L in L_2 containing $(\gamma(l_a), A) \exists$ a SLO set F_A^L in L_1 containing $(l_a, A) \ni \gamma_g(F_A^L) \subseteq G_A^L$.
- (3) The inverse image of every SLC set in L_2 is SLO set in L_1 .
- (4) $\overline{(\gamma_g^{-1}(F_A^L))} = \overline{(\gamma_g^{-1}(F_A^L))}$ as an each SLC set F_A^L in L_2 .
- (5) $\overline{(\gamma_g^{-1}(G_A^L))} = \overline{(\gamma_g^{-1}(G_A^L))}$ as an each SLO set G_A^L in L_2 .

Proof: (1) \Rightarrow (2) Let $\gamma_g: L_1 \rightarrow L_2$ be SLCC. Let (l_a, A) be a SLO set and G_A^L be a SLC set in L_2 containing $(\gamma(l_a), A)$. Then H_A^L is a SLO set in L_2 not containing $(\gamma(l_a), A)$. γ_g is SLCC. i.e., $(\gamma_g^{-1}(H_A^L))$ is SLC set in L_1 not containing (l_a, A) . Thus, $F_A^L = (\gamma_g^{-1}(G_A^L))$ is the SLO set in L_1 containing $(l_a, A) \ni \gamma_g(F_A^L) \subseteq G_A^L$. This proves the statement (2).

(2) \Rightarrow (3) Let G_A^L be a SLC set in L_2 . Let SL point $(l_a, A) \in \gamma_g^{-1}(G_A^L)$, then $(\gamma(l_a), A) \in G_A^L$. Aside (2), there is SLO set F_A^L in L_1 containing $F_A^L \ni (l_a, A) \in \gamma_g^{-1}(l_a, A) \subseteq G_A^L$. i.e., $F_A^L \subseteq \gamma_g^{-1}(G_A^L)$. Hence, $\gamma_g^{-1}(G_A^L) = \cup_{(l_a, A) \in \gamma_g^{-1}(G_A^L)} \{F_A^L \mid F_A^L \text{ is a SLO set containing } (l_a, A)\}$. Therefore, $\gamma_g^{-1}(G_A^L)$ is SLO in L_1 . This proves the statement (3).

(3) \Rightarrow (4) Let F_A^L be a SLC set in L_2 . $\gamma_g^{-1}(F_A^L)$ is SLO in L_1 . $(\gamma_g^{-1}(F_A^L))^{\circ} = \gamma_g^{-1}(F_A^L)$. Taking closure, $\overline{(\gamma_g^{-1}(F_A^L))} = \overline{(\gamma_g^{-1}(F_A^L))}$. This proves the statement (4).





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(4) ⇒ (5) Let G_A^L be a SLO set in L_2 . Then $L_2 \setminus G_A^L$ is SLC in L_2 . According to (4),

$(\overline{\gamma_g^{-1}(L_2 \setminus G_A^L)})^\circ = \overline{L_1 \setminus \gamma_g^{-1}(G_A^L)}$. By taking complements, we get

$(\overline{\gamma_g^{-1}(G_A^L)})^\circ = (\gamma_g^{-1}(G_A^L))^\circ$. This proves the statement(5).

(5) ⇒ (1) Let G_A^L be a SLO set in L_2 , to prove, $\overline{\gamma_g^{-1}(G_A^L)}$ is SLC in L_1 . Then we take

$(\overline{\gamma_g^{-1}(G_A^L)})^\circ = (\gamma_g^{-1}(G_A^L))^\circ \Rightarrow \overline{(\gamma_g^{-1}(G_A^L))^\circ} = \overline{\gamma_g^{-1}(G_A^L)}$. This implies $\overline{\gamma_g^{-1}(G_A^L)}$ is a SLC set in L_1 . Hence γ is SLCC This proves the statement (1).

Definition 3.2 We consider (L, θ, A) as a SLTS and F_A^L be a SL set. Thereafter the SL kernel of F_A^L indicated by $SL \ker F_A^L$, is the intersection of all SLO super sets of F_A^L . $SL \ker (F_A^L)$ is the smallest SLO set over L which contains F_A^L .

Theorem: 3.3

- (1) $F_A^L \subseteq SL \ker F_A^L$.
- (2) F_A^L is the SLO set if and only if $SL \ker F_A^L = F_A^L$.
- (3) $F_A^L \subseteq G_A^L$ which implies $SL \ker F_A^L \subseteq SL \ker G_A^L$.

Proof

- (1) is Obvious.
- (2) If F_A^L is a SLO set then, F_A^L is itself SLO set containing F_A^L . So, F_A^L is the smallest SL-set containing F_A^L and $F_A^L = SL \ker F_A^L$. Conversely, suppose that $F_A^L = SL \ker F_A^L$. Since, intersection of all SLO set is SLO. So, $SL \ker F_A^L$ is SLO over L .
- (3) Suppose that $F_A^L \subseteq G_A^L$. Then every SLO super set of G_A^L will also contain F_A^L . Which implies every SLO super set of G_A^L is also SLO super set of F_A^L . Hence, the intersection of SLO super set of F_A^L is contained in the intersection of SLO super sets of G_A^L . Thus, $SL \ker F_A^L \subseteq SL \ker G_A^L$.

Theorem: 3.4 We know that (L_1, θ_1, A) and (L_2, θ_2, A) are two Soft Lattice Topological Spaces, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$ be a mapping. Then as a result of are equivalent.

- (1) $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$ is soft lattice contra continuous mapping.
- (2) On every SLC set G_A^L over L_2 , $\gamma_g^{-1}(G_A^L)$ is a SLO set over L_1 .
- (3) On every SL-set F_A^L over L_2 , $\gamma_g(SL \ker F_A^L) \subseteq \overline{\gamma_g(F_A^L)}$
- (4) On every SL-set G_A^L over L_2 , $SL \ker (\gamma_g^{-1}(G_A^L)) \subseteq \overline{\gamma_g^{-1}(G_A^L)}$.
- (5) On every SL-set G_A^L over L_2 , $(SL \ker (\gamma_g^{-1}(G_A^L)))' \supseteq \overline{\gamma_g^{-1}(G_A^L)}^\circ$.

Proof:

- (1) ⇔ (2) are obvious.
- (2) ⇒ (3) Let $y \notin \gamma_g(F_A^L)$. $y \notin H_A^L$ for some SLC set H_A^L , $\exists \gamma_g(F_A^L) \subseteq H_A^L$. $\gamma_g^{-1}(y) \notin \gamma_g^{-1}(H_A^L)$ for some SLO $\gamma_g^{-1}(H_A^L)$, $\exists F_A^L \subseteq \gamma_g^{-1}(H_A^L)$. $\gamma_g^{-1}(y) \notin SL \ker(F_A^L)$, $y \notin \gamma_g(SL \ker(F_A^L))$, which implies $\gamma_g(SL \ker(F_A^L)) \subseteq \overline{\gamma_g(F_A^L)}$.
- (2) ⇒ (4) consider, $y \notin \gamma_g^{-1}(G_A^L)$, $\gamma_g(y) \notin \overline{(G_A^L)}$. $\gamma_g(y) \notin$ intersection of all SLC set H_A^L , $\exists (G_A^L) \subseteq H_A^L$. $\gamma_g(y) \notin H_A^L$ for some SLC, $(G_A^L) \subseteq H_A^L$. $y \notin \gamma_g^{-1}(H_A^L)$ (for some SLO set $\gamma_g^{-1}(H_A^L)$, $\exists \gamma_g^{-1}(G_A^L) \subseteq \gamma_g^{-1}(H_A^L)$. $y \notin SL \ker(\gamma_g^{-1}(G_A^L))$. which implies $SL \ker(\gamma_g^{-1}(G_A^L)) \subseteq \overline{\gamma_g^{-1}(G_A^L)}$.
- (4) ⇒ (5) By using (4), $SL \ker (\gamma_g^{-1}(G_A^L)) \subseteq \overline{\gamma_g^{-1}(G_A^L)}$. By taking complements on both sides we get, $(SL \ker (\gamma_g^{-1}(G_A^L)))' \supseteq \overline{\gamma_g^{-1}(G_A^L)}^\circ$.
- (4) ⇒ (2) Let G_A^L be a SLC set in L_2 . $\overline{(G_A^L)} = G_A^L$. which implies, $\gamma_g^{-1}(\overline{(G_A^L)}) = \gamma_g^{-1}(G_A^L)$. i.e., $SL \ker(\gamma_g^{-1}(G_A^L)) \subseteq \overline{\gamma_g^{-1}(G_A^L)}$, then, $SL \ker(\gamma_g^{-1}(G_A^L)) = \overline{\gamma_g^{-1}(G_A^L)}$. Therefore, $\overline{\gamma_g^{-1}(G_A^L)}$ is SLO set in L_1 .
- (5) ⇒ (2) Let G_A^L be a SLC in L_2 . Let to prove, $\overline{\gamma_g^{-1}(G_A^L)}$ be a SLO set in L_1 . (5) ⇒ $[SL \ker (\gamma_g^{-1}(G_A^L))] \supseteq \overline{\gamma_g^{-1}(G_A^L)}^\circ$. Taking complements, $SL \ker(\gamma_g^{-1}(G_A^L)) \subseteq \overline{\gamma_g^{-1}(G_A^L)} = \overline{\gamma_g^{-1}(G_A^L)}$, ($\because, \overline{(G_A^L)} = G_A^L$) i.e., $SL \ker(\gamma_g^{-1}(G_A^L)) \subseteq \overline{\gamma_g^{-1}(G_A^L)}$. Hence, $\overline{\gamma_g^{-1}(G_A^L)}$ is SLO set in L_1 .





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(3) ⇒ (4) Let $G_A^L \in L_2, \Rightarrow \gamma_g^{-1}(G_A^L) \in L_1$. By(3), $\Rightarrow \gamma_g(\text{SL ker } (F_A^L)) \subseteq \overline{\gamma_g(F_A^L)}$, $\Rightarrow \gamma_g(\text{SL ker } (\gamma_g^{-1}(G_A^L))) \subseteq \overline{\gamma_g(\gamma_g^{-1}(G_A^L))}$. $\gamma_g(\text{SL ker } (\gamma_g^{-1}(G_A^L))) \subseteq \overline{(G_A^L)}$, $(\because, \gamma_g(\gamma_g^{-1}(G_A^L)) = \overline{(G_A^L)})$. Hence, $\text{SL ker } (\gamma_g^{-1}(G_A^L)) \subseteq \gamma_g^{-1}(\overline{(G_A^L)})$.

PROLONGATIONS OF SLCC MAPPING

We investigate the linked characteristics of the Soft Lattice Contra Continuous Mapping between two SLTS right below the segment. 'A' should be the non-void parameter whereas X and Y are the two initial universe sets. The sequence of all SL-sets over X is refers $S_{L_1}(X)$. Also, the sequence of all SL-sets over Y is meant $S_{L_2}(Y)$.

Definition 4.1 Let (L_1, θ_1, A) and (L_2, θ_2, A) be two SLTS, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$ act as mapping. Further,

- (1) If the image $\gamma_g(F_A^L)$ of every SLO set F_A^L over L_1 is a SLC set in L_2 , then γ_g is said to be a SL-Contra Open Mapping.
- (2) If the image $\gamma_g(H_A^L)$ of every SLC set H_A^L over L_1 is a SLO set in L_2 , then γ_g is said to be a SL-Contra Closed Mapping.

Definition 4.2 Consider (L_1, θ_1, A) and (L_2, θ_2, A) be two SLTS and $\gamma_g: L_1 \rightarrow L_2$. If $\forall G_A^L \in \theta_2, \gamma_g^{-1}(G_A^L) \in \theta_1'$, then γ_g is called Soft Lattice Contra Continuous Mapping from (L_1, θ_1, A) and (L_2, θ_2, A) .

Example 4.1 Let us assume that $L_1 = \{u_1, u_2, u_3\}$, $L_2 = \{h_1, h_2, h_3\}$, $A = \{Q_1, Q_2\}$ and $\theta_1 = \{\phi_A, L_1, F_{1A}^L, F_{2A}^L\}$ is a SLTS over X, where F_{1A}^L, F_{2A}^L are SL over X defined by $F_{1A}^L = \{(Q_1, \{u_2\}), (Q_2, \{u_1\})\}$, $F_{2A}^L = \{(Q_1, \{u_2, u_3\}), (Q_2, \{u_1, u_2\})\}$. Then θ_1 is SLT on X.

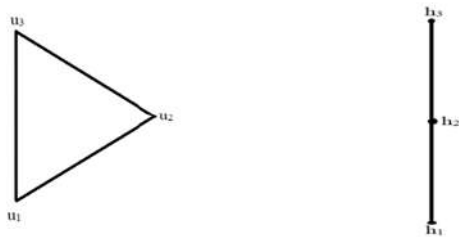


Figure.1: Complete Lattice

Also $\theta_2 = \{\phi_A, L_2, G_{1A}^L, G_{2A}^L\}$ is a SLTS over Y, where G_{1A}^L, G_{2A}^L are SL over Y defined by, $G_{1A}^L = \{(Q_1, \{h_1, h_2\}), (Q_2, \{h_1, h_3\})\}$, $G_{2A}^L = \{(Q_1, \{h_2\}), (Q_2, \{h_1\})\}$.

If $\gamma_g: L_1 \rightarrow L_2$ as $\gamma_g(u_1) = h_2, \gamma_g(u_2) = h_3, \gamma_g(u_3) = h_1$. Here $\gamma_g^{-1}(G_A^L) \in \theta_1' \forall G_A^L \in \theta_2$. Therefore SLCC, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$.

Proposition 4.1 We have $\gamma_g: (L_1, \theta_1, A)$ and (L_2, θ_2, A) as the two SLTS over X and Y accordingly. If SLCC Mapping, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$, then SCCM, $\gamma_g: (L_1, \theta_{1c}) \rightarrow (L_1, \theta_{2c}) \forall c \in A$.

Proof

Here we have, (L_1, θ_{1c}) and (L_1, θ_{2c}) are two SLTS, $\forall c \in A$. If $A' \in \theta_{2c}$, then \exists a SL-set $G_A^L \in \theta_2 \ni A' = g(c)$.

We know that γ_g is SLCCM from (L_1, θ_1, A) to (L_2, θ_2, A) , further $\gamma_g^{-1}(G_A^L) \in \theta_1'$. $\Rightarrow \gamma_g^{-1}(A') = \gamma_g^{-1}(g(c)) = \{I | \gamma_g(I) \in g(c)\} = \gamma_g^{-1}(g(c)) \in \theta_{1c}'$. As per the explanation of SCC, γ_g is a SCCM, from $(L_1, \theta_{1c}) \rightarrow (L_1, \theta_{2c}) \forall c \in A$. This claim states that a SLCCM originates in a parameterized set of SCCM.

Example 4.2 The complete lattice from the aforementioned Example: 4.1 is depicted in Figures: 4.1, Assume $L_1 = \{u_1, u_2, u_3\}$, $L_2 = \{h_1, h_2, h_3\}$, $A = \{Q_1, Q_2\}$ and $\theta_1 = \{\phi_A, L_1, F_{1A}^L, F_{2A}^L\}$ is a SLTS over X, where F_{1A}^L, F_{2A}^L are SL over X defined by $F_{1A}^L = \{(Q_1, \{u_2\}), (Q_2, \{u_1\})\}$, $F_{2A}^L = \{(Q_1, \{u_2, u_3\}), (Q_2, \{u_1, u_2\})\}$. Then θ_1 is SLT on X. Also $\theta_2 = \{\phi_A, L_2, G_{1A}^L, G_{2A}^L\}$ is a SLTS over Y, where G_{1A}^L, G_{2A}^L are SL over Y defined by, $G_{1A}^L = \{(Q_1, \{h_2\}), (Q_2, \{h_3\})\}$, $G_{2A}^L = \{(Q_1, \{h_2, h_3\}), (Q_2, \{h_1, h_3\})\}$.





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If $\gamma_g: X \rightarrow Y$ as $\gamma_g(u_1) = h_2, \gamma_g(u_2) = h_1, \gamma_g(u_3) = h_3$. Now, $\gamma_g^{\leftarrow}(G_A^L) \in \theta'_1 \forall G_A^L \in \theta_2$. Hence SLCC, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$. Using way of Theorem, $\theta_{1\rho_1} = \{\phi_A, L_1, \{u_2\}, \{u_2, u_3\}\}$, and $\theta_{1\rho_2} = \{\phi_A, L_1, \{u_1\}, \{u_1, u_2\}\}$ are two topologies on X. $\theta_{2\rho_1} = \{\phi_A, L_2, \{h_2\}, \{h_2, h_3\}\}$, and $\theta_{2\rho_2} = \{\phi_A, L_2, \{h_3\}, \{h_1, h_3\}\}$ are two topologies on Y. Consequently, SCCM $\gamma_g: (L_1, \theta_{1\rho_1})$ to $(L_2, \theta_{2\rho_1})$ and also a SCCM, $\gamma_g: (L_1, \theta_{1\rho_2})$ to $(L_2, \theta_{2\rho_2})$. The example below demonstrates that the opposite of the statement of proposition: 4.1 is not always true.

Example 4.3 In accordance with Figures: 4.1 of the complete lattice from the preceding example 4.1, Assuming $L_1 = \{u_1, u_2, u_3\}, L_2 = \{h_1, h_2, h_3\}, A = \{Q_1, Q_2\}$ and $\theta_1 = \{\phi_A, L_1, F_{1A}^L, F_{2A}^L\}$ is a SLTS over X, where $f_1(Q_1) = \{u_2\}; f_1(Q_2) = \{u_1, u_2\}$ $f_2(Q_1) = \{u_2, u_3\}; f_2(Q_2) = \{u_1\}$ $f_3(Q_1) = \{u_2\}; f_3(Q_2) = \{u_1\}$. Then θ_1 is a SLT on L_1 and for that reason (L_1, θ_1, A) is a SLTS over X. For $L_2 = \{h_1, h_2, h_3\}$; and let $\theta_2 = \{\phi_A, L_2, G_{1A}^L\}$, in which SL-set G_{1A}^L over Y stated by $g_1(Q_1) = \{h_1\}; g_1(Q_2) = \{h_2\}$. Here γ_g is a mapping from (L_1, θ_1, A) to (L_2, θ_2, A) as $\gamma_g(u_1) = h_1; \gamma_g(u_2) = h_3; \gamma_g(u_3) = h_2$. Here, by above proposition, $\theta_{1\rho_1} = \{\phi, L_1, \{u_2\}, \{u_2, u_3\}\}, \theta_{1\rho_2} = \{\phi, L_1, \{u_1\}, \{u_1, u_2\}\}$ are two topologies on X. Also, $\theta_{2\rho_1} = \{\phi_A, L_2, \{h_1\}\}, \theta_{2\rho_2} = \{\phi_A, L_2, \{h_2\}\}$ are two topologies on Y.

Thus, γ_g is a Contra Continuous Mapping from $(L_1, \theta_{1\rho_1})$ to $(L_2, \theta_{2\rho_1})$ and also from $(L_1, \theta_{1\rho_2})$ to $(L_2, \theta_{2\rho_2})$. However, $\gamma_g^{\leftarrow}(G_{1A}^L) = \{\gamma_g^{\leftarrow}(g_1)(Q_1) = \{u_1\}, \gamma_g^{\leftarrow}(g_1)(Q_2) = \{u_3\}\} \notin \theta'_1 \Rightarrow \gamma_g$ is not a SLCCM from (L_1, θ_1, A) to (L_2, θ_2, A) . The aforementioned statement describes SLCC in some terms that are equivalent.

Theorem: 4.1 Let (L_1, θ_1, A) and (L_2, θ_2, A) be a SLTS, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$ be a mapping a bijection. Then, the subsequent statement holds true.

- (i) γ_g and γ_g^{-1} both are SLCC on SLTS,
- (ii) γ_g and γ_g^{-1} both are SLCC and Soft contra closed mapping on SLTS,
- (iii) γ_g and γ_g^{-1} both are SLCC and Soft contra open mapping on SLTS.

Theorem: 4.2 Let γ_g be a bijection SLCCM, γ_g is a SL-contra openif and only if $\overline{\gamma_g(F_A^L(\alpha))} = \gamma_g(\text{SL ker}(F_A^L(\alpha)))$

Proof: Let $y \in \overline{\gamma_g(F_A^L(\alpha))}$
 $\Leftrightarrow y \in \cap$ of SLC set $H_A^L, \exists \gamma_g(F_A^L) \subseteq H_A^L$.
 $\Leftrightarrow y \in H_A^L, \gamma_g(F_A^L)(\alpha) \subseteq H_A^L$.
 $\Leftrightarrow \gamma_g^{-1}(y) \in \gamma_g^{-1}(H_A^L)$, for each SLO set $\gamma_g^{-1}(H_A^L), F_A^L(\alpha) \subseteq \gamma_g^{-1}(H_A^L)$.
 $\Leftrightarrow \gamma_g^{-1}(y) \in \cap$ SLO set $H_A^L, F_A^L(\alpha) \subseteq \gamma_g^{-1}(H_A^L)$.
 $\Leftrightarrow \gamma_g^{-1}(y) \in \text{SL ker}(F_A^L(\alpha))$
 $\Leftrightarrow y \in \gamma_g(\text{SL ker}(F_A^L(\alpha)))$. Then, $y \in \gamma_g(\text{SL ker}(F_A^L(\alpha))) \Leftrightarrow y \in \overline{\gamma_g(F_A^L(\alpha))}$.

Hence, $\overline{\gamma_g(F_A^L(\alpha))} = \gamma_g(\text{SL ker}(F_A^L(\alpha)))$.
 Conversely, Suppose $\overline{\gamma_g(F_A^L(\alpha))} = \gamma_g(\text{SL ker}(F_A^L(\alpha)))$. To prove: Image of SLO is SLC set. Let $F_A^L(\alpha)$ be a SLO in $L_1 \Rightarrow \text{SL ker } F_A^L(\alpha) = F_A^L(\alpha)$. Therefore, $\gamma_g(\text{SL ker}(F_A^L(\alpha))) = \gamma_g(F_A^L(\alpha)) \Rightarrow \overline{\gamma_g(F_A^L(\alpha))} = \gamma_g(F_A^L(\alpha))$. Hence, $\gamma_g(F_A^L(\alpha))$ is SLC in L_2 .

Proposition 4.2 If $\gamma_g: L_1 \rightarrow L_2$ is SLCC and F_A^L is SLC set in L_1 , Then the restriction $\gamma_g | F_A^L$ is SLCC.

Proof: Let G_A^L be any SLO set of L_2 . We have $[\gamma_g | F_A^L]^{-1}(G_A^L) = \gamma_g^{-1}(G_A^L) \cap F_A^L$ is SLC in L_1 . Hence, $\gamma_g | F_A^L$ is SLCC.

Proposition 4.3 We have $\gamma_g: L_1 \rightarrow L_2$ is SLCC. If L_3 is a subspace of L_2 containing the image SL-set $\gamma_g(L_1)$, then the following $\Omega_g: L_1 \rightarrow L_3$ obtained by restricting the image of γ_g is SLCC.

Proof: Consider as H_A^L be a SLO subset of L_3 . Then, $H_A^L = L_3 \cap F_A^L$, where $F_A^L \in L_2$. On the premise of $\gamma_g(L_1) \subseteq L_3$, thus we Conclude, $\gamma_g^{-1}(F_A^L) = \Omega_g^{-1}(H_A^L)$. γ_g is SLCC, $\gamma_g^{-1}(F_A^L)$ is SLC in L_1 . Therefore, $\Omega_g^{-1}(H_A^L)$ is also SLC in L_1 . Hence, Ω_g is the SLCC.

Theorem: 4.3 We have (L_1, θ_1, A) and (L_2, θ_2, A) be two SLTS, $\gamma_g: (L_1, \theta_1, A) \rightarrow (L_2, \theta_2, A)$. Then,





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- (a) γ_g is SL-contra open if for every SLO set F_A^L over L_1 , $SL \ker (\gamma_g (F_A^L))^c \subseteq [\gamma_g(F_A^L)]^c$
- (b) γ_g is SL-contra closed if for every SLC set F_A^L over L_1 , $SL \ker(\gamma_g(F_A^L)) \subseteq [\gamma_g(F_A^L)]$.

Proof:

- (a) Let, F_A^L be a SLO set in L_1 . $\Rightarrow (F_A^L)^o = F_A^L$. By given, $SL \ker (\gamma_g (F_A^L))^c \subseteq [\gamma_g (F_A^L)]^c = (\gamma_g (F_A^L))^c \Rightarrow [\gamma_g (F_A^L)]^o$ is SLO $\Rightarrow \gamma_g (F_A^L)$ is SLC.
- (b) Let, F_A^L be a SLC $\Rightarrow F_A^L = \overline{F_A^L} \Rightarrow SL \ker (\gamma_g (F_A^L)) \subseteq \overline{\gamma_g (F_A^L)} = \gamma_g (F_A^L)$. $\Rightarrow \gamma_g (F_A^L)$ is SLO set in L_2 .

Theorem: 4.4 If $\gamma_g: L_1 \rightarrow L_2$ is SLCM and $\Omega_g: L_2 \rightarrow L_3$ is SLCC, then $\Omega_g \circ \gamma_g: L_1 \rightarrow L_3$ is SLCC.

Proof: Let M_A^L be a SLO set in L_3 . Ω_g is SLCC function. $\Rightarrow \Omega_g^{-1}(M_A^L)$ is SLC in L_2 . γ_g is SLCM function. $\gamma_g^{-1}(\Omega_g^{-1}(M_A^L))$ is SLC in L_1 . Therefore, $(\Omega_g \circ \gamma_g)^{-1}(M_A^L)$ is SLC in L_1 . Hence, $(\Omega_g \circ \gamma_g)$ is SLCC.

Theorem: 4.5 If $\gamma_g: L_1 \rightarrow L_2$ is SLCC and $\Omega_g: L_2 \rightarrow L_3$ is SLCM, then $\Omega_g \circ \gamma_g: L_1 \rightarrow L_3$ is SLCC.

Proof: Let (M_A^L) be as SLO set in L_3 . Ω_g is SLCM. $\Rightarrow \Omega_g^{-1}(M_A^L)$ is SLO set in L_2 . γ_g is SLCC. $\gamma_g^{-1}(\Omega_g^{-1}(M_A^L))$ is SLC in L_1 . Therefore, $(\Omega_g \circ \gamma_g)^{-1}(M_A^L)$ is SLC in L_1 . Hence, $(\Omega_g \circ \gamma_g)$ is SLCC.

Theorem: 4.6 If $\gamma_g: L_1 \rightarrow L_2$ is SLCC and $\Omega_g: L_2 \rightarrow L_3$ is SLCC, then $\Omega_g \circ \gamma_g: L_1 \rightarrow L_3$ is SLCM.

Proof: Let M_A^L be a SLO set in L_3 . Ω_g is SLCC $\Rightarrow \Omega_g^{-1}(M_A^L)$ is SLC set in L_2 . γ_g is SLCC. $\gamma_g^{-1}(\Omega_g^{-1}(M_A^L))$ is SLO in L_1 . Therefore, $(\Omega_g \circ \gamma_g)^{-1}(M_A^L)$ is SLO in L_1 . Hence, $(\Omega_g \circ \gamma_g)$ is SLCM. This statement is true.

CONCLUSIONS

Our focus in this work is on the analysis of SLCC on SLTS. We have introduced SLCC functions and SL-contra open, and SL-contra closed associated with SLTS. The conceptual framework of SLCCM in SLTS, specified using a set of parameters across a universal set, is covered in this study. The SLCC receives findings from this study that were achieved using a SL kernel in SLTS.

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Regular Semirings and Characterisation of P-Regular Semirings by Quasi Ideals

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 14 Jun 2024

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ABSTRACT

The aim of this paper is to study and investigate different types of semirings namely Neumann regular semirings, weakly regular semirings, reduced semiring and P - regular semirings with different properties and conditions. We have done an intensive study on P -regular semirings using k- ideals , quasi ideal and extended well known theorems.

Keywords: Semiring, ordered semiring, reduced semiring ,regular and P -regular semiring.

Mathematics Subject Classification:16Y99,16Y60

INTRODUCTION

H.S.Vandiver proposed the idea of semiring in 1934.Semiring is a natural topic in mathematics and it is broad and diverse mathematical topic, this issue has a significant impact on both mathematics and computer science. In this paper we have charac- terised different classes using different ideals and structural properties. Throughout this paper $(S, +, \cdot)$ stands for semiring and (S_1, S_2, S_3) represents sveral types of semiring namely reduced semiring,regulr semiring and P -regular semiring. Here we have introduced essential ideals, k-ideals, quasi-ideals and bi-ideals in semirings to characterise them and on the basis of structural properties and different ideals results have been proved.

PRELIMINARIES

Definition 2.1. [1, 3] A semiring $(S, +, \cdot)$ is an algebraic system having two bilateral operations $+$ and \cdot such that $(S, +)$ is commutative semigroup and (S, \cdot) is semigroup and following properties hold.

$$x(y + z) = xy + xz \text{ and } (y + z)x = yx + zx \quad \forall x, y, z \in S.$$

Definition 2.2. [8, 9] A non-empty subset A of a semiring S is called (left, right) ideal in S if $x, y \in A$ and for all $r \in S$ then $x + y \in A$ and $(rx, xr \in A)$.If A is both left and right ideal than it called two sided ideal or simply ideal.





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Definition 2.3. [13, 14] An ideal A of a semi ring S is called subtractive ideal or k -ideal if $x, x + y \in A, y \in S$ than $y \in A$

Definition 2.4. [2] A semiring S is cancellable if for every $x, y, z \in S$ we have $x + z = y + z$ than $x = y$.

Reduced semiring

In this section S_1 stands for a semiring having both multiplicative identity ($1 \neq 0$) and additive identity. Here we discuss few results and examples of reduced semiring.

Definition 3.1. [10] A semiring S_1 is said to be reduced if S_1 doesn't contain non- zero nilpotent elements.

Example:- Integer modulo 6 i.e Z_6 is reduced semiring, while Z_8 is not reduced because 2, 4, 6 are nilpotent elements in Z_8 .

Definition 3.2. [1] An ideal A of a semiring S_1 is said to be essential if $A \cap H \neq \{0\}$ for every nonzero ideal H of S_1

Example: Z_8 be the semiring and $A = (2), B = (4)$, then A and B are essential ideals in Z_8 . Suppose Z_6 be the semiring then $A = (2)$ is not essential in Z_6

Definition 3.3. [12] In a semiring S_1 right annihilator of a non-zero element x is defined by $r(x) = \{y \in S : xy = 0\}$. A left annihilator $l(x)$ is defined by

$$l(x) = \{y \in S : yx = 0\} .$$

Definition 3.4. [1] Suppose a be an element of semiring S_1 than a is said to be right singular iff $r(a)$ is essential in S_1 . The set of all right singular elements is denoted by $rZ(S_1)$ left singular set is denoted by $lZ(S_1)$.

Example: Z_{12} be the semiring. Clearly $r(6)$ and $r(0)$ are the only essential ideals in Z_{12} . So $rZ(Z_{12}) = lZ(Z_{12}) = \{0, 6\}$

Example: Z_8 is semiring with integer modulo 6 which is reduced while Z_8 is not reduced, since 2, 4, 6 are nilpotent elements of Z_8 .

Theorem 3.5. If $lZ(S_1)$ contains no nonzero nilpotent elements than $lZ(S_1) = (0)$

Proof: Suppose $lZ(S_1) \neq 0$ than $\exists 0 \neq z$ such that $l(z)$ is essential in S_1 . Thus $l(z) \cap S_1x \neq 0$ for each $x \in S_1$.

Inparticular for $x = z$ than $\exists rz \in l(z) \cap S_1z$ with $rz \neq 0$.

Now $(rz)^2 = (rz)(rz) = r(zrz) = 0 \Rightarrow (rz) \in Z(S_1)$ and rz is nil potent

REGULAR SEMIRINGS

In this section S_2 stands for a semiring having both multiplicative and additive identity. Here we discuss few results and definitions.

Definition 4.1. [3] A semiring S_1 is said to be regular if for any $a \in S_2 \exists b \in S_2$ such that $a = aba \forall a, b \in S_2$.

Definition 4.2. [14] A semiring S_2 is said to be strongly regular if for each $a \in S_2 \exists b, c \in S_2$ such that $a = a^2b = ca^2$.

Definition 4.3. [14, 9] A semiring S_2 is said to be left(right) weakly regular if $K^2 = K$ for each left(right) ideal K of S_2 . If it is both left right weakly regular than it is weakly regular.

Definition 4.4. [9] A semiring S_2 is said to be left(right) duo if every left(right) ideal of S_2 is two sided ideal.

Definition 4.5. [14] An element a of a semiring S_2 is unit element if \exists some unique $b \in S_2$ such that $ab = 1$.

Definition 4.6. [10, 11] A semiring S_2 is unit regular if $\forall a \in S_2 \exists$ unit $b \in S_2$ such that $a = aba$.

Definition 4.7. [9] A semiring S_2 is yorked if for every $x, y \in S_2$ we have $x + l = y$ or $x = y + l$ for some $l \in S_2$.





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Theorem 4.8. Let S_2 be semiring then given below conditions are equivalent.

(a) S_2 is Neumann regular. (b) $\forall a \in S_2 \exists$ an idempotent $e \in S_2$ such that

$$\text{Now } eS_2 = (ab)S_2 \subseteq aS_2$$

Proof: (a) implies (b) Suppose S_2 is Neumann regular semiring than $\forall a \in S_2 \exists b \in S_2$ such that $a = aba$.

Now we suppose $e = ab$ which gives $e = e^2$ for some $e \in S_2$.

Since S_2 is Neumann regular semiring we can write

$$aS_2 = (aba)S_2 = eaS_2 \subseteq eS_2$$

$$\text{Now } eS_2 = (ab)S_2 \subseteq aS_2$$

$$\text{Hence } aS_2 = eS_2.$$

(b) Implies (a) Let $aS_2 = eS_2$ and e is the element with idempotence than $a = ey$ for some $y \in S_2$.

$$\text{Now } a = ey = e^2y = ea.$$

Let $e = ab$ (since $e \in aS_2$ implies $e = ab$).

We obtain $a = aba$. Therefore S_2 is Neumann regular.

Theorem 4.9. Suppose that S_2 is a right weakly regular, cancellative and yoked semiring. Than $S_2aS_2 = S_2$ for any right non-zero divisor element a of S_2 .

Proof: Assume a be a right non-zero divisor of S_2 than $aS_2 = (aS_2)^2$ (because $a \in (aS_2)^2$)

Let $rat \in S_2aS_2$, then by yoked property either $1 + h = rat$

or $1 = rat + h$ implies $1 \in S_2$(1)

implies $a + ah = arat$ or $a = arat + ah$

since $(a, arat \in (aS_2)^2$ then by subtractive property we obtain $ah \in (aS_2)^2$

$$\Rightarrow ah = auav \text{ for some } u, v \in S_2$$

Again, by yoked property either $h = s + uav$ or $h + s = uav$ for some $s \in S_2$

$$\Rightarrow as + auav = auav \text{ or } ah + as = ah$$

By cancellative property, we have $as = 0 \Rightarrow s = 0$ Because (a is non - zero divisor)

$$\Rightarrow h = uav \in S_2ah$$

$$\text{Now by (1) } 1 \in S_2aS_2 \Rightarrow S_2aS_2 = S_2.$$

Theorem 4.10. Suppose $x \in S_2$, if x is unit regular , then $x = cb$ for some idempotent element c and some unit element b .

Proof: Assume that y is a unit regular. Then \exists a unit $x \in S_2$ such that $xyx = y$. Suppose $c = yx$. Then $c^2 = yxyx = yx = c$, so c is an idempotent element of S_2 . Suppose $b = x^{-1}$ so we obtain $y = cb$.

Theorem 4.11. Suppose S_2 be a right duo semiring than the below mentioned statements are equivalent.

(a) S_2 is right weakly regular semiring

(b) S_2 is strongly regular semiring

(c) S_2 is Neumann regular semiring.

Proof: (a) implies (b) By theorem 4.6 $S_2 = S_2aS_2$

implies that $1 = rat \Rightarrow a = arat$ implies $a = a(as)t$ for some $s \in S_2$ than we have $a = a^2st \Rightarrow a = a^2b$ where $b = st$.





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(b) implies (c) Assume that S_2 is strongly regular than $\forall a \in S_2$.
 $\exists b, c$ such that $a = a^2b = ca^2 \Rightarrow a = aab = aba$ ($ab = ba$ because S_2 is right duo semiring).

$\Rightarrow S_2$ is Neumann regular.

(c) Implies (a) $\forall a \in S_2 \exists b \in S_2$ such that $a = aba \Rightarrow ar = abar$

implies that $a \in aS_2aS_2$

This shows that S_2 is right weakly regular semiring.

P-Regular semirings

In this portion, we investigate the concept of P-regular semiring and few properties regarding to the P-regular semiring.

Note:- S_3 stands for semiring having additive identity only.

Definition 5.1. An additive subsemigroup Q of S_3 is referred as quasi ideal of S_3

if $S_3Q \cap QS_3 \subseteq Q$.

Definition 5.2. [6] Let S_3 be a semiring and P be a right k- ideal of S_3 . Then semiring S_3 is called P-regular if for every $\alpha \in S_3 \exists \beta \in S_3$ such that $\alpha + p_1 = \alpha\beta\alpha + p_2$ for some $p_1, p_2 \in P$ and $\alpha\beta P \subseteq P$.

Example:- $Z_4 = \{0, 1, 2, 3\}$ under addition and multiplication modulo 4 is semiring and $A = \{0, 2\}$ is right k-ideal of Z_4 . Here Z_4 is not regular because $2 \neq$

$2 \cdot x \cdot 2$ for any $x \in Z_4$ but it is P-regular.

Definition 5.3. [5, 6] A semiring S_3 is said to be weak P-regular

if for each $\alpha \in S_3, \exists \beta \in S_3$ such that $\alpha = \alpha\beta\alpha + p_1$ for some $p_1 \in P$ and $\alpha\beta P \subseteq P$.

Definition 5.4. [5] Suppose S_3 be a semiring and P be a right k- ideal of S_3 . An element $a \in S_3$ is called idempotent relative to P if $a + p_1 = a^2 + p_2$ for some $p_1, p_2 \in P$ and $aP \subseteq P$.

Theorem 5.5. Let P is any right k-ideal of S_3 and H is any ideal of S_3 such that $P \subseteq H$. If S_3 is p-regular than H is p-regular.

Proof: Let S_3 is P-regular and H is an ideal of S_3 such that $P \subseteq H$. Then

for each $\alpha \in H \exists \beta \in S_3$ and $p_1, p_2 \in P$ such that $\alpha + p_1 = \alpha\beta\alpha + p_2$ and $\alpha\beta P \subseteq P$.

Let $\gamma = \beta\alpha\beta \in H$.

Then $\alpha\beta\alpha + p_1\beta\alpha = \alpha\beta\alpha\beta\alpha + p_2\beta\alpha$.

This implies $p_2 + \alpha\beta\alpha + p_1\beta\alpha = \alpha\gamma\alpha + p_2\beta\alpha + p_2$.

$\Rightarrow \alpha + p_1 + p_1\beta\alpha = \alpha\gamma\alpha + p_2\beta\alpha + p_2$

$\Rightarrow \alpha + p' = \alpha\gamma\alpha + p''$ for some $p', p'' \in P$

Also $\alpha\gamma P = \alpha(\beta\alpha\beta)P = \alpha\beta(\alpha\beta P) \in \alpha\beta P \subseteq P$.

Thus H is a P-regular.

Theorem 5.6. Suppose S_3 be a weak P-regular semiring and A be any right ideal of S_3 . Then the following holds:

(i) $A + P = A^2 + P$

(ii) if $A^2 \subseteq P$ than $A \subseteq P$

Proof: (i) Since S_3 is a weak P-regular so for each $\alpha \in S_3 \exists \beta \in S_3$ and some $p \in P : \alpha = \alpha\beta\alpha + p$ and $\alpha\beta P \subseteq P$.





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Let $\alpha \in A$.

Then $\alpha = (\alpha\beta)\alpha + p \in A^2 + P \Rightarrow A \subseteq A^2 + P \Rightarrow A + P \subseteq A^2 + P$.

But $A^2 + P \subseteq A + P$ (always)

Therefore $A + P = A^2 + P$

(ii) Given that $A^2 \subseteq P$ so $A^2 + P \subseteq P$. This shows $A + P \subseteq P$.

Therefore $A \subseteq P$ (as P is a right k -ideal of S_3). Hence proved

Theorem 5.7. If S_3 is weak P -regular, then every element of a quasi-ideal A can be shown as the sum of two elements of P and A .

Proof: Assume S_3 be a weak P -regular semiring and A be a quasi-ideal of S_3 . Then any $a \in A$ can be written as $a = axa + p$ and $axP \subseteq P$ for some $p \in P$ and $x \in S_3$.

Given A is a quasi-ideal of S_3 therefore $axa \in AS_3A \subseteq AS_3 \cup S_3A \subseteq A$ and therefore we have $a = p + axa \in P + A$. statement follows.

Theorem 5.8. Suppose S_3 be a weak P -regular semiring and A, B are quasi-ideals of S_3 . If $a \in A \cap B$, then this element a can be expressed as $a = p + a_1xa_2$ for some $p \in P, x \in S_3, a_1 \in A$ and $a_2 \in B$ and also $a_1xa_2xP \subseteq P$.

Proof: Let $a \in A \cap B$. Since S_3 is a weak P -regular then $\exists x \in S_3$ such that $a = axa + p$ for some $p \in P$ and $axP \subseteq P$. Since $A \cap B$ is a quasi-ideal of S_3 so the element $a \in A \cap B$ can be expressed as in two ways $a = p_1 + a_1 \in A$ and $a = p_2 + a_2 \in B$ for some $p_1, p_2 \in P, a_1 \in A, a_2 \in B$. Since S_3 is a weak P -regular therefore the element $a \in S_3$ can be written as $a = p_3 + axa$ for some $p_3 \in P$ and $axP \subseteq P$.

Now we have $a = p_3 + axa = p_3 + (p_1 + a_1)x(p_2 + a_2) = p_3 + a_1xp_2 + a_1xa_2 + p_1xp_2 + p_1xa_2 = p_6 + a_1xa_2$ where $p_6 \in P$ because $axp_2 = p_1xp_2 + a_1xp_2 \in P$ and P is a right k -ideal of S_3 , therefore $a_1xp_2 \in P$.

Again, $axP = p_6xP + a_1xa_2xP \subseteq P$. Since P is a right k -ideal of S_3 therefore $a_1xa_2xP \subseteq P$.

CONCLUSION

This study introduces different properties and ideals in different semirings namely regular semirings, reduced semiring. P -regular semirings have been described using quasi-ideal and bi-ideal features. We have focused and investigated the characterisation of P -regular semiring and representation of elements in terms of quasi ideals of weak- P -regular related to right k -ideal.

Competing Interest

The author(s) declare that they have no competing interest.

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Some Results on Product Binary L-Cordial Labeling Respect to Vertex Switching Operation

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 18 Jun 2024

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ABSTRACT

This study examines the probability of the vertex switching operation results from various graphs being product binary L-cordial graphs. The graphs under investigation include the Path graph (P_n), Helm graph (H_n), Wheel graph ($W_n; n > 3$), Cycle graph ($C_n; n > 3$). The application of product binary L-cordial labeling demonstrates that these analyzed graphs exhibit characteristics of product binary L-cordial Graphs.

Keywords: L-cordial graph; Binary L- cordial graph; Product binary L- cordial labeling; Product binary L- cordial graph; Vertex Switching.

2020 AMS Classification: 05C78.

INTRODUCTION

A graph labeling involves assigning distinct labels to the edges and vertices of a graph. For standardized terminology and notations in graph theory, the work of Clark and Holton [2] is consulted. Gallian [1] provides a comprehensive survey with extensive bibliographic references on various graph labeling problems. To conduct our analysis, we begin with a simple, finite, con- nected, and undirected graph denoted as $G = (V(G), E(G))$. The subsequent section provides a concise overview of definitions and relevant information essential for the current investigation.





PRELIMINARIES

L-cordial labeling was introduced by M. Bapat [3] and is described in Definition 2.1. He also shown [3, 4, 5] that the triangular snakes, Star, Path and Cycle are L-cordial graphs. Then, he extended his research to include $FL(C_n)$, C_n , Bull (C_n) , Shell graph S_n , S_n^+ and S_n^{+t} , demon- n stating that these graphs are likewise L-cordial.

Definition 2.1 [3] A graph $G(V, E)$ possesses an L-cordial labeling if there exists a bijection function r from $E(G)$ to $\{1, 2, 3, \dots, |E|\}$. Each vertex u is labeled 0 if the highest label on its incident edges is even and 1 otherwise. The terms $v_r(1)$ and $v_r(0)$ denote the total count of vertices u 's labeled as 1 and 0, respectively. The labeling function r is considered an L-cordial labeling of the graph if the absolute difference between $v_r(1)$ and $v_r(0)$ is less than or equal to 1. It's important to note that isolated vertices are not included in this labeling process. Steffi and Subhashini [6] have introduced binary L-cordial labeling and product binary L-cordial labeling, detailed in Definition 2.2 and Definition 2.3, respectively. They have explored the product binary L-cordial labeling of graphs such as Path, Comb graph $P_n \odot k_1$, Dumbell graph, Flag graph and Crown graph $C_n \odot k_1$.

Definition 2.2 [6]

A graph $G(V, E)$ featuring a binary operation exhibits a binary L-cordial labeling when there exists a bijective function r from $E(G)$ to $\{1, 2, 3, \dots, |E|\}$. In this scenario, each vertex u is assigned the label 1 or 0 based on a binary operation $*$, where uv_i , uv_j possess the smallest and greatest r values, respectively. Label 1 is assigned if $r(uv_i) * r(uv_j)$ is odd, and 0 is assigned otherwise. The quantities $v_r(1)$ and $v_r(0)$ denote the total number of vertices labeled as 1 and 0, respectively. The labeling function r is deemed a binary L-cordial labeling of the graph if the absolute difference between $v_r(1)$ and $v_r(0)$ is less than or equal to 1. This labeling scheme is represented by the acronym $BLCL$ and graph which hold the said labeling viz., binary L-cordial graph is represented by the acronym $BLCG$.

Definition 2.3 [6]

A graph $G(V, E)$ featuring a binary operation exhibits a product binary L-cordial labeling when there exists a bijective function r from $E(G)$ to $\{1, 2, 3, \dots, |E|\}$. In this scenario, each vertex u is assigned the label 1 or 0 based on a multiplication binary operation \cdot , where uv_i , uv_j possess the smallest and greatest r values, respectively. Label 1 is assigned if $r(uv_i) \cdot r(uv_j)$ is odd, and 0 is assigned otherwise. The quantities $v_r(1)$ and $v_r(0)$ denote the total number of vertices labeled as 1 and 0, respectively. The labeling function r is deemed a product binary L-cordial labeling of the graph if the absolute difference between $v_r(1)$ and $v_r(0)$ is less than or equal to 1. This labeling scheme is represented by the acronym $PBLCL$ and graph which hold the said labeling viz., product binary L-cordial graph is represented by the acronym $PBLCG$.

Definition 2.4 [7] A graph obtained by selecting a vertex u from graph G , removing all edges connecting u to its neighboring vertices, and introducing new edges connecting u to vertices in G that were not originally adjacent is termed the vertex switching G_u of G . Now, the descriptions of graphs used in the present investigation are provided below.

Definition 2.5 Path graph (P_n) is a type of walk in which $v_i \neq v_j$ for any pair of distinct indices i and j . In simpler terms, a path is a walk that traverses each vertex at most once.

Definition 2.6 Cycle graph (C_n) is a particular kind of path graph P_n that begins and ends at the same vertex.





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Definition 2.7 Helm graph (H_n) is derived from an wheel graph (W_n) by adding a pendant edge at every node of the cycle.

Definition 2.8 Wheel graph (W_n) is created by linking each vertex of a cycle graph (C_n) to an extra vertex identified as the center. In mathematical terms, $W_n = C_n + K_1$ with the graph having $n + 1$ vertices and $2n$ edges.

RESULTS AND DISCUSSIONS

Theorem 3.1 Applying switching operation on pendant vertex in Path graph (P_n) is a PB_{LCC} .

Proof. Let $u_1, u_2, u_3, \dots, u_n$ denote the vertices of the path graph (P_n) and consider the graph P_n^* obtained by performing a switching operation on a pendant vertex in the path graph (P_n). For the sake of simplicity, let's assume, without loss of generality, that the vertex switched is denoted as u_1 . Thus, $V(P_n^*) = \{u_k : 1 \leq k \leq n\}$ and $E(P_n^*) = \{u_1u_k : 3 \leq k \leq n\} \cup \{u_{k+1}u_{k+2} : 1 \leq k \leq n-2\}$. In the context where $|V(P_n^*)|$ equals n and $|E(P_n^*)|$ equals $2n-4$. Labeling function $r : E(P_n^*) \rightarrow \{1, 2, 3, \dots, |E(P_n^*)|\}$ is defined as follows:

Case 1: $n \equiv 1 \pmod{4}$
Subcase 1: For $n = 3$,

$$r(p) = \begin{cases} 1 & \text{for } p = u_2u_3; \\ 2 & \text{for } p = u_1u_3. \end{cases}$$

Subcase 2: For $n = 5$,

$$r(p) = \begin{cases} 1 & \text{for } p = u_2u_3; \\ 2 & \text{for } p = u_3u_4; \\ 3 & \text{for } p = u_4u_5; \\ 5 & \text{for } p = u_1u_3; \\ 4 & \text{for } p = u_1u_4; \\ 6 & \text{for } p = u_1u_5. \end{cases}$$

Subcase 3: For $n > 5$,

$$r(p) = \begin{cases} 2k - 1 & \text{for } p = u_{k+1}u_{k+2}, \quad 1 \leq k \leq \frac{n-3}{2}; \\ 2k & \text{for } p = u_{\frac{n-1}{2}+k}u_{\frac{n-1}{2}+k+1}, \quad 1 \leq k \leq \frac{n-3}{2}; \\ n - 2 & \text{for } p = u_{n-1}u_n; \\ n + 2k - 2 & \text{for } p = u_1u_{k+2}, \quad 1 \leq k \leq \frac{n-5}{2}; \\ n + 2k - 3 & \text{for } p = u_1u_{\frac{n-1}{2}+k}, \quad 1 \leq k \leq \frac{n-1}{2}; \\ 2n - 5 & \text{for } p = u_1u_n. \end{cases}$$

Consequently, $v_r(1) = \frac{n-1}{2}$ and $v_r(0) = \frac{n+1}{2}$.

Case 2: $n \equiv 0 \pmod{4}$

Subcase 1: For $n = 4$,

$$r(p) = \begin{cases} 2k - 1 & \text{for } p = u_{k+1}u_{k+2}, \quad 1 \leq k \leq n - 2; \\ 2k & \text{for } p = u_1u_{k+1}, \quad 1 \leq k \leq n - 2. \end{cases}$$

Subcase 2: For $n > 4$,

$$r(p) = \begin{cases} 2k - 1 & \text{for } p = u_{k+1}u_{k+2}, \quad 1 \leq k \leq n - 2; \\ 2k & \text{for } p = u_1u_{k+2}, \quad 1 \leq k \leq \frac{n-2}{2}; \\ 2n - 2k - 2 & \text{for } p = u_1u_{\frac{n}{2}+k+1}, \quad 1 \leq k \leq \frac{n-2}{2}. \end{cases}$$





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Example 3.1 P_7^* is a PB_{LCC} which is shown in Figure 1.

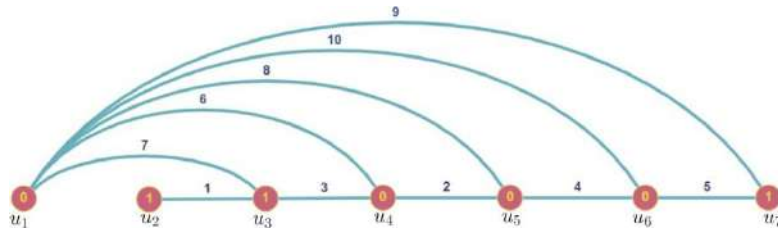


Figure 1: P_7^* with its PB_{LCL} .

Theorem 3.2 Applying switching operation on a middle vertex in helm graph (H_n) is a PB_{LCC} .

Proof. Consider a cycle with a central vertex denoted as v and alternating n vertices labeled as $u_1, u_2, u_3, \dots, u_n$. Additionally, there are pendant vertices $v_1, v_2, v_3, \dots, v_n$. Let H_n^* represent the graph formed by applying a switching operation to the middle vertex v in the helm graph (H_n). So, $V(H_n^*) = \{v, u_k, v_k : 1 \leq k \leq n\}$ and $E(H_n^*) = \{v v_k, u_k v_k : 1 \leq k \leq n\} \cup \{u_k u_{k+1} : 1 \leq k \leq n-1\} \cup \{u_n u_1\}$. In the context where $|V(H_n^*)|$ equals $2n + 1$ and $|E(H_n^*)|$ equals $3n$. Labeling function $r : E(H_n^*) \rightarrow \{1, 2, 3, \dots, |E(H_n^*)|\}$ is defined as follows:

Case 1:

Subcase 1: For $n = 3$,

$$r(p) = \begin{cases} 9 & \text{for } p = u_1 u_2; \\ 6 & \text{for } p = u_2 u_3; \\ 8 & \text{for } p = u_1 u_3; \\ 1 & \text{for } p = u_1 v_1; \\ 3 & \text{for } p = u_2 v_2; \\ 2 & \text{for } p = u_3 v_3; \\ 5 & \text{for } p = v v_1; \\ 7 & \text{for } p = v v_2; \\ 4 & \text{for } p = v v_3. \end{cases}$$

Consequently, $v_r(1) = 4$ and $v_r(0) = 3$.

Subcase 2: $n \equiv 1 \pmod{2}$

$$r(p) = \begin{cases} 2n + 2k + 1 & \text{for } p = u_k u_{k+1}, \quad 1 \leq k \leq \frac{n-1}{2}; \\ 2n + 2k - 2 & \text{for } p = u_{\frac{n-1}{2}+k} u_{\frac{n-1}{2}+k+1}, \quad 1 \leq k \leq \frac{n+1}{2}; \\ 2k - 1 & \text{for } p = u_k v_k, \quad 1 \leq k \leq \frac{n+1}{2}; \\ 2k & \text{for } p = u_{\frac{n+1}{2}+k} v_{\frac{n+1}{2}+k}, \quad 1 \leq k \leq \frac{n-1}{2}; \\ n + 2k & \text{for } p = v v_k, \quad 1 \leq k \leq \frac{n+1}{2}; \\ n + 2k - 1 & \text{for } p = v v_{\frac{n+1}{2}+k}, \quad 1 \leq k \leq \frac{n-1}{2}. \end{cases}$$

Case 2: $n \equiv 0 \pmod{2}$

$$r(p) = \begin{cases} 2n + 2k + 1 & \text{for } p = u_k u_{k+1}, \quad 1 \leq k \leq \frac{n-2}{2}; \\ n + 2k & \text{for } p = u_{\frac{n-2}{2}+k} u_{\frac{n-2}{2}+k+1}, \quad 1 \leq k \leq \frac{n+2}{2}; \\ 2k - 1 & \text{for } p = u_k v_k, \quad 1 \leq k \leq \frac{n}{2}; \\ 2k & \text{for } p = u_{\frac{n}{2}+k} v_{\frac{n}{2}+k}, \quad 1 \leq k \leq \frac{n}{2}; \\ n + 2k - 1 & \text{for } p = v v_k, \quad 1 \leq k \leq \frac{n+2}{2}; \\ 2n + 2k + 2 & \text{for } p = v v_{\frac{n+2}{2}+k}, \quad 1 \leq k \leq \frac{n-2}{2}. \end{cases}$$

Consequently, $v_r(1) = n$ and $v_r(0) = n + 1$.

The observation of $|v_r(1) - v_r(0)| \leq 1$ in all the cases in theorem 3.2 highlights that the H_n^* is in fact a PB_{LCC} .





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Example 3.2 H_5^* is a PB_{LCC} which is shown in Figure 2.

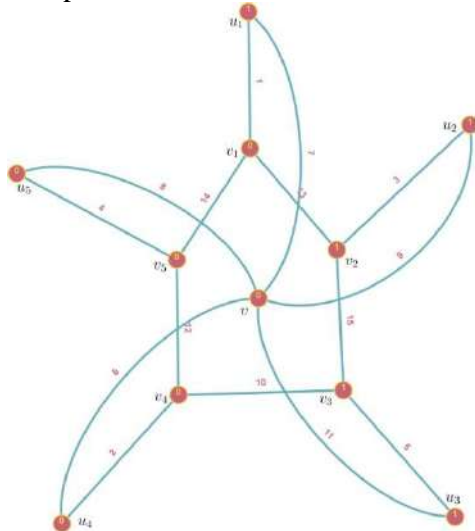


Figure 2: H_5^* with its PB_{LCL} .

Theorem 3.3 Applying switching operation on a rim vertex in wheel graph $(W_n; n > 3)$ is a PB_{LCC} .

Proof. Consider u as the central vertex and $u_1, u_2, u_3, \dots, u_n$ as the alternating n rim vertices in a cycle. Let W_n^* denote the graph obtained by applying a switching operation to a rim vertex in the wheel graph W_n , where $n > 3$. Without loss of generality, applying switching operation on vertex u_1 . So, $V(W_n^*) = \{u, u_k : 1 \leq k \leq n\}$ and $E(W_n^*) = \{uu_{k+1}, u_{m+1}u_{m+2}, u_1u_q : 1 \leq k \leq n-1, 1 \leq m \leq n-2, 3 \leq q \leq n-1\}$. In the context where $|V(W_n^*)|$ equals $n+1$ and $|E(W_n^*)|$ equals $3n-6$. Labeling function $r : E(W_n^*) \rightarrow \{1, 2, 3, \dots, |E(W_n^*)|\}$ is defined as follows:

Case 1: $n \equiv 0 \pmod{2}$

$$r(p) = \begin{cases} 2k+1 & \text{for } p = u_{k+1}u_{k+2}, 1 \leq k \leq n-3; \\ n & \text{for } p = u_{n-1}u_n; \\ 1 & \text{for } p = uu_2; \\ 2n+2k-5 & \text{for } p = uu_{k+2}, 1 \leq k \leq \frac{n-2}{2}; \\ 2k & \text{for } p = uu_{\frac{n+2}{2}+k}, 1 \leq k \leq \frac{n-2}{2}; \\ n+2k & \text{for } p = u_1u_{k+2}, 1 \leq k \leq n-3. \end{cases}$$

Consequently, $v_r(1) = \frac{n+2}{2}$ and $v_r(0) = \frac{n}{2}$.

Case 2: $n \equiv 1 \pmod{2}$

$$r(p) = \begin{cases} 2k+1 & \text{for } p = u_{k+1}u_{k+2}, 1 \leq k \leq \frac{n-1}{2}; \\ n+2k-1 & \text{for } p = u_{\frac{n+1}{2}+k}u_{\frac{n+1}{2}+k+1}, 1 \leq k \leq \frac{n-3}{2}; \\ 1 & \text{for } p = uu_2; \\ n+2k & \text{for } p = uu_{k+2}, 1 \leq k \leq \frac{n-3}{2}; \\ 2k & \text{for } p = uu_{\frac{n+1}{2}+k}, 1 \leq k \leq \frac{n-1}{2}; \\ 2n+2k-3 & \text{for } p = u_1u_{k+2}, 1 \leq k \leq \frac{n-3}{2}; \\ 2n+2k-4 & \text{for } p = u_1u_{\frac{n+1}{2}+k}, 1 \leq k \leq \frac{n-3}{2}. \end{cases}$$

Consequently, $v_r(1) = n+1 = v_r(0)$.

The observation of $|v_r(1) - v_r(0)| \leq 1$ in all the cases in theorem 3.3 highlights that the W_n^* is in fact a PB_{LCC} .





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Example 3.3 Wn^* is a PB_{LCC} which is shown in Figure 3.

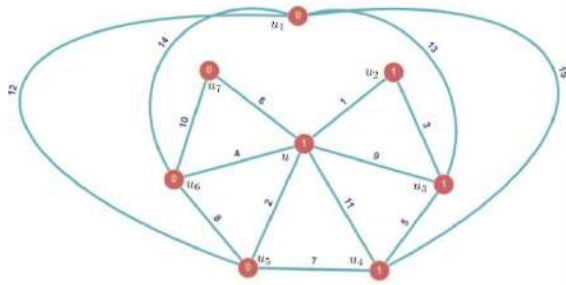


Figure 3: $W7^*$ with its PB_{LCL} .

Theorem 3.4 Applying switching operation on a vertex in cycle graph $(C_n; n > 3)$ is a PB_{LCC} .

Proof. Consider the vertices $u_1, u_2, u_3, \dots, u_n$, which alternate in cycle C_n . Now, let C_n^* be the graph obtained by performing a switching operation on a vertex in the cycle graph C_n , where n is greater than 4. Without loss of generality, applying switching operation on vertex u_1 . So, $V(C_n^*) = \{u_k : 1 \leq k \leq n\}$ and $E(C_n^*) = \{u_k u_{k+1} : 2 \leq k \leq n-1\} \cup \{u_1 u_{k+2} : 1 \leq k \leq n-3\}$. In the context where $|V(C_n^*)|$ equals n and $|E(C_n^*)|$ equals $2n - 5$. Labeling function $r : E(C_n^*) \rightarrow \{1, 2, 3, \dots, |E(C_n^*)|\}$ is defined as follows:

Case 1: $n \equiv 0 \pmod{2}$,

$$r(p) = \begin{cases} 2k - 1 & \text{for } p = u_{k+1}u_{k+2}, \quad 1 \leq k \leq \frac{n-2}{2}; \\ 2k & \text{for } p = u_{\frac{n}{2}+k}u_{\frac{n}{2}+k+1}, \quad 1 \leq k \leq \frac{n-4}{2}; \\ 2n - 5 & \text{for } p = u_{n-1}u_n; \\ n + 2k - 3 & \text{for } p = u_1u_{k+2}, \quad 1 \leq k \leq \frac{n-4}{2}; \\ n + 2k - 4 & \text{for } p = u_1u_{\frac{n}{2}+k}, \quad 1 \leq k \leq \frac{n-2}{2}. \end{cases}$$

Consequently, $v_r(1) = \frac{n}{2} = v_r(0)$.

Case 2: $n \equiv 1 \pmod{2}$,

Subcase 1: For $n = 5$,

$$r(p) = \begin{cases} 3 & \text{for } p = u_1u_4; \\ 5 & \text{for } p = u_1u_3; \\ 1 & \text{for } p = u_2u_3; \\ 4 & \text{for } p = u_3u_4; \\ 2 & \text{for } p = u_4u_5. \end{cases}$$

Subcase 2: For $n > 5$,

$$r(p) = \begin{cases} 2k - 1 & \text{for } p = u_{k+1}u_{k+2}, \quad 1 \leq k \leq \frac{n-1}{2}; \\ 2k & \text{for } p = u_{\frac{n+1}{2}+k}u_{\frac{n+1}{2}+k+1}, \quad 1 \leq k \leq \frac{n-5}{2}; \\ 2n - 5 & \text{for } p = u_{n-1}u_n; \\ n + 2k - 2 & \text{for } p = u_1u_{k+2}, \quad 1 \leq k \leq \frac{n-5}{2}; \\ n + 2k - 5 & \text{for } p = u_1u_{\frac{n-1}{2}+k}, \quad 1 \leq k \leq \frac{n-1}{2}. \end{cases}$$

Consequently, $v_r(0) = n-1$ and $v_r(1) = \frac{n+1}{2}$.

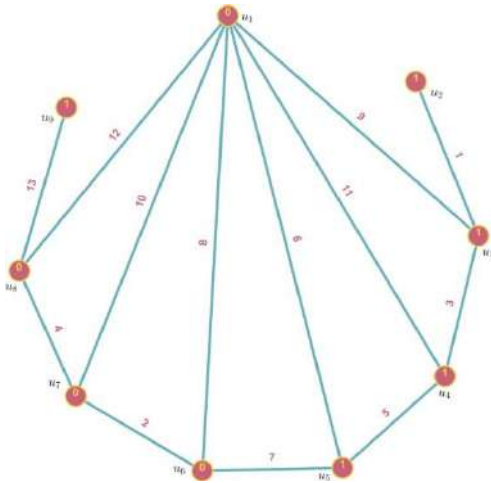
The observation of $|v_r(1) - v_r(0)| \leq 1$ in all the cases in theorem 3.4 highlights that the C_n^* is in fact a PB_{LCC} .

Example 3.4 $C9^*$ is a PB_{LCC} which is shown in Figure 4.





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Figure 4: C_9^* with its PB_{LCL} .

CONCLUSIONS

The study you described investigates the potential application of vertex switching graphs from various types of graphs, including the Path graph (P_n), Helm graph (H_n), Wheel graph ($W_n; n > 3$), and Cycle graph ($C_n; n > 3$), as product binary L-cordial graphs. Through the utilization of product binary L-cordial labeling, the study confirms that these analyzed graphs demonstrate the characteristics of product binary L-cordial graphs. The utilization of this type of labeling extends beyond theoretical implications; it finds relevance in several practical domains including Network Analysis, Computer Science, Telecommunications, Bioinformatics, Operations Research, Cryptography, Data Science, and Mathematics Education. By demonstrating the applicability of product binary L-cordial labeling to diverse graph structures, the study contributes to advancing knowledge in these fields and potentially inspires further research and applications in related areas. This research presents opportunities for further exploration, suggesting that similar methodologies could be employed in other graph operations such as Shadow, Mirror, etc., and across different categories of graphs.

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Prime Graceful Labeling on Some Graphs

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 06 Jun 2024

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ABSTRACT

One of the main topics of research in graph theory is graph labeling. A graph's labeling is the assignment of a number, under particular conditions, to a vertex (dots), edge (lines), or both. Important information about what the data in the graph represents is enhanced by the addition of labels. The literature defines a wide variety of labeling techniques. The most popular labeling patterns are graceful labeling, harmonious labeling, edge graceful labeling and so on. Our central focus in this paper is prime graceful labeling on shadow graphs, split graph, diamond graph, house graph, tetrahedral graph, tent graph.

Keywords: Prime labeling, Graceful labeling, Prime graceful labeling, Shadow graph and Split graph.

MSC 2010 :05C78

INTRODUCTION

Alexander Rosa initially proposed the graph labeling in 1967. α -labeling, β -labeling, and q -labeling are the three types of labeling that Rosa identified. Solomon Golomb later renamed β -labeling as "graceful" in 1972. More than 3000 studies have examined more than 200 graph labeling approaches throughout the internship years. A prime graceful labeling is a mathematical concept used in graph theory. Tout, Dabboucy, and Howalla invented prime labeling in 1982. While the prime graceful labeling was introduced by T.M.Selvarajan and R.Subramaniam. The study of prime graceful labeling contributes to a deeper understanding of graph properties and their mathematical structure. A graph G with p vertices and q edges is said to be prime graceful labeling, if there is an injection ϕ from the vertices of





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G to $\{1, 2, \dots, m\}$ where $m = \min(2p, 2q)$ such that $\gcd(\varphi(v_i), \varphi(v_j)) = 1$ induced injective function φ^* from the edge of G to $\{1, 2, \dots, m - 1\}$ defined by $\varphi^*(v_i v_j) = |\varphi(v_i) - \varphi(v_j)|$, the resulting edge labels are distinct. The labeling is considered "graceful" because it exhibits a harmonious distribution of labels across the graph's vertices, creating an aesthetically pleasing structure. Numerous fields, including coding theory, x-ray crystallography, communication networks, and others, use graph labeling. Prime graceful labeling finds application in various areas such as coding theory, network design and scheduling problems. In this paper we focus on prime graceful labeling which is a combination of both prime labeling and graceful labeling. The definition of both labeling are varied from each other

PRELIMINARIES

Definition 2.1

Let $G = (V(G), E(G))$ be a graph with p vertices. A bijection $f: V \rightarrow \{1, 2, \dots, p\}$ is called a prime labeling if for each edge $e = uv$, $\gcd(f(u), f(v)) = 1$. A graph which admits a prime labeling is called prime graph.

Definition 2.2

Let $G = (V(G), E(G))$ be a simple, finite and undirected graph with $|V| = p$ and $|E| = q$. An injective function $f: V \rightarrow \{1, 2, \dots, p\}$ is called graceful labeling of G if all the edge labels of G given by $f(uv) = |f(u) - f(v)|$ for every $uv \in E$ are distinct. A graph which admits a graceful labeling is called graceful graph.

Definition 2.3

A graph G with p vertices and q edges is said to be prime graceful labeling, if there is an injection φ from the vertices of G to $\{1, 2, \dots, m\}$ where $m = \min(2p, 2q)$ such that $\gcd(\varphi(v_i), \varphi(v_j)) = 1$ induced injective function φ^* from the edge of G to $\{1, 2, \dots, m - 1\}$ defined by $\varphi^*(v_i v_j) = |\varphi(v_i) - \varphi(v_j)|$, the resulting edge labels are distinct.

Definition 2.4

A connected graph G 's shadow graph $D_2(G)$ is created by making two copies of G , say G' and G'' , and joining each vertex V' in G' ; to the neighbors of the corresponding vertex V'' in G'' .

Definition 2.5

In order to obtain the split graph of a graph G , a new vertex V' must be added to each vertex V so that every vertex adjacent to V in G is adjacent to V' . $\text{spl}(G)$ represents the resulting graph.

MAIN RESULTS

Prime Graceful Labeling on some graphs :

Theorem 3.1

$D_2(C_n)$ admits prime graceful labeling.

Proof

The shadow graph $D_2(C_n)$ has $2n$ vertices and $4n$ edges.

$$m = \min(2p, 2q)$$

$$= \min(2(2n), 2(4n))$$

$$= \min(4n, 8n)$$

$$m = 4n$$

The vertices of $D_2(C_n)$ are labeled from the set $S = \{1, 2, 3, \dots, 4n - 1, 4n\}$. Choose an arbitrary vertex in $D_2(C_n)$ and label it with 1. Choose last two integers from the set S . i.e. $4n - 1$ and $4n$ label it to the adjacent vertices of vertex label 1. Choose the integers from the beginning of the set S and label with the vertex adjacent to the vertex $4n - 1$ or $4n$. So that the gcd of a two consecutive vertices is 1 and edge labels are distinct.

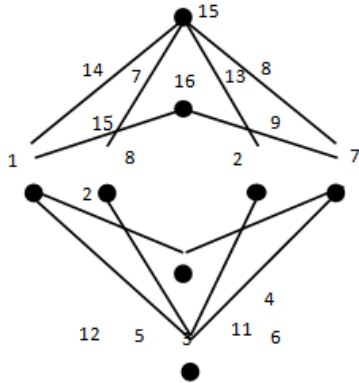




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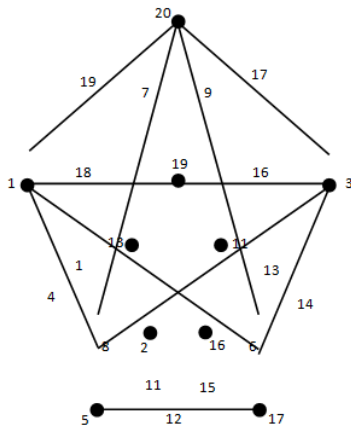
Example

Shadow graph of $D_2(C_4)$ is a prime graceful labeling.



Prime graceful labeling of $D_2(C_4)$

Shadow graph of $D_2(C_5)$ is a prime graceful labeling.



Prime graceful labeling of $D_2(C_5)$

Theorem 3.2

$D_2(K_{1,n})$ admits prime graceful labeling.

Proof

The shadow graph $D_2(K_{1,n})$ has $2n+2$ vertices and $4n$ edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(2n + 2), 2(4n)) \\
 &= \min(4n + 4, 8n) \\
 m &= 4n + 4.
 \end{aligned}$$

In $D_2(K_{1,n})$ two vertices are adjacent with remaining n vertices. Let us label the vertices of degree n with 1 and 2 and remaining with $3, 5, 7, \dots, 2n+2$. The gcd of the end vertices of each edge is 1. The edge labels $1, 2, 3, 4, \dots$ are distinct.

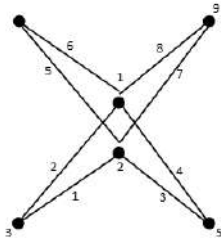
Example

The shadow graph of $D_2(K_{1,2})$ permits prime graceful labeling.



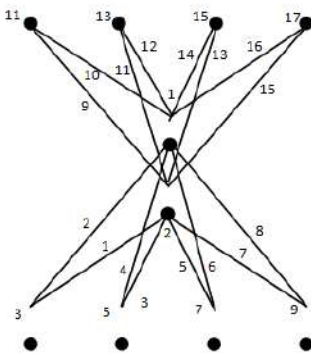


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Prime graceful labeling of $D_2(K_{1,2})$

The shadow graph of $D_2(K_{1,4})$ permits prime graceful labeling.



Prime graceful labeling of $D_2(K_{1,4})$

Theorem 3.3

Diamond graph permits prime graceful labelling.

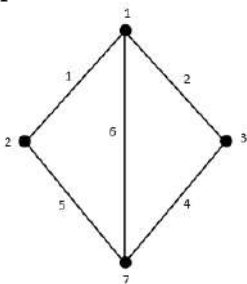
Proof

The diamond graph D is a planer undirected graph with 4 vertices and 5 edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(4), 2(5)) \\
 &= \min(8, 10) \\
 m &= 8.
 \end{aligned}$$

The vertices of the graph is labeled from the set $D = \{1, 2, 3, 4, 5, 6, 7, 8\}$. Choose an arbitrary vertex in diamond graph and label it as 1. And label the other vertex by a prime number. So that the gcd of two consecutive vertices is 1 and edge labels are distinct.

Example



Prime graceful labeling of Diamond graph





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Theorem 3.4

House graph permits prime graceful labeling.

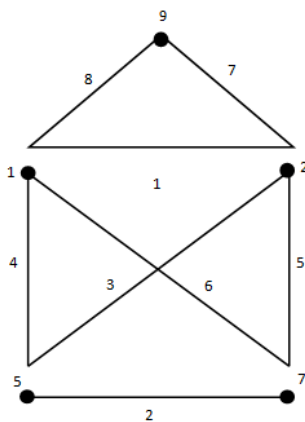
Proof

The house graph H is a simple graph with 5 vertices and 8 edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(5), 2(8)) \\
 &= \min(10, 16) \\
 m &= 10.
 \end{aligned}$$

The vertices of the graph is labeled from the set $H = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. Label the vertex, roof of the house graph H with 9 from the vertex set. And label the other vertices with prime number like 1, 3, 5, 7. So that the gcd of two consecutive vertices of each edge is 1 and resulting edge labels are distinct.

Example



Prime graceful labeling of House graph

Theorem 3.5

$Spl(K_{1,n})$ permits prime graceful labeling.

Proof

The $Spl(K_{1,n})$ contains $2n + 2$ vertices and $3n$ edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(2n + 2), 2(3n)) \\
 &= \min(4n + 4, 6n) \\
 m &= 6n.
 \end{aligned}$$

Label the vertex having degree $2n$ of $K_{1,n}$ with 1 and label the vertex having degree n with $(6n - 5)$. And label the remaining vertices with remaining numbers from the set $2, 3, \dots, 6n$. Hence the gcd of two adjacent vertices of each edge is 1. And then edges labels are $1, 2, 3, \dots, 6n$ are distinct.

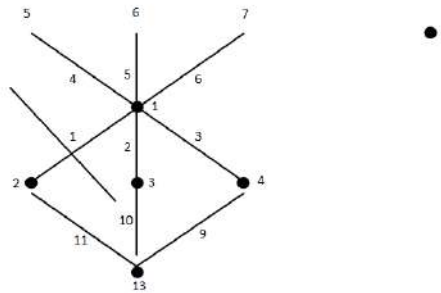
Example

The $Spl(K_{1,3})$ is a prime graceful labeling.



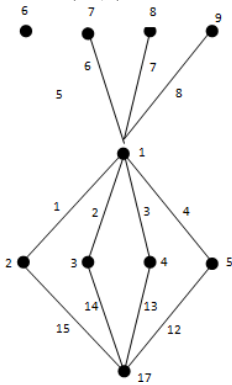


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Prime graceful labeling of $Spl(K_{1,3})$

The $Spl(K_{1,4})$ is a prime graceful labeling.



Theorem 3.6

Tetrahedral graph permits prime graceful labeling.

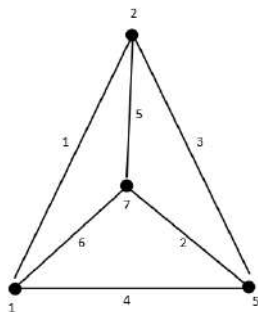
Proof

The tetrahedral graph, T is a graph with four vertices and six edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(4), 2(6)) \\
 &= \min(8, 12) \\
 m &= 8.
 \end{aligned}$$

The vertices of the graph is labeled from the set $\{1,2,3,4,5,6,7,8\}$. Label the center vertex of the graph with number 7 and labeling the remaining vertices with prime numbers from the set. Eg: 1,2,3,5. So that the gcd of a consecutive vertices is 1 and each edges are labeled with distinct numbers.

Example



Prime graceful labeling of Tetrahedral graph





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Theorem 3.7

Tent graph permits prime graceful labeling.

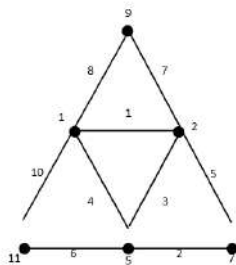
Proof

The graph is an undirected graph with six vertices and nine edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(6), 2(9)) \\
 &= \min(12, 18) \\
 m &= 12 .
 \end{aligned}$$

The vertices of the graph are labeled from the set $T = \{1,2,3,4,5,6,7,8,9,10,11,12\}$. Three vertices are of the degree four and the remaining three vertices are of degree three. The vertices with degree 4 are labeled by a prime number i.e., 1,2 and 5. The vertex with degree two are labeled by odd numbers i.e., 7,9 and 11. Hence the gcd of the any two adjacent vertices is 1 and each edges is labeled by distinct numbers from the set.

Example:



Prime graceful labeling of Tent graph

CONCLUSION

In this paper the concept of the prime graceful labeling and proof of the existence of prime graceful labeling for graphs such as shadow graph $D_2(C_n)$, shadow graph $D_2(K_{1,n})$, split graph $Spl(K_{1,n})$, diamond graph, house graph, tetrahedral graph, tent graph.

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Relatively Generalized Concepts of Continuous Functions in Micro Topological Spaces

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 06 Jun 2024

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ABSTRACT

Micro Topological Spaces introduced by S.Chandrasekar and introduces a new type of $O(X)$ (open sets) . Regular- $O(X)$, $-O(X)$, $eI-O(X)$, $I-O(X)$, Somewhat-I-continuous functions, Almost somewhat -continuous functions, somewhat eI_r -continuous functions introduced by P.L.Powar, W.AI-Omeri, Shikha Bhadauria. In this paper we introduce MIC - $eI-O(X)$, Relatively -MIC-r-continuous functions, Relatively -MIC- eI -continuous functions, almost relatively MIC-continuous functions, relatively MIC--continuous functions , relatively MIC- β_r -continuous functions also, find part of their required resources in MTS.

Keywords: MIC-regular $O(X)$, MIC- $eI -O(X)$, Relatively -MIC- eI -continuous functions , almost relatively -MIC-continuous functions, relatively - MIC - -continuous functions relatively - MIC - β_r -continuous functions.

INTRODUCTION

R.Vaidyanathaswamy [1] proposed the localization theory in set topology in 1944 . S.Ganesan [2] has developed a new concept of Micro topological space through smaller systems, in 2018. Regular- $O(X)$, $-O(X)$, $eI-O(X)$, $I-O(X)$ somewhat-I-continuous functions, Almost somewhat-continuous functions, Somewhat eI_r -continuous functions introduced by P.L.Powar, W.AI-Omeri, Shikha Bhadauria[3] in 2020.S.Selvaraj Ganesan [4] proposed a MIC-G-c(x) and MIC-G-Continuous in MTS in 2020. In 2022 M.Josephine Rani and R.Bhavani[5] MIC-Ig and MIC-Ig Closed Sets in Micro Ideal Topological Spaces In this paper Proposed MIC - $eI-O(X)$, relatively - MIC --continuous functions,





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relatively - MIC - β r -continuous functions, almost relatively MIC-continuous functions, relatively MIC - eI-continuous functions in MTS and some of its structures are being investigated.

PRELIMINARIES

Explication 2.1[4]

Start U as a set of horizontal instruments called the Universe and R as the equivalent relationship with U , which is called the relation of ignorance.

This couple (U, R) is said to be the space of enterprise. Enable $X \subseteq U$.

i) The minimum X relative to R is the set of all the details, which is set for the object divided by X relative to R and denoted by $L_R(X)$. That is,

$L_R X = \{x \in U \mid \exists R(x) \subseteq X\}$ Where $R(x)$ represents the equivalent class determined by X .

ii) The maximum X value relative to R is $U_R(X) = \{x \in U \mid \{R(x) \subseteq X\}$.

iii) The boundary area of X with respect to R is a set of all objects which is intermediate or non- X with respect to R and is defined as $B_R(X)$. That is, $B_R(X) = U_R(X) - L_R(X)$. and their complement is called micro closed sets.

Explication 2.2[5]

$(U, \tau_R(X))$ is a Nano topological space then $R(X) = \{N \cup (N' \cap \mu) : N, N' \in \tau_R(X)\}$ and called it Micro topology of $\tau_R(X)$ by μ where $\mu \notin \tau_R(X)$.

Explication 2.3[5]

Micro topology $R(X)$ satisfies the following theories

(i) $U, \phi \in R(X)$

(ii) A combination of any of the elements the group is $R(X)$ in $R(X)$

(iii) The intersection of parcels of any finite subdivision of $R(X)$ in $R(X)$. Also $R(X)$ is called the micro topology in relation to X in U . Triplets $(U, \tau_R(X), R(X))$ are called micro topological spaces and the bases of $R(X)$ are called micro open sets and their complements are called micro closed Sets.

Explication 2.4

A subset A of an ideal topological spaces (IDTS) (U, τ, ID) is said to be R -ID- $O(X)$ (resp. R -ID- $C(X)$) if $A = \text{Int}(\text{clr}^*(A))$ (resp. $\text{clr}^*(\text{Int}(A))$). The $-ID$ -interior of A is the union of all R -ID- $O(X)$ of X contained in A and is denoted by $-IntI(A)$.

Explication 2.5

A subset A of an ideal topological space (U, τ, ID) is said to be

1. Regular $O(X)$ if $A = \text{Int}(\text{clr}(A))$

2. $-O(X)$ if $A = \text{clr}(\text{Int}(\text{clr}(A)))$

The family of regular $O(X)$ (ie. $RO(X)$), β - $O(X)$ respectively.

Explication 2.6

A subset A of an ideal topological space (U, τ, ID) is said to be $eI - O(X)$ $A = \text{clr}(\text{IntI}(A)) \cap \text{Int}(\text{clrI}(A))$

Explication 2.7

A function $f : (U, \tau_1) \rightarrow (U, \tau_2)$ is said to be relatively continuous if for each V_2 and $f^{-1}(V_2) \neq \emptyset$ there exist $U_1 \subseteq U$ and $U_1 \neq \emptyset$ and $U_1 \subseteq f^{-1}(V_2)$.

Explication 2.8

A function $f : (U, \tau_1, ID_1) \rightarrow (U, \tau_2, ID_2)$ is said to be relatively eI -continuous if for each V_2 and $f^{-1}(V_2) \neq \emptyset$ there exist $U_1 \subseteq U$ and $U_1 \neq \emptyset$ and $U_1 \subseteq f^{-1}(V_2)$.





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Generalized Relatively Micro Continuous Functions

In this section, we have introduced the generalized versions of relatively continuous function with illustrative examples.

Relatively-r-Continuous Functions

Definition 3.1.1

A function $f : (\mathcal{U}_1, \mathcal{U}_1) \rightarrow (\mathcal{U}_2, \mathcal{U}_2)$ is impart to be relatively $-r$ -MIC-continuous if for each $V_2 \in \mathcal{RO}(\mathcal{U}_2)$ and $f^{-1}(V_2) \neq \emptyset$, there exist $U \in \mathcal{U}_1$ such that $U \neq \emptyset$ and $U \subset f^{-1}(V_2)$.

Remark 3.1.2

Each relatively continuous function is relatively-MIC-r-continuous functions yet the converse may not hold necessarily.

Illustration: 3.1.3

Enable $\mathcal{U}_1 = \{e_1, e_2, e_3, e_4\}$ be a non-empty set with the Micro topology $\mathcal{U}_1 = \{\emptyset, \{e_1\}, \{e_2\}, \{e_1, e_2\}, \{e_1, e_2, e_3\}\}$, $\mathcal{U}_1R(X_1) = \{\{e_3\}, \{e_4\}, \{e_1, e_2\}\}$ and $X_1 = \{e_1, e_2\}$, $\mu = \{e_3\} \notin R(X)$, $R(X_1) = \{\emptyset, \{e_1, e_2\}\}$, Consider $\mathcal{U}_2 = \{l_1, l_2, l_3, l_4\}$, $\mathcal{U}_2R(X_2) = \{\{l_1\}, \{l_2\}, \{l_3, l_4\}\}$ and $X_2 = \{l_1, l_3\}$, $R(X_2) = \{\emptyset, \{l_1\}, \{l_3, l_4\}, \{l_1, l_3, l_4\}\}$, $\mu = \{l_2\} \notin R(X_2)$, $\mathcal{U}_2 = \{\emptyset, \{l_1\}, \{l_2\}, \{l_1, l_2\}, \{l_1, l_3, l_4\}, \{l_3, l_4\}, \{l_2, l_3, l_4\}\}$, $I = \{\emptyset, \{l_3\}\}$,

The function $f : (\mathcal{U}_1, NA, MIC) \rightarrow (\mathcal{U}_2, NA, MIC)$ is defined by $f(e_1) = l_3$, $f(e_2) = l_4$, $f(e_3) = l_1$, $f(e_4) = l_2$. First, we show that the function f is relatively $-MIC - r -$ continuous functions.

Enable $V_1 \in \mathcal{MIC-R-O}(\mathcal{U}_2)$ and $f^{-1}(\{l_1\}) = \{e_3\} \neq \emptyset$ and there exists $U_1 = \{e_3\} \in \mathcal{U}_1$ and $U_1 \subset f^{-1}(V_1)$. Similarly, for the other regular open sets of \mathcal{U}_2 , there exists $U_1 \in \mathcal{U}_1$ such that the condition $U_1 \subset f^{-1}(V_1)$ holds. So, the function f is relatively-MIC-r-continuous. Next we show that the function f is not relatively-MIC-continuous function. For $V_1 = \{l_2\} \in \mathcal{U}_2$, $f^{-1}(V_1) = \{e_4\}$ but there does not exist any $U_1 \in \mathcal{U}_1$ such that $U_1 \neq \emptyset$ and $U_1 \subset f^{-1}(V_1)$. Therefore, the function f is not relatively-MIC-continuous function.

Remark: 3.1.4

Relatively-MIC-r-continuous functions and Relatively-MIC-e-I-continuous functions are independent of one another. The examples below support this statement.

Illustration: 3.1.5

Enable $\mathcal{U}_1 = \{5, 6, 7, 8\}$ be a non-empty set with the Micro topology $\mathcal{U}_1 = \{\emptyset, \{5\}, \{6, 7\}, \{6, 7, 8\}\}$, $\mathcal{U}_1R(X_1) = \{\{5\}, \{6, 7\}, \{8\}\}$, $X_1 = \{6, 7\}$ and $\mu = \{8\}$. Enable $\mathcal{U}_2 = \{p_1, q_1, r_1, s_1\}$ consider $\mathcal{U}_2 = \{\emptyset, \{p_1\}, \{q_1\}, \{p_1, q_1\}, \{p_1, q_1, r_1\}, \{p_1, q_1, r_1, s_1\}\}$ with the Micro topology $\mathcal{U}_2 = \{\emptyset, \{p_1\}, \{q_1\}, \{p_1, q_1\}, \{p_1, q_1, r_1\}, \{p_1, q_1, r_1, s_1\}\}$, $\mathcal{U}_2R(X_2) = \{\{p_1, q_1\}, \{r_1\}, \{s_1\}\}$, $X_2 = \{p_1, s_1\}$, $\mu = \{q_1\}$, $I_2 = \{\emptyset, \{r_1, s_1\}\}$. The collection of closed set is $F_2 = \{\emptyset, \{p_1\}, \{q_1\}, \{p_1, q_1\}, \{p_1, q_1, r_1\}, \{p_1, q_1, r_1, s_1\}\}$. The function $f : (\mathcal{U}_1, \mathcal{U}_1) \rightarrow (\mathcal{U}_2, \mathcal{U}_2)$ is defined by $f(5) = p_1, f(6) = q_1, f(7) = r_1, f(8) = s_1$. Now we show that the function f is Relatively-MIC-r-continuous. Enable $V_2 = \{q_1, s_1\} \in \mathcal{MIC-R-O}(\mathcal{U}_2)$ and $f^{-1}(\{q_1, s_1\}) = \{6, 8\} \neq \emptyset$ and there exists $U_1 = \{6, 8\} \in \mathcal{U}_1$ such that $U_1 \subset f^{-1}(V_2)$. So f is Relatively-MIC-r-continuous. Similarly, it has been verified for the other MIC-regular- $O(X)$ V_2 of \mathcal{U}_2 there exist $U_1 (\neq \emptyset) \in \mathcal{U}_1$ the function f is Relatively-MIC-r-continuous. But for $V_2 = \{p_1\} \in \mathcal{U}_2$, $f^{-1}(\{p_1\}) = \{5\}$, there does not exist any $U_1 \in \mathcal{MIC-eIO}(\mathcal{U}_1)$ such that $U_1 \neq \emptyset$ and $U_1 \subset f^{-1}(V_2)$. Therefore, the function f is Relatively e-I-continuous.

Illustration 3.1.6

Enable $\mathcal{U}_1 = \{n, o, p, q\}$ be a non-empty set with the Micro topology $\mathcal{U}_1 = \{\emptyset, \{n\}, \{o\}, \{n, p\}, \{n, o, p\}\}$, $\mathcal{U}_1R(X_1) = \{\{n\}, \{o, q\}, \{p\}\}$, $X_1 = \{n, p\}$, and $I_1 = \{\emptyset, \{o, p\}\}$, $\mu = \{o\}$. consider $\mathcal{U}_2 = \{1, 2, 3, 4\}$ with the Micro topology $\mathcal{U}_2 = \{\emptyset, \{1\}, \{2\}, \{3\}, \{4\}, \{1, 2\}, \{1, 3\}, \{1, 2, 3\}, \{1, 3, 4\}\}$, $I_2 = \{\emptyset, \{6\}, \{7, 8\}\}$, $\mu = \{2\}$. The collection of closed set is $F_2 = \{\emptyset, \{1\}, \{2\}, \{3\}, \{4\}, \{1, 2, 3\}, \{1, 3, 4\}\}$. The function $f : (\mathcal{U}_1, \mathcal{U}_1) \rightarrow (\mathcal{U}_2, \mathcal{U}_2)$ is defined by $f(n) = 1, f(o) = 2, f(p) = 3, f(q) = 4$. Now we show that the function f is Relatively-MIC-e-I-continuous. For $V_2 = \{2\} \in \mathcal{U}_2$ and $f^{-1}(\{2\}) = \{o\} \neq \emptyset$ and there exists $U_1 = \{o\} \in \mathcal{MIC-eIO}(\mathcal{U}_1)$ such that $U_1 \subset f^{-1}(V_2)$ and





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$U_1 f^{-1}(V_2)$. Similarly, for the other MIC-regular- $O(X)$ of U_2 there exist $U_1 (\neq \emptyset) \in \tau_1, U_1 \neq \emptyset$ and $U_1 f^{-1}(V_2)$ holds. So, the function f is Relatively-MIC-e-I-continuous functions. Next, we show that the function f is not Relatively-MIC-r-continuous. For $V_2 = \{2\} \in R-O(U_2)$, $f^{-1}(\{2\}) = \{n\}$, but there exists no $(U_1 \neq \emptyset) \in \tau_1$, satisfying the condition $U_1 f^{-1}(V_2)$. Therefore, the function f is not Relatively-MIC-r-continuous.

Relatively-MIC--continuous functions

Definition 3.2.1

A function $f : (U_1, \tau_1) \rightarrow (U_2, \tau_2)$ is called as Relatively-MIC--continuous functions if for every $V_2 \in \tau_2$ and $f^{-1}(V_2) \neq \emptyset$ there exists $U_1 \in MIC-\beta O(X_1) \ni U_1 \neq \emptyset$ and $U_1 f^{-1}(V_2)$.

Remark 3.2.2

Each relatively continuous function is relatively- β -continuous although the converse may not be valid always.

Example 3.2.3

Enable $U_1 = \{d_1, d_2, d_3, d_4\}$ be a non-empty set with the Micro topology $\tau_1 = \{\emptyset, U_1, \{d_3\}, \{d_1, d_2\}, \{d_1, d_2, d_3\}\}$, $MIC-c(x) = \{\emptyset, U_1, \{d_4\}, \{d_3, d_4\}, \{d_1, d_2, d_4\}\}$, $U_1 R(X_1) = \{\{d_1, d_2\}, \{d_3\}, \{d_4\}\}$, $X_1 = \{d_1\}$, and $I_1 = \{\emptyset, \{d_1\}, \{d_2\}, \{d_1, d_2\}, \{d_3\}\}$, consider $U_2 = \{i_1, i_2, i_3, i_4\}$ with the Micro topology $\tau_2 = \{\emptyset, U_2, \{i_1\}, \{i_2\}, \{i_1, i_2\}, \{i_2, i_3\}, \{i_1, i_2, i_3\}\}$. The collection of closed set is $F_2 = \{\emptyset, U_2, \{i_2, i_3, i_4\}, \{i_1, i_3, i_4\}, \{i_3, i_4\}, \{i_1, i_4\}, \{i_4\}\}$, $U_1 R(X_2) = \{\{i_2, i_3\}, \{i_1\}, \{i_4\}\}$, $X_2 = \{i_1, i_3\}$,

$\{i_2\}, I_2 = \{\emptyset, \{i_4\}\}$. The function $f : (U_1, \tau_1) \rightarrow (U_2, \tau_2)$ is defined by $f(d_1) = i_4, f(d_2) = i_1, f(d_3) = i_2, f(d_4) = i_3$. Now we show that the function f is Relatively-MIC- β -continuous. For $V_1 = \{i_2\} \in \tau_2$ and $f^{-1}(\{i_2\}) = \{d_3\} \neq \emptyset$ and there exists $U_1 = \{d_3\} \in MIC-O(U_1) \ni U_1 \neq \emptyset$ and $U_1 f^{-1}(V_2)$. Similarly it has been verified that for the remaining $O(X)$ of U_2 there exist $U_1 \in MIC-O(U_1)$ such that the condition $U_1 f^{-1}(V_2)$ holds. Hence the mapping f is Relatively-MIC- β -continuous. Next, we show that the function f is not Relatively-MIC-continuous. For $V_2 = \{i_1\} \in \tau_2$, $f^{-1}(\{i_1\}) = \{d_2\}$, but there exists no $(U_1 \neq \emptyset) \in \tau_1$, satisfying the condition $U_1 f^{-1}(V_2)$. Therefore, the mapping f is not Relatively-MIC-continuous.

Remark 3.2.4

It has been noted that relatively- r-continuous functions and relatively- β -continuous functions are independent of one another.

Example 3.2.5

Enable $U_1 = \{n_1, o_1, p_1, q_1\}$ be a non-empty set with the Micro topology $\tau_1 = \{\emptyset, U_1, \{q_1\}, \{o_1, p_1\}, \{o_1, p_1, q_1\}\}$, $U_1 R(X_1) = \{\{n_1, q_1\}, \{o_1\}, \{p_1\}\}$, $X_1 = \{o_1, p_1\}$, and $I_1 = \{\emptyset, \{o_1\}, \{p_1, q_1\}, \{q_1\}\}$. consider $U_2 = \{1, 2, 3, 4\}$ with the Micro topology $\tau_2 = \{\emptyset, U_2, \{1\}, \{2\}, \{1, 2\}, \{3, 4\}, \{1, 3, 4\}, \{2, 3, 4\}\}$, $U_1 R(X_2) = \{\{1\}, \{2\}, \{3, 4\}\}$, $X_2 = \{1, 3\}$, $I_2 = \{\emptyset, \{3\}\}$. The function $f : (U_1, \tau_1) \rightarrow (U_2, \tau_2)$ is defined by $f(n_1) = 1, f(o_1) = 4, f(p_1) = 3, f(q_1) = 2$. Now we show that the function f is relatively-MIC- r-continuous. For $V_1 = \{2\} \in MIC-R-O(U_2)$ and $f^{-1}(\{2\}) = \{q_1\} \neq \emptyset$ and there exists $U_1 = \{q_1\} \in \tau_1 \ni U_1 \neq \emptyset$ and $U_1 f^{-1}(V_2)$. Similarly it has been verified that the condition $U_1 f^{-1}(V_2)$ for all $V_2 \in MIC-R-O(U_2)$ and for some $U_1 \in \tau_1$ holds. Hence the mapping f is relatively-MIC- r-continuous. Next, we show that the function f is not Relatively-MIC- β -continuous. For $V_2 = \{1\} \in \tau_2$, $f^{-1}(\{1\}) = \{n_1\}$, but there exists no $U_1 \in MIC-\beta O(U_1)$ such that $U_1 \neq \emptyset$ and $U_1 f^{-1}(V_2)$. Therefore, the function f is not Relatively-MIC--continuous.

Example 3.2.6

Enable $U_1 = \{h_1, h_2, h_3, h_4\}$ be a non-empty set with the Micro topology $\tau_1 = \{\emptyset, U_1, \{h_3\}, \{h_1, h_2\}, \{h_1, h_2, h_3\}\}$, $U_1 R(X_1) = \{\{h_1, h_2\}, \{h_3\}, \{h_4\}\}$, $X_1 = \{h_1\}$, and $I_1 = \{h_3\}$, consider $U_2 = \{d_1, e_1, f_1, g_1\}$ with the Micro topology $\tau_2 = \{\emptyset, U_2, \{d_1\}, \{e_1\}, \{d_1, e_1\}, \{e_1, f_1\}, \{d_1, e_1, f_1\}\}$, $U_1 R(X_2) = \{\{e_1, f_1\}, \{d_1\}, \{g_1\}\}$, $X_2 = \{d_1, f_1\}$, $I_2 = \{e_1\}$. The function $f : (U_1, \tau_1) \rightarrow (U_2, \tau_2)$ is defined by $f(h_1) = g_1, f(h_2) = d_1, f(h_3) = e_1, f(h_4) = f_1$





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Now we show that the function f is relatively-MIC--continuous. For $V_1 = \{d_1\} \in \mathcal{U}_2$ and $f^{-1}(\{d_1\}) = \{h_2\} \neq \emptyset$ and there exists $U_1 = \{h_2\} \in \text{MIC-}\beta\mathcal{O}(\mathcal{U}_1)$ $U_1 \neq \emptyset$ and $U_1 \cap f^{-1}(V_2)$. Similarly, for the remaining open sets of \mathcal{U}_2 , there exists $U_1 (\neq \emptyset) \in \text{MIC-}\beta\mathcal{O}(\mathcal{U}_1) \ni$ the condition $U_1 \cap f^{-1}(V_2)$ holds. Hence the mapping f is relatively-MIC- β - continuous. Next, we show that the function f is not Relatively-MIC- r -continuous. For $V_2 = \{d_1\} \in \text{MIC-R-O}(\mathcal{U}_2)$, $f^{-1}(\{d_1\}) = \{h_2\}$, but there exists no $U_1 \in \mathcal{U}_1$ such that $U_1 \neq \emptyset$ and $U_1 \cap f^{-1}(V_2)$. Therefore, the function f is not Relatively-MIC- r -continuous.

Relatively-MIC- β - r -continuous functions

Definition 3.3.1

A function $f : (\mathcal{U}_1, \tau_1) \rightarrow (\mathcal{U}_2, \tau_2)$ is known as Relatively-MIC- β - r -continuous functions if for every $V_2 \in \text{MIC-R-O}(\mathcal{U}_2)$ and $f^{-1}(V_2) \neq \emptyset$ there exists $U_1 \in \text{MIC-O}(\mathcal{U}_1) \ni U_1 \neq \emptyset$ and $U_1 \cap f^{-1}(V_2)$.

Remark 3.3.2

Each relatively- r -continuous function is relatively- β - r -continuous but it is not necessary that the converse be true and its validation has been assured by the following counter example.

Example 3.3.3

Enable $\mathcal{U}_1 = \{p_1, q_1, r_1, s_1, t_1\}$ be a non-empty set with the Micro topology $\tau_1 = \{\emptyset, \mathcal{U}_1, \{t_1\}, \{p_1, q_1, r_1, s_1\}\}$, $\text{MIC-c}(x) = \{ \emptyset, \mathcal{U}_1, \{t_1\}, \{p_1, q_1, r_1, s_1\} \}$, $\mathcal{U}_1 R(X_1) = \{ \{p_1, q_1\}, \{r_1, s_1\}, \{t_1\} \}$, $X_1 = \{d_1\}$, and $I_1 = \{\emptyset, \{p_1, q_1, r_1\}\}, = \{t_1\}$, we obtain, consider $\mathcal{U}_2 = \{a_2, b_2, c_2, d_2, e_2\}$ with the Micro topology $\tau_2 = \{\emptyset, \mathcal{U}_2, \{a_2\}, \{a_2, b_2\}, \{a_2, e_2\}, \{c_2, d_2\}, \{a_2, b_2, e_2\}, \{a_2, c_2, d_2\}, \{a_2, c_2, d_2, e_2\}\}$, $\mathcal{U}_2 R(X_2) = \{ \{a_2\}, \{b_2\}, \{c_2, d_2\}, \{e_2\} \}$, $X_2 = \{a_2, d_2, e_2\}$, $I_2 = \{\emptyset, \{b_2\}\}$, The function $f : (\mathcal{U}_1, \tau_1) \rightarrow (\mathcal{U}_2, \tau_2)$ is defined by $f(p_1) = b_2, f(q_1) = c_2, f(r_1) = d_2, f(s_1) = e_2, f(t_1) = a_2$. Now we show that the function f is Relatively-MIC- β - r -continuous. For $V_1 = \{a_2, b_2, e_2\} \in \text{MIC-R-O}(\mathcal{U}_2)$ and $f^{-1}(\{a_2, b_2, e_2\}) = \{p_1, s_1, t_1\} \neq \emptyset$ and there exists $U_1 = \{p_1, s_1, t_1\} \in \text{MIC-O}(\mathcal{U}_1)$ $U_1 \neq \emptyset$ and $U_1 \cap f^{-1}(V_2)$. Similarly it has been verified that for the remaining $\mathcal{O}(X)$ of \mathcal{U}_2 there exist $U_1 \in \text{MIC-O}(\mathcal{U}_1)$ such that the condition $U_1 \cap f^{-1}(V_2)$ holds. Hence the mapping f is Relatively-MIC- β - continuous. Next, we show that the function f is not Relatively-MIC- β - r -continuous. For $V_2 = \{a_2, b_2, e_2\} \in \text{MIC-R-O}(\mathcal{U}_2)$, $f^{-1}(\{a_2, b_2, e_2\}) = \{p_1, s_1, t_1\}$, but there exists no $(U_1 \neq \emptyset) \in \mathcal{U}_1$, satisfying the condition $U_1 \cap f^{-1}(V_2)$. Therefore, the mapping f is not Relatively-MIC- r -continuous.

Remark 3.3.3

Each relatively-MIC--continuous function is relatively-MIC- β - r -continuous but the converse might not be essentially true. So as to support this statement, the subsequent example could be referred.

Example 3.3.4

Enable $\mathcal{U}_1 = \{5, 6, 7, 8\}$ be a non-empty set with the Micro topology $\tau_1 = \{\emptyset, \mathcal{U}_1, \{8\}, \{6, 7\}, \{6, 7, 8\}\}$, $\mathcal{U}_1 R(X_1) = \{ \{5, 8\}, \{6\}, \{7\} \}$, $X_1 = \{6, 7\}$, and $I_1 = \{\emptyset, \{6\}, \{7, 8\}\}$. consider $\mathcal{U}_2 = \{11, 12, 13, 14\}$ with the Micro topology $\tau_2 = \{\emptyset, \mathcal{U}_2, \{11\}, \{12\}, \{11, 12\}, \{11, 13, 14\}, \{13, 14\}, \{12, 13, 14\}\}$, $\mathcal{U}_2 R(X_2) = \{ \{11\}, \{12\}, \{13, 14\} \}$, $X_2 = \{11, 13\}$, $I_2 = \{\emptyset, \{13\}\}$, The function $f : (\mathcal{U}_1, \tau_1) \rightarrow (\mathcal{U}_2, \tau_2)$ is defined by $f(5) = 11, f(6) = 13, f(7) = 14, f(8) = 12$. Now we show that the function f is Relatively-MIC--continuous. For $V_2 = \{12\} \in \mathcal{U}_2$ and $f^{-1}(\{12\}) = \{8\} \neq \emptyset$ and there exists $U_1 = \{8\} \in \text{MIC-}\beta\mathcal{O}(\mathcal{U}_1)$ $U_1 \neq \emptyset$ and $U_1 \cap f^{-1}(V_2)$. Similarly, the condition $U_1 \cap f^{-1}(V_2)$ for all $V_2 \in \text{MIC-R-O}(\mathcal{U}_2)$ and for some $U_1 (\neq \emptyset) \in \text{MIC-}\beta\mathcal{O}(\mathcal{U}_1) \ni$ the condition $U_1 \cap f^{-1}(V_2)$ holds. Hence the mapping f is relatively-MIC- β - r - continuous. Next, we show that the function f is not Relatively-MIC- β - r -continuous. For $V_2 = \{11\} \in \mathcal{U}_2$, $f^{-1}(\{11\}) = \{5\}$, but there exists $U_1 (\neq \emptyset) \in \text{MIC-}\beta\mathcal{O}(\mathcal{U}_1)$ satisfy the condition $U_1 \cap f^{-1}(V_2)$. Therefore, the function f is not Relatively-MIC--continuous.





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SOME IMPORTANT RESULTS

In this section, we have proved that for all \mathcal{U}_1 belonging to \mathcal{U}_1 , there exists a set B which is a member of $MIC-\beta O(\mathcal{U}_1)$ such that \mathcal{U}_1 belongs to B. Certain composite maps of various relatively functions have been also discussed.

Theorem 4.1 Let $(\mathcal{U}_1, \mathcal{U}_1)$ be the Micro topological space and $MIC-\beta O(\mathcal{U}_1)$ be the collection of $MIC-\beta$ -open sets. Then for each \mathcal{U}_1 belonging to \mathcal{U}_1 , there exists at least one $MIC-\beta$ -open set containing it.

Proof. Let \mathcal{U}_1 be a nonempty set with the Micro topology \mathcal{U}_1 (\mathcal{U}_1). The collection of open sets is $\{U\}_{\alpha \in K}$ and the collection F of closed sets is $\{V\}_{\delta \in k}$.

Now, we consider the following cases for the desired result.

Case I For each $\mathcal{U}_1 \in \mathcal{U}_1, \exists$ an index $\beta \in J$ such that $U \in \mathcal{U}_1$ (\mathcal{U}_1) and $\mathcal{U}_1 \in U$. We know that \mathcal{U}_1 (\mathcal{U}_1) $\subset MIC-\beta O(X)$. Hence, for each $\mathcal{U}_1 \in \mathcal{U}_1, \exists$ one $MIC-\beta$ -open set containing it.

Case II Let $\mathcal{U}_1 \in \mathcal{U}_1$ and $x \notin U$ ($\neq X$) for each $\alpha \in J$

Now, we construct $U \cup \{\mathcal{U}_1\} = W$ (say) (4.1)

We show that $W(\neq \mathcal{U}_1) \in MIC-\beta O(\mathcal{U}_1)$

For $V \in F$, if $W \subseteq \mathcal{U}_1(V) = \mathcal{U}_1$, where \mathcal{U}_1 is the smallest closed set containing W), then trivially $W \in MIC-\beta O(X)$. Next, we consider $W \subseteq V \in F$ (since, $V \subset \mathcal{U}_1$).

In view of Explication 2.5, it is enough if we show the following:

$$W \subseteq MIC-cl(MIC-Int(MIC-cl(W))) \quad (4.2)$$

Now, by construction, we have, $MIC-cl(W) = V$. By taking MIC -interior on both the sides, we have, $MIC-Int(cl(W)) = MIC-Int(V) = U$ (cf. relation (4.1))

Now, by taking MIC -closure on both the sides, we get,

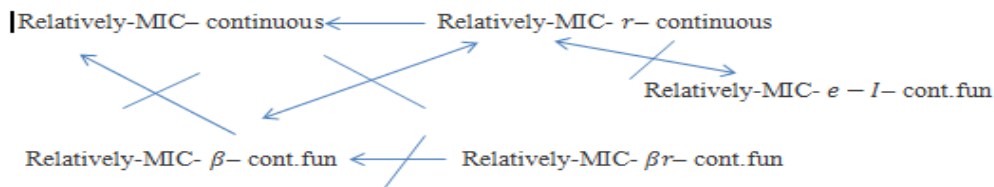
$$MIC-cl(MIC-Int(MIC-cl(W))) = MIC-cl(U) = V.$$

Since, $W \subseteq V$, hence, relation (4.2) follows directly,

Finally, we conclude that W is a $MIC-\beta$ -open set containing $\mathcal{U}_1 \in \mathcal{U}_1$.

Remark 4.2

If functions $g: (\mathcal{U}_1, \mathcal{U}_1) \rightarrow (\mathcal{U}_2, \mathcal{U}_2)$ and $h: (\mathcal{U}_2, \mathcal{U}_2) \rightarrow (\mathcal{U}_3, \mathcal{U}_3)$ are $MIC-\beta$ -continuous then it is not necessarily true that $h \circ g$ is relatively $MIC-\beta$ -continuous function.



CONCLUSION

The concept of relatively- MIC -continuous function has been generalized in the form of relatively – MIC - r -continuous functions, relatively- MIC - β -continuous functions and Almost relatively - MIC -continuous functions. These relatively functions were further generalized in the context of MIC - regular open, $MIC-\beta$ -open sets. Finally, It is also proved that for all \mathcal{U}_1 belonging to \mathcal{U}_1 , there exists a set B that is a member of $MIC-\beta O(X)$ such that \mathcal{U}_1 belongs to B. In addition, various composite maps of relatively functions were discussed. We can extend the notion of relatively e - I -continuous





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functions to define relatively ϵ - I -homeomorphism to obtain relatively ϵ -I-homeomorphic image of the Micro topological space $\mathcal{U}1$.

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A New Method for Minimizing Costs in the Single-Valued Neutrosophic Transportation Issue

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Received: 21 Feb 2024

Revised: 03 Apr 2024

Accepted: 06 Jun 2024

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ABSTRACT

In the present world, some incidents have happened without anyone knowing beforehand. In this instance, industrial peoples and our entire human society (survival, health, etc.) are impacted in numerous ways. The most crucial daily necessity is transportation in particular. Therefore, we take into consideration the afore mentioned scenario in this research and examine the optimum range value of the neutrosophic translation problem. The goal of this paper is to build the transportation problem algorithm in a neutrosophic setting. There is an example provided.

Keywords: Neutrosophic, beforehand, algorithm, world, problem.

INTRODUCTION

In December 2019, a novel corona virus(COVID-19) was discovered in Wuhan, China, and has spread to different cities in China as well as many other countries day to day affected in this cases. Such a situation many countries had declared the lockdown and to taken the precatation measure for the purpose of controlled level. Such a cases, many country economic level are also decreased for particularly affected to the industry production and transporstation. For the uncertain situation Fuzzy set theory gives to the exact optimal solution. Many research has





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declared various algorithms and results. But Fuzzy set theory failed to indeterminate or inconsistent information problem. To overcome of such problem Neutrosophic set has been derived from a new branch of philosophy, namely Neutrosophy. Neutrosophic set is capable of dealing with uncertainty, indeterminacy and inconsistent information. Neutrosophic set approaches are suitable to modeling problems with uncertainty, indeterminacy and inconsistent information in which human knowledge is necessary, and human evaluation is needed. Neutrosophic set theory was proposed in 1998 by Florentin Smarandache, who also developed the concept of single valued neutrosophic set, oriented towards real world scientific and engineering applications. Since then, the single valued neutrosophic set theory has been extensively studied in books and monographs introducing neutrosophic sets and its applications, by many authors around the world. Also, an international journal - Neutrosophic Sets and Systems started its journey in 2013. In neutrosophic logic a proposition has a degree of truth (T), a degree of indeterminacy (I), and a degree of falsity (F), where T, I, F are standard or nonstandard subsets of $] - 0, 1+ [$. Multi-objective linear programming problem (MOLPP) a prominent tool for solving many real decision-making problems like game theory, inventory problems, agriculture based management systems, financial and corporate planning, production planning, marketing and media selection, university planning and student admission, health care and hospital planning, air force maintenance units, bank branches etc. Neutrosophic theory was introduced by Smarandache [8]. Recently some author has stated results in Neutrosophic transportation model. Particularly, Thamaraiselvi and Santhi (2016) [10] proposed the approaches for solving neutrosophic transportation problem of Type I (transportation problem in which cost for transporting unit quantity of the product is represented as trapezoidal neutrosophic number, whereas availability and demands are represented as real numbers) and neutrosophic transportation problem of Type II (transportation problem in which cost for transporting unit quantity of the product, availability of a product, and demand of the product are represented as trapezoidal neutrosophic numbers). Thamaraiselvi and Santhi [10] pointed out that neutrosophic set [9], one of the extensions of fuzzy set, is used in different research areas. However, till now no one has used the neutrosophic set in transportation problems, while several researchers have used fuzzy numbers for representing various parameters of transportation problems [8]. In this paper, we proposed an algorithm to minimize the transportation cost on neutrosophic environment. A numerical example included.

Preliminaries

Definition

A fuzzy set \bar{A} in X is a set of ordered pairs $\bar{A} = \{(x, \mu_{\bar{A}}(x)) / x \in X\}$, where X is a collection of objects denoted generically by x and $\mu_{\bar{A}}(x): X \rightarrow [0,1]$ is called the membership function or grade of membership of x in \bar{A} .

Definition: Neutrosophic Set

Let X be a space of points with a generic element in X denoted by x . A neutrosophic set (NS) \bar{A}^N in X is characterized by a truth membership function $\mu_A(x)$, an indeterminacy membership function $\sigma_A(x)$ and a falsity membership function $\nu_A(x)$ and having of the form

$\bar{A}^N = \{ \langle x, \mu_A(x), \nu_A(x), \sigma_A(x) \rangle / x \in X \}$, Where $\mu_A(x), \nu_A(x)$, and $\sigma_A(x)$ are real standard or non-standard subsets of $] 0^-, 1^+ [$, i.e. $\mu_A(x): X \rightarrow] 0^-, 1^+ [$, $\nu_A(x): X \rightarrow] 0^-, 1^+ [$

$\sigma_A(x): X \rightarrow] 0^-, 1^+ [$, There is no restriction on the sum of $\mu_A(x), \nu_A(x)$, and $\sigma_A(x)$.

So, $0^- \leq \sup \mu_A(x) + \sup \nu_A(x) + \sup \sigma_A(x) \leq 3^+$.

Definition: Single-valued neutrosophic set [12]

Let X be a space of points with a generic element x in X . A single-valued neutrosophic set (SVNS) \bar{A}^N in X is characterized by $\mu_A(x), \nu_A(x)$, and $\sigma_A(x)$, and having the form $\bar{A}^N = \{ \langle x, \mu_A(x), \nu_A(x), \sigma_A(x) \rangle / x \in X \}$, Where $\mu_A(x): X \rightarrow [0,1]$, $\nu_A(x): X \rightarrow [0,1]$, $\sigma_A(x): X \rightarrow [0,1]$, With $0 \leq \mu_A(x) + \nu_A(x) + \sigma_A(x) \leq 3$ for all $x \in X$.

Proposed Algorithms

Step 1: Construct the Neutrosophic Transportation problem.

Step 2: Convert Neutrosophic cost value into Crisp value with the help of single valued function.





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Step 3: Find the penalty cost for each row and each column

(It is difference between the smallest and next smallest cost value)

Step 4: Consider the maximum penalty value and allocate as much as possible in the lowest rank cell of the row or column chosen in the step (3)

Step 5: If the allocation is made fully to a row or column then the future consideration regarding ignore the entire row or column.

Step 6: continue the procedure for step (2) to step (5) until all the demands are satisfied.

The feasible solution thus obtained is the initial basic feasible solution.

Neutrosopic optimality test can be conducted to any NBFS of a NTP problem provided such allocation has exactly an $(m + n-1)$ non-negative allocation, where “m” is the number of origins and “n” is the number of destinations. Also these allocations must the independent positions- which is the optimality finding procedure that is given below

Step 7: Find the set of Neutrosopic numbers $u_i + v_i = c_{ij}$ for each occupied cells (i, j) received allocations.

Step 8: To start with zero Neutrosopic number to any row (or) column having maximum number of allocations. If the maximum number of allocations is more than one, and then choose any one arbitrary.

Step 9 : For each unoccupied cell (i, j), find u_i and v_j .

Step10: Calculate the net evaluation $z_{ij} = u_i + v_i = c_{ij}$. Then to find the S (N) of the net evaluation z_{ij} , this step gives the optimality conclusion is:

- (i) If $S(N) < 0$ for all (i, j), then the optimal allocation is made as it is a unique optimal solution.
- (ii) If $S(N) > 0$ for atleast one (i, j), then the solution is optimal but an alternate optimal solution exists.
- (iii) If $S(N) = 0$ for all (i, j), then the solution is not optimal.

Step 11: Select the un occupied cell having the most positive value of S (N). From this cell draw a closed loop path consists of successive horizontal and vertical segments whose corner cells are occupied cell which starts and ends at the designated unoccupied cell. This loop is unique and this process is summarized by positive and negative signs in the appropriate corners; this change will keep the supply and demand restrictions satisfied.

Step 12:The above step yield a better solution by making one (or) more basic cell as unoccupied cell. For the new set of NBFS allocation, repeat the above procedure from case (ii) step 1, until a NBFS obtained.

Numerical Example

Calculate the score value of each neutrosopic cost by the score function of the trapezoidal neutrosopic number to obtain the crisp transport problem.

Hence the minimum total neutrosopic cost is Minimize $= \sum_{i=0}^3 \sum_{j=0}^4 x_{ij} \bar{c}_{ij}^N$
 $= 3(3,5,6,8);0.6,0.5,0.4 + 23(5,8,10,14);0.3,0.6,0.6 + 14(0,1,3,6);0.7,0.5,0.3 +$
 $10(9,11,14,16);0.5,0.4,0.7 + 28(5,7,8,10);0.5,0.4,0.7 + 2(5,9,14,19);0.3,0.7,0.6 = (364,537,682,908);0.3,0.7,0.7$

RESULTS AND DISCUSSIONS

In the above Section, the neutrosopic optimum solution (488, 947.5 1586); 0.4, 0.8, 0.7 is better than the neutrosopic initial basic feasible solution. In the optimum solution, the total minimum transportation cost will be greater than 488 and less than 1586. And as the total minimum transportation cost lies in 947.5, the overall level of acceptance or satisfaction or the truthfulness is 30%. Also for the remaining values of total minimum transportation cost, the degree of truthfulness is $\mu(x) \times 100$ where x denotes the total cost and $\mu(x)$ is given by

$$\mu(x) = \begin{cases} 0.4 \left(\frac{x - 488}{947.5 - 488} \right) & \text{for } 488 \leq x \leq 947.5 \\ 0.4 \left(\frac{1586 - x}{1586 - 947.5} \right) & \text{for } 947.5 \leq x \leq 1586 \end{cases}$$

In the optimum solution, the degrees of indeterminacy and falsity are the same. Hence, degree of indeterminacy and falsity for the minimum transportation cost are





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$$v(x) = \begin{cases} \frac{947.5-x+0.8(x-488)}{947.5-488} & \text{for } 488 \leq x \leq 947.5 \\ \frac{x-947.5+0.8(1586-x)}{1586-947.5} & \text{for } 947.5 \leq x \leq 1586 \end{cases}$$

$$\lambda(x) = \begin{cases} \frac{947.5-x+0.7(x-488)}{947.5-488} & \text{for } 488 \leq x \leq 947.5 \\ \frac{x-947.5+0.7(1586-x)}{1586-947.5} & \text{for } 947.5 \leq x \leq 1586 \end{cases}$$

respectively. Hence, a decision maker can conclude the total neutrosophic cost from the range 488 to 1586, with its truth degree, indeterminacy degree, and falsity degree. Based on the above result, he may schedule the transportation and budget constraints.

$$\mu_{\bar{a}}(x) = [x_L, x_U] = \left[\frac{\alpha(459.5)+195.2}{0.4}, \frac{634.4-\alpha(638.5)}{0.4} \right]$$

A	x_L	x_U	
0	488	1586	1037
0.1	602.875	1426.375	1014.625
0.2	717.75	1266.75	992.25
0.3	832.25	1107.125	969.6875
0.4	947.5	947.5	947.5
0.5	1062.375	787.875	925.125
0.6	1177.25	628.25	902.74
0.7	1292.125	468.625	880.375
0.8	1407	309	858
0.9	1521.875	149.375	835.625

$$v_{\bar{a}}(x) = [x_L, x_U] = \left[\frac{557.1-\alpha(459.5)}{0.2}, \frac{\alpha(638.5)+321.3}{0.2} \right]$$

A	xL	xU	
0	2785.5	-1606.5	589.5
0.1	2555.75	-1287.25	634.25
0.2	2326	-968	679
0.3	2096.25	-648.75	723.75
0.4	1866.5	-329.5	768.5
0.5	1636.75	-10.25	812.25
0.6	1407	309	858
0.7	1177.25	628.25	902.75
0.8	947.5	947.5	947.5
0.9	717.75	1266.75	992.25





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$$\lambda_{\tilde{a}}(x) = [x_L, x_U] = \left[\frac{605.9 - \alpha(459.5)}{0.3}, \frac{\alpha(638.5) + 162.7}{0.3} \right]$$

A	xL	xU	
0	2019.67	-542.33	738.67
0.1	1866.5	-329.5	768.5
0.2	1713.33	-116.67	798.33
0.3	1560.17	96.17	828.17
0.4	1407	309	858
0.5	1253.83	521.83	887.83
0.6	1100.67	734.67	917.67
0.7	947.5	947.5	947.5
0.8	794.33	1160.33	977.33
0.9	641.17	1373.17	1007.1

A	μ	v	λ
0	1037	589.5	738.67
0.1	1014.625	634.25	768.5
0.2	992.25	679	798.33
0.3	969.6875	723.75	828.17
0.4	947.5	768.5	858
0.5	925.125	812.25	887.83
0.6	902.74	858	917.67
0.7	880.375	902.75	947.5
0.8	858	947.5	977.33
0.9	835.625	992.25	1007.1

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Table 1

	D ₁	D ₂	D ₃	D ₄	Supply
O ₁	(3, 5, 6, 8); 0.6, 0.5, 0.4	(5, 8, 10, 14); 0.3, 0.6, 0.6	(12, 15, 19, 22); 0.6, 0.4, 0.5	(14, 17, 21, 28); 0.8, 0.2, 0.6	26
O ₂	(0, 1, 3, 6); 0.7, 0.5, 0.3	(5, 7, 9, 11); 0.9, 0.7, 0.5	(15, 17, 19, 22); 0.4, 0.8, 0.4	(9, 11, 14, 16); 0.5, 0.4, 0.7	24
O ₃	(4, 8, 11, 15); 0.6, 0.3, 0.2	(1, 3, 4, 6); 0.6, 0.3, 0.5	(5, 7, 8, 10); 0.5, 0.4, 0.7	(5, 9, 14, 19); 0.3, 0.7, 0.6	30
Demand	17	23	28	12	

Using proposed algorithm, to obtained the allocation value (table:2) and Neutrosophic transportation cost as follows:

Table 2

	D ₁	D ₂	D ₃	D ₄	Supply
O ₁	3	23	--	--	
O ₂	14	--	--	10	
O ₃	--	--	28	2	
Demand					

Hence the minimum total neutrosophic cost is Minimize $= \sum_{i=0}^3 \sum_{j=0}^4 x_{ij} \bar{c}_{ij}^N$
 $= 3(3,5,6,8);0.6,0.5,0.4 + 23(5,8,10,14);0.3,0.6,0.6 + 14(0,1,3,6);0.7,0.5,0.3 +$
 $10(9,11,14,16);0.5,0.4,0.7 + 28(5,7,8,10);0.5,0.4,0.7 + 2(5,9,14,19);0.3,0.7,0.6 = (364,537,682,908);0.3,0.7,0.7$

Model II (Consider the cost parameter values in Neutrosophic Triangular number)

Table(3) : Neutrosophic Transportation Problem(Triangular Numbers)

	D ₁	D ₂	D ₃	D ₄	Supply
O ₁	(3, 5.5, 8); 0.6, 0.5, 0.4	(5, 9, 14); 0.3, 0.6, 0.6	(12, 17, 22); 0.6, 0.4, 0.5	(14, 19, 28); 0.8, 0.2, 0.6	(22,27,32);0.7,0.3,0.4
O ₂	(0, 2, 6); 0.7, 0.5, 0.3	(5, 8, 11); 0.9, 0.7, 0.5	(15, 18, 22); 0.4, 0.8, 0.4	(9, 12.5, 16); 0.5, 0.4, 0.7	(17,24.5,3);0.6,0.4,0.5
O ₃	(4, 9.5, 15); 0.6, 0.3, 0.2	(1, 3.5, 6); 0.6, 0.3, 0.5	(5, 7.5, 10); 0.5, 0.4, 0.7	(5, 11.5, 19); 0.3, 0.7, 0.6	(21,30,37);0.8,0.2,0.4
Demand	(13,17,21);0.5,0.5,0.6	(17,22.5,28);0.8,0.2,0.4	(24,30.5,35);0.9,0.5,0.3	(6,11.5,15);0.7,0.3,0.4	

Using proposed algorithm, to obtained the allocation value (table:3) and Neutrosophic transportation cost as follows:





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Table 4

	D ₁	D ₂	D ₃	D ₄	Supply
O ₁	3.5	3.9	10.8	15.3	(22,27,32);0.7,0.3,0.4
O ₂	1.9	5.1	8.3	6.6	(17,24.5,3);0.6,0.4,0.5
O ₃	7.5	2.4	3.9	4.4	(21,30,37);0.8,0.2,0.4
Demand	(13,17,21);0.5,0.5,0.6 (17,22.5,28);0.8,0.2,0.4 (24,30.5,35);0.9,0.5,0.3 (6,11.5,15);0.7,0.3,0.4				

Table 5

	D ₁	D ₂	D ₃	D ₄	Supply
O ₁	(13,17,22);0.5,0.5,0.6	--	(9,10,10);0.7,0.3,0.4	(6,11.5,15);0.7,0.3,0.4	
O ₂	--	--	(11,13,16);0.7,0.3,0.4	--	
O ₃	--	(17,22.5,28);0.8,0.2,0.4	(15,20.5,25);0.9,0.3,0.3	--	
Demand					

Hence the minimum total neutrosophic cost is :

$$\sum_{i=0}^3 \sum_{j=0}^4 x_{ij} \bar{c}_{ij}^N = \{ [488, 947.5, 1586]: (0.4, 0.8, 0.7) \}$$





M Modulo N Graceful Labeling of H - Class Graphs and Corresponding Algorithm

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Received: 21 Feb 2024

Revised: 10 Apr 2024

Accepted: 06 Jun 2024

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ABSTRACT

A graph G is said to be M modulo N Graceful then there is an one to one function f from the vertex set of G to $\{0, M, N, N + M, 2N, \dots, (q - 1)N, (q - 1)N + M\}$ and f induces a bijection f^* from edge set of G to $\{M, N + M, 2N + M, \dots, (q - 1)N + M\}$ where $f^*(u, v) = |f(u) - f(v)|$, for all $u, v \in V(G)$. In this paper, it is shown that H – class graph and $H_{(n)}^m$ graph are M modulo N graceful for all positive integers N and $M = 1$ to N and also its C programming algorithm is described.

Keywords: Graceful Labeling, M modulo N Graceful Labeling, H class graph, Algorithm

INTRODUCTION

Graph labeling is known as the vertices are assigned values subject to certain conditions that have been motivated by the practical problem. Labeled graphs serve as useful mathematical models for a broad range of applications such as coding theory, including the design of good radar type codes, missile guidance codes and convolution codes with optimal auto correction properties. Labeled graphs have also been applied in determining ambiguities in X-ray crystallographic analysis, design a communication network addressing system, determining optimal circuit layouts and radio astronomy problems etc. Graph labeling introduced by Rosa in 1967 and defined labeling of a graph G with q edges if f is an injection from the vertices of G to the set $\{0, 1, 2, \dots, q\}$ such that when each edge xy is assigned the label $|f(x) - f(y)|$, the resulting edge labels are distinct. The above said labeling is known as graceful and this is now a popular term [5]. Joseph A. Gallian, presented surveyed numerous graph labeling methods for various graphs





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[1] and Golomb S. W, explained how to number a graph with examples [3]. Perumal etc. talked about and proved super graceful labeling for H-class of graphs[4]. Gnanajothi. R .B, discussed that one modulo 2 gracefulness of various graphs[2]. Ramachandran. V and Sekar. C are showed that one modulo N gracefulness of H - class of graphs and acyclic graphs [6, 8] and Sekar. C proved that one modulo 3 gracefulness of various graphs [7]. Velmurugan. C and Ramachandran. V, introduced M modulo N Graceful Labeling and showed that arbitrary supersubdivision of ladder graph, path union and join sum of complete bipartite graphs are M modulo N graceful with corresponding algorithms[9, 10].

In this paper, H – class graph and $H_{(n)}^m$ graph are M modulo N graceful for all positive integers N and $M = 1$ to N is showed and also its C programming algorithm is described.

M modulo N Graceful Labeling of H - Class Graph

Definition: 2.1 Let $P_1 (u_1, u_2, \dots, u_n)$ and $P_2 (v_1, v_2, \dots, v_n)$ be two paths of length n. The graph obtained by joining $u_{(n+1)/2}$ and $v_{(n+1)/2}$ (or $u_{n/2}$ and $v_{n/2+1}$), if n is odd (or even) is called as H - class graph of length n.

Theorem: 2.2 A H – class graph is M modulo N graceful for all positive integers N and $M = 1$ to N.

Proof: It is clear that H - class graph is bipartite. Hence the vertex set can be partitioned into two disjoint vertex sets say A and B having same cardinality such that every vertex in A is adjacent to atleast one vertex in B. Let $A = \{\alpha_1, \alpha_2, \dots, \alpha_n\}$ and $B = \{\beta_1, \beta_2, \dots, \beta_n\}$. And also H – class graph have 2n vertices and 2n – 1 edges.

Define M modulo N graceful labeling of vertices of H – class graph as follows:

$$f(\alpha_\tau) = (\tau - 1)N, \tau = 1 \text{ to } n.$$

$$f(\beta_\tau) = (2n - \tau - 1)N + M, \tau = 1 \text{ to } n.$$

From the definition of f, its clear that $\{f(\alpha_\tau), \tau = 1 \text{ to } n\} \cup \{f(\beta_\tau), \tau = 1 \text{ to } n\} = \{0, N, 2N, \dots, (n - 1)N\} \cup \{(2n - 2)N + M, (2n - 3)N + M, \dots, (n - 1)N + M\} = \{0, N, 2N, \dots, (2n - 2)N + M\} \subseteq \{0, M, N, N + M, \dots, (2n - 2)N + M\}$. Hence, vertices of H- class graph have distinct labels.

Define M modulo N graceful labeling of edges of H – class graph as follows:

$$f^*(e_i) = (2n - 1 - i)N + M, i = 1 \text{ to } n - 1.$$

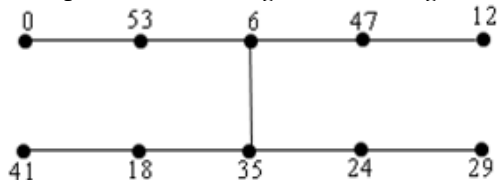
$$f^*(e_n) = (n - 1)N + M,$$

$$f^*(e_{n+i}) = (n - 1 - i)N + M, i = 1 \text{ to } n - 1.$$

It is clear that $\{f^*(e_i), i = 1 \text{ to } n - 1\} \cup \{f^*(e_n)\} \cup \{f^*(e_{n+i}), i = 1 \text{ to } n - 1\} = \{(2n - 2)N + M, (2n - 3)N + M, \dots, nN + M\} \cup \{(n - 1)N + M\} \cup \{(n - 2)N + M, (n - 3)N + M, \dots, M\} = \{M, N + M, 2N + M, \dots, (2n - 2)N + M\}$. Hence, edges of H- class graph have distinct labels.

Therefore H – class graph is M modulo N graceful labeling for all positive integers N and $M = 1$ to N.

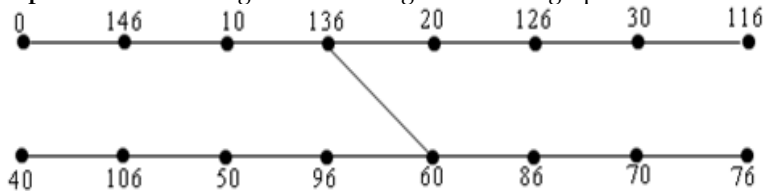
Example. 1 5 Modulo 6 graceful labeling of H – class graph.





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Example. 2 6 Modulo 10 graceful labeling of H – class graph.



M modulo N Graceful Labeling of $H_{(n)}^{(m)}$ Graph

Definition: 3.1 The graph $H_{(n)}^{(m)}$ is obtained from the H- class graph by attaching m number of pendant vertices at each vertex on the two paths with n vertices, where m is fixed. Hence, graph $H_{(n)}^{(m)}$ has $2n(m + 1)$ vertices and $2n(m + 1) - 1$ edges.

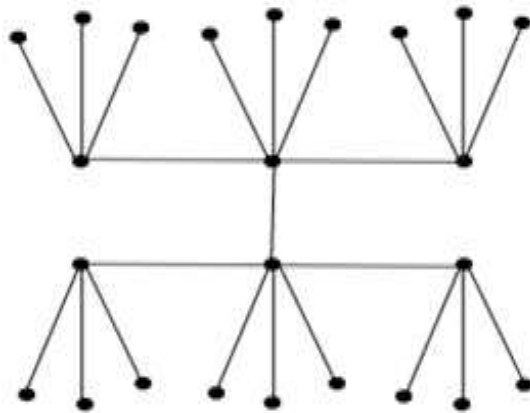


Figure. 2 The graph $H_{(3)}^{(3)}$

Theorem: 3.2 A $H_{(n)}^m$ - graph is M modulo N graceful for all positive integers m, n and N where $M = 1$ to N.

Proof: It is clear that $H_{(n)}^m$ - graph is bipartite. Hence the vertex set can be partitioned into two disjoint vertex sets, say A and B having same cardinality. Let $A = \{ \alpha_1, \alpha_2, \dots, \alpha_{n(m+1)} \}$, $B = \{ \beta_1, \beta_2, \dots, \beta_{n(m+1)} \}$ and $H_{(n)}^m$ - graph has $2n(m + 1)$ vertices and $2n(m + 1) - 1$ edges.

M modulo N graceful labeling of vertices of $H_{(n)}^m$ - graph as follows:

$$f(\alpha_\tau) = (\tau - 1)N, \tau = 1 \text{ to } n(m + 1).$$

$$f(\beta_\tau) = (2nm + 2n - \tau - 1)N + M, \tau = 1 \text{ to } n(m + 1).$$

From the definition of f, it is clear that $\{f(\alpha_\tau), \tau = 1 \text{ to } n(m + 1)\} \cup \{f(\beta_\tau), \tau = 1 \text{ to } n(m + 1)\} = \{0, N, 2N, \dots, (nm + n - 1)N\} \cup \{(2nm + 2n - 2)N + M, (2nm + 2n - 3)N + M, \dots, (nm + n - 1)N + M\} = \{0, N, 2N, \dots, (2nm + 2n - 2)N + M\}$. Thus vertices of $H_{(n)}^m$ - graph have distinct labels.

M modulo N graceful labeling of edges of $H_{(n)}^m$ - graph as follows:

$$f^*(e_i) = (2nm + 2n - 1 - i)N + M, i = 1 \text{ to } n(m + 1) - 1.$$

$$f^*(e_{n(m+1)}) = (nm + n - 1)N + M.$$

$$f^*(e_{n(m+1)+i}) = (nm + n - 1 - i)N + M, i = 1 \text{ to } n(m + 1) - 1.$$

It is clear that $\{f^*(e_i), i = 1 \text{ to } n(m + 1) - 1\} \cup \{f^*(e_{n(m+1)})\} \cup \{f^*(e_{n(m+1)+i}), i = 1 \text{ to } n(m + 1) - 1\} = \{(2nm + 2n - 2)N + M, (2nm + 2n - 3)N + M, \dots, (nm + n)N + M\} \cup \{(nm + n - 1)N + M\} \cup \{(nm + n - 2)N + M, (nm + n - 3)N + M, \dots, M\} = \{M, N + M, 2N + M, \dots, (2nm + 2n - 2)N + M\}$. Hence, edges of $H_{(n)}^m$ graph have distinct labels.





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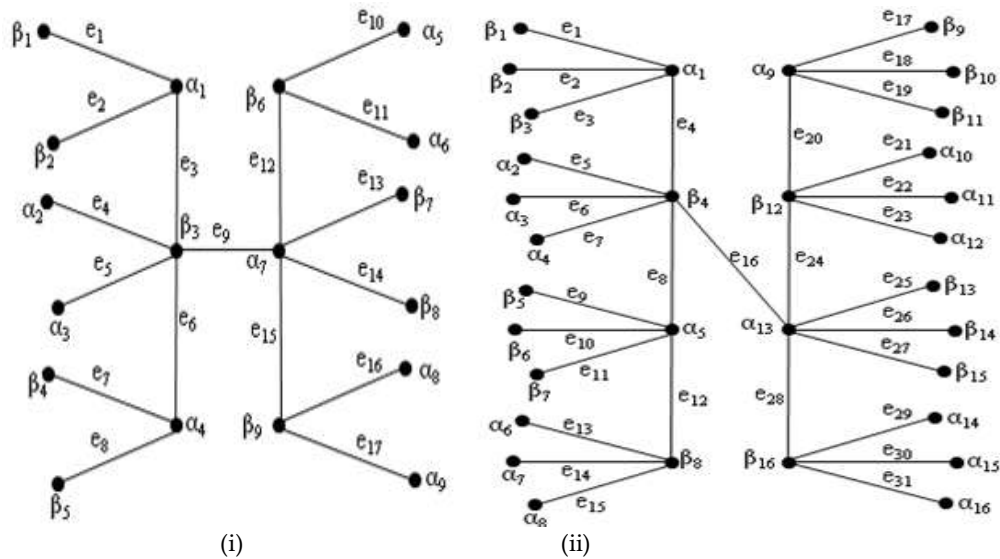
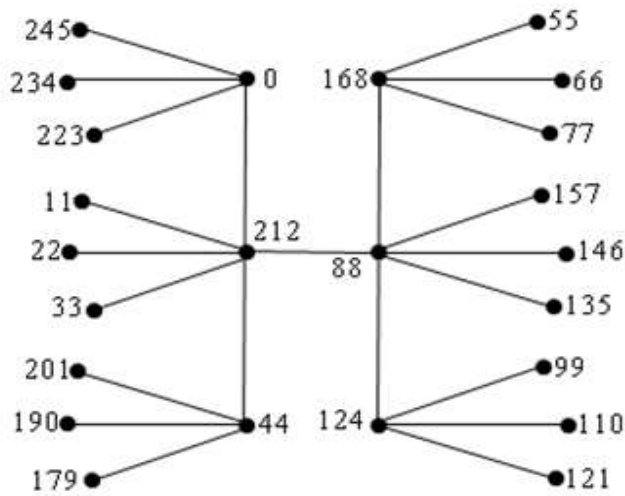


Figure. 3 (i) $H_{(n)}^m$ – graph when n is odd and m is even and (ii) $H_{(n)}^m$ – graph when n is even and m is odd.

Therefore, $H_{(n)}^m$ - graph is M modulo N graceful for all positive integers m, n and N where $M = 1$ to N.

Example. 3 3 modulo 11 graceful labeling of $H_{(3)}^3$ - graph

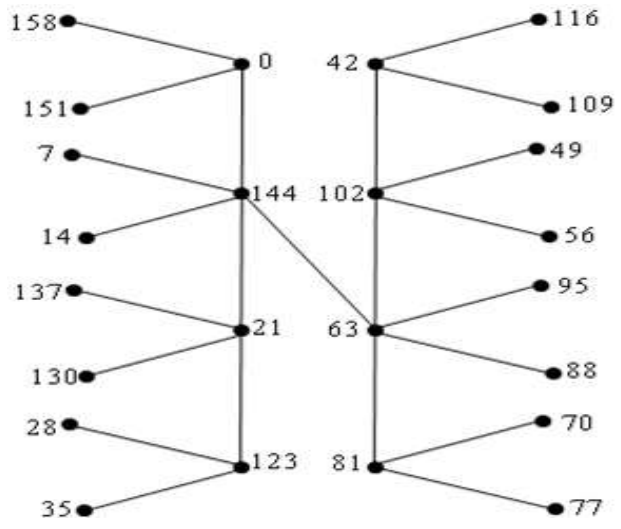


Example. 4 4 modulo 7 graceful labeling of $H_{(4)}^2$ - graph





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4. Algorithm for M modulo N graceful labeling of $H_{(n)}^m$ – graph

Algorithm: 4.1 C programming algorithm of M modulo N graceful labeling of $H_{(n)}^m$ – graph for all positive integers N and M = 1 to N.

In that algorithm put m = 0 we get on H - Class graph

```
#include<stdio.h>
int main()
{
int i,j,k,l,m,n,M, N,u[100],v[100],e[100];
clrscr();
printf("Enter m,n,N:");
scanf("%d %d %d",&m,&n,&N);
printf("m = %d, n = %d, N = %d",m,n,N);
for(M=1;M<=N;M++)
{
for(i=1;i<=n*(m+1);i++)
{
u[i]=N*(i-1);
v[i]=N*(2*n*(m+1)-i-1)+M;
if(i<=n*(m+1)-1)
{
e[i]=(2*n*(m+1)-1-i)*N+M;
e[n*(m+1)+i]=(n*(m+1)-1-i)*N+M;
}
}
e[n*(m+1)]=(n*(m+1)-1)*N+M;
printf("\n %d modulo %d graceful labeling on vertices:", M, N);
for(k=1;k<=n*(m+1);k++)
{
printf(",%d",u[k]);
}
for(j=1;j<=n*(m+1);j++)
{
```





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```
printf(,"%d",v[j]);
}
printf("\n %d modulo %d graceful labeling on edges:", M, N);
for(l=1;l<=2*n*(m+1)-1;l++)
{
printf(,"%d",e[l]);
}
}
getch();
}
```

OUTPUT: 4.2

I) 5 modulo 6 graceful labeling of H – class graph.

```
NeuTroN DOS-C++ 0.77, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Enter m,n,M,N:0
5
5
6
m = 0, n = 5, M = 5, N = 6
5 modulo 6 graceful labeling on vertices: ,0,6,12,18,24,53,47,41,35,29
5 modulo 6 graceful labeling on edges: ,53,47,41,35,29,23,17,11,5
```

II) 3 modulo 11 graceful labeling of $H_{(3)}^3$ - graph

```
NeuTroN DOS-C++ 0.77, Cpu speed: max 100% cycles, Frameskip 0, Program: TC
Enter m,n,M,N:3
3
3
11
m = 3, n = 3, M = 3, N = 11
3 modulo 11 graceful labeling on vertices: ,0,11,22,33,44,55,66,77,88,99,110,121,
245,234,223,212,201,190,179,168,157,146,135,124
3 modulo 11 graceful labeling on edges: ,245,234,223,212,201,190,179,168,157,146,
135,124,113,102,91,80,69,58,47,36,25,14,3
```

CONCLUSION

In this paper, M modulo N graceful labeling of H – class graph and $H_{(n)}^{(m)}$ – graph with its C programming algorithm is discussed.



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***In silico* Molecular Docking Analysis of Phytoconstituents of Turmeric as an Antiacne Agent**

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

Acne vulgaris is the most common chronic inflammatory skin disease, affecting about 85% of young people globally. Recent studies have pushed the extraction of phytochemicals from plants as a means of treating acne; however, very few have examined the effects of these phytochemicals on the activity of the bacteria's transporters or enzymes. Therefore, the goal of this work is to determine the mode of action of a few anti-acne phytoconstituents that were extracted from *Curcuma longa* using a computational method. Swiss ADME was used in order to ascertain the selected phytoconstituents' physicochemical characteristics. The result shows that all the four compounds have a high potential as an antibacterial compound against MMP2 Receptor and less potential towards PPARA receptor.

Keywords: Acne, Turmeric, Curcumin, ADME, Molecular docking

INTRODUCTION

Acne vulgaris is the most common skin disorder that results from chronic inflammation of sebaceous follicles which is characterized by tender inflammatory papules and nodules. Acne typically appears on the face, forehead, chest, upper back, and shoulders because these areas of skin have the most oil (sebaceous) glands [1]. The pathogenesis of acne is multifaceted and includes inflammation, hyper colonization of bacteria like *Propionibacterium acnes* (*P. acnes*), hyperkeratosis, and hyper seborrhea [2]. Environmental and genetic variables are known to play a role in the



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development or worsening of acne. Last many decades, oral and topical antibiotics have been the most effective therapy for acne treatment, by inhibiting the production of inflammatory factors but they produce a high incidence of side effects and symptoms, some of them also lead to skin dryness, peeling and skin irritation, or bacterial resistance. Thus herbs and naturally derived compounds, have received considerable interest as they have fewer adverse effects than synthetic agents [3-4]. Turmeric (*Curcuma longa*), a widely used spice throughout the world has a long history of use in Ayurvedic medicine for the treatment of inflammatory conditions [5]. Turmeric constituents include pale yellow to orange-yellow volatile oil (6%) made up of several monoterpenes and sesquiterpenes, such as zingiberene, curcumene, α - and β turmerone. The coloring agents (5%) are curcuminoids, of which 50–60% are a combination of curcumin, demethoxycurcumin, and bisdemethoxycurcumin [6, 7]. It possesses anti-inflammatory, antibacterial, antioxidant, and anti-neoplastic properties. Curcumin, one of turmeric's active ingredients, may be used medically to treat several dermatologic conditions, according to growing research [8, 9]. In the present study, we have selected four Phytoconstituents for ADME analysis and recognize the mechanism of action of four phytoconstituents obtained from *Curcuma longa* for acne treatment with the computational approach of phytochemical search, molecular docking simulation to predict the pocket region of the protein, and binding conformations of ligands with the receptor protein [10].

MATERIALS AND METHODS

Software and Tools [11]

Protein Data Bank (PDB), Pub Chem, SwissADME, Chem Draw Ultra 12.0, AutoDockTools- 1.5.7, Discovery Studio Visualizer v21.1.020298.

ADME and other pharmacokinetic properties

Based on Lipinski's rule of five (Lipinski 2004), the drug-likeness analysis was conducted [12]. A ligand's pharmacokinetic features called absorption, distribution, metabolism, and excretion (ADME) principally relate to how the ligand is absorbed, distributed, processed, and excreted by the body. For determining the pharmacological significance, SwissADME was used to generate the key parameter, Lipinski's rule of five [13, 14]. The ligands were converted from the PDB format to the canonical SMILES format and uploaded to SwissADME prediction.

Docking studies

Ligand preparation

The 2D and 3D structures of the Phytoconstituents were obtained from the PubChem database (<https://pubchem.ncbi.nlm.nih.gov/>) in SDF format. Discovery Studio Visualizer was used to convert the SDF file into a PDB file (Figure 1) [15].

Protein preparation

The protein was retrieved from Protein database (<https://www.rcsb.org/>) in PDB format (Figure 2). The retrieved PDB structures contain water molecules, heavy atoms, cofactors, metal ions, etc. and these structures do not have information about topologies, bond orders, and formal atomic charges. By eliminating all ligands, water molecules, and other heteroatoms from the structures, the target proteins were made ready. The atoms received hydrogen atoms to fulfill their valences. The CHARMM force field was then applied to the structures to eliminate steric conflicts between the atoms and achieve stable conformation. Receptor files in the PDB file format were converted to the PDBQT file format [16, 17].

Docking studies using AutoDockTools

Low-energy substances in the pdbqt format were simulated molecular docking with target proteins using AutoDockTools- 1.5.7. The docking procedure takes place in receptors with a box spacing of 1 Å. Because the molecules that interact are still flexible, this seeks to maintain the receptors stiff and the ligand flexible. The



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interaction energy between the ligand and receptor for each binding site is used to calculate a binding affinity score (kcal/mol) [18, 19, 20].

Protein-ligand interactions

AutoDockTools- 1.5.7 software was employed to explain interactions between target receptors and ligands. 3D interactions were used to visualize docking result files. Receptor ligand interactions can assess intermolecular interactions, such as hydrogen and hydrophobic bonding types that attach to the receptor binding pocket's active side [21, 22].

RESULTS AND DISCUSSIONS

Turmeric root extract contains active compounds such as curcumin, demethoxycurcumin, bisdemethoxycurcumin, alpha turmerone that have antimicrobial and antibacterial activity. A drug-likeness test was conducted to determine the similarity properties of the drug in the four selected active compounds of *Curcuma longa*. Through this test, the potential of a compound as a drug candidate can be identified. The results of the drug-likeness test in Table 1 showed that four compounds of *Curcuma longa* extract have a molecular weight (MW) less than 500g/mol indicating all compounds comply with Lipinski's first rule which means it has the potential to be a drug candidate. Compounds with a small molecular weight will be easier to pass through the cell membrane. Conversely, if the molecular weight is more than 500 g/mol, it will cause molecular absorption to fail or the body will have difficulty being able to absorb it completely. Curcumin, demethoxycurcumin, bisdemethoxycurcumin, alpha turmerone have H-bond acceptors (HBA) <10 H-bond donors (HBD) <5 both of which met Lipinski's rules. The low number of H-bond acceptors and H-bond donors indicated that the energy required in the absorption of molecules is also low and vice versa. Log P indicates the lipophilic properties of a molecule; this property indicated the ability of a molecule to dissolve in fat. Molecules are categorized as having good lipophilicity if the Log P value < 4.15. The lower the log P value, the higher the hydrophilic properties of a molecule and lower the hydrophobic properties. Table 1 showed that all four active compounds of *Curcuma longa* comply with the Lipinski rule. Then it can be concluded that the four compounds have good lipophilic properties as drug candidates. A drug molecule can function properly if its hydrophobicity is not too high so that it can be widely distributed in the body. On the other hand, high Log P values are more hydrophobic. This causes drug compounds to tend to be toxic because they will be retained longer in the lipid bilayer so that they are less distributed in the body which results in the bond to the target enzyme being reduced.

Molecular docking is one of the in silico methods applied at several levels in drug development for three main purposes, namely, the search for new ligands, predicting the bond model of active ligands, and predicting their affinity and conformation. This method is one of the more concise and simple methods of approach. The results of molecular docking analysis were presented in Table 2. All Four compounds have the lowest binding affinity energy for MMP2 receptor. In addition, they also have an RMSD value of less than 1Å. The more negative the affinity energy indicates a more stable bond. It can be claimed that low-affinity energy suggests a molecule has a stronger ability to interact with the target protein because low affinity signifies a molecule takes less energy to bind. Likewise, the RMSD value was declared valid to use if the value < 2Å. The greater the RMSD value, the greater the deviation that occurs. The low RMSD value indicates that the docking ligand poses closer to the natural ligand pose. The lower the RMSD value the closer the position of the native ligand of the docking result to the native ligand of the crystallographic result. Thus, all the four compounds have a high potential as an antibacterial compound against MMP2 Receptor and less potential towards PPARA receptor. Important parameters in predicting the potential of a compound to the interacting target proteins (receptors) can be seen from the type of bond and amino acid residues at the binding site. Through the visualization stage, the type of bond and amino acid residue can be determined (Figure 3-7). The type of amino acid residue at the binding site with target proteins (CYP1A2, MMP2, PPARA, SELE, TNFRSF1A, MMP3) are shown in Table 3.





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CONCLUSIONS

All the four phytoconstituents (curcumin, alpha turmerone, demethoxycurcumin, bisdemethoxycurcumin) have a high potential as an antiacne compound against MMP2 receptor. While curcumin, demethoxycurcumin, bisdemethoxycurcumin have less potential towards PPARA receptor and alpha turmerone has less potential as an antiacne compound against CYP1A2 receptor.

CONFLICTS OF INTEREST

There are no conflicts of interest.

ABBREVIATIONS

ADMET: Absorption, Distribution, Metabolism, Excretion and Toxicity;

HIA: human intestinal absorption (probability);

log S value: solubility;

MW: molecular weight (Dalton);

HBD: hydrogen bond donor;

HBA: hydrogen bond acceptor;

log P: lipophilicity

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Table 1: Physicochemical Properties of selected phytochemicals from *Curcuma longa*

Sr. No.	Compound	HIA	Log S value	MW	HBD	HBA	Log P value	Rule of 5 violations	Skin Sensitization
1	Demethoxycurcumin	0-0.1 (excellent)	-3.611	338.12	2	5	2.786	Accepted	0.9-1.0 (+++) POOR
2	Bisdemethoxycurcumin	0-0.1 (excellent)	-3.427	308.1	2	4	2.847	Accepted	0.9-1.0 (+++) POOR
3	Curcumin	0-0.1 (excellent)	-3.921	368.13	2	6	2.742	Accepted	0.9-1.0 (+++) POOR
4	alpha Turmerone	0-0.1 (excellent)	-4.258	218.17	0	1	3.956	Accepted	0.9-1.0 (+++) POOR

Rule of 5 violations Lipinski rule of 5





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Table 2: Molecular docking results of phytoconstituents of *Curcuma longa* with each target protein

Protein	RCSB PDB Entry ID	Binding energy (kcal/mol)			
		Demethoxycurcumin	Bisdemethoxycurcumin	Curcumin	alpha Turmerone
SELE	1esl	-7.82	-6.42	-6.34	-5.31
TNFRSF1A	1ich	-9	-6.84	-6.29	-7.2
MMP2	1rtg	-10.24	-8.95	-6.8	-7.92
CYP1A2	2hi4	-8	-6.48	-6.02	-4.12
PPARA	7e5i	-6.46	-4.77	-4.04	-7.38

Table 3: The interactions between Ligand against receptor

Protein	Amino acid residue			
	Demethoxycurcumin	Bisdemethoxycurcumin	Curcumin	alpha Turmerone
SELE	GLU71, GLU72, LEU69, LYS74, PRO66, TRP70, TRP76, VAL59	ASN124, CYS133, GLU132, GLU135, GLY64, GLY131, LYS67, THR65, THR123, TYR118, TRP1, VAL134	ASN139, ASP145, LEU151, LYS143, LYS152, THR141, TYR140, CYS142, CYS144, PHE148	ASN124, GLU132, GLY129, GLY131, CYS122, CYS133, SER126, THR123
TNFRSF1A	ALA387, PRO327, LEU330, LEU389, LEU405, LEU412, THR329, THR388, GLU390, GLY393	ASP357, ALA370, ILE356, GLN371, GLU360, MET374, PRO339, TRP342, LEU359, LEU367, LYS343, VAL346	ARG394, ARG397, ALA387, GLY393, GLU390, THR329, PRO327, LEU389, LEU405	LEU359, LEU367, LYS343, ILE356, GLN371, PRO339, TRP342, GLU360, MET374, ALA370, ASP357
MMP2	ALA479, ASN573, ASP622, GLU525, GLN624, GLN480, GLY625, GLY627, LEU623, PHE572, SER575, TYR524, VAL523	ASN573, ASP622, GLN624, GLU525, GLY625, GLY627, LEU623, LYS578, PHE572, PRO527, SER575, TYR524, VAL621	ASP622, ASN573, LYS578, PRO527, VAL621, GLN624, GLU530, GLU525, SER575, PHE572	TYR524, ASN573, GLU525, ASP622, LYS578, SER575, GLN624, GLN480, ALA479, VAL621, ALA479
CYP1A2	ASN234, GLY233, GLY58, LEU51, LEU55, LEU57, LYS59, PHE239, PRO235, SER231, TYR495, VAL54	ASN234, ASN247, GLU228, GLY58, LEU55, LEU57, LEU236, PRO325, TYR495, VAL54	ASN234, ASN247, LEU57, LEU233, LEU242, GLY58, PRO235, SER231, SER232, TYR495, VAL54	LEU57, LEU55, LEU242, GLY233, GLY58, VAL54, PHE239, PRO235
PPARA	HIS396, LEU206, LYS399, GLY296, GLY403, PRO295, MET400	GLN413, ILE420, PHE421, PHE423, PRO424	ILE420, LYS425, PHE421, PHE423, PRO424	PRO417, ASP419, ILE420, LEU412, LEU422, GLN413, PHE423, PRO424, HIS416





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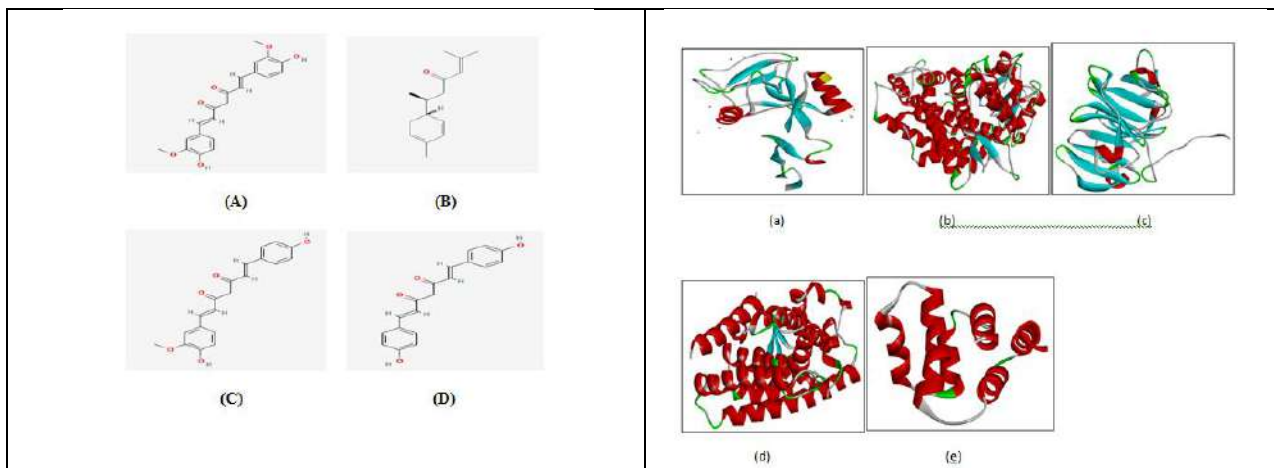


Figure 1: The Two Dimensional structures of ligands. (A)curcumin(B)alphaturmerone(C)demethoxycurcumin (D) bisdemethoxycurcumin

Figure 2: Structure of the target protein (A) SELE (PDB ID: 1esl), (B) CYP1A2 (PDB ID: 2hi4), (C) MMP2 (PDB ID: 1rtg), (D) PPARA (PDB ID: 7e5i), (E) TNFRSF1A (PDB ID: 1ich)

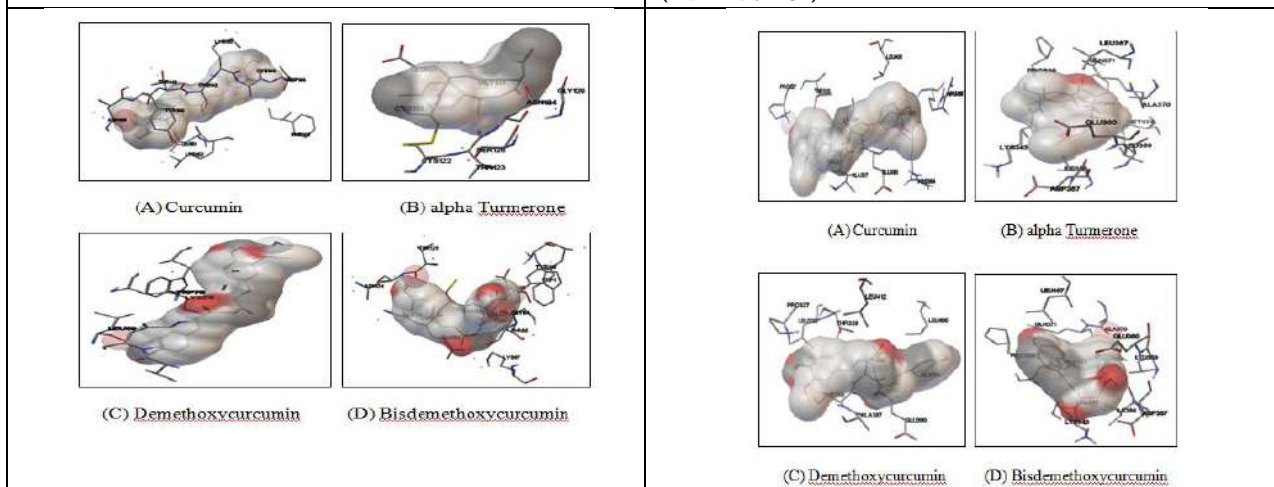


Figure 3: Interaction of ligands with SELE (1esl) receptor (A) Curcumin (B) alpha Turmerone (C) Demethoxycurcumin (D) Bisdemethoxycurcumin

Figure 4: Interaction of ligands with TNFRSF1A (1ich) receptor (A) Curcumin (B) alpha Turmerone (C) Demethoxycurcumin (D) Bisdemethoxycurcumin





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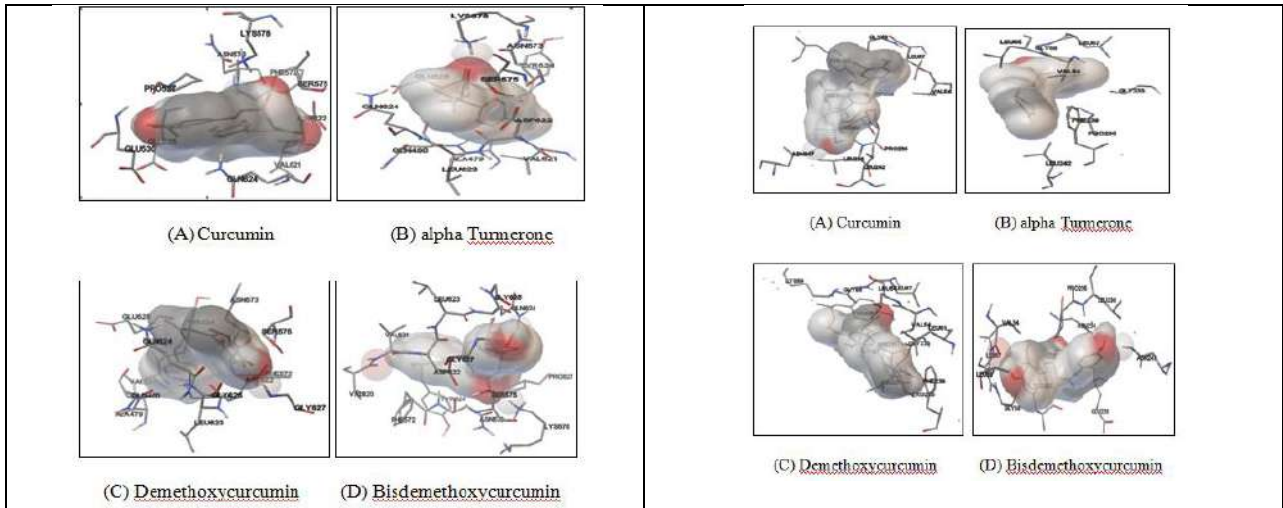


Figure 5: Interaction of ligands with MMP2 (1rtg) receptor (A) Curcumin (B) alpha Turmerone (C) Demethoxycurcumin (D) Bisdemethoxycurcumin

Figure 6: Interaction of ligands with CYP1A2 (2hi4) receptor (A) Curcumin (B) alpha Turmerone (C) Demethoxycurcumin (D) Bisdemethoxycurcumin

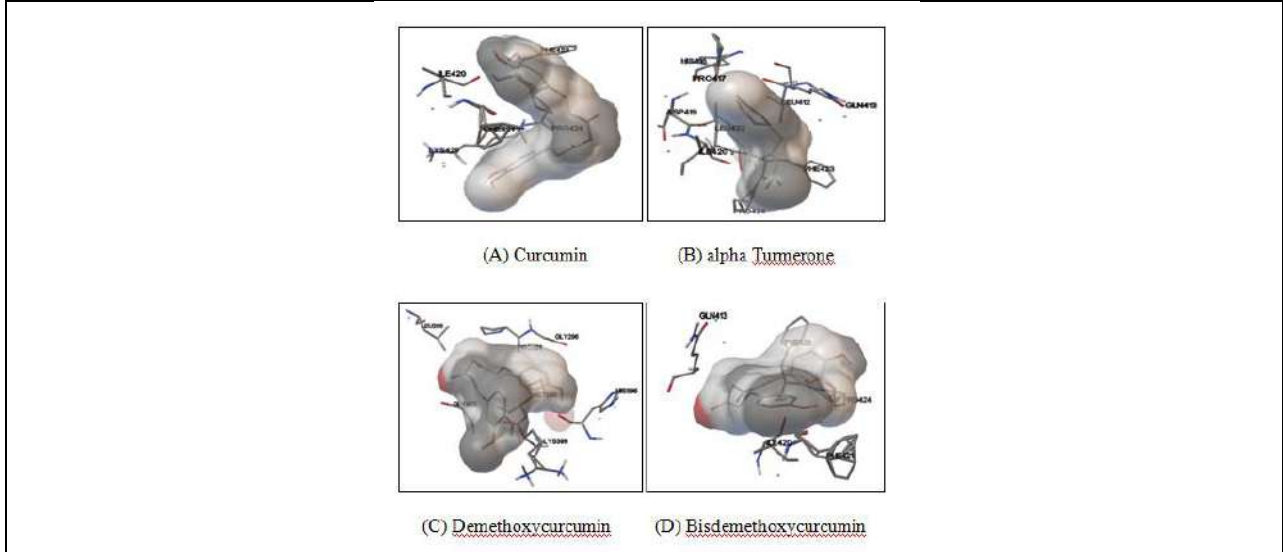


Figure 7: Interaction of ligands with PPARA (7e5i) receptor (A) Curcumin (B) alpha Turmerone (C) Demethoxycurcumin (D) Bisdemethoxycurcumin





Positivity and Resilience amidst Calamity: A Critical Exploration of Kim Stanley Robinson's *The Ministry for the Future*

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 25 Jul 2024

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ABSTRACT

Kim Stanley Robinson, a prominent contemporary author, stands out for his meticulous exploration of climate change. With a body of works spanning nearly four decades and encompassing twenty novels, Robinson consistently delves deep into topics like social justice, political and environmental economy, and the potential for utopian ideals. Within his literary repertoire, *The Ministry for the Future* stands as an exceptional accomplishment. This novel is positioned in the foreseeable future, commencing a few years ahead and extending over multiple decades. It addresses the pressing issue of global warming and the strategies available to prevent an impending climate catastrophe. Amidst the challenges posed by climate change disasters, the importance of maintaining optimism and hope cannot be emphasized enough. These elements serve as powerful drivers for action, cultivate resilience, facilitate collaboration, enhance mental well-being, and ignite inspiration among future generations. Amidst the challenges posed by climate issues, these optimistic perspectives motivate both individuals and communities to actively pursue remedies, adjust to evolving situations, collaborate effectively, manage feelings of unease, and empower the younger generation to initiate transformative actions. While they might not offer distinct solutions, optimism and hope serve as essential drivers for fostering positive transformations and laying the foundation for a sustainable tomorrow. This article investigates the significance of maintaining optimism and hope in the face of climatic disasters, drawing inspiration from Kim Stanley Robinson's novel, *The Ministry for the Future*. The novel illustrates how these mindsets can act as potent stimulants for proactive engagement, spurring both individuals and communities to actively explore inventive remedies. Instead of succumbing to despondency, individuals are urged to acclimate to evolving situations and devise strategies to alleviate the impact of climate shifts. This united endeavor gains



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pivotal importance in constructing a sustainable tomorrow, fostering teamwork and harmonious interaction across a variety of factions.

Keywords: Climate change, Climate fiction, Catastrophe, Environmental change, Optimism, Postmodernism

Climate change is undeniably reshaping our world for the worst, leading to an increase in natural disasters and extreme weather events on a global scale. One alarming consequence is the rapid warming of our oceans, driving coral reefs to the brink of extinction and compelling marine life to seek refuge in cooler waters. Wildfires, growing in frequency and intensity, are blanketing vast regions in thick smoke, severely impacting air quality. Moreover, the unpredictability of weather patterns, such as El Niño, is on the rise. The occurrence of the global tsunami following the eruption of the Hunga Tonga-Hunga Ha'apai volcano in early 2022 served as a vivid illustration of the intricate interconnectedness of our planet. Drought-induced record-low river levels, devastating hurricanes, and cyclones have become distressingly common. These occurrences underscore the immediate necessity for resolute measures to address climate change and mitigate its extensive repercussions. The Paris Agreement, a pact endorsed by 195 nations in 2015, is a critical step toward limiting global temperature increases to well below 2 degrees Celsius. It seeks to expedite the peak of global emissions and subsequently attain a delicate equilibrium between human-generated emissions and the removal of greenhouse gases from the atmosphere, ultimately achieving "net zero emissions." The imperative to act on climate change has never been more pressing. In addition to the Paris Agreement, there has been a growing call for immediate and ambitious action from scientists, activists, and concerned citizens worldwide. Climate marches, youth-led movements, and environmental advocacy have gained momentum, pressuring governments and corporations to accelerate their efforts to reduce emissions, and moving towards transition to renewable energy sources, and implement sustainable practices. The consequences of inaction are stark, affecting not only ecosystems but also food security, human health, and global stability. As we have been witnessing the increasing frequency and severity of climate-related disasters, the need for a collective and sustained response becomes ever more apparent. It is a reminder that climate change is not a distant threat but a present reality that requires coordinated global efforts to mitigate its impacts and safeguard our planet for future generations.

Fiction serves as a potent catalyst for igniting awareness about climate change. Story telling engages readers and viewers on both emotional and intellectual levels, making the complex issue of climate change relatable and personal. Fiction explores the multifaceted dimensions of this challenge, from its environmental impacts to its social, political, and economic ramifications. It encourages audiences to connect with characters facing the consequences of environmental degradation, fostering empathy and a sense of shared responsibility. Climate fiction also sparks critical thinking, inspiring discussions and asks questions about ethics, human agency, and the path forward. By offering imaginative visions of the future potential solutions, it motivates individuals and communities to take initiatives. With its wide-reaching influence and capacity to shape public opinion, fiction plays a crucial role in driving awareness, bring policy changes, and make people to take collective efforts to combat climate change. Majority of the contemporary climate fiction tends to delve into climate catastrophe from a dystopian perspective, vividly portraying the grim visions of the future (Heise and Robinson 17). For instance, Cormac McCarthy's *The Road* (2006) paints a harrowing post-apocalyptic landscape where environmental decay has triggered societal collapse, forcing its characters into a desperate struggle for survival. Paolo Bacigalupi's *The Water Knife* (2015) unfolds in a future southwestern United States crippled by severe drought and water scarcity, where powerful factions tightly control access to water, leading to widespread violence and chaos. Octavia E. Butler's *Parable of the Sower* (1993) is set in a climate-ravaged America during the 2020s, marked by dwindling resources and societal unrest disintegrating once-stable institutions. These examples collectively highlight the prevailing trend in cli-fi literature, focusing on the darker consequences of environmental crises and the urgent need to attend to such crisis for change. In contrast, Kim Stanley Robinson's *The Ministry for the Future* takes a more optimistic and utopian approach by exploring practical solutions to collectively address climate change and its associated challenges.



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The first chapter of *The Ministry for the Future* depicts a disastrous and realistic weather event in excruciating detail. Recent scientific research indicates that human survival becomes unfeasible when exposed to a wet-bulb temperature exceeding 35 degrees Celsius, which measures the combined impact of heat and humidity (Raymond et al.). In a situation of extreme heat and humidity, human body reaches a point where it can no longer regulate its temperature effectively. Even individuals in good health, with access to water and shelter, themselves become unable to maintain a balanced body temperature. In the opening chapter of the novel, this scenario is envisioned in the Indian state of Uttar Pradesh, resulting in the unfortunate demise of 20 million people within a few days. At the story's outset, the impact of the climate crisis is witnessed through the perspective of an individual, Frank May, a central figure in the novel, confronting a perilous life-threatening situation. We perceive events through Frank's perspective: "The heat coming from it was palpable, a slap to the face. Solar radiation heating the skin of his face, making him blink. Stinging eyes flowing, he couldn't see much" (Robinson 1). This passage combines his visual impairment with its impact on his sense of touch. Subsequently, the influence of the high bulb temperatures on his respiratory system is evidenced: "The air, already bad, would soon be a blanket of exhaust. Like breathing from the exhaust pipe of an old bus. Frank coughed at the thought of it. . ." (Robinson 2). After the intense beginning, the novel delves into how people respond and what happens as they realize the pressing importance of dealing with climate change. The story revolves around two main characters. Frank May, an American aid worker based in India, is one of the rare survivors of the climatic catastrophe described in the initial chapter. Understandably, he suffers from Post Traumatic Stress Disorder (PTSD) and carries a heavy burden of guilt for having survived. Mary Murphy, the other protagonist, is an Irish politician appointed as the leader of *The Ministry for the Future*, a UN agency established to uphold the Paris Agreement and other global climate agreements. Not only is the agency underfunded and lacks the authority to deploy military or police forces in penalizing nations or corporations that disregard the agreements, but also it is handicapped in providing financial assistance to small-scale climate initiatives and exert moral influence on governments and financial institutions. *The Ministry for the Future*, unlike most of Robinson's previous novels, exhibits a more loosely structured narrative. While it consistently follows the journeys of Frank and Mary, it also presents a diverse array of perspectives and voices. Robinson's approach is different from the typical focus on individual middle-class experiences often seen in literary novels, even ones with elements of science fiction. Contrarily, the primary characters are deliberately depicted as ordinary and emblematic. The individual characteristics come to the fore through intricate interactions among the economic, social, political, and technological forces within their environment.

Apart from the initial catastrophic event encountered by Frank, the lives of Frank and Mary in general are relatively uneventful. A genuine dramatic essence is revealed through the occurrences that take place in their vicinity - incidents possessing worldwide consequences yet frequently unfolding on a local and modest scale. The narrative of the novel is composed of numerous succinct chapters, with an average length of approximately three pages. While a portion of these chapters presents third-person perspectives centered on Frank and Mary, the majority introduce diverse voices. These voices range from straightforward information dumps to descriptions of local occurrences presented in diverse and often collective perspectives, frequently using the pronoun "we" rather than "I." For instance, in chapter 88 of the novel, the collective voices of animals in the forest is presented in the following manner:

We are a herd made of individuals. We move in lines one after another. "The land we walk over is mostly water. When we walk on water we grow frightened and hurry to return to land. Some of us lead astray the stupid, others urge fools to rash adventures. If we follow the wrong leader we die. If we panic we die. . . . We are caribou, we are reindeer, we are antelope, we are elephants, we are all the great herd animals of Earth, among whom you should count yourselves." (443)

Within the novel, we are introduced to a diverse range of individuals and entities, including climate refugees who flee from developing nations that are devastated due to extreme climate events and seek refuge in Switzerland and the Western world, enduring years in refugee camps; engineers stationed in Antarctica, conducting experiments and exploring various techniques aimed at slowing down the glacial melting process; economists and lawyers advocating for the adoption of climate-friendly policies by the world's central banks; terrorist groups engaging in targeted



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assassinations of wealthy individuals, such as oil company executives, who bear direct responsibility for exploiting the climate for immediate financial gain; exploited workers who rise up against oppressive conditions akin to modern-day slavery in mining industry; and nonhuman entities like glaciers and photons contributing to climate crisis. The narrative encompasses the experiences and perspectives of these diverse characters and entities as they navigate the challenges and complexities of the climate crisis.

The copiousness of chapters within the novel enriches its expansive and multi-dimensional essence. Robinson skillfully manages various storylines without aiming at merging them into a tightly structured narrative. This approach mirrors the complexity and openness of the real world, which defies simplistic organization. *The Ministry for the Future*, paying homage to Fredric Jameson, offers a thoughtful solution to the challenges outlined by Jameson in his exploration of postmodernism years ago. It grapples with the task of granting individuals a heightened awareness of their position within the intricate and interconnected global system, which resists conventional modes of representation (Jameson 54). Robinson acknowledges the inherent limitations of capturing the experiential and cognitive complexities of the world system in its entirety. As a result, he presents us with multiple perspectives that are only loosely connected. Each perspective is rooted in specific yet incomplete experiences, but its impacts extend far beyond the immediate individuals involved. Throughout the novel detailed descriptions of local places and actions are provided, which carry implications that transcend immediate contexts. Instead of trying to make everything fit perfectly together, the novel has a disconnected structure. Robinson shows that a too carefully arranged and organized description is not enough. It is precisely the openness, expansiveness, and ongoing nature of the endeavor that renders science fiction writing the realism of our time, as Robinson asserts in his essays and interviews. Through its multiplicity, the novel grants us a heightened awareness of both the tangible reality and the boundless potentiality of our approaching social reality.

In a certain aspect, *The Ministry for the Future* serves as a practical handbook on how we can confront the devastating effects of global warming and prevent a catastrophic climate crisis. Unlike a lofty and idealized depiction of revolution, the novel approaches things differently. It thoroughly examines practical policies that can actually be put into action in our current world, providing valuable insights and producing important positive results. Through thoughtful discussions, the book presents actionable strategies that can make a meaningful difference in addressing the urgent challenges we face. The prospective policies encompass: implementing a blockchain-regulated "carbon coin" system where entities that effectively sequester carbon instead of emitting it receive financial rewards, including states, corporations, and individuals; exploring geo engineering techniques to enhance the reflectivity of Arctic waters, mitigating global heating once the inevitable melting occurs; conducting drilling operations in Antarctica to access liquid water beneath glaciers, reducing the amount of water trapped in ice form when extracted and refrozen on the surface; establishing rewilding corridors globally to support the growth of animal populations and facilitate the circulation of biotic products without releasing carbon into the atmosphere; replacing traditional gasoline-powered airplanes with airships (large helium- or air-filled balloons) and introducing new types of clipper ships that combine sail power with solar energy harnessed through photovoltaic cells; and transitioning from monopolistic private platforms such as Facebook and Google to a publicly owned Internet organization that safeguards the privacy of individuals.

While each of these technologies, representing various approaches, cannot individually prevent the climate catastrophe, using them together and fostering a supportive social environment for continued research and development can help reduce the worsening effects of global warming and potentially lessen its seriousness. Detailed explanations of these processes in the novel show that they can work within our current technology, society, and politics. Robinson is open about the fact that making these realistic policies happen will require not only large protests worldwide but also planned acts of environmental activism. A notable instance is the shift from conventional airplanes to environmentally friendly airships. The change is prompted by eco-terrorist drone attacks that instill fear in people about flying in regular planes. The novel portrays violence against big oil and gas companies caused by less wealthy nations as something reasonable and needed, a way to fight against imperialism and find a survival. However, the author, possibly is aiming more at readers from wealthier countries, concentrating



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on ways to change the core power structures, particularly the American financial and monetary systems. Amitav Ghosh's *The Great Derangement* conveys a perspective akin to this: "To look at the climate crisis through the prism of empire is to recognise, first, that the continent of Asia is conceptually critical to every aspect of global warming: its causes, its philosophical and historical implications, and the possibility of a global response to it" (87). Additionally, the novel indicates that influencing central bankers, who wield significant power on global matters, involves a mix of pressure, persuasion, and coercion. They will be motivated to guide the world's economies toward more favorable arrangements when they realize that continuing with current policies will lead to a global economic collapse and currency devaluation.

Filled with authentic scientific examples and principles, *The Ministry for the Future* presents a scientifically grounded and thought-provoking exploration of the worldwide climate crisis and potential solutions. Kim Stanley Robinson, has extensively incorporated real scientific examples and concepts into the novel. Robinson's narrative is firmly rooted in scientific realism, and he draws upon current scientific understanding of climate change, ecology, economics, and technology to construct a compelling and plausible vision of the future. This integration of scientific principles and ideas is the central aspect of the novel, helping to make the global climate crisis and its potential solutions comprehensible and accessible to readers. Throughout the novel, Robinson refers scientific phenomena and theories, such as the impact of greenhouse gas emissions on global temperatures, the consequences of melting glaciers and rising sea levels, and the potential for geoengineering projects to address climate issues. These scientific elements are woven into the narrative to provide a firm foundation for the speculative aspects of the story. Moreover, the novel explores various technological solutions and innovations, often rooted in real-world scientific research. Examples include the use of AI technology to enhance sailships, the concept of carbon quantitative easing, and the development of sustainable energy sources. These elements are presented in a way that aligns with current scientific debates and discussions surrounding climate change mitigation.

Engaging with central banks aside, Mary actively shapes the decisions of leaders in fossil fuel corporations. The early stages of the narrative provide readers with a depiction of the top-ranking figures steering the fossil fuel industry. This portrayal sets the scene for her subsequent encounters with leaders working in this industry. After an informative note that elucidates how humanity currently consumes 40 gigatons of fossil carbon annually (Robinson 27) and underscores the calculation that permits only an additional 500 gigatons of consumption in total before breaching a 2-degree Celsius increase in the average global temperature compared to pre-industrial levels, the novel goes on to provide a succinct depiction of corporate executives:

They will be good people. Patriotic politicians, concerned for the fate of their beloved nation's citizens; conscientious hard-working corporate executives, fulfilling their obligations to their board and their shareholders. Men, for the most part; family men for the most part: well-educated, well-meaning. Pillars of the community. Givers to charity. . . They will want the best for their children. (30)

In a profoundly impactful way, *The Ministry for the Future* tells an optimistic story. It believes that those in charge of the capitalist system can be convinced to make the changes needed to save humanity from disaster. Rather than advocating for revolution, the novel takes a reformist stance, recognizing the unyielding grip of corporates but offering the prospect of social transformations that may partially reduce its influence and affluence. This hopeful vision seeks to avert what Marx and Engels referred to as "the common ruin of the contending classes" (36). The novel also presents the hope of international progress. By referring a little about the United States, the novel suggests that the conditions there are so irreparably degraded and bleak. However, it highlights positive ecological endeavors at the state level, particularly in California, which holds significance in many of Robinson's works. Although Robinson envisions the catastrophic flooding of Los Angeles, he also visualizes a progressive California that leads the way in rewilding initiatives, despite opposition from the federal government.

However, in the novel's perspective, other parts of the world fare significantly better than the United States. In many European countries, even though right-wing, anti-immigrant parties continue to exist after four decades, they are unable to take control or disrupt the enlightened internationalism that has its origins in Europe's more progressive



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traditions. In short, *The Ministry for the Future* presents an optimistic scenario, albeit not without its challenges. Even though there are problems and violent incidents, when the novel ends, it seems like the world has avoided a climate catastrophe, although the improvements made are still delicate. In the global scenario, ongoing hard work and international solidarity are imperative for the foreseeable future, given the precarious environmental and social situations. While the ultimate salvation of the world is not guaranteed, the worst-case scenario has been temporarily averted. This kind of hopeful speculation serves as a necessary counterbalance to the prevailing trend of dystopian narratives.

The Ministry for the Future is considered offering the best-case scenario, but it must be acknowledged that if events in the near future do not unfold favorably, the consequences could be dire. The novel emphasizes that it is highly improbable for all the necessary factors to align as depicted within its narrative. While it showcases the potential for a better and achievable world using existing resources and technologies, it is difficult to ignore the realization that without these politically challenging advancements, the situation is indeed bleak and hopeless.

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Nanomaterials for Combating Antibiotic Resistance: Current Progress, Challenges, and Future Directions

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Received: 30 Mar 2024

Revised: 09 May 2024

Accepted: 24 Jul 2024

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ABSTRACT

Antibiotic resistance has emerged as a pressing global health concern that demands immediate attention. Historically, antibiotics have been instrumental in combating various infectious diseases caused by pathogenic bacteria. However, the current rapid rise in antibiotic resistance is alarming, primarily due to the misuse and indiscriminate application of antibiotics across ecosystems and communities. The synthesis of new antibiotics has failed to keep pace with the emergence of increasingly virulent and resistant bacterial strains. Among the potential solutions to this challenge, nanoparticles have shown significant promise as both delivery systems and nanoantibiotics. This review explores the use of nanoengineered systems to overcome antibiotic resistance, providing insights into the interactions between bacteria and nanomaterials. Growing evidence supports the application of nanoantibiotics as an alternative strategy for treating clinical infections, potentially mitigating the reliance on conventional



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antibiotics. The review highlights the current progress, challenges, and future directions in the development of nanomaterials for combating antibiotic resistance. By examining the potential of these innovative approaches, this review aims to contribute to a better understanding of how nanotechnology can be harnessed to address the urgent problem of antibiotic resistance.

Keywords: Antibiotic resistance, Nanoparticles, Nanoantibiotics, Nanomaterials, Bacterial infections,

INTRODUCTION

Nanomaterials (NMs) and nanostructures, having dimensions in nano-range (1-100 nm), exhibit unconventional properties and have found extensive applications in various fields, such as electronics, catalysis, textiles, and biomedicine. Biomedical applications of nanotechnology include targeted drug therapy, diagnostics, tissue regeneration, cell culture, and biosensor development [1,2]. One emerging application of special significance is the use of NMs with antimicrobial properties, often referred to as 'nAbts' [3]. Rise of antibiotic resistance has seriously limited the use of popular antibiotics. Combating multidrug resistance with traditional antibiotics is becoming increasingly challenging. Therefore, searching for more effective alternatives has become a top priority [4]. The use of NMs as antibiotics, conveniently termed nanoantibiotics (nAbts), has emerged as a potential solution to address the challenge of antibiotic resistance. Studies have demonstrated that nAbts possess remarkable biocidal properties against various pathogenic and non-pathogenic bacterial strains. Various metal oxide nanoparticles have been reported to exhibit broad-spectrum antimicrobial activity [5]. Silver based nanoparticles (Ag-NPs) are already established as potential nanoparticles and these are being utilized in various drugs and consumer products [6]. Despite a very effective demonstration of antibacterial effect, *in-vivo* use of NMs is considerably less popular in current scenarios owing to various reasons which will be discussed in this review. Broadly, there are two potential approaches to develop antibacterial nanomaterials. The first approach involves NMs possessing inherent bactericidal properties, while the second approach combines NMs with conventional antibiotics to enhance their effects [7]. In this review, we critically discuss the features, types and properties of potential NMs and nanostructures which act as antibiotic agents. We also present recent studies demonstrating the effectiveness of nAbts and various approaches against resistant bacterial strains. Finally, we explore the future directions to overcome the challenges in the development of effective nAbts.

FEATURES OF NANOANTIBIOTICS

Nanoantibiotics offer several advantages over conventional antibiotics, making them more effective in combating drug resistant bacteria. The physico-chemical features of NMs, like size, shape, surface area, aqueous dispersibility, functional group chemistry all play crucial roles in the design of nAbts. Nanoparticles are inherently small, with dimensions ranging from 1-100 nm, which endow them with novel structural, electronic, and optical properties [8]. Their small size allows them to penetrate bacterial cell walls and membranes more efficiently than conventional antibiotics, potentially leading to higher efficacy. In a recent investigation conducted by Osonga et al. 2020, the effectiveness of luteolin tetraphosphate (LTP) synthesized AgNPs and gold nanoparticles (AuNPs) in combating bacteria and fungi was evaluated [9]. The nanoparticles were synthesized with varying shapes and sizes, wherein the LTP-AgNPs exhibited better results in comparison to the LTP-AuNPs. The study also conclusively demonstrated that smaller sized particles with quasi-spherical shape possessed stronger effects against tested microbes. It reflects the impact of type of functional group, nature and size of nanoparticles on efficacy of nAbts. Nanoparticles come in various shapes, such as spheres, discs, hemispheres, cylinders, tubes, cones, and wires. These diverse shapes can influence the interaction between nAbts and bacteria, potentially enhancing their antimicrobial properties [10]. One of the advantages that nanoparticles offer is their high surface area. The extremely small size of nanoparticles leads to an exponential increase in surface area, which in turn results in a greater proportion of atoms localizing on the particle's surface compared to the core. This makes nAbts more reactive than conventional antibiotics, increasing their ability to interact with and disrupt cellular and subcellular structures [11]. The design and small size of



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nanoparticles enable them to cross physiological barriers for effective delivery of various drugs. For example, AgNPs cause noticeable damage to bacterial cell membranes at sublethal concentrations. The increased penetrance inside the bacterial cells also leads to the synergistic and additive effects of combining AgNPs with certain antibiotics, such as kanamycin and chloramphenicol, helping to combat antimicrobial infections more efficiently [12]. Nanoparticles can be functionalized to enhance their water dispersibility. Non-polar poorly soluble drugs can be conjugated with nanoparticles. Suitable functional groups can then be added to these conjugate nanomaterials for enhanced solubility [13]. Improved solubility can enhance the bioavailability of antibiotic agents, increasing their effectiveness against bacterial infections. Nanoantibiotics can also be designed to carry multiple therapeutic agents, allowing for the simultaneous delivery of different antibiotics or the combination of antibiotics and other antimicrobial agents. This multifunctionality can improve treatment efficacy and potentially reduce the likelihood of bacteria developing resistance. A recent study has revealed that the effectiveness of AuNPs against microbes is heavily influenced by their surface characteristics. By producing AuNPs with a range of cationic functional groups, including different lengths of chains and aromatic properties, the researchers found a strong correlation between structure and activity. The study demonstrated that hydrophobic AuNPs were more successful in inhibiting *E. coli* growth, with the most hydrophobic nanoparticle, AuNP-3 (which had an n-decane end group), being able to prevent *E. coli* proliferation at a concentration of only 32 nM. [14]. This facile functionalization also allows the design of nanostructures which can mediate controlled and sustained release of the antibiotic agents, maintaining therapeutic concentrations over an extended period. This feature can improve treatment efficacy, reduce the frequency of administration, and minimize potential side effects associated with high antibiotic doses [15].

Targeted delivery can increase the selectivity and effectiveness of the antibiotic agents while minimizing collateral damage to the host's healthy cells and microbiota [16]. Nanoantibiotics can be designed with adaptive properties that enable them to respond to changes in the local environment, such as pH, temperature, or the presence of specific bacterial biomarkers. These adaptive features can enhance the antimicrobial activity of nAbts under specific conditions, ensuring optimal performance in the infection site [17]. Combining nAbts with other antimicrobial agents or treatment strategies, such as photodynamic therapy or antimicrobial peptides, can result in synergistic effects. These combinations can enhance the overall antimicrobial activity and overcome the limitations of individual agents, providing a more effective approach to combat antibiotic-resistant bacteria [18]. Due to their unique properties, nAbts can potentially act through multiple mechanisms, such as disrupting bacterial cell membranes, inhibiting enzymes, or interfering with bacterial communication. This multi-targeted approach can make it more challenging for bacteria to develop resistance, as they would need to simultaneously acquire resistance mechanisms against multiple modes of action [11]. Overall, these features further highlight the potential advantages of nAbts over conventional antibiotics, offering innovative and promising solutions to address the growing problem of antibiotic resistance.

MECHANISM OF ACTION

Nanoantibiotics represent a new avenue for combating antibiotic resistance. Researchers have proposed that bacteria cannot develop resistance against nAbts due to their multiple mechanisms of action. A single nanoparticle can act via different ways. Nanoparticles can physically adsorb and damage cell wall and membrane, inhibit enzymes, prevent DNA replication, lead to generation of reactive oxygen species (ROS) and reactive nitric oxide (NO). Further, nAbts may interrupt the transmembrane electron transport chains to impair energy transfer, and release of heavy metal ions with harmful effects [19]. Nanoantibiotics can inhibit the function of crucial enzymes and disrupt DNA synthesis in bacterial cells. By targeting enzymes responsible for cell division, replication, and essential metabolic pathways, nAbts hinder bacterial growth and proliferation. For example, AgNPs have been shown to bind with bacterial DNA, interfering with replication and transcription processes, ultimately leading to cell death. The study by Keskin et al. aimed to synthesize AgNPs using chestnut honey (CH) at different temperatures (30, 60, and 90 °C) and investigate their antioxidant, enzyme inhibition, and antibacterial properties. The results revealed that as the temperature increased during the green synthesis process, the nanoparticle sizes decreased, ranging from 55 nm to 27 nm. Furthermore, a decrease in particle size led to an increase in the inhibition rates of myeloperoxidase (from 34.0% to 36.4%) and collagenase enzymes (from 68.7% to 74.2%). These findings suggest that smaller CH-AgNPs



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have a stronger enzyme inhibitory effect on bacteria [20]. Nanoantibiotics can induce the generation of ROS and reactive NO in bacterial cells. These highly reactive molecules can cause oxidative stress, damaging cellular components like proteins, lipids, and nucleic acids. This oxidative damage can lead to a loss of cell function, structural integrity, and eventually cell death. For instance, metal oxide nanoparticles, such as zinc oxide and titanium dioxide, are known to generate ROS, causing oxidative stress and bacterial cell damage [21]. They can interact with the bacterial cell membrane or cell wall, causing structural damage and compromising its integrity. This interaction can lead to the leakage of cellular contents, increased membrane permeability, and ultimately cell lysis. Some nanoparticles, such as AgNPs and AuNPs, are known to interact with the negatively charged bacterial cell membrane, disrupting its function and causing cell death [22,23] They can interfere with the bacterial electron transport chain, a vital process for energy production in cells. By disrupting the flow of electrons across the membrane and inhibiting the generation of adenosine triphosphate (ATP), nAbts deprive bacterial cells of the energy required for growth and survival. For example, some metal nanoparticles, such as copper and silver, have been reported to interact with the electron transport chain, causing dysfunction and energy depletion in bacterial cells [24]. Some nAbts, particularly metal-based nanoparticles, can release heavy metal ions that have toxic effects on bacterial cells. These ions can bind to cellular components like proteins and enzymes, disrupting their function and causing cellular damage. In addition, the released ions can trigger the production of ROS, further exacerbating oxidative stress and cell damage. For instance, silver nanoparticles can release silver ions, which can bind to bacterial proteins, disrupt cellular processes, and lead to cell death [25].

CURRENT PROGRESS

Indiscriminate use of antibiotics has led to a situation where most antibiotics are rendered ineffective. This phenomenon is expected to increase in magnitude in coming years. Therefore, it requires urgent attention [26,27]. In order to tackle the issue, there is a pressing need to develop antibiotics that are efficient against many bacterial targets, have the capacity to impair pathogen resistance systems, and are less likely to result in the establishment of multi-drug resistant (MDR) infections [28]. Nanoantibiotics are a promising solution due to their distinct pharmacokinetic and dynamic properties that enable efficient medication administration to the target region. They can also serve as nano-carriers, ensuring the general efficacy and safety of antibiotics. The unique physicochemical properties of nAbts enable them to overcome multidrug resistance and act in novel and multiple pathways. For instance, nAbts can connect with microbial cellular membranes and rupture their integrity, leading to the release of cytoplasmic components [29]. After entry into the cell, nAbts may bind with biomolecules like DNA, enzymes and disrupt the cellular functions. Inhibition of these vital physiological processes results in an electrolyte imbalance, oxidative stress, and cell death. Silver-based nAbts, for instance, release Ag⁺ which disrupt microbial membranes which impairs electron transport and leads to DNA damage, culminating in cell death. Copper-based nAbts, on the other hand, release Cu²⁺, interfere with bacterial metabolism and lead to oxidative damage. Similarly, TiO₂ and ZnO-based nAbts also mediate their effects via oxidative damage. Metal-based nAbts have been reported to possess strong affinity for phosphorus and sulfur-containing biomolecules. It is also reported that nAbts also hinder microbial cell signalling by blocking the dephosphorylation of proteins specifically on tyrosine residues [30].

Various recent studies have highlighted the effectiveness of nAbts in combating antibiotic-resistant bacteria. Dzuvor et al. 2022, engineered protein-only nanoparticles against resistant Gram-positive bacteria, specifically methicillin-resistant *Staphylococcus aureus* (MRSA) strains. The engineered endolysin nanoparticles demonstrated significantly increased antibacterial effect when compared to monomeric protein molecules [31]. Hetta et al. 2023 conducted a comprehensive review on the advances in nanotechnology for combating multidrug-resistant bacteria and biofilm infection. The study highlighted the development of nanomaterial-based therapeutics and the difference between free antibiotics and nAbts [32]. Abeer Mohammed et al. 2022 investigated antibacterial efficacy of AgNPs which showed that the minimum inhibitory concentration was 1 mg/ml against multidrug-resistant bacteria [33]. Haji et al. 2022 tested AgNPs synthesized using biological materials against carbapenem-resistant Gram-negative bacilli. The group also used a combination of carbapenem and AgNPs. The study clearly demonstrated the synergistic action against the resistant bacteria [34]. Piktel et al. 2022 conjugated AuNPs with N-acetyl-L-cysteine (NAC) to derive Au-NAC. Au-NAC had significantly higher antibacterial effect against biofilm producing *Pseudomonas aeruginosa* [35].





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Similarly, Diksha et al. 2023 synthesized AuNPs from leaf extract of *Syzygium cumini* and tested their antibacterial potential against multidrug-resistant urinary tract pathogens [36]. Patwekar et al. 2022 capped silver nanoparticles with vancomycin to enhance the antibacterial potency against both *Staphylococcus aureus* and *Escherichia coli* [37]. Apparently, several nAbts have been shown to be effective against MDR bacteria, but not with limitations. Nano-based antibiotics may have narrow-spectrum activity and may also cause toxicity to non-target cells. Therefore, there is great scope to improve their surface chemistry to overcome these limitations [38]. Following description presents a thorough discussion of progress in the field for various prominent nanoparticles.

SILVER NANOPARTICLES

Antibacterial effects of AgNPs are well established [39]. Research has shown that silver nanoparticles have the strongest antibacterial activity when compared to other metal nanoparticles [40]. AgNPs can act as potent bactericidal agents due to their small size and large surface area, which facilitate the release of silver ions (Ag⁺), interaction with lipids and proteins, and DNA damage and generation of ROS that all combine to produce profound toxicity to the bacteria [41,42]. Owing to strong bactericidal properties, AgNPs are variously used to prepare antibacterial and deodorant fabrics, nanogels, and nanolotions, as well as for the healing of burns, surgical masks, medical instrument coatings, and ointments [43,44]. Latest research in the field has shown promising use of AgNPs based drug conjugates against drug-resistant bacteria. In one study, AgNPs synthesized using carbapenem-degrading *Acinetobacter baumannii* were tested against other similar carbapenem resistant bacteria. The study demonstrated that the combination of Ag NPs and antibiotics showed significant reduction in antibiotic concentrations against the bacteria [34]. In another study, AgNPs were conjugated with the antibiotic ciprofloxacin (CIP) and poly-ethylene glycol (PEG). These PEGylated conjugates exhibited remarkable inhibitory effects of Gram-negative and Gram-positive pathogens. The approach offers the additional advantage of higher aqueous solubility and lesser side effects due to PEGylation [45]. A similar conjugate was created by Patwekar et al. 2022. The group conjugated AgNPs with vancomycin. Antibacterial effects improved significantly in the study. Another important development in this regard is the innovative synthesis approaches [37]. Researchers are using diverse biological source materials during the synthesis procedure. Several microorganisms and plants have been used for the production of silver nanoparticles such as *Pseudomonas rhodesiae* [46], *Stenotrophomonas sp* [47], *Aspergillus niger* [48], *Penicillium duclauxii* [49], *Piper nigrum* [50], *Citrus maxima* [51], and *Artemisia absinthium* [52]. In a recent study 'biomass-free filtrate of *Aspergillus flavus*' was used for the synthesis of AgNPs. The particles showed very good broad-spectrum activity against all tested bacterial strains. Moreover, considerable synergistic effect was also observed with various antibiotics [53].

CHITOSAN NANOPARTICLE

Significant antibacterial activities have been demonstrated for chitosan (-N-acetylglucosamine) and its nanoscale derivatives [54]. Chitosan (CS), a cationic polymer that is degradable, is created by partially acetylating chitin. The mechanism of action of CS is based on the electrostatic interaction between the negatively charged cell wall polymers and the polycationic chitosan macromolecule [55]. It has been demonstrated that these particles have better antibacterial action against gram-positive bacteria as compared to gram-negative bacteria. The antibacterial action of CS is highly influenced by molecular weight, organism type, pH, degree of polymerization, and other factors, such as the microbial surface's lipid and protein content [54]. Additionally, chitosan causes the chelation of metals in minute levels, which prevents enzyme function and microbial development. Chitosan nanoparticles (CNPs) have advantage of being highly biocompatible. Due to its safe nature, it is being widely used as a bioadhesive polymer to treat the oral mucosa because of its biologically safe nature [56]. One limitation of CNPs is their less water solubility [57]. Efforts to improve the solubility and efficacy, CNPs are being synthesized using biogenic sources. These CNPs exhibit rich functional group chemistry which enhances the solubility and antibacterial effect. For instance, El-Naggar et al. 2022 biosynthesized CNPs using the aqueous extract of fresh *Eucalyptus globulus Labill* leaves as a bio-reductant. The biosynthesized CNPs had positively charged surface moieties. The CNPs were also found to exhibit antibacterial activity against pathogenic multidrug-resistant bacteria, *Acinetobacter baumannii* [58] Another approach is to combine various antibiotics with CNPs. β -lactam antibiotic-loaded CNPs, for instance, are substantially more





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effective at inhibiting growth of MRSA strains of *Staphylococcus aureus* [59]. Additionally, iron-loaded CNPs exhibited antimicrobial effects on *E. coli*, *S. aureus*, *Candida albicans* [60].

COPPER OXIDE NANOPARTICLES

The use of copper-containing nanoparticles as antimicrobial coatings has been demonstrated to inhibit the growth of MDR biofilms and be effective against bacteria. Cu₂O nanoparticles (CuO-NPs) create holes in bacterial cell membranes [61]. The release of metallic ions by CuO-NPs produces ROS, which can accelerate DNA damage. The entry of CuO-NPs inside the bacteria affects metabolic processes such as nitrogen metabolism, active transport, and electron transfer [62]. Kruk et al. 2015 found that copper NPs were successful in preventing the growth of MRSA and *Pseudomonas aeruginosa* [63]. Zhang et al. 2019 observed a significant synergistic antibacterial activity against *E. coli* when CuO-NPs were conjugated with aminoglycoside antibiotics. The inhibition zone area increased by 59% when CuO-NPs were combined with neomycin [61]. Researchers have recently used CuO-NPs to create nanocomposites with superior activity. For instance, Umoren et al. 2022 synthesized chitosan-copper oxide (CH-CuO) nanocomposites using olive leaf extract (OLE) as a reducing agent and copper sulphate as a precursor. The nanocomposite significantly inhibited bacterial growth [64].

ZINC OXIDE NANOPARTICLES

Zinc oxide nanoparticles (ZnO-NPs) have antimicrobial properties and can kill various bacteria and fungi. Like Ag NPs, ZnO-NPs induce the production of free radicals, which trigger cell death. They might even compromise the integrity of the bacterial cell membrane, causing leakage and eventual bacterial death. Cao et al. 2019b found that ZnO-NPs can arrest *Streptococcus pneumoniae* from producing biofilms at low concentrations (as low as 12 g/mL). ZnO-NPs can damage oral biofilms in multiple ways, including disrupting EPS and separating individual bacteria from the biofilm, inducing the production of ROS, and interacting with DNA and enzymes to impair their normal function [65]. Furthermore, Agarwal et al. concluded that in addition to blocking or inhibiting the zinc ion efflux pump, zinc oxide nanoparticles also aid in increasing local zinc ion concentration in a vulnerable condition [66]. Zinc oxide nanoparticles also have the potential to prevent the formation of biofilms caused by uropathogenic *E. coli* strains. Recent studies show that the shape of ZnO-NPs can influence the antibacterial activity. ZnO-NPs in the shape of nanorods exhibited stronger antibacterial activity against *E. coli* and *S. aureus* [67]. There is a great scope for designing better, safer and improved nanocomposites of ZnO-NPs that can be employed against drug resistant bacteria.

IRON OXIDE NANOPARTICLES

In the biomedical field, iron oxide is known for its biocompatibility and magnetic qualities. Recent research has revealed that reduced iron and iron oxide nanoparticles (IONPs) have antibacterial capabilities that break down bacterial membranes and instigate oxidative stress within the cell thereby killing bacterial cells [68]. In relation to this, Taylor et al. found that *Staphylococcus* and antibiotic-resistant biofilms can be effectively inactivated by IONPs [69]. IONPs have recently gained attention as potential antibiotic agents against antibiotic-resistant bacteria. Several studies have reported the development and investigation of IONPs and their conjugates for their antibacterial efficacy against various bacterial strains, including *Staphylococcus aureus*, *Escherichia coli*, and other multidrug-resistant bacteria. Guo et al. 2022 synthesized IONPs that were safe, had good photothermal sensitivity and catalytic activities. IONPs catalysed formation of hydroxyl free radicals from H₂O₂ under an acidic environment. This activity was enhanced at increased temperature. The IONPs showed a very strong antibacterial effect against *E. coli* and *S. aureus*, promoting wound healing in mice [71]. Sharaf et al. 2022 developed rhamnolipid-coated Fe₃O₄ nanoparticles combined with p-coumaric acid and gallic acid antimicrobial drugs using polyvinyl alcohol as a coating. These nanoparticles showed significant inhibition of bacterial growth and biofilm formation in *S. aureus* and *E. coli*, suggesting they could be potential multitarget antivirulence candidates [72]. Abdulsada et al. 2022 investigated the antibacterial properties of IONPs conjugated with polyethylene glycol and gentamicin against MDR bacteria. They found a significant improvement in antibacterial activity and biofilm inhibition, particularly for IONPs with PEG and gentamicin composites [72]. Faisal et al. 2022 synthesized iron nanoparticles using a microwave-induced





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precipitation method and functionalized them with p-amino benzoic acid and anthranilic acid. The functionalized nanoparticles showed greater inhibition zones against *Staphylococcus aureus*. Anthranilic acid-functionalized IONPs were found to be the most effective against the Gram-positive bacterium [73]

GOLD NANOPARTICLES (AuNPs)

AuNPs have shown metabolic disruption in bacteria by altering energy mechanisms and protein synthesis. For instance, AuNPs suppressed ATPase synthesis and inhibited the ribosome binding component to tRNA [74]. Additionally, Shamaila et al. 2016 hypothesized that the antibacterial properties of gold might cause AuNPs to disrupt bacterial respiratory chains by degrading nicotinamide [75]. Gold and platinum bimetallic nanoparticles have antibacterial effects against multidrug-resistant *E. coli* by reducing bacterial membrane potential and increasing ATP levels [76]. Alafnan et al. 2022 explored the use of AuNPs as a drug delivery vehicle to enhance the potency of antibiotics against clinical Gram-negative pathogens. They synthesized AuNPs reduced and stabilised by cefoxitin, and found that cefoxitin-loaded AuNPs were effective against cefoxitin-resistant *E. coli* and *K. pneumoniae* [77].

TITANIUM DIOXIDE NANOPARTICLES

Titanium dioxide nanoparticles (TiO₂-NPs) function as photocatalysts and can produce oxidizing agents that destroy *Listeria monocytogenes* bacteria when exposed to UV light [78]. They also potentially reduce bacterial growth and biofilm formation in pathogens such as *Pseudomonas aeruginosa*, *Enterococcus faecium*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* via several mechanisms including generation of ROS, DNA damage, damaging cell membrane and disrupting cellular respiration [79]. The generation of reactive oxygen species, especially hydroxyl free radicals, is primarily responsible for the antimicrobial activities of TiO₂-NPs [80]. Mirković et al. 2022 fabricated hydroxyapatite/titanium dioxide NMs with good structural and antimicrobial properties. The composite material exhibited superior photocatalytic properties [81]

ENCAPSULATED NANOPARTICLES

Nanoparticles can be variously encapsulated with liposomes, lipid monolayers, dendrimers etc. They exhibit unique features like amphiphilic nature, greater loading capacity which make them more effective against bacteria [82,83]. Liposomes can easily be packed with lipid soluble antibiotics. Liposomes are stable structures which release the drug at desired sites [84]. This approach offers another advantage. It minimizes the release of pure antibiotics into the environment further preventing emergence of antibiotic-resistant bacterial strains [85]. Liposomes used for drug delivery are typically 50-200 nm in size. An example is the conjugation of liposomes with vancomycin (Van) to target *Staphylococcus aureus*. The self-assembly of DNA nanostructured liposomes enhances Van's loading capacity and allows for extended-release and continuous ROS production [86]. Specialized liposomes and micelles are made in such a way that they contain only one lipid bilayer. Micelles used for drug delivery are typically 5-100 nm in size. An example is the conjugation of micelles with vancomycin and ciprofloxacin to target *Escherichia coli* and *Pseudomonas aeruginosa*. Synthesized micelles successfully carried the drugs to infection affected areas, releasing drug conjugates in large amounts when needed through interactions with bacterial lipid membranes and target-specific adhesion processes [87]. Dendrimers are another popular smaller sized nanoparticles having unique surface features.

They consist of a central core surrounded by numerous layers with surface groups that can be functionalized in a facile manner [88]. They also have multiple hydrophilic or hydrophobic pockets that can enclose one or more drugs [89]. Lipid-coated nAbts can effectively entrap amphiphilic antibiotics due to their hydrophilic and hydrophobic cores. An example is the conjugation of dendrimers with vancomycin to target drug resistant bacterial strains including MRSA [90]. Researchers have also used CNPs as a polymeric material to encapsulate antibiofilm agents such as antibiotics and natural phytochemicals. The positively charged chitosan shows affinity towards negatively-charged bacterial cell membranes, which increases the efficacy of encapsulated drugs/phytochemicals due to higher rate of delivery [91]. Similarly, Abo-zeid et al. 2022 used poly(lactic-co-glycolic acid) (PLGA) to encapsulate azithromycin. Authors wanted to create a larger sized antibiotic without affecting efficacy to resist the efflux mechanism of drug resistant bacteria. The antibacterial activity of AZI-PLGA NPs was evaluated against AZI-





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resistant bacteria, including MRSA and *Enterococcus faecalis* (*E. faecalis*). Interestingly, the results showed that AZI-PLGA NPs were successful in overcoming the efflux-resistant mechanism of the test bacteria, as demonstrated by the four-fold reduction in the minimum inhibitory concentration (MIC) of AZI-PLGA NPs compared to free AZI. The report opens new dimensions to create efficient NMs that act against various mechanisms of drug resistance [92].

CARBON-BASED NANOPARTICLES

Carbon-based nanoparticles have not been extensively explored, and there is limited information on them in the literature. However, they are excellent drug delivery vehicles due to their high adsorption capabilities. Graphene and carbon nanotubes (CNTs), for instance, physically penetrate the cell membrane, they become trapped inside, preventing the ejection of drug-carrying nAbts through efflux pumps [93]. A study by Stegarescu et al. 2022 investigated the antibacterial properties of different nanocomposites based on functionalized multi-walled carbon nanotubes (MW-CNTs) against four common bacterial strains. The nanocomposites were created by combining two metal oxides (CuO and NiO) and two antibiotics (azithromycin and ciprofloxacin). The results indicated that the nanocomposites functionalized with ciprofloxacin were most effective against all tested bacterial strains. One very interesting approach to use CNTs for dealing antibiotic resistance is worth mentioning here [94]. Cruz-Cruz et al. (2023) recently reviewed the possibility of carbon-based materials such as biochar, CNTs, activated carbon, and graphene to be used as agents which can adsorb antibiotics from water [95].

SILICA NANOPARTICLES

Another development is the use of mesoporous silica nanoparticles (SNPs), which are considered excellent nanocarriers and provide ideal nanoplatforms for designing targeted and stimulus-responsive release systems for various antimicrobial drugs. These multifunctional nano systems are anticipated to be effective antibacterial nano formulations for therapeutic use in personalized treatments. The development of nano systems like these offers a novel approach with improved efficacy, increasing the local concentration of the medication in the biofilm without significantly harming healthy tissues and causing fewer side effects. Such nanocarriers have a substantial impact on infection treatment, as they can alter the *Staphylococcus aureus* bacterial biofilm's structure and inhibit its growth [96]. Recent approaches utilize advanced nano-structures having unique features. Ni et al. 2022 demonstrated the co-delivery of vancomycin and AgNPs through silica nano pollen with a pollen-like morphology. The unique spiky morphology provides adhesive properties to the nanoparticle. Increased adsorption onto the bacterial surface promotes localized drug release for bacterial killing. The nano pollen significantly improved the antibacterial effect [97].

NANOZYMES

Nanozymes are fascinating broad-spectrum nAbts with low biotoxicity and potent antibacterial activity. Researchers are becoming increasingly interested in nanozymes, inorganic nanostructures with inherent enzyme activity, due to their unique advantages. Nanozymes can kill more bacteria than natural enzymes, bridging the gap between biology and nanotechnology [98]. In a recent study, Guo et al. 2023 utilized a unique approach for synthesizing a versatile and comprehensive antimicrobial system. The group employed cationic polypeptides functionalized with meso-tetra(4-carboxyphenyl)-porphine (TCPP-PG) nanoparticles [99]. The researchers synthesized TCPP-PG nanoparticles that were water-soluble and had reduced self-aggregation of porphyrins, thereby enhancing their dispersion in aqueous solutions. This strategy not only allowed bacterial inhibition but simultaneous imaging of bacteria was also possible.

SYNERGISTIC EFFECTS OF NANOPARTICLES: EXAMINING THE CASE OF SILVER AND ZINC-BASED NANOPARTICLES (ZNPs) IN COMBATING ANTIBIOTIC RESISTANCE

In recent years, the synergistic effects of nanoparticles, particularly AgNPs and ZNPs, have been increasingly explored to enhance the antimicrobial properties of these materials. By combining these nanoparticles with other antimicrobial agents, such as antibiotics or other nanoparticles, researchers aim to increase the effectiveness of the treatment while simultaneously reducing the likelihood of bacterial resistance. This approach has shown promising



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results in various studies, with synergistic effects being observed in enhanced antibacterial activity, reduced MIC, and increased eradication rates of drug-resistant bacterial strains. Abo-Sharma et al. 2020 reported that increasing the concentration of both AgNPs and zinc oxide nanoparticles (ZnO-NPs) enhanced their antibacterial activity against Gram-positive bacteria like *S. aureus* and Gram-negative bacteria such as *E. coli* and *Salmonella sp.* Since AgNPs, ZnO-NPs, and antibiotics work well together, a potential combination therapy against pathogenic bacteria could be proposed [100]. Multiple antibiotics loaded onto nanoparticles synergistically increase the effectiveness and rate of bacterial eradication. Ag and Zn nanoparticles combined with streptomycin demonstrated a synergistic effect against *S. aureus*, which had previously been resistant to streptomycin but became susceptible after being used in combination with nanoparticles [101]. Heidary et al. 2019 showed that drug-resistant *M. tuberculosis* strains exhibited bacteriostatic effects in exposure to Ag and ZnO-NPs, indicating that these NPs could be viewed as promising antimycobacterial nanomedicines [102]. However, further research is required to validate the bactericidal effects of these NPs against TB. Zeidan et al. 2022 found that when Ag and ZnO-NPs were used for coating orthodontic brackets, they depicted stronger antibacterial activity against *Streptococcus mutans* and *Lactobacillus acidophilus* compared to uncoated or single-coated brackets [103]. Visnapuu et al. 2018 conducted a study on the synthesis of ZnO/AgNPs coated surfaces and assessed their antimicrobial activity towards *E. coli*, *S. aureus*, and *C. albicans* in dark and UV-A illumination conditions. After numerous usage cycles, surfaces still had substantial antibacterial and photocatalytic characteristics [104]. Dove et al. 2023 investigated the antimicrobial activity and safety of AgNPs against various antibiotic-resistant bacteria. The AgNPs did not cause toxicity to non-target mammalian cells and demonstrated synergy with aminoglycoside antibiotics, reducing their MIC by approximately 22-fold [105].

Adeniji et al. 2022 synthesized and examined the antibacterial properties of AgNPs and ZnO-NPs against multidrug-resistant bacteria and explored combination antibiotic therapy involving these nanoparticles. The results showed that AgNPs exhibited strong antibacterial effects against tested bacterial strains, while ZnO-NPs showed moderate antibacterial effects against Enterococcus species. Combination activities of AgNPs and ZnO-NPs demonstrated synergistic and additive effects [106]. In a contrasting note, Zhang et al. 2022 investigated the effect of nanoparticles on bacterial persistence, finding that a wide range of NPs promoted the formation of bacterial persistence by exerting hyperosmotic pressure around the cells. The researchers discovered that this persister promotion effect occurred through the induction of the aggregation of outer membrane proteins OmpA and OmpC [107]. This finding raises concern that widespread use might support the bacterial antibiotic tolerance. In conclusion, studies have shown that AgNPs and ZnO-NPs can be effective against various drug-resistant bacterial strains, and their combination with antibiotics can lead to synergistic effects in bacterial eradication. However, some research also indicates that nanoparticles can promote bacterial persistence, which could be a concern for their use as antimicrobial agents. Therefore, further research is needed to understand the mechanisms of antibiotic resistance and nanoparticle use better. This will help develop a more comprehensive understanding of the interaction between nanoparticles and bacterial cells, enabling the development of more effective antimicrobial strategies that can tackle both antibiotic resistance and persistence.

CHALLENGES IN THE DEVELOPMENT OF NANOANTIBIOTICS

Nanoantibiotics have emerged as a promising alternative to traditional antibiotics due to their enhanced antimicrobial properties and potential to overcome bacterial resistance. However, several challenges, including purity, toxicity, delivery, stability, and unintended effects, need to be addressed before these novel therapeutics can be successfully implemented in clinical settings. Most materials used to create nano systems may be hazardous for use in clinical settings [107]. Moreover, the nanoparticulate components and structural properties of nanoparticles made from pure molecular antibiotics using different pharmacological or engineering methods are still not well understood [108]. Inorganic materials that are not biodegradable and magnetic nanoparticles may have unfavourable characteristics in humans, raising safety concerns regarding renal excretion. Even though the materials used to manufacture nanocarriers are typically biodegradable, biocompatible, and non-toxic, some reagents used during the preparation, such as surfactants or solvents, may have a negative effect on human health. The limitation of tissue specificity is a significant issue in targeted drug delivery, such as in tumour treatment, where drugs must be delivered to both cancer cells and healthy organs [109]. Similarly, targeted release of antibiotics to infection sites





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remains a major challenge, despite considerable progress [110]. The efficacy and effectiveness of a drug-loaded nano-formulation are significantly influenced by drug release kinetics. Slow release of drugs from the carrier is important to ensure that sufficient drugs reach the desired site [111]. Despite the numerous advantages of nAbts, there are challenges in transitioning from laboratory to clinical applications, and their use in real-life situations. Moreover, some studies have found that certain nanoparticles can promote antibiotic resistance phenomena [24]. Although nAbts offer significant potential in combating antibiotic-resistant bacteria, several challenges must be addressed to ensure their safe and effective application in clinical settings. Future research should focus on overcoming these challenges by developing novel materials, optimizing drug release kinetics, improving tissue specificity, and thoroughly investigating the unintended effects of nAbts on bacterial persistence and resistance.

Future Perspectives on Overcoming Nanoantibiotics Challenges

Developing advanced green synthesis methods and optimizing existing ones can improve the purity of synthesized nanoparticles. Additionally, thorough characterization and quality control techniques should be employed to confirm the purity and effectiveness of the particles. Aljeldah et al. 2023 conducted a recent investigation into the synergistic antibacterial effects of AgNPs and fosfomycin against various nosocomial bacterial pathogens. In this study, AgNPs were synthesized using an eco-friendly method that utilized *Hibiscus sabdariffa* flower extract. The results revealed that the biogenic AgNPs exhibited potent antibacterial activity against *Enterobacter cloacae*, MRSA, *Klebsiella pneumoniae*, and *Escherichia coli* strains. The green synthesis approach employed in this study contributes to the development of safer and more environmentally friendly nanoantibiotics. Further research and optimization of such nanoparticle-antibiotic combinations may lead to the development of more effective, safer, and targeted treatments against antibiotic-resistant bacteria in clinical settings [113]. To reduce toxicity, future research should focus on developing targeted drug delivery systems that ensure nanoparticles reach the specific site of infection. This could be achieved by attaching specific ligands to nanoparticles, allowing them to selectively target and bind to bacterial cells, minimizing damage to healthy host cells. A new study by Sun et al. 2023 reports on the development of a photoresponsive antibacterial platform that utilizes polydopamine-functionalized selenium nanoparticles loaded with indocyanine green. Under 808 nm laser irradiation, the platform displayed 100% antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*, while also promoting wound healing in a mouse wound infection model. These results suggest that the platform holds promise for use in biomedical applications, reflecting recent advancements in the development of safer and more effective nAbts [113].

Nanoparticle formulations, such as incorporating hydrophilic coatings or using amphiphilic polymers can be used to enhance water solubility. Furthermore, developing nanoparticle carriers or controlled release systems can ensure the optimum delivery of nAbts to the target site. Devlin et al. 2023 have demonstrated the efficacy of enzyme-functionalized mesoporous SNPs in treating *Staphylococcus aureus* biofilms. The nanoparticles were modified with three enzymes, namely lysostaphin, serrapeptase, and DNase I, which significantly improved the treatment's effectiveness against both methicillin-resistant and methicillin-sensitive *S. aureus*. The findings suggest that these enzyme-functionalized nanoparticles could be a promising therapeutic option for *S. aureus* infections with a biofilm component [114]. This study underscores the potential of NMs for delivering antibiofilm agents and targeting biofilm-related infections with greater efficiency. Bioaccumulation, biodegradable and eco-friendly NMs should be prioritized. These materials will break down into non-toxic components after their therapeutic action, reducing the potential for accumulation and adverse environmental impacts. By addressing these challenges through innovative research and development, nAbts have the potential to revolutionize the fight against antibiotic resistance. A multidisciplinary approach, combining expertise in microbiology, nanotechnology, materials science, and pharmacology, will be essential for designing and developing more effective nAbts to combat resistant bacterial infections.



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CONCLUSIONS

In conclusion, antibiotic resistance is a pressing issue that demands immediate attention. While nanoparticles show promise as an alternative solution to address this challenge, recent studies have presented conflicting results. For instance, a recent study found that nanoparticles could promote the formation of bacterial persistence, thus enhancing the resistance capacity of bacteria. Given these contradictory findings, it is crucial to study the interaction of nanoparticles with bacteria in greater detail. This will enable researchers to develop a more comprehensive understanding of the effects of nanoparticles on bacterial cells and develop more effective antimicrobial strategies. One potential approach is to design functionalized, tailor-made nanostructures and particles that selectively target and kill specific pathogens without exacerbating their antibiotic tolerance. By creating nanoparticles that are specifically engineered to combat particular bacterial strains, we can minimize the risk of inadvertently promoting antibiotic resistance and persistence. In light of these considerations, extensive research on the potential of nAbts is essential to prevent future pandemics caused by antibiotic resistance in various microbial pathogens. Developing a deeper understanding of the interactions between nanoparticles and bacteria will be crucial for designing effective therapeutic strategies that can tackle both antibiotic resistance and persistence.

Funding

This work was supported by Rashtriya Uchchatar Shiksha Abhiyan (RUSA), Department of Higher Education, Ministry of Education, Government of India.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

Naresh Kumar Nirmal provided overall supervision and was responsible for the study conception and design, as well as drafting the manuscript. Sakshi Patel and Ashish Kumar Tiwari conducted literature analysis, and were instrumental in synthesizing and organizing the information presented in the article. Sunidhi Kashyap contributed to the study design and provided valuable feedback on the manuscript. Monika Yadav and Suresh Kumar Bunker contributed to the study conception and design, as well as provided feedback on the manuscript. Farah Syed and Rajbala Verma assisted with providing critical feedback on the manuscript. Gajraj Singh Verma provided important insights into the study design and offered critical feedback on the manuscript. All authors read and approved the final manuscript.

Availability of data and materials

Not applicable.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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Table 1. Summary of nanoparticles used as nanoparticles.

S.No.	Nanoparticle	Use as Antibiotics	Reference
1	Silver Nanoparticles	Act as potent bactericidal agents due to their small size and large surface area. Used to	[39],[40],[41],[42],[43],[44],[34],[45],[37]



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		prepare antibacterial fabrics, nanogels, and nanolotions. Also used for healing burns, surgical masks, medical instrument coatings, and ointments. Showed significant reduction in antibiotic concentrations against drug-resistant bacteria in conjunction with antibiotics. Conjugated with antibiotics like ciprofloxacin and vancomycin for improved antibacterial effects.	
2	Chitosan Nanoparticles	Demonstrated antibacterial activities, especially against gram-positive bacteria. Used as a bioadhesive polymer to treat the oral mucosa. Antibiotic-loaded CNPs showed higher effectiveness. Iron-loaded CNPs exhibited antimicrobial effects on <i>E. coli</i> , <i>S. aureus</i> , <i>Candida albicans</i> .	[54],[55],[56],[57],[58],[59],[60]
3	Copper Oxide Nanoparticles	Used as antimicrobial coatings to inhibit the growth of MDR biofilms and be effective against bacteria. Found to prevent the growth of MRSA and <i>Pseudomonas aeruginosa</i> . Showed significant synergistic antibacterial activity against <i>E. coli</i> when conjugated with aminoglycoside antibiotics.	[61],[62],[63],[64]
4	Zinc Oxide Nanoparticles	Showed antimicrobial properties against various bacteria and fungi. Blocked the production of biofilms at low concentrations. Impaired the normal function of DNA and enzymes. Prevented the formation of biofilms caused by uropathogenic <i>E. coli</i> strains. Nanorods shaped ZnO-NPs exhibited stronger antibacterial activity against <i>E. coli</i> and <i>S. aureus</i> .	[65],[66],[67]
5	Iron Oxide Nanoparticles	Demonstrated antibacterial capabilities by breaking down bacterial membranes and instigating oxidative stress within the cell, effectively inactivating <i>Staphylococcus</i> and antibiotic-resistant biofilms, and showing a strong antibacterial effect against <i>E. coli</i> and <i>S. aureus</i> .	[68, 69, 71, 72, 73]
6	Gold Nanoparticles (AuNPs)	Shown to disrupt metabolic activity in bacteria by altering energy mechanisms and protein synthesis, effective against multidrug-resistant <i>E. coli</i> , and successfully used as a drug delivery vehicle to enhance the potency of antibiotics against clinical Gram-negative pathogens.	[74, 75, 76, 77]
7	Titanium Dioxide Nanoparticles	Act as photocatalysts and produce oxidizing agents that destroy <i>Listeria monocytogenes</i> bacteria when exposed to UV light, also reduce bacterial growth and biofilm formation in	[78, 79, 80, 81]



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		various pathogens such as <i>Pseudomonas aeruginosa</i> , <i>Enterococcus faecium</i> , <i>Klebsiella pneumoniae</i> , and <i>Staphylococcus aureus</i>	
8	Encapsulated Nanoparticles	Liposomes, lipid monolayers, dendrimers etc. used to encapsulate nanoparticles offer greater drug loading capacity, stability, and can easily deliver antibiotics at desired sites, hence are more effective against bacteria. Liposomes with vancomycin (Van) used to target <i>Staphylococcus aureus</i> , micelles with vancomycin and ciprofloxacin used to target <i>Escherichia coli</i> and <i>Pseudomonas aeruginosa</i> , dendrimers with vancomycin used to target drug resistant bacterial strains including MRSA	[82, 83, 84, 85, 86, 87, 88, 89, 90]
9	Chitosan Nanoparticles (CNPs) as Encapsulation Material	CNPs used to encapsulate antibiofilm agents such as antibiotics and natural phytochemicals, show affinity towards negatively-charged bacterial cell membranes, hence increase the efficacy of encapsulated drugs/phytochemicals	[91]
10	Poly(lactic-co-glycolic acid) (PLGA) Nanoparticles	Used to encapsulate azithromycin to create larger sized antibiotic to resist efflux mechanism of drug resistant bacteria, were successful in overcoming the efflux-resistant mechanism of bacteria like MRSA and <i>Enterococcus faecalis</i> (<i>E. faecalis</i>)	[92]
11	Carbon-based Nanoparticles	Excellent drug delivery vehicles due to their high adsorption capabilities, graphene and carbon nanotubes physically penetrate the cell membrane, preventing the ejection of drug-carrying nanoparticles through efflux pumps, nanocomposites created by combining metal oxides and antibiotics were effective against various bacterial strains	[93, 94, 95]
12	Silica Nanoparticles (SNPs)	Considered excellent nanocarriers and provide ideal platforms for designing targeted and stimulus-responsive release systems for various antimicrobial drugs, nanosystems like these offer a novel approach with improved efficacy, can alter the <i>Staphylococcus aureus</i> bacterial biofilm's structure and inhibit its growth	[96, 97]
13	Nanozymes	Fascinating broad-spectrum nanoparticles with low biotoxicity and potent antibacterial activity, nanozymes can kill more bacteria than natural enzymes, in a recent study, cationic polypeptides functionalized with nanoparticles were synthesized that not only allowed bacterial inhibition but simultaneous imaging of bacteria was also possible	[98, 99]





Nutritional and Phytochemicals Profile of *Cassia tora*, *Moringa oleifera* and *Asparagus racemosus* Pellets Formulation

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Asparagus racemosus, *Cassia tora*, and *Moringa oleifera* are just a several of the therapeutic herbs native to the Indian subcontinent. The primary goal of this study is to formulate pellets and to determine them for its nutritional value and phytochemical contents. *Asparagus racemosus*, *Moringa oleifera*, and *Cassia tora* have a lot of phytopharmacological activity. Pellets were made by Extrusion / Spheronisation is a multistage process of individual herb and evaluated for its nutritional value. Three different batches of pellets were prepared from the extracts, and it was found that the F1 batch of all the three extract shows good flow properties of pellets. So the F1 batch were selected for nutritional evaluation. These studies refer to a good prospect for herbal research to improve their contribution to the study of a drug's nutritional significance, which might help to resolve the nutritional deficiencies due to unhealthy lifestyle. In pre formulation study the crude drug, extracts were evaluated for its phytochemical screening, physicochemical parameters.

Keywords: nutritional, pellets, *Asparagus racemosus*, *Cassia tora*, *Moringa oleifera*

INTRODUCTION

Ayurveda is derived from the ancient Sanskrit terms 'ayur' (life) and 'ved' (medicine). It is one of the world's oldest surviving systems of health care (knowledge). Ayurveda is a holistic healing system based entirely on plants. These herbs have been used since Prevedic times because they are safe, affordable, and convenient [1]. Ayurveda is



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achieving popularity around the world. It has an ancient legacy of herbal medicine. Ayurveda is naturally derived healing system that is based mainly on herbal medicines as its foundation. Ayurveda has turned into a mainstream healing approach in current history. The majority of disorders for which there is no treatment in the allopathic system can be successfully treated with traditional medicines[2]. *Asparagus racemosus* has been indicated as uterine tonic, thus it cleanses, nourishes, and strengthens the female reproductive system and so it is traditionally used for amenorrhea[1]. Ayurvedic literature introduce Shatavari as the major Rasayan medication. In folk medicine, it is also known as the Queen of Herbs. [2] The roots of this plant are used as a uterine tonic, galactagogue, hyperacidity treatment, and rejuvenator[1]. Moringa oil which is extracted from seeds of *Moringa oleifera* is also called as ben oil, as it has a high amount of behenic acid. It is good for topical use on the skin and the hair[3]. Flavonoids, alkaloids, saponin, and phenolic acid are some of the phytoconstituents found in *Moringa oleifera*[4]. *Cassia tora* (*Cassia obtusifolia*) is a common annual herb that grows as a weed in India. A natural gelling agent which has industrial and food application. Cassia contains sugars, resins, and mucilage, as well as cinnamaldehyde, gum, tannins, mannitol, coumarins, and essential oils (aldehydes, eugenol, and pinene)[5]. Pelletization is an agglomeration (size-enlarging) process that converts fine powders or particles of bulk pharmaceuticals and excipients into small, free-flowing, more or less spherical units known as pellets. Pelletization is a size-enlargement process that involves the production of agglomerates with a relatively limited size range, usually with a mean size of 0.5 to 2.0 mm, which are referred to as "pellets" Most pharmaceutical industry use Extrusion-Spheronization technique to produce pellets[6].

EXPERIMENTAL WORK

Extraction process

Extraction of *Cassia tora*:-[8]

35 grams of coarse powder of Chakramarda seeds (*Cassia tora* Linn) was placed inside a thimble made from thick filter paper which was loaded into the main chamber of the Soxhlet extractor. 350ml of Ethanol as extraction solvent was taken in a distillation flask and Soxhlet extractor was placed on the flask. The 4 cycle was carried out. After extraction, the Ethanol was removed and it was later dried over water bath. The final product obtained was 2.67 gram of alcoholic extract of Chakramarda. It was solid in nature.

Extraction of *Moringa oleifera* :-[9]

In the first stage of the investigation, the dried powdered leaves were macerated with (1:10) dried powdered leaves to extraction solvent ratio for 48 hours with either 95 percent ethanol, 50 percent ethanol, or water. A glass flask was filled with 100 grammes of powdered leaves, 1000 ml of either extraction solvent, and the flask was wrapped with aluminium foil and transferred to a water bath with occasional shaking. The extracts were filtered using Whatman No.1 filter paper and concentrated by rotary evaporator to around 10% of their original volume at the end of the maceration period. The marc was extracted three times using the same procedure and solvent, and the concentrated extracts were mixed. The concentrated extracts were then dried in a drying oven at 45 °C until the dry mass weight was constant. The optimal extraction solvent was determined using the dried extracts collected.

Extraction of *Asparagus racemosus*:[10]

250 g tuberous roots of *Asparagus racemosus* were pulverised, defatted with Hexane, and macerated with 90% methanol at room temperature for 24 hours. The whole methanolic extract was evaporated over a water bath to produce a concentrated liquid syrupy mass (100 mL) that was dissolved in 10% methanol.

Phytochemical evaluation: - [11]

The obtained extract were evaluated for its phytochemical screening for carbohydrates, proteins, amino acids etc.





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TLC (Thin Layer Chromatography): [12]

The Principle of TLC is the distribution of a compound between a solid fixed phase (thin layer) placed on a glass or plastic plate and a liquid mobile phase (eluting solvent) moving across the solid phase is the basic premise of TLC.

PELLETS

Pellets are small, free-flowing, spherical particles made by agglomerating fine powders or granules of drug component and excipients with the help of appropriate processing equipment. [14]

FORMULATION OF PELLETS[6]

Extrusion / Spheronisation is a multistage process for obtaining pellets with uniform size from wet granulates (extrudates). The method involves the following main steps:

- The dry mixing of the ingredients, in order to achieve homogenous powder dispersions wet massing, in which the powders are wet mixed to form a sufficiently plastic mass.
- An extrusion stage, in which the wet mass is shaped into cylindrical segments with a uniform diameter;
- The spheronisation stage, in which the small cylinders are rolled into solid spheres (spheroids);
- The drying of the spheroids, in order to achieve the desired final moisture content;
- Screening (optional), to achieve the desired narrow size distribution.

EVALUATION OF PELLETS [8]:

Pellets are evaluated for their flow properties

Bulk density

Bulk density is defined as the total mass of the powder divided by the bulk volume and is expressed as gm/ml. This was calculated by using the formula:

$$BD = \frac{\text{Weight of powder (in gm)}}{\text{Bulk Volume of Powder (in ml)}}$$

Tapped density

It is the ratio of the powder's total mass to its tapped volume. The following calculation was used to calculate tapped density:

$$TBD = \frac{\text{Weight of powder (in gm)}}{\text{Tapped Volume of Powder (in ml)}}$$

Angle of Repose

The funnel method was used to determine it. The powder was weighed and placed in a funnel. A funnel is attached to the graph paper and fastened with its tip at a height (h) of 2 cm above the horizontal surface. The powder was carefully weighed and poured into the funnel. The powder mixture was allowed to run freely through the funnel onto the surface. The angle of repose was computed by multiplying the diameter and height of the powder cone by the following equation.

$$\theta = \tan^{-1}(h/r)$$

Where;

θ = Angle of repose

h = Height of pile cone, pile(cm)

r = Radius of the powder pile

Compressibility index /Carr's index

The Carr's index of the powder blend was determined by using the formula:

$$\text{Carr's index} = \frac{\text{tapped density} - \text{bulk density}}{\text{tapped density}} \times 100$$



**Vijaya Rabade et al.,****Hausner's ratio**

If the hausner's ratio is less than 1.25, the material is free flowing; if it is greater than 1.25, the material has poor flow ability. It was calculated using the formula:

$$\text{Hausner's ratio} = \frac{\text{tapped bulk density}}{\text{bulk density}}$$

RESULT AND DISCUSSION

All the three extracts were evaluated for phytochemical screening and it shows positive results for carbohydrates, proteins, tannins and phenolic content and alkaloids, but only *Asparagus Racemosus* shows foam test positive for saponin glycosides.

CHROMATOGRAPHIC EVALUATION OF EXTRACT

The Rf is calculated by dividing the distance the compound travelled from the original position by the distance the solvent travelled from the original position (the solvent front).

$$\text{Rf} = \frac{\text{Distance of Centre of spot from starting oint}}{\text{Distanant from solvent front from starting point}}$$

MORPHOLOGICAL EVALUATION

Crude fibre content more present in *Asparagus racemosus*(17.4%) than that of cassia tora (13.9%) and *Moringa oleifera* (7.71%). Crude protein more present in cassia tora (18.35%) than that of the *Moringa oleifera* (16.5%) and *Asparagus racemosus* (6.88). Ether extract content more present in *Cassia tora*(5.54%) than *Moringa oleifera*(2.5%) and *Asparagus racemosus*(2.14%). Total ash more present in *Cassia tora*(4.88%)and nitrogen free extract more present in *Asparagus racemosus* is about 69.52.

SUMMARY AND CONCLUSION

The detailed literature survey was done and it was found that the herbal pellets having nutritional value can be an interesting topic of research. Here nutritional pellets were prepared individually from *Cassia tora*, *Moringaoleifera* and *Asparagusracemosus* which having high nutritional profile and lower side effects. These herbal drugs are collected from DadasahebBalpande College of Pharmacy,Besa, Nagpur and authenticated from botany department Nagpur. Three batches of pellets were prepared of each drug extract and evaluated for its morphological, phytochemical, physicochemical and quantitative determination. Out of these three batches, batch F1gives best result than F2 and F3 batch. The nutritional profile of *Asparagusracemosus* contain high content of crude fibre (i.e 17.1) and *Cassia tora* has high content of crude proteins(i.e18.35).

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Table 1.

Sr.no.	Sample Extract	Solvent system	Detecting Agent
1.	Sample extract of <i>Cassia tora</i>	CHCL ₃ :CH ₃ OH (18:2)	Iodine vapours
2.	Sample extract of <i>Moringa oleifera</i>	1-butanol : methanol (9:5:0:5:0:5)	Methanol
3.	Sample extract of <i>Asparagus racemosus</i>	Ethylacetate : Methanol : Water (7:5:1:5:1 v/v)	Vanillin sulphuric acid reagent

Table 2. Formulation of *Cassia to rapellets* (extract)

Sr.	Ingredient	F1	F2	F3
1	<i>Cassia Tora</i>	4g	4g	4g
2	Mcc(Microcrystalline Cellulose)	0.7g	0.5g	0.4g
3	Talc	0.1g	0.2g	0.3g
4	Magnesium Sterate	0.2g	0.3g	0.3g
5	Total Weight(g)	5g	5g	5g

Table 3. Formulation of *Moringa oleifera pellets*(extract)

Sr. No.	Ingredients	F1	F2	F3
1.	<i>Moringa oleifera</i>	4g	4g	4g
2.	Mcc (Microcrystalline Cellulose)	.6g	0.5g	0.4g
3.	Talc	0.2g	0.1g	0.3g
4.	Magnesium Stearate	0.3g	0.4g	0.3g
5	Total Weight(g)	5g	5g	5g





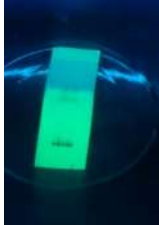
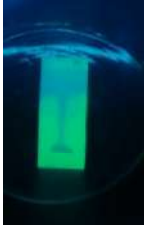
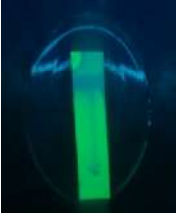
Table 4. Formulation of *Asparagus racemosus* pellets(extract)

Sr.No.	Ingredients	F1	F2	F3
1.	<i>Asparagus racemosus</i>	4g	4g	4g
2.	Mcc (Microcrystalline Cellulose)	0.5g	0.4g	0.3g
3.	Talc	0.2g	0.3g	0.4g
4.	Magnesium Stearate	0.3g	0.3g	0.3g
5	Total Weight(g)	5g	5g	5g

Table 5.Phytochemical Evaluation of Extract

Chemical test	<i>Cassia tora</i>	<i>Moringa oleifera</i>	<i>Asparagus racemosus</i>
Carbohydrate			
• Molisch test	+	+	+
• Fehlings test	+	+	+
• Benedict's test	+	+	+
Proteins			
• Biuret test	+	+	+
• Millions test	+	+	+
Saponinglycoside			
• Foam test	-	-	+
Tanninsand phenolic content			
• 5%ferric chloride solution	+	-	+
• Lead acetate test	+	+	+
• Bromine water test	+	-	+
• Acetic acid	+	-	+
• Potassium dichromate	+	+	-
Alkaloid			
• Dragandroff's test	+	+	+
• Mayer's test	-	+	-
• Hager's test	+	+	+
• Wagner's test	+	+	+

Table 6. Chromatographic evaluation of pellets

		
Fig. 1: <i>Cassia tora</i> Rf value = 0.75	Fig. 2 :<i>Moringa oleifera</i> Rf value = 0.75	Fig. 3 :<i>Asparagus racemosus</i> Rf value = 0.61





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Table 7. Morphological evaluation of pellets




Evaluation	 Fig. 4: <i>Cassia tora</i> extract Pellets	 Fig. 5: <i>Moringa oleifera</i> extract Pellets	 Fig. 6: <i>Asparagus racemosus</i> extract Pellets
Color	Yellowish Brown	Light Brownish	Orangish Brown

Table 8. Physicochemical evaluation of pellets

Sr. No.	Parameters	Crude drugs			Conclusion
		<i>Cassia tora</i>	<i>Moringa oleifera</i>	<i>Asparagus Racemosus</i>	
1.	Angle of repose	37	36	28	<i>Cassia tora</i> – fair property <i>Moringa oleifera</i> – fair property <i>Asparagus racemosus</i> – excellent property
2.	Bulk density	13	7.5	5.4	<i>Cassia tora</i> has highest bulk density than <i>moringa oleifera</i> & <i>asparagus racemosus</i>
3.	Tapped density	0.64	12	4.1	<i>Moringa oleifera</i> has highest tapped density than <i>cassia tora</i> & <i>asparagus racemosus</i>
4.	Carr’s index	40	31	23	<i>Cassia tora</i> – very poor property <i>Moringa oleifera</i> – very poor property <i>Asparagus racemosus</i> – passable property
5.	Hausner’s Ratio	1.6	1.46	1.31	<i>Cassia tora</i> - very poor property <i>Moriga oleifera</i> – very poor property <i>Asparagus racemosus</i> – passable property

Table 9. Particle size determination of pellets

Sr. no.	Name of pellets	Particle size determination
1.	<i>Cassia tora</i>	87.66µm
2.	<i>Asparagus racemosus</i>	109.34µm
3.	<i>Moringa oleifera</i>	89.44µm

Table 10. Nutritional evaluation of pellets

Sr. no.	Phytoconstituents	Result in %		
		<i>Cassia tora</i>	<i>Moringa oleifera</i>	<i>Asparagus racemosus</i>
1	Crude fibre	13.9	7.71	17.4
2	Crude Protein	18.35	16.5	6.88
3	Ether extract	5.54	2.5	2.14
4	Total ash	4.88	4.2	4.06
5	Nitrogen free extract	57.33	59.09	69.52





Generalized Contractions for Self- Mappings in Theorem of Fixed Point

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Received: 28 Feb 2024

Revised: 03 Mar 2024

Accepted: 26 Jun 2024

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ABSTRACT

Within this paper, the contraction circumstances will be examined in detail and investigate the fact that there is unique common fixed point for self- mappings in Probabilistic Metric space through the current generalization of contraction type condition.

Keywords: PM-space, Contraction, Fixed point, Distribution function, Weakly compatible mapping.

INTRODUCTION

Several generalizations of metric space have been published in the literature since the French mathematician M. Fréchet established metric space in 1906. In 1942, K. Menger [12] stated an influential generalization called Probabilistic Metric spaces (shortly PM-space), via non-negative real numbers substituting for the conceptual framework of distribution functions. It plays an important role in stochastic analysis. As an extension for the prominent Banach contraction principle, H. Sehgal and A. T. Bharucha-Reid [10] established contraction mapping on PM- space. and derive many theoretical frameworks for single and multi-valued mappings. T.L. Hicks [11] introduced a convenient and similar explanation of contraction in metric space, whereby numerous contraction conditions in PM-space are able to be efficiently explored. Jungck [13] introduced compatible mappings and Mishra [14] extended his work. Concept of weakly compatible mapping given by Jungck and Rhoades [15], which is more general than that of compatibility. The present research explores an original class of probabilistic contractions, motivated by the contractively requirement of Hicks [11] and available literature of M. Stojaković [1].





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MATERIALS AND METHODS

To begin with, we review through basic terminology and theories from the theory of PM-spaces that we are going to apply in the sequel.

Definition[9]: Let $f: X \rightarrow X$ describe a mapping corresponding to the non-empty set X . If $fx = x$, then a point x in X is a fixed point of f .

Definition[4]: If a mapping $F: R \rightarrow R_+$ is left continuous, non-decreasing, and includes a value that is $\inf \{F(t) : t \in R\} = 0$ as well as $\sup \{F(t) : t \in R\} = 1$, it is often referred to as a distribution function. Where R_+ indicates a set of real numbers which can't be negative and R indicates the set for real numbers.

Δ_+ symbolizes the collection of all distribution functions.

The value of F at $(x, y) \in X \times X$ is written as $F_{x,y}$ and $F: X \times X \rightarrow \Delta_+$ is usually referred to indicate a probabilistic distance on X if X is non-empty set.

Definition[2]: On a given set X , a metric d is a function $d: X \times X \rightarrow [0, \infty)$ such that for every $x, y \in X$

- (i). If x equals y , then $d(x, y) = 0$ and $d(x, y) \geq 0$
- (ii). Symmetry dictates that $d(x, y) = d(y, x)$
- (iii). According to triangle inequality, $d(x, y) \leq d(x, z) + d(z, y)$.

A set X carrying a metric d mentioned on it constitutes a metric space (X, d) . It is aware of the distance $d(x, y)$ that exists among every pair of points in X .

Definition[2]: If d defines the mapping $d: X \times X \rightarrow \Delta_+$ and X is a non-empty set, then a pair of ordered elements (X, d) is called a PM-space. When $x, y \in X$, we define $F_{(x,y)}$ to represent the distribution function $d(x, y)$, and $F_{(x,y)}(\epsilon)$ to indicate the value of $F_{(x,y)}$ at $\epsilon \in R > 0$. We assume the following conditions have been fulfilled by the functions $F_{(x,y)}$:

- (i). $F_{x,y}(\epsilon) = 1 \iff x = y$
- (ii). $F_{x,y}(0) = 0$
- (iii). $F_{x,y}(\epsilon) = F_{y,x}(\epsilon)$
- (iv). $F_{x,y}(\epsilon) = 1, F_{y,z}(\lambda) = 1 \implies F_{x,z}(\epsilon + \lambda) = 1$ for $\forall z \in X$ and $\lambda > 0$.

Definition[9]: For each $\epsilon > 0, \lambda \in (0, 1)$, an integer $n_0(\epsilon, \lambda)$ such that $f_{(x, x_n)}(\epsilon) > 1 - \lambda$ for all $n > n_0$, indicates that a sequence $\{x_n\}$ in PM-space has converged to a point $x \in X$.

A convergent sequence's limit in PM-space is observed to be unique at all times.

Definition[9]: When an integer $n_0(\epsilon, \lambda)$ occurs such that $f_{x_n, x_m}(\epsilon) > 1 - \lambda$ for every $n, m > n_0$, then the sequence $\{x_n\}$ in PM-space is considered to be a Cauchy. Also, the Cauchy sequence in a PM-space that converges to a single point in the space qualifies it as complete.

Definition.[8]. If two self mappings of a non-empty set X , A and S , commute over a set of coincidence points, meaning that $Ap = Sp$ for each $p \in X$ implies that $ASP = SAP$, then the pair is considered weakly compatible.

Lemma[5]. For every function $\phi: R^+ \rightarrow R^+$, let ϕ^n be the n^{th} iterate of ϕ . Then the subsequent statements are true:

- (i). For every $\epsilon > 0$, if ϕ is nondecreasing, then $\phi(\epsilon) < \epsilon$
- (ii). This means that $\lim_{n \rightarrow \infty} \phi^n(\epsilon) = 0$ if ϕ is right continuous.

Proposition[1]. Let M represent the family of continuous transformations $m: R_+ \rightarrow R_+$ that are such that

- (i). $m(\epsilon + \lambda) \geq m(\epsilon) + m(\lambda)$, for all $\epsilon, \lambda > 0$,





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(ii). $m(\varepsilon) = 0 \Leftrightarrow \varepsilon = 0$.

The following definition relates to H. Sehgal and A. T. Bharucha-Reid's [10] introduction of the contraction condition over PM-space.

Definition[10]: Consider the PM-space (X, d) . When $\lambda \in (0, 1)$ exists, then a mapping $f: X \rightarrow X$ such that $F_{fx, fy}(\varepsilon) \geq F_{x,y}(\varepsilon / \lambda)$ where $x, y \in X$ and $\varepsilon > 0$ is a contraction mapping (also known as a B-contraction, Sehgal-contraction, or just C-contraction) on (X, d) .

T. L. Hicks [11] has introduced another extension of probabilistic contractions, which have been extensively explored for the fixed point theory of PM-spaces.

Definition[11]: Let d represent a metric on X that is probabilistic. If $\lambda \in (0, 1)$ such that the following implication holds for each $x, y \in X$ and $\varepsilon > 0$, then the mapping $f: X \rightarrow X$ is known as the Hicks C-contraction (H-contraction or C-contraction).

$$F_{fx, fy}(\lambda\varepsilon) > 1 - \lambda\varepsilon \text{ whenever } F_{x,y}(\varepsilon) > 1 - \varepsilon.$$

RESULTS AND DISCUSSION:

Based on findings from [3], we may infer that the function $d_{m_1, m_2}: X \times X \rightarrow R$ represents a metric on X and is defined by

$$d_{m_1, m_2}(x, y) = \sup_{\varepsilon > 0} \{g \cdot F_{x,y}(m_2(\varepsilon)) \geq m_1(\varepsilon)\}$$

$$d_{m_1, m_2}(x, y) \Leftrightarrow g \cdot F_{x,y}(m_2(\varepsilon)) < m_1(\varepsilon)$$

M. Stojaković[1] worked over this result and derives a new generalization of Hicks-type contraction. In following theorem we modify both concepts and derive a novel fixed point theory for self mappings in PM-spaces that have generalized contraction.

Theorem. Let (X, d) represent a complete PM-space in which the family of self weakly compatible mappings $\{f_i\}_{i \in N}$ of X be holds following implications:

$$(i). d_{m_1, m_2}(x, y) = \sup_{u, v \in \{x, y, f_i^{n_i} x, f_j^{n_j} y\}} \{g \cdot F_{u,v}(m_2(\varepsilon)) > m_1(\varepsilon)\}$$

$$\Leftrightarrow g \cdot F_{f_i^{n_i} x, f_j^{n_j} y}(m_2(\varphi(\varepsilon))) > m_1(\varphi(\varepsilon))$$

$$(ii). x_{i+1} = f_i^{n_i} x_i$$

Where $\{n_i\}_{i \in N}$ the sequence of natural numbers and g is additive generator [7].

Then the set $\{f_i\}_{i \in N}$ has a unique common fixed point.

Before we start main theorem to show the completeness of X , it is required to demonstrate that the series $\{x_i\}_{i \in N}$ forms a Cauchy sequence. For this let us state a lemma which gives a sufficient condition. Later we make use of this lemma in main theorem.

Lemma. A series $\{x_i\}_{i \in N}$ is said to be Cauchy if, for each $x_1 \in X$ the family of self mappings $\{f_i\}_{i \in N}$ satisfy inequality (i).

Proof: To prove the lemma we proceed as follows

From (ii), it is clear that $x_{i+1} = f_i^{n_i} x_i$.

Suppose that a generalization of generator g , defined as

$$g \cdot F_{x,y}(\varepsilon + \lambda) \geq g \cdot F_{x,z}(\varepsilon) + g \cdot F_{z,y}(\lambda)$$

Since $\lim_{\varepsilon \rightarrow \infty} m_1(\varepsilon) = \infty$ and

$$g(0) \geq \infty + g \cdot F_{z,y}(\lambda)$$





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$g(0) \geq \infty$
 We get $g(0) > m_1(\epsilon)$.

After changing the identification of x, y with elements of sequence $\{x_i\}$ we obtain from (i) for all $i, j \in \{1, 2, \dots\}$ and $\epsilon > 0$

$$d_{m_1, m_2}(x, y) =_{u, v \in \{x_i, x_j, f_i^{n_i} x_i, f_j^{n_j} x_j\}} \min \{g \cdot F_{u, v}(m_2(\epsilon)) \geq g(0) > m_1(\epsilon)\} \dots (iii)$$

$$\Leftrightarrow g \cdot F_{f_i^{n_i} x_i, f_j^{n_j} x_j}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon))$$

$$\Leftrightarrow g \cdot F_{x_{i+1}, x_{j+1}}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon)) \text{ (by (ii))}$$

Therefore, from (iii) we receive

$$d_{m_1, m_2}(x, y) =_{u, v \in \{x_i, x_j, x_{i+1}, x_{j+1}\}} \min \{g \cdot F_{u, v}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon))\}$$

Similarly for $i, j \in \{2, 3, \dots\}$, we have

$$\Leftrightarrow g \cdot F_{x_{i+1}, x_{j+1}}(m_2(\varphi^2(\epsilon))) > m_1(\varphi^2(\epsilon))$$

If we continue the whole process then for $i, j \in \{k + 1, k + 2, \dots\}$

$$\Leftrightarrow g \cdot F_{x_i, x_j}(m_2(\varphi^k(\epsilon))) > m_1(\varphi^k(\epsilon))$$

There may be an integer $k_0(\epsilon, \lambda)$ such that all values $\epsilon > 0$ and $\lambda \in (0, 1)$

$$m_1(\varphi^k(\epsilon)) > g(1 - \lambda) \text{ and } m_2(\varphi^k(\epsilon)) > \epsilon, \text{ for all } k > k_0 \dots (iv)$$

Now for all $i, j \in \{k_0 + 1, k_0 + 2, \dots\}$

$$\Leftrightarrow g \cdot F_{x_i, x_j}(m_2(\varphi^k(\epsilon))) > m_1(\varphi^k(\epsilon)) > g(1 - \lambda)$$

$$\Leftrightarrow g \cdot F_{x_i, x_j}(m_2(\varphi^k(\epsilon))) > g(1 - \lambda)$$

$$\Leftrightarrow g \cdot F_{x_i, x_j}(\epsilon) > g(1 - \lambda)$$

$$\Leftrightarrow F_{x_i, x_j}(\epsilon) > (1 - \lambda)$$

Thus proven that the Cauchy sequence $\{x\}_{i \in \mathbb{N}}$ exists.

Proof of theorem: Since $\{x\}_{i \in \mathbb{N}}$ is a Cauchy sequence, it can be assumed for completeness that it converges to a point $z \in X$, where $\lim_{i \rightarrow \infty} x_i = z$.

In order to prove that z is a unique fixed point of $\{f_i\}_{i \in \mathbb{N}}$ we have to show that $f_i^{n_i} z = z$. For this we proceed as follows.

From (iii)

$$d_{m_1, m_2}(x, y) =_{u, v \in \{x_j, z, f_j^{n_j} x_j, f_i^{n_i} z\}} \min \{g \cdot F_{u, v}(m_2(\epsilon)) \geq g(0) > m_1(\epsilon)\}$$

Where $j \in \mathbb{N}, j \in \{1, 2, \dots\}$

$$\Leftrightarrow g \cdot F_{f_j^{n_j} x_j, f_i^{n_i} z}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon))$$

$$\Leftrightarrow g \cdot F_{x_{j+1}, f_i^{n_i} z}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon)) \text{ (by (ii))}$$

As $j \in \mathbb{N}$, taking $j \rightarrow \infty$

$$\Leftrightarrow g \cdot F_{z, f_i^{n_i} z}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon))$$

Similarly for $j \in \{2, 3, \dots\}$

$$\Leftrightarrow g \cdot F_{z, f_i^{n_i} z}(m_2(\varphi^2(\epsilon))) > m_1(\varphi^2(\epsilon))$$

This continuity for $j \in \{k + 1, k + 2, \dots\}$ give us

$$\Leftrightarrow g \cdot F_{z, f_i^{n_i} z}(m_2(\varphi^k(\epsilon))) > m_1(\varphi^k(\epsilon))$$

This is similar situation arises in previous lemma. By applying condition (iv) over here, we obtain

$$\Leftrightarrow g \cdot F_{z, f_i^{n_i} z}(m_2(\varphi^k(\epsilon))) > m_1(\varphi^k(\epsilon)) > g(1 - \lambda)$$

$$\Leftrightarrow g \cdot F_{z, f_i^{n_i} z}(m_2(\varphi^k(\epsilon))) > g(1 - \lambda)$$





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$$\Leftrightarrow g. F_{z, f_i^{n_i} z}(\epsilon) > g(1 - \lambda)$$

$$\Leftrightarrow F_{z, f_i^{n_i} z}(\epsilon) > (1 - \lambda)$$

This inequality means that $f_i^{n_i} z = z$. The existence of a common fixed point z for a set of self mappings $\{f_i\}_{i \in N}$ is implied by this necessary condition in PM-spaces.

Uniqueness: We suppose that $z \in X$ is another fixed point for same set of mappings, such that $f_i^{n_i} w = w$.

From (i)

$$d_{m_1, m_2}(x, y) = \min_{u, v \in \{z, w, f_i^{n_i} z, f_i^{n_i} w\}} \{g. F_{uv}(m_2(\epsilon)) > m_1(\epsilon)\} \\ \Leftrightarrow g. F_{f_i^{n_i} z, f_i^{n_i} w}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon))$$

Since z and w , both are common fixed points, then

$$\Leftrightarrow g. F_{z, w}(m_2(\varphi(\epsilon))) > m_1(\varphi(\epsilon))$$

After completing the whole procedure in same manner we can have

$$\Leftrightarrow g. F_{z, w}(m_2(\varphi^k(\epsilon))) > m_1(\varphi^k(\epsilon))$$

$$\Leftrightarrow F_{z, w}(\epsilon) > (1 - \lambda)$$

i. e. $z = w$

Thus, it is apparent z is the only fixed point in $f_i^{n_i}$. As mappings are also weakly compatible, then

$$f_i^{n_i} f_i z = f_i f_i^{n_i} z = f_i z \text{ and also } f_i^{n_i} z = z.$$

So that $f_i z = z$.

This concludes the proof.

CONCLUSION

This paper derives new result concern with unique fixed point, governed by a group of self-mappings in the PM-space field. The preceding section generalizes and improves properties of contradiction.

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Generating Particular Perfect Squares using Continued Fractions

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Received: 21 May 2024

Revised: 03 June 2024

Accepted: 20 July 2024

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ABSTRACT

Continued fraction is one of the most notable concepts in mathematics. Using Continued fractions, in this paper we have produced a way to generate specific perfect squares. A nice recurrence relation is obtained in determining these perfect squares. Illustrations has been provided for verification of the results obtained.

Keywords: Continued fractions, Convergents, Perfect square, Pell's equation.

INTRODUCTION

In 17th century, the theory of continued fraction has begun to bloom as a field in number theory and started to grow progressively. Most common usage of continued fractions is solving Diophantine equations and approximation of irrational numbers. In this paper, we have applied continued fractions to generate specific perfect squares using Pell's equation in section 3 and also we have formed a recurrence related to generating those square numbers. Finally, few examples were provided for verifying the results derived.

Preliminaries

In this section let us provide some basic definitions.





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Definition:A finite continued fraction is an expression of the form

$$a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{\ddots + \frac{1}{a_{n-1} + \frac{1}{a_n}}}}} \tag{2.1}$$

Where a_0, a_1, \dots, a_n are real numbers and a_1, a_2, \dots, a_n are positive. The a_i 's are called the partial quotients of the continued fraction. If the partial quotients are all integers, then the continued fraction is simple. We use the notation $[a_0; a_1, \dots, a_n]$ to represent the continued fraction given in equation (2.1). When $n = 0$ we write $[a_0]$

Definition: For $1 \leq k \leq n$, the k^{th} convergent C_k of a continued fraction $[a_0; a_1, a_2, \dots, a_n]$ is the continued fraction $C_k = [a_0; a_1, a_2, \dots, a_k]$

We extend this definition to include $k = 0$ and so we set $C_0 = a_0$.

Definition: A Pell's equation is a quadratic Diophantine equation of the form $x^2 - dy^2 = 1$ where $x, y \in \mathbb{Z}$ and d is a given natural number which is not a square.

Definition :Perfect squares are the numbers of the form $n^2, n \in \mathbb{N}$.

Generating Particular Perfect Squares

Theorem

There exists infinitely many whole numbers n such that both $kn + 1$ and $(k + 1)n + 1$ are perfect squares where $k \in \mathbb{N}$.

Proof:

Since both $kn + 1$ and $(k + 1)n + 1$ are perfect squares where $k \in \mathbb{N}$, let us assume that $kn + 1 = x^2$ and $(k + 1)n + 1 = y^2$ (3.1)

From (3.1), $n = \frac{x^2-1}{k} = \frac{y^2-1}{k+1}$, that is $\frac{x^2-1}{k} = \frac{y^2-1}{k+1}$ (3.2)

On simplifying equation (3.2) we obtain,

$$(k + 1)x^2 - ky^2 = 1 \tag{3.3}$$

Let $z = x\sqrt{k + 1}$ (3.4)

then equation (3.3) becomes $z^2 - ky^2 = 1$ (3.5)

The trivial solution of equation (3.5) is $(z, y) = (1, 0)$

To solve equation (3.5), let us first find the continued fraction expansion for \sqrt{k} in terms of $\sqrt{k + 1}$

Consider $(\sqrt{k + 1} - \sqrt{k})(\sqrt{k + 1} + \sqrt{k}) = 1$

$$\begin{aligned} \sqrt{k + 1} - \sqrt{k} &= \frac{1}{\sqrt{k+1} + \sqrt{k}} & (3.6) \\ &= \frac{1}{\sqrt{k + 1} + \sqrt{k} + \sqrt{k + 1} - \sqrt{k + 1}} \\ &= \frac{1}{2\sqrt{k+1} - \frac{1}{\sqrt{k+1} + \sqrt{k}}} \quad (\text{by equation (3.6)}) \\ &= \frac{1}{2\sqrt{k+1} - \frac{1}{2\sqrt{k+1} - \frac{1}{2\sqrt{k+1} - \dots}}} \end{aligned}$$





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$$\sqrt{k} = \sqrt{k+1} - \frac{1}{2\sqrt{k+1} - \frac{1}{2\sqrt{k+1} - \frac{1}{2\sqrt{k+1} - \dots}}} \quad (3.7)$$

Using convergent definition, the convergents of the continued fraction (3.7) are given below,

$$C_0 = \sqrt{k+1}$$

$$C_1 = \frac{2k+1}{2\sqrt{k+1}}$$

$$C_2 = \frac{(4k+1)\sqrt{k+1}}{4k+3}$$

$$C_3 = \frac{8k^2+8k+1}{(8k+4)\sqrt{k+1}}$$

$$C_4 = \frac{(16k^2+12k+1)\sqrt{k+1}}{16k^2+20k+5}$$

$$C_5 = \frac{32k^3+48k^2+18k+1}{(32k^2+32k+6)\sqrt{k+1}}$$

$$C_6 = \frac{(64k^3+80k^2+24k+1)\sqrt{k+1}}{64k^3+112k^2+56k+7}$$

...

From the above convergents, the solution of equation (3.5) are given below,

$$\begin{aligned} (z, y) = & (1,0), (\sqrt{k+1}, 1), (2k+1, 2\sqrt{k+1}), ((4k+1)\sqrt{k+1}, 4k+3), \\ & (8k^2+8k+1, (8k+4)\sqrt{k+1}), ((16k^2+12k+1)\sqrt{k+1}, 16k^2+20k+5), \\ & (32k^3+48k^2+18k+1, (32k^2+32k+6)\sqrt{k+1}), \\ & ((64k^3+80k^2+24k+1)\sqrt{k+1}, 64k^3+112k^2+56k+7), \dots \end{aligned} \quad (3.8)$$

From equation (3.4) $x = \frac{z}{\sqrt{k+1}}$

By substituting the second, fourth, sixth, ... values of (3.8) in the above equation, we will get the following solutions for equation (3.3)

$$\begin{aligned} (x, y) = & (1,1), (4k+1, 4k+3), (16k^2+12k+1, 16k^2+20k+5), \\ & (64k^3+80k^2+24k+1, 64k^3+112k^2+56k+7), \dots \end{aligned} \quad (3.9)$$





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From equation (3.1), $n = \frac{x^2-1}{k}$ and $n = \frac{y^2-1}{k+1}$

From (3.9), using the values of x in $n = \frac{x^2-1}{k}$ or values of y in $n = \frac{y^2-1}{k+1}$, we will obtain the following values of n ,

$$n = 0, 16k + 8, 256k^3 + 384k^2 + 176k + 24, \\ 4096k^5 + 10240k^4 + 9472k^3 + 3968k^2 + 736k + 48, \dots \quad (3.10)$$

Observe that the values of n from (3.10) are whole numbers since k is a natural number

For the values of n in (3.10), the values of $kn + 1$ and $(k + 1)n + 1$ are perfect squares that are given below,

$$kn + 1 = 1, (4k + 1)^2, (16k^2 + 12k + 1)^2, (64k^3 + 80k^2 + 24k + 1)^2, \dots \quad (3.11)$$

$$(k + 1)n + 1 = 1, (4k + 3)^2, (16k^2 + 20k + 5)^2, (64k^3 + 112k^2 + 56k + 7)^2, \dots \quad (3.12)$$

Hence there exists infinitely many whole numbers n such that both $kn + 1$ and $(k + 1)n + 1$ are perfect squares when k is a natural number.

Recurrence Relation

In this section we will provide the recurrence relation to generate the perfect squares which we obtained from the above theorem.

Let S_m be the square root of m th perfect square of the sequence (3.11) or (3.12). Then for a given natural number k we can define,

$$S_m = (4k + 2)S_{m-1} - S_{m-2}, m \geq 2 \quad (3.13)$$

Where $S_0 = 1$ and $S_1 = 4k + 1$ or $4k + 3$

Case (i): If we choose $S_0 = 1$ and $S_1 = 4k + 1$, from the recurrence relation (3.13) we will obtain the m th perfect square of the sequence (3.11), i.e. $(S_m)^2$ for $m = 0, 1, 2, 3 \dots$

Therefore, from (3.13) we will obtain the following sequence of perfect squares which are nothing but the values of $kn + 1$ given in (3.11).

$$\{(S_m)^2\} = 1, (4k + 1)^2, (16k^2 + 12k + 1)^2, (64k^3 + 80k^2 + 24k + 1)^2, \dots$$

Case (ii): If we choose $S_0 = 1$ and $S_1 = 4k + 3$, from the recurrence relation (3.13) we will obtain the m th perfect square of the sequence (3.12) i.e. $(S_m)^2$ for $m = 0, 1, 2, 3 \dots$

Therefore, from (3.13) we will obtain the following sequence of perfect squares which are nothing but the values of $(k + 1)n + 1$ given in (3.12).

$$\{(S_m)^2\} = 1, (4k + 3)^2, (16k^2 + 20k + 5)^2, (64k^3 + 112k^2 + 56k + 7)^2, \dots$$

We can observe that, if we know the first two perfect squares of (3.11) and (3.12), we will generate infinitely many such perfect squares using the recurrence relation (3.13).





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Illustration

There exists infinitely many whole numbers n such that both $kn + 1$ and $(k + 1)n + 1$ are perfect squares for $k = 1,2,3$.

Solution

From the above theorem, there exists infinitely many whole numbers n such that both $kn + 1$ and $(k + 1)n + 1$ are perfect squares for $k = 1,2,3$.

By substituting $k = 1$ in (3.10) we will get the following values of n such that both $n + 1$ and $2n + 1$ are perfect squares,

$$n = 0, 24, 840, 28560, \dots$$

Table 1 Verification for $k = 1$:

n	$n + 1$	$2n + 1$
0	1	1
24	$25 = 5^2$	$49 = 7^2$
840	$841 = 29^2$	$1681 = 41^2$
28560	$28561 = 169^2$	$57121 = 239^2$
...

For $k = 1$, from the case (i) of the recurrence relation (3.13), we will obtain the following sequence of perfect square which are nothing but the values of $n + 1$ given in table 1.

$$\{(S_m)^2\} = 1, 5^2, 29^2, 169^2, \dots$$

For $k = 1$, from the case (ii) of the recurrence relation (3.13), we will obtain the following sequence of perfect square which are nothing but the values of $2n + 1$ given in table 1.

$$\{(S_m)^2\} = 1, 7^2, 41^2, 239^2, \dots$$

By substituting $k = 2$ in (3.10) we will get the following values of n such that both $2n + 1$ and $3n + 1$ are perfect squares,

$$n = 0, 40, 3960, 388080, \dots$$

Table 2 Verification for $k = 2$:

n	$2n + 1$	$3n + 1$
0	1	1
40	$81 = 9^2$	$121 = 11^2$
3960	$7921 = 89^2$	$11881 = 109^2$
388080	$776161 = 881^2$	$1164241 = 1079^2$
...

For $k = 2$, from the case (i) of the recurrence relation (3.13), we will obtain the following sequence of perfect square which are nothing but the values of $2n + 1$ given in table 2.

$$\{(S_m)^2\} = 1, 9^2, 89^2, 881^2, \dots$$

For $k = 2$, from the case (ii) of the recurrence relation (3.13), we will obtain the following sequence of perfect square which are nothing but the values of $3n + 1$ given in table 2.





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$$\{(S_m)^2\} = 1, 11^2, 109^2, 1079^2, \dots$$

By substituting $k = 3$ in (3.10) we will get the following values of n such that both $3n + 1$ and $4n + 1$ are perfect squares,

$$n = 0, 56, 10920, 2118480, \dots$$

Table 3 Verification for $k = 3$:

n	$3n + 1$	$4n + 1$
0	1	1
56	$169 = 13^2$	$225 = 15^2$
10920	$32761 = 181^2$	$43681 = 209^2$
2118480	$6355441 = 2521^2$	$8473921 = 2911^2$
...

For $k = 3$, from the case (i) of the recurrence relation (3.13), we will obtain the following sequence of perfect square which are nothing but the values of $3n + 1$ given in table 3.

$$\{(S_m)^2\} = 1, 13^2, 181^2, 2521^2, \dots$$

For $k = 3$, from the case (ii) of the recurrence relation (3.13), we will obtain the following sequence of perfect square which are nothing but the values of $4n + 1$ given in table 3.

$$\{(S_m)^2\} = 1, 15^2, 209^2, 2911^2, \dots$$

CONCLUSION

In this paper, in theorem, we have constructed infinitely many whole numbers n such that both $kn + 1$ and $(k + 1)n + 1$ are perfect squares where $k \in \mathbb{N}$ and we have provided the recurrence relation (3.13) to generate infinitely many perfect squares of the form $kn + 1$ and $(k + 1)n + 1$ obtained in theorem when we know the first two such perfect squares. Also we have verified the result for the cases $k = 1, 2, 3$ in tables 1, 2, 3 respectively. Thus using the continued fraction expansion we have obtained particular perfect squares for any given natural number k .

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Effect of Iron Oxide Nanoparticles on Growth and Biochemical Properties of *Chlorella sorokiniana*

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 08 Jun 2024

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ABSTRACT

Chlorella sorokiniana is an industrially important microalgae due to its lipid profile and therefore in this study an attempt was made to improve growth and enhance production of photosynthetic pigments and lipids by supplying iron oxide nanoparticle (FeO NP) in the culture/growth medium. The effect of iron oxide nanoparticles on growth of the microalgae was evaluated in terms of cell density and microalgae biomass, which was comparatively higher in FeO NP containing growth medium. Growth parameters of microalgae exhibited a concentration dependent increase and maximum growth with cell density of 34.7×10^3 cells/ μ L and biomass of 2.6 g/L was obtained at 8 ppm after 35 days of incubation. Further, chlorophyll content exhibited similar trend such that maximum content of both chlorophyll *a* (16.9 g/L) and chlorophyll *b* (19.99 g/L) was also recorded at 8 ppm but after 35 days and 27 days of incubation, respectively. Lipid profile, however exhibited slight variation such that the relative abundance of the lipid compounds that were commonly present was higher than control only at 8 ppm after 15 days of incubation, which thereafter decreased in comparison to control at all FeO NP levels after 35 days of incubation. Presence of some lipid compounds exclusively in algal cells harvested from FeO NP containing medium was also noted. Therefore, based on the findings of the present study it can be concluded that metal oxide nanoparticles can be used to enhance overall growth and production of important metabolites in microalgae which can be further optimised at commercial scale to meet the industrial need, and these microalgae can be converted into single cell bioreactors for production of lipids used in various applications.

Keywords: Microalgae; Metal oxide nanoparticle; GC-MS; Chlorophyll content; Lipid profiling

INTRODUCTION

Microalgae play a crucial role in our ecosystem and have garnered increasing attention in recent years due to their remarkable importance in various fields. These microscopic photosynthetic organisms are essential for the planet's health as they are responsible for a significant portion of the Earth's oxygen production and carbon dioxide



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absorption. Moreover, microalgae are a valuable source of biofuels, capable of generating renewable energy while mitigating greenhouse gas emissions[1]. They also serve as a fundamental component of aquatic food chains, supporting marine life and fisheries. In addition to their environmental significance, microalgae have found applications in industries such as pharmaceuticals, cosmetics, and food production, owing to their rich nutritional profile and potential for producing bioactive compounds [2], [3]. Their versatility and adaptability make microalgae a key player in addressing some of the pressing challenges of our time, including climate change, energy sustainability and food security. One such non-motile & unicellular freshwater microalga, *Chlorella sorokiniana* is the only known species of *Chlorella* that is capable of growing at higher temperatures (38°C – 42°C)[4]. This species is renowned for its ability to accumulate substantial quantities of protein and lipid, and thus holds a prominent place in the realm of microalgae due to its multifaceted importance [1]. This species of *Chlorella* is valued for its exceptional growth rate, high lipid content, and versatility. Its rapid growth makes it an ideal candidate for biofuel production, as it offers a renewable and sustainable source of energy. Moreover, it has a remarkable ability to remove pollutants from water, contributing to its role in bioremediation and environmental conservation. Furthermore, its nutritional value, rich in proteins and other essential nutrients, makes it a promising resource in the development of functional foods and dietary supplements[5]. Thus, applications of this *Chlorella* sp. span from renewable energy solutions to environmental remediation and human nutrition, making it a microalga of significant interest in various fields. However, there are still numerous questions to be answered and challenges to be overcome. Research in *Chlorella* can help us unlock its full potential by optimizing growth conditions, enhancing lipid, carbohydrate and protein contents for biofuel and food production, and improving its efficiency in environmental clean-up. Furthermore, as climate change and resource scarcity continue to pose threats, *Chlorella* research becomes even more critical in our quest for sustainable and environmentally friendly solutions. The application of nanobiotechnology has shown remarkable potential in improving the growth, lipid, and carbohydrate profiles of microalgae. Nanomaterials, such as nanoparticles and nanocarriers, can be used to enhance the efficiency of nutrient delivery to microalgae cultures. By encapsulating essential nutrients or growth-promoting substances within nanocarriers, they can be precisely targeted to microalgae cells, promoting faster growth and improved biomass production.

Additionally, nanoscale sensors and monitoring systems can provide real-time data on the culture conditions, allowing for precise adjustments to optimize growth parameters like temperature, pH, and light intensity. Furthermore, nanotechnology-assisted genetic engineering techniques enable the creation of microalgae strains with enhanced lipid and carbohydrate content, making them more suitable for biofuel production and other applications. These advancements in nanobiotechnology hold great promise for increasing the overall efficiency and sustainability of microalgae-based industries while addressing global challenges related to renewable energy and sustainable resource utilization. Iron nanoparticles have found promising applications in enhancing the growth and biochemical properties of microalgae. Iron is an essential micronutrient for microalgae, playing a critical role in photosynthesis and other metabolic processes. Nanoparticles can improve iron uptake efficiency by microalgae due to their high surface area and reactivity. When appropriately engineered and applied, iron nanoparticles can act as efficient iron fertilizers in microalgae cultures, alleviating iron deficiency and promoting robust growth. Moreover, these nanoparticles can be used to enhance the production of valuable biochemical compounds in microalgae, such as lipids and antioxidants. Iron nanoparticles can act as catalysts in certain biochemical reactions within microalgae cells, thus boosting the synthesis of desired compounds. This innovative application of iron nanoparticles holds significant promise for optimizing microalgae cultivation for biofuel production, pharmaceuticals, and various biotechnological processes, ultimately contributing to sustainable and economically viable solutions. Therefore, in present study effect of iron oxide nanoparticles on growth and metabolic activity in terms of lipid content of *C. sorokiniana* was evaluated with an aim to identify optimum levels of the aforementioned metal oxide nanoparticle for enhancing lipids produced by microalgae.

MATERIAL AND METHODS

Microalgae Growth and Culture conditions

C. sorokiniana stock culture was procured from Banaras Hindu University (BHU), India and was grown on BG-11 medium (SRL, India) devised by ². For optimum growth, algal cultures were kept on a rotary shaker (100 rpm) in



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plant growth chamber maintained at 25°C having 20W lights with ~2000 photon lux which were timed for 16/8 h photoperiod.

Preparation of Nanomaterial (NM) Solution

Stock solution (10 mg/ml) of iron oxide (FeO) NP was prepared by dissolving 100 mg in 10 ml sterile distilled water followed by continuous shaking until homogenous suspension is formed. The resulting stock solution was then used to prepare working concentrations (2 ppm, 4 ppm, 6 ppm, 8 ppm & 10 ppm) of NMs in 100 ml culture medium.

Experimental Design

FeO NP stock solution was added to 250 ml Erlenmeyer flasks containing 100 ml BG-11 broth in different volumes so as to obtain the aforementioned final concentrations of the FeO NP in the culture medium. Culture medium without FeO NP was used as control. Culture medium with and without FeO NP was then sterilised using autoclave at 121°C and 15 psi for 20 minutes. All the treatments including control were prepared in triplicates. 1 ml of algal culture (20 days old) was added to each flask as inoculum and the inoculated flasks were then incubated in plant growth chamber for 5 weeks. To avoid aggregation of the algal cells, all the cultures were continuously agitated at ~100 rpm on a rotary shaker (Orbitek, India). Further, aliquots were collected from each flask every week to determine algal growth. For lipid profiling, algal biomass of each treatment was harvested through centrifugation at 10,000 rpm for 20 min at 25°C and was oven dried at 30°C. The dried cell biomass was then used for biochemical analysis as described in subsequent sections.

Determination of Cell Growth

Cell growth was determined in terms of cell count per unit volume of algal culture. 10 µl algal culture from each treatment was loaded into Neubauer chamber and the algal cells were visualised and counted at 40 x magnification using compound light microscope (Olympus, India). Further, cell density was calculated as per following standard formulae used for cell counting in Neubauer chamber:

$$\text{Cell density (cells/}\mu\text{l)} = \frac{\text{number of cells counted in outer/inner square}}{\text{ccf}}$$

where,

ccf = chamber conversion factor *i.e.* volume of the chamber

Determination of Microalgae Biomass

Microalgal biomass was estimated in terms of dry cell weight (DCW) as per method given by Liu *et al.* [6]. Absorbance of 1 ml algal culture was recorded at 680 nm using UV-2600 UV-Vis spectrophotometer (Shimadzu, Japan) and DCW was calculated as per following formulae [6]:
DCW (g/L) = 0.2662 x A₆₈₀ + 1.5796

Determination of Chlorophyll Content

Extraction of chlorophyll pigments was done as per method reported by Ritchie *et al.*[7] with slight modifications. Briefly, 1 ml of algal culture was withdrawn from each treatment and were centrifuged at 10,000 rpm for 15 minutes at 25°C. Supernatant was discarded and the algal cell pellet was resuspended in chilled 90% (v/v) acetone (Rankem, India) followed by overnight incubation at -20°C. The extract was then centrifuged at 10,000 rpm for 10 min at 4°C, supernatant was collected in a separate vial and the pellet was re-extracted with chilled 90% acetone thrice to ensure maximum recovery of the pigments in the acetone and the supernatant thus obtained from each extraction was collected in a single vial for each treatment/sample. Absorbance of pigment extract thus obtained was recorded at 630 nm, 647 nm, 664 nm and 691 nm using UV-2600 UV-Vis spectrophotometer (Shimadzu, Japan) and content of different chlorophyll pigments was calculated as per formulae given by Ritchie *et al.* [7].





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Lipid Profiling using GC-MS

Extraction of lipids was performed as per method given by Bligh and Dyer [8] with slight modifications. Lipids were extracted from dried algal biomass (~100 mg) using chloroform: methanol (2:1) at 25°C for 24 h with intermittent mixing. The extracts were centrifuged at 10,000 rpm for 15 min at 25°C and the lower (non-polar) layer thus obtained was collected in a fresh vial. The extracts were concentrated by evaporating the solvent at 70°C in water bath and the dried extract was weighed to determine total lipid content. Further, the dried extract was reconstituted in 1 ml HPLC grade ethyl acetate (Merck, India), filtered with 0.2 µm membrane filter (Axiva, India) and was then subjected to GC-MS analysis. For GC-MS analysis, single quadrupole GCMS QP-2020 Plus (Shimadzu, India) equipped with Rxi®-5Sil MS (Crossbond®, 5% diphenyl/95% dimethyl polysiloxane) column of 30 m length, 0.25 mm internal diameter and 0.25 µm film thickness was used. The filtered samples were injected into the column at 280°C in split mode and the flow rate of the carrier gas (helium) within the column was maintained at 1.02 ml/min. The oven temperature was maintained at 80°C with 1 min hold and the oven column temperature increased at the rate of 20°C/min upto 280°C, at which was kept on hold for 6 min. Ion source & interface temperature was maintained at 280°C, the solvent cut time was set at 3 min and the mass scan range was set between m/z 40 to m/z 500. The compounds were identified based on the similarity of their mass spectrum with NIST17 library.

STATISTICAL ANALYSIS

All the tests were conducted in triplicates and mean values along with the standard error was calculated using MS Excel. Further, means of different treatment were compared through ANOVA and Duncan's post-hoc test using IBM SPSS software.

RESULT AND DISCUSSION

Effect of FeO NP on Cell Density

Algal cell count increased with increasing incubation time in all treatments and was recorded maximum in all treatments after 5 weeks of incubation/inoculation (Table 1). In control group, cell count increased at the rate of 17.8 cells/day, 372.8 cells/day, 186.4 cells/day, 392.8 cells/day and 1794.6 cells/day during 1st, 2nd, 3rd, 4th and 5th week, respectively after inoculation/of incubation (Figure 1). On the contrary, cell count increased at the rate of 35.7 – 156.1 cells/day, 371.8 – 564.3 cells/day, 142.9 – 1874.6 cells/day, 187.5 – 812.5 cells/day and 776.8 – 2142.9 cells/day during 1st, 2nd, 3rd, 4th and 5th week, respectively in algal cultures grown on FeO NP containing medium (Figure 1). Maximum growth rate was recorded of 2142.9 cells/day was noted at 4 ppm FeO NP during 5th week of incubation, while during 1st to 4th weeks of incubation maximum growth rate was noted at 8 ppm FeO NP (Figure 1). Further, cell density was upto 3.5 times higher FeO NP supplemented medium than that in control and was maximum in culture medium containing 8 ppm FeO NP followed by 6 ppm FeO NP, 4 ppm FeO NP and 10 ppm FeO NP (Table 1). Maximum fold increase in cell count was recorded during 3rd week at higher FeO NP levels, and during 2nd and 1st week at 4 ppm and 2 ppm FeO NP, respectively (Table 1).

Effect of FeO NP on Microalgae Biomass

Microalgae biomass was determined in terms of dry cell weight (DCW), and it was comparatively higher in FeO NP containing medium than in control (without FeO NP) (Figure 2). Though DCW increased with time in all treatments irrespective of the treatment, but maximum rise was recorded at 8 ppm (1.36 folds) followed by that at 6 ppm & 4 ppm (1.31 folds), 10 ppm (1.3 folds), 2 ppm (1.26 folds) and control (0.3 folds) (Table 2). Trends in DCW were similar to that obtained for cell density as maximum DCW (2.156 ± 0.01 g/L) was also recorded at 8 ppm. Like in case of cell density, DCW also increased with increasing concentration of FeO NP in the culture medium upto 8 ppm, and a slight decline was noted at 10 ppm (Table 2).





Effect of FeO NP on Chlorophyll Content

Since *C. sorokinianais* a photosynthetic alga, therefore Chla and Chlb pigments are dominantly present than other types of chlorophylls, thus in present study content of these pigments was measured and was used as an indicator of photosynthetic efficiency of the microalgae studied. Chlorophyll *a* (Chla) content was higher than control at all levels of FeO NP, and showed a concentration dependent increase upto 8 ppm, wherein slight decline was recorded at maximum (10 ppm) FeO NP level (Figure 3a). Increase in Chla content was in accordance with the algal growth pattern, such that it increased with increasing cell density and biomass. Time dependent increase in chlorophyll *a* content was recorded at all treatments, though maximum increase of upto 10.9 folds was recorded at 10 ppm followed by 4 ppm, 6 ppm, 8 ppm and 8 ppm (Figure 3a). Throughout the incubation cycle, chlorophyll content was upto 3.1 times higher (maximum) than control. Chlorophyll *b* (Chlb) content exhibited concentration dependent increase upto 8 ppm FeO NP, while a sharp decline was recorded at maximum (10 ppm) concentration of FeO NP (Figure 3b). However, unlike chla, chlb content exhibited variable pattern *w.r.t.* time interval such that maximum chlb content in all treatments except 8 ppm was maximum at 35 days. Further, comparison of chlb content of every week elucidated that the content was maximum at 8 ppm during all 4 weeks, while during 5th week it was maximum at 10 ppm (Figure 3b).

Effect of FeO NP on Total Lipid content and Lipid Profile

Total lipid content was determined in terms of yield of lipid extract per unit weight of algal biomass. After 15 days, a sharp increase of upto 4.7 times *w.r.t.* control was recorded at higher (8 ppm & 10 ppm) FeO NP levels, while at lower FeO NP levels, total lipid content increased around 1.4 times to 2.5 times *w.r.t.* control (Figure 4). A similar trend was recorded even after 35 days such that total lipid content increased slightly (~1.5 – 1.6 times) at 2 ppm and 4 ppm, while at levels \geq 6ppm, it was atleast 3 times more (Figure 4). Further, it is also noteworthy that although lipid content exhibited a significant rise with increasing FeO NP concentration at both 15 days and 35 days, but overall rise in lipid content after 35 days *w.r.t.* 15 days ranged from 1.1x to 1.7x at all concentrations except at 6 ppm with a rise of ~2.2 times (Figure 4). Lipid profiling of algal samples harvested after 15 days and 35 days of incubation was done using GC-MS. In 15 days' samples, from all the compounds detected in each extract, total 42 compounds were present in two or more extracts. Majority (60%) of the compounds detected in control were also present in lipid extracts of FeO NP treated algal culture, while around 36% to 42% of the compounds detected in FeO NP treated samples were exclusive to these extracts and were not detected in control samples (Table 3).

Among all the common compounds identified, only 5 of them were present in all treatments, while rest of the compounds were present in either two or more of the treatments (Table 3). Content of the lipid compounds identified in all treatments was determined in terms of their relative abundance in each extract. Relative abundance of Neophytidine which belongs to the class of prenol lipids decreased *w.r.t.* control at all treatments except at 8 ppm FeO NP at which it was around 17.2% higher than that in control (Table 3). Similar pattern was also noted for 3,7,11,15-Tetramethyl-2-hexadecen-1-ol (chlorophyll component, lipophilic fatty chain), Hexadecanoic acid, ethyl ester (long chain fatty acid), such that their relative abundance was ~67.7% and 47.9% higher than that in control at 8 ppm FeO NP whereas at other FeO NP levels it was lesser than control (Table 3). On the contrary, relative abundance of hexadecanoic acid, methyl ester (fatty acid methyl esters) was lowest (54.7 % lesser than control) at 8 ppm and was highest at 10 ppm (47.6% higher than control) followed by 6 ppm (4.8% lesser than control). Heneicosane (also known as white wax) was relatively more abundant (upto 12.5 times) in all FeO NP treatments (except at 4 ppm and 10 ppm) than in control (Table 3). Overall, total relative abundance of these 5 common lipid compounds constituted 41.1%, 34.8%, 35.3%, 42.4%, 53.8% and 37.4% of the total lipid compounds identified in extracts obtained from algal cultures grown on culture medium containing 0 ppm, 2 ppm, 4ppm, 6 ppm, 8 ppm and 10 ppm FeO NP, respectively, thus indicating significant enhancement in overall levels of these lipid components at 8 ppm which aligns with the outcomes of other physiochemical and cell growth parameters discussed in previous sections.

In 35 days' samples, total 61 compounds were identified to be common in two or more treatment extracts and out of these only 4 compounds were present in all treatments, while around 27 (44.3%) compounds were exclusive to FeO NP treated algal samples and were not present in control (Table 4). From the four compounds present in all 6 samples, relative abundance of Neophytadiene (prenol lipid - sesquiterpenoid) was higher (2.3x to 3.3x) than control



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in all FeO NP levels (except 4 ppm and 10 ppm) with maximum abundance at 8 ppm followed by 2 ppm and 6 ppm, whereas at 10 ppm its relative abundance reduced ~3.6 times and at 4 ppm it was nearly same to that in case of control (Table 4). Further, relative content of Eicosane and Glycidyl palmitate was ~14.3% to 74.3% and 1.2 times to 39.6 times higher than control at all treatments, respectively. On the contrary, levels of Hexadecanoic acid, methyl ester was lesser than control at all treatments and it reduced upto 3.9 times with minimum abundance at 4 ppm followed by 10 ppm, 2 ppm, 6 ppm and 8 ppm (Table 4). However, it is noteworthy that unlike in 15 days samples, in this case the total relative abundance of the four common lipids constituted around 18.7%, 28.6%, 31.8%, 28.2%, 33.9% and 27.1% of the total lipids identified in extracts of 0 ppm (control), 2 ppm, 4 ppm, 6 ppm, 8 ppm and 10 ppm FeO NP, respectively (Table 4).

CONCLUSION

Present study aims to study the effect of iron oxide nanoparticle and growth and physiochemical properties of an important photosynthetic microalgae, *Chlorella sorokiniana* which is known for its high lipid content and capability to tolerate high temperatures. Findings of the present revealed that all the concentrations tested in the present study had more or less positive impact on both growth and physiochemical properties of the microalgae, and in fact all the tested parameters improved when algal cultures were grown in presence of FeO NP than that raised in culture medium without FeO NP. However, best optimum response in terms of cell density, microalgae biomass, chlorophyll content, and lipid content (15 days) were obtained at 8 ppm FeO NP and therefore, it can be concluded that since Fe plays crucial role in various metabolic processes of a living cell, therefore its presence in the growth medium would have in some way promoted the metabolic processes that must be either directly or indirectly involved in growth, chlorophyll production, and biosynthesis of lipids. The findings of this study are intriguing and could be used as foundation stone to further dwell deep into the various mechanisms through which metal oxide NPs affect growth and metabolic processes of these single cell microorganisms. In fact, findings of this study could also be used further to develop methods to enhance production of important metabolites in microalgae at commercial scale, thereby meeting the industrial demand for the raw materials produced by these single celled factories.

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Table 1: Effect of different concentration of FeO NP levels on cell density

Treatment	0 Week	1 st Week	2 nd Week	3 rd Week	4 th Week	5 th Week
	Cell count \pm SE ($\times 10^3$ cells/ μ l)					
C	1.65 \pm 0.1	1.8 \pm 0.5	4.4 \pm 0.3	5.7 \pm 0.8	8.44 \pm 0.7	21.0 \pm 0.04
2	1.65 \pm 0.1	2.35 \pm 0.2	4.95 \pm 0.2	6.06 \pm 0.7	10.2 \pm 0.1	24.3 \pm 0.2
4	1.65 \pm 0.1	2.5 \pm 0.1	6.44 \pm 0.4	7.43 \pm 1.2	11.6 \pm 0.1	26.6 \pm 0.2
6	1.65 \pm 0.1	2.5 \pm 0.1	6.45 \pm 0.5	13.9 \pm 0.1	15.2 \pm 0.2	27.7 \pm 0.2
8	1.65 \pm 0.1	2.74 \pm 0.1	6.69 \pm 0.9	19.8 \pm 0.1	24.2 \pm 0.2	34.7 \pm 0.3
10	1.65 \pm 0.1	1.9 \pm 0.1	5.06 \pm 0.6	13.7 \pm 0.1	19.4 \pm 0.1	24.5 \pm 0.1

Table 2: Effect of different concentration of FeO NP levels on microalgae

Treatment	0 Week	1 st Week	2 nd Week	3 rd Week	4 th Week	5 th Week
	DCW (g/L)					
C	1.59 \pm 0.0	1.597 \pm 0.0	1.618 \pm 0.0	1.660 \pm 0.01	1.716 \pm 0.0	1.931 \pm 0.0
2	1.59 \pm 0.0	1.603 \pm 0.0	1.634 \pm 0.0	1.664 \pm 0.0	1.744 \pm 0.02	2.003 \pm 0.03
4	1.59 \pm 0.0	1.599 \pm 0.0	1.650 \pm 0.0	1.682 \pm 0.01	1.803 \pm 0.01	2.076 \pm 0.03
6	1.59 \pm 0.0	1.605 \pm 0.0	1.650 \pm 0.0	1.721 \pm 0.0	1.811 \pm 0.0	2.084 \pm 0.0
8	1.59 \pm 0.0	1.633 \pm 0.0	1.683 \pm 0.0	1.813 \pm 0.0	1.859 \pm 0.02	2.156 \pm 0.01
10	1.59 \pm 0.0	1.603 \pm 0.0	1.626 \pm 0.0	1.667 \pm 0.0	1.866 \pm 0.02	2.066 \pm 0.04

Table 3: Comparative lipid profile showing relative abundance of common lipid compounds in different treatments after 15 days of incubation

	Compound	Relative Abundance (%)					
		Control	2ppm	4ppm	6ppm	8ppm	10ppm
1	3-Octadecene, (E)-	1.3				2.6	0.3
2	Hexadecane	1.9	2.5	1.2	0.5		0.2
3	1-Nonadecene	1.3				2.9	
4	Isopropyl myristate	0.8	0.3	0.3		2.1	0.4
5	Neophytadiene	20.9	14.9	18.1	21.0	24.5	17.3
6	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	6.5	5.0	5.9	6.2	10.9	5.5
7	Hexadecanoic acid, methyl ester	8.4	7.4	7.7	8.8	3.8	12.4
8	Hexadecanoic acid, ethyl ester	4.8	3.9	3.5	4.5	7.1	1.7
9	Isopropyl palmitate	1.5		0.4	0.5	4.0	0.3
10	Bis(2-ethylhexyl) methylphosphonate	1.6	0.4		0.4	2.3	
11	Heneicosane	0.6	3.6	0.1	1.9	7.5	0.5
12	2,4,4,6,6,8,8-Heptamethyl-1-nonene	0.5		0.2	0.6	1.6	
13	Dodecane, 4,6-dimethyl-	0.9	1.4		2.8		0.5





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14	3-Hexadecene, (Z)-		0.2	0.2		1.6	0.1
15	2,4-Di-tert-butylphenol		0.8	1.3			
16	Benzoic acid, 4-ethoxy-, ethyl ester	2.3	1.1	0.4	2.1		1.5
17	1-Pentadecene		0.3	0.3			
18	2-Propenoic acid, tridecyl ester	1.2	0.4	0.4	0.8		0.3
19	2,6,10-Trimethyltridecane		0.5	0.2		0.9	
20	9,11-Octadecadienoic acid, methyl ester, (E,E)-	4.9	4.5	4.6	4.5		13.5
21	10-Heptadecen-8-ynoic acid, methyl ester, (E)-		4.8		3.8		
22	Sulfurous acid, cyclohexylmethylheptadecyl ester		2.4	2.2			
23	9(E),11(E)-Conjugated linoleic acid, ethyl ester		2.8		2.4		
24	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	21.3	18.0	19.4			34.5
25	Methyl stearate		0.3	0.2			0.4
26	Z-(13,14-Epoxy)tetradec-11-en-1-ol acetate		0.5	0.7			0.5
27	9(E),11(E)-Conjugated linoleic acid		2.7	1.4			0.7
28	9,12,15-Octadecatrienoic acid, ethyl ester, (Z,Z,Z)-		1.6	0.8			
29	Octadecane, 1-iodo-		1.0	0.6			
30	2-Hexadecen-1-ol, 3,7,11,15-tetramethyl-, acetate, [R*[R*,R*-(E)]]-		10.4	8.4	2.3		1.9
31	2-Methylhexacosane		2.6				0.3
32	Sulfurous acid, cyclohexylmethylpentadecyl ester		0.5	0.2			
33	Pentadecane			0.1			0.9
34	Heptadecane, 2,6,10,15-tetramethyl-			1.1	1.2		
35	Sulfurous acid, cyclohexylmethyl octadecyl ester			0.7			

Table 4: Comparative lipid profile showing relative abundance of common lipid compounds in different treatments after 35 days of incubation

	Compound	Relative Abundance (%)					
		Control	2ppm	4ppm	6ppm	8ppm	10ppm
1.	Nonadecane	2.9	4.5				
2.	Hexadecane, 2,6,10,14-tetramethyl-	0.5	0.1				
3.	9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-	6.3	4.4				
4.	9-Eicosene, (E)-		0.8	0.3			
5.	2-Methyltetracosane	5.0		3.3			
6.	Tetrapentacontane	2.0		1.1			
7.	3-Hexadecene, (Z)-	0.3			0.6		
8.	Dodecane, 4,6-dimethyl-	0.4	0.2		0.3		
9.	2,5-Difluorobenzoic acid, 5-tetradecyl ester		0.5		0.9		
10.	3-Octadecene, (E)-	0.5			1.0		
11.	Methyl tetradecanoate	0.4	0.2		0.4		
12.	Heptadecanal		0.6		0.6		
13.	Octadecanoic acid	1.0			1.1		
14.	5Z,?8Z,?11Z,?14Z-Eeicosatetraenoic acid,? 3-?theinylmethyl ester		4.3		1.0		
15.	9,12-Octadecadien-1-ol, (Z,Z)-			3.9	8.6		
16.	1-Hexacosene	2.1			0.9		
17.	2-Tritriacontanone		0.5		0.5		





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18.	Eicosane, 1-iodo-		0.1			0.5	
19.	2,5-Difluorobenzoic acid, 5-pentadecyl ester	0.4				0.9	
20.	Hexadecane	0.3			1.0	0.7	
21.	9,12-Octadecadienoic acid, methyl ester		1.1	0.6		2.4	
22.	n-Pentadecanol	2.4	0.8	0.3	2.6	5.9	
23.	Isopropyl palmitate		1.1	0.7	0.7	0.5	
24.	Nonane, 2,2,4,4,6,8,8-heptamethyl-		0.8			0.3	
25.	Triacontane, 1-iodo-			1.1		1.3	
26.	2-Hexadecen-1-ol, 3,7,11,15-tetramethyl-, acetate, [R-[R*,R*-(E)]]-				1.1	0.8	
27.	Palmitoyl chloride		2.8		2.9	0.5	
28.	1,8,11-Heptadecatriene, (Z,Z)-				0.8	1.0	
29.	Linoleic acid ethyl ester	1.0				1.2	
30.	Phytol	2.6			0.4	1.5	
31.	Myristic acid glycidyl ester	2.1	2.7		2.9	2.0	
32.	Bis(2-ethylhexyl) phthalate	0.8	0.7		0.5	0.6	
33.	Tetracosylpentafluoropropionate		0.6			0.7	
34.	Squalene	0.6	1.7	0.3	1.4	1.5	
35.	1-Pentadecene		1.2				0.2
36.	9-Octadecene, (E)-	0.8	0.5		1.2	0.8	0.3
37.	Heptadecane			1.4	6.6	6.7	1.2
38.	1-Nonadecene				1.2		0.2
39.	Dodecane, 1-iodo-					0.6	0.3
40.	Neophytadiene	6.2	15.7	6.1	14.3	20.5	3.9
41.	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	1.0	1.7		1.8	2.3	0.5
42.	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	2.3			4.9		1.4
43.	9,11-Octadecadienoic acid, methyl ester, (E,E)-	1.9					0.6
44.	11,14,17-Eicosatrienoic acid, methyl ester		1.4		6.7	2.1	0.8
45.	Hexadecanoic acid, methyl ester	8.5	6.2	2.0	7.9	8.0	2.2
46.	Carbonic acid, eicosyl vinyl ester					1.2	1.2
47.	n-Hexadecanoic acid	6.3		1.8	7.3		1.7
48.	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	4.9	4.3	4.7		8.9	4.8
49.	Methyl stearate	3.4	2.7		3.4	2.1	2.1
50.	5,15-Dimethylnonadecane			1.6			2.0
51.	2-Methylhexacosane			7.5		2.0	5.0
52.	Heneicosane, 5-methyl-						2.8
53.	Glycidyl palmitate	3.5	6.1	4.0	5.2	4.3	4.2
54.	Heneicosane		2.0	9.3		0.9	15.6
55.	Pentatriacontane	3.1					5.1
56.	Tetracontane			5.6			0.9
57.	Tetrapentacontane, 1,54-dibromo-	2.5		3.4	2.2		2.1
58.	Tetratetracontane			3.9			6.5
59.	Eicosane	0.5	0.6	19.8	0.9	1.1	16.8
60.	Dotriacontane	1.2					1.0





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61.	11-Methyltricosane						4.1
Total	77.8	70.9	82.6	93.7	83.8	83.5	
Total no. of common compounds	33	31	22	34	31	26	
Total no. of compounds detected	46	45	34	44	44	33	
% of common compounds	71.7	68.9	64.7	77.3	70.5	78.8	

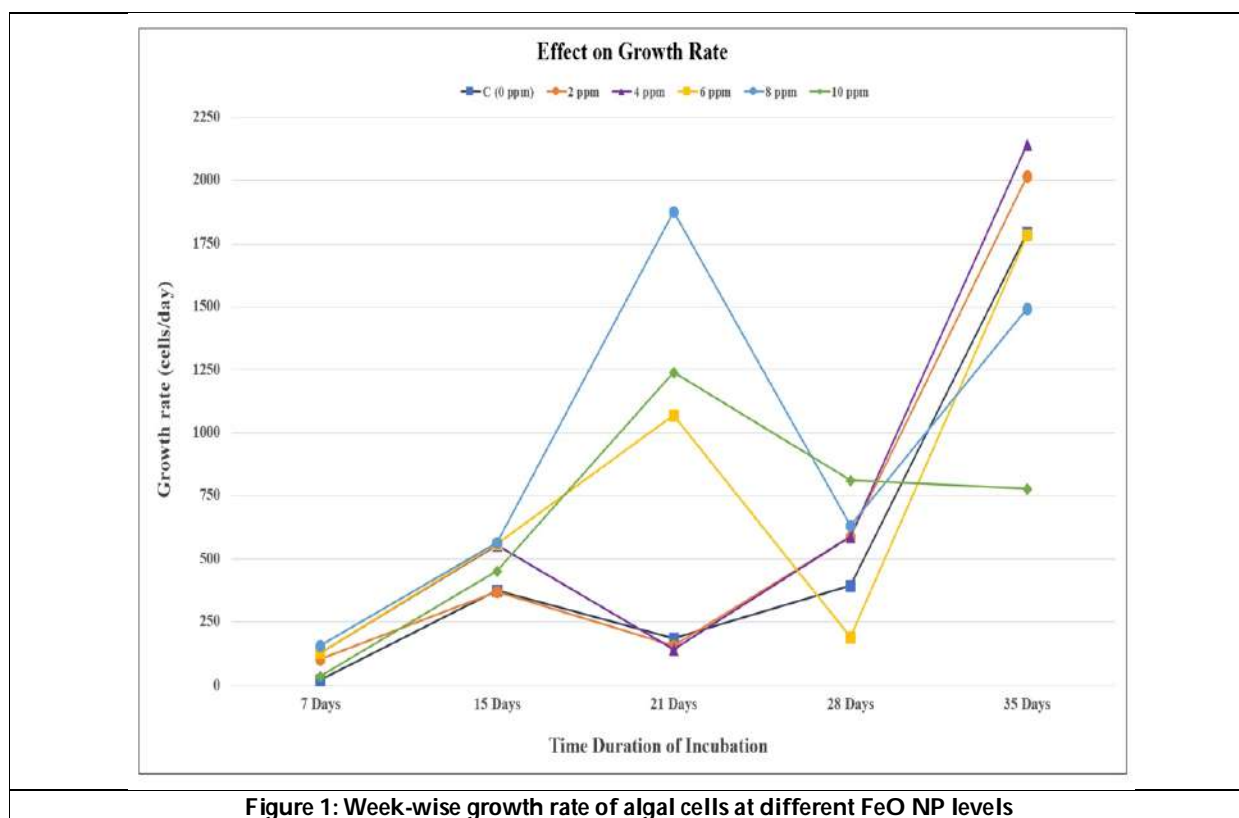


Figure 1: Week-wise growth rate of algal cells at different FeO NP levels





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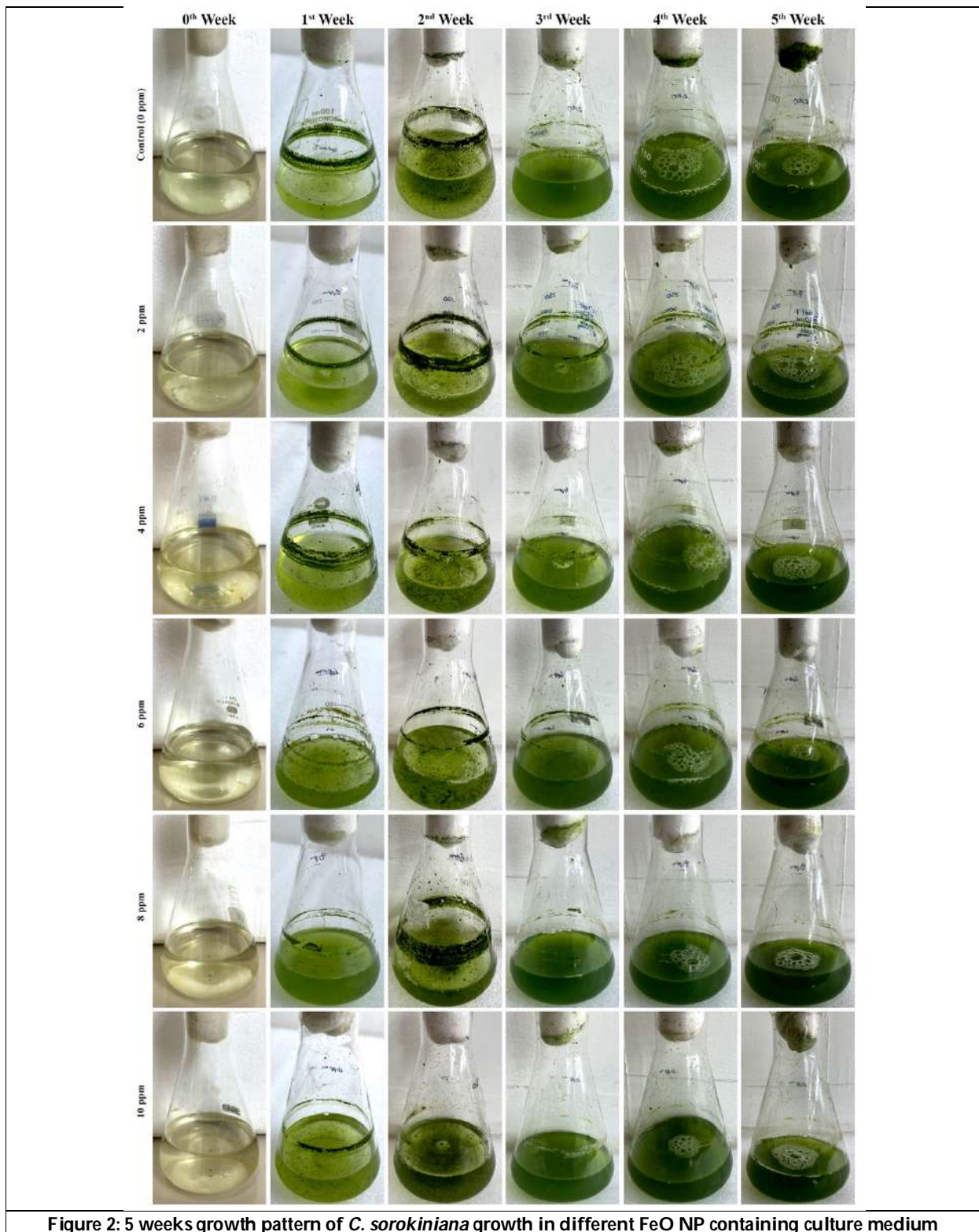


Figure 2: 5 weeks growth pattern of *C. sorokiniana* growth in different FeO NP containing culture medium





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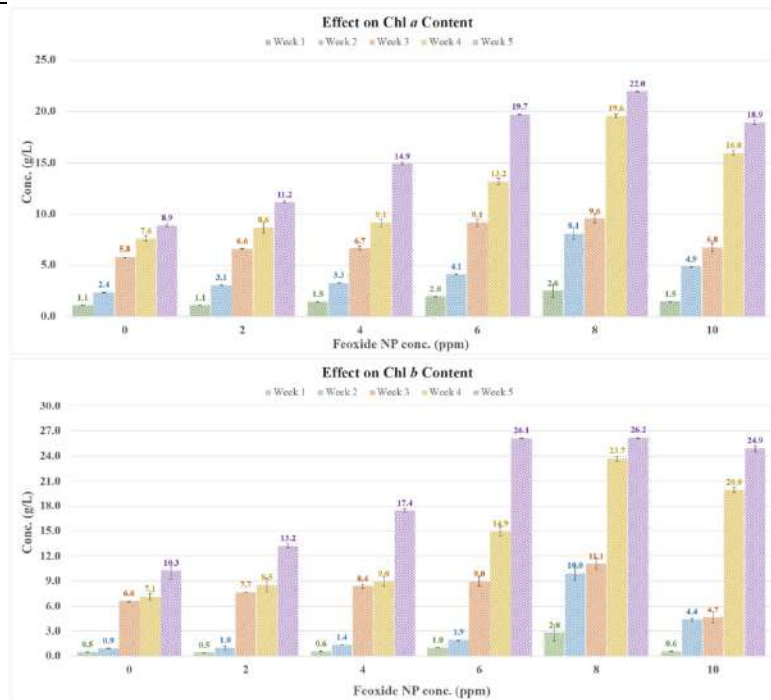


Figure 3: Week-wise chlorophyll content of *C. sorokiniana* grown on culture medium supplemented with different concentrations of FeO NP

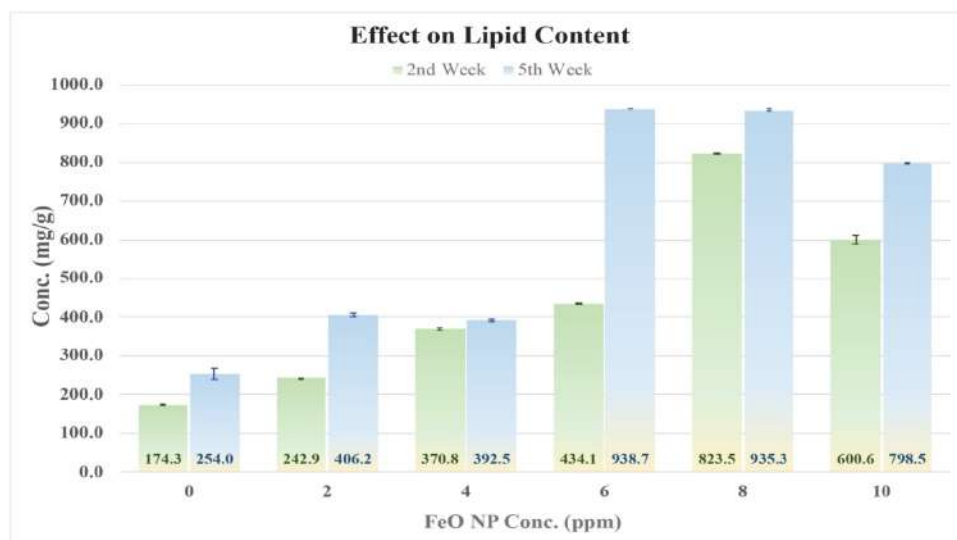


Figure 4: Effect of FeO NP on total lipid content of *C. sorokiniana*





RESEARCH ARTICLE

On Nano Soft $s(J)$ Connectedness Spaces

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 18 Jun 2024

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ABSTRACT

This paper aims to define and study the notion of connectedness to nano soft ideal topological space. Further we define \star - nano soft $s(J)$ separation, \star - nano soft $s(J)$ connected space. Also their properties and characterization are discussed.

Keywords: Nano Soft $s(J)$ Separation, Nano Soft $s(J)$ Connected, \star - Nano Soft $s(J)$ Separation, \star - Nano Soft $s(J)$ Connected.

AMS Subject Classification 2010 MSC: 54A10, 54C50, 54G20

INTRODUCTION

The soft set theory was developed by Molodstov[12] in 1999 to solve the problem in a mathematical model to the uncertainty. M. Shabir and M. Naz[14] introduced the soft topological spaces. They defined basic notion of soft topological spaces such as open soft and closed soft sets, soft subspace, soft closure, soft neighbourhood of a point, soft separation axioms and established their several properties. The soft open(closed), soft neighbourhood and soft closure was investigated by Hussain and Ahmad[3]. They also discussed the properties of soft interior and soft exterior and soft boundary. The notion of soft ideal is initiated by Kandil et. al[4]. The nano topology was produced by Lellis Thivagar[8] in 2013. Jankovic and Hamlett[2] was developed the ideal topological space in 1990. The nano soft ideal topology was introduced by S. P. R. Priyalatha et. al[13]. The notion of soft connectedness to soft

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topological space with soft ideals was introduced by A.Kandil et. al[5]. Applications to various fields were further investigated by Kandil et. al[6]. In this paper we introduce nano soft $^s(\mathcal{J})$ connectedness with soft ideals and discuss their properties. Furthermore, \star - nano soft $^s(\mathcal{J})$ separation, \star - nano soft $^s(\mathcal{J})$ connected with soft ideals.

Preliminaries

Definition 2.1:[8]

Let \tilde{U} be a non empty finite set of objects called the universe, R be an equivalence relation on \tilde{U} named as the indiscernibility relation. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair (\tilde{U}, R) is said to be approximation space. Let $X \subseteq \tilde{U}$.

The Lower approximation of X with respect to R is the set of all objects, which can be for certain classified as X with respect to R and it is denoted by $L_R(X)$.

That is, $L_R(X) = \left\{ \bigcup_{x \in \tilde{U}} \{R(x) : R(x) \subseteq X\} \right\}$, where $R(x)$ denotes the equivalence class determined by x .

The Upper approximation of X with respect to R is the set of all objects, which can be for possibly classified as X with respect to R and it is denoted by $U_R(X)$.

That is, $U_R(X) = \left\{ \bigcup_{x \in \tilde{U}} \{R(x) : R(x) \cap X \neq \emptyset\} \right\}$.

The Boundary region of X with respect to R is the set of all objects which can be classified neither as X nor as not X with respect to R and it is denoted by $B_R(X) = U_R(X) - L_R(X)$.

Definition 2.2:[8,9] Let \tilde{U} be the universe, R be an equivalence relation on \tilde{U} and $\tau_R(x) = \{\tilde{U}, \tilde{\emptyset}, L_R(X), U_R(X), B_R(X)\}$ where $X \subseteq \tilde{U}$ and $\tau_R(X)$ satisfies the following axioms.

- i. \tilde{U} and $\tilde{\emptyset} \in \tau_R(X)$.
- ii. The union of the elements of any subcollection $\tau_R(X)$ is in $\tau_R(X)$.
- iii. The intersection of the elements of any finite sub collection $\tau_R(X)$ is in $\tau_R(X)$.

That is, $\tau_R(X)$ forms a topology on \tilde{U} and it is called as the nano topology on \tilde{U} with respect to X . The elements of $\tau_R(X)$ are called as nano open sets.

Definition 2.3:[11,12]

A soft set $\mathcal{F}_{\mathcal{A}}$ on the universe \tilde{U} is defined by the set of ordered pairs $\mathcal{F}_{\mathcal{A}} = \{(e, F(e)) : e \in E, F(e) \in P(\tilde{U})\}$, where $F: E \rightarrow P(\tilde{U})$ such that $F(e) = \emptyset$, if $e \notin \mathcal{A}$ and $\mathcal{A} \subseteq E$.

Definition 2.4:[14]

Let $\tilde{\tau}$ be the collection of soft sets over \tilde{U} , then $\tilde{\tau}$ is said to be soft topology on \tilde{U} if

- i. $\tilde{U}, \tilde{\emptyset} \in \tilde{\tau}$
- ii. Union of any number of soft sets in $\tilde{\tau}$ belongs to $\tilde{\tau}$.
- iii. Intersection of any two soft sets in $\tilde{\tau}$ belongs to $\tilde{\tau}$.

The triplet $(\tilde{U}, \tilde{\tau}, E)$ is called soft topological space over \tilde{U} . The members in $\tilde{\tau}$ are said to be soft open sets in \tilde{U} .

Definition 2.5:[14]

A soft subset $\mathcal{F}_{\mathcal{A}}$ of a soft topological space \tilde{U} is said to be soft closed if $\tilde{U} - \mathcal{F}_{\mathcal{A}}$ is soft open.

Definition 2.6:[14]

Let $(\tilde{U}, \tilde{\tau}, E)$ be a soft topological space over \tilde{U} and $\mathcal{F}_{\mathcal{A}}$ be a soft set over \tilde{U} . Then the soft closure of $\mathcal{F}_{\mathcal{A}}$, denoted by $\overline{\mathcal{F}_{\mathcal{A}}}$ is the intersection of all soft closed supersets of $\mathcal{F}_{\mathcal{A}}$.





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Definition 2.7:[14]

Let $(\tilde{U}, \tilde{\tau}, E)$ be a soft topological space over \tilde{U} , \mathcal{F}_A be a soft set over \tilde{U} and $u \in \tilde{U}$. Then u is said soft interior of \mathcal{F}_A if there exists a soft open set \mathcal{G}_A such that $u \in \mathcal{G}_A \subset \mathcal{F}_A$.

Definition 2.8:[7]

An ideal \mathcal{J} on a topological space $(\tilde{U}, \tilde{\tau})$ is a non empty collection of subsets of \tilde{U} which satisfies

- i. $A \in \mathcal{J}$ and $B \subseteq A$ imply $B \in \mathcal{J}$
- ii. $A \in \mathcal{J}$ and $B \in \mathcal{J}$ imply $A \cup B \in \mathcal{J}$.

Definition 2.9:[4]

Let \mathcal{J} be the non empty collection of soft sets over \tilde{U} , with the same set of parameters E . Then $\mathcal{J} \subseteq SS(\tilde{U})_E$ is called a soft ideal on \tilde{U} with the same set E if,

- i. $\mathcal{F}_E \in \mathcal{J}$ and $\mathcal{G}_E \in \mathcal{J}$ implies $\mathcal{F}_E \cup \mathcal{G}_E \in \mathcal{J}$.
- ii. $\mathcal{F}_E \in \mathcal{J}$ and $\mathcal{G}_E \subseteq \mathcal{F}_E$ implies $\mathcal{G}_E \in \mathcal{J}$.

Definition 2.10:[13]

Let \tilde{Y} be non empty finite universe, \mathcal{F}_A be a soft set over \tilde{Y} and ${}^s(\mathcal{J})$ be a SI over a universe \tilde{Y} . Let \mathcal{R} be a soft equivalence relation on $\mathcal{F}_A \subseteq \mathcal{F}_B$. Elements belonging to the soft equivalence class of $\mathcal{F}(a)$ denoted by $[\mathcal{F}(a)]$ are said to be soft indiscernible with one another. The ordered pair $(\tilde{Y}, \mathcal{F}_A, {}^s(\mathcal{J}))$ is said to be SIAS. Let ${}^s(\mathcal{J}) \subseteq \mathcal{F}_E$.

- (i) If $\mathcal{L}_{\mathcal{R}}({}^s(\mathcal{J})) = \bigcup_{a \in A} \{[\mathcal{F}(a)]: [\mathcal{F}(a)] \subseteq ({}^s(\mathcal{J}))\}$ is a SI L-approximation of \mathcal{F}_A with respect to ${}^s(\mathcal{J})$.
- (ii) If $\mathcal{U}_{\mathcal{R}}({}^s(\mathcal{J})) = \bigcup_{a \in A} \{[\mathcal{F}(a)]: [\mathcal{F}(a)] \cap ({}^s(\mathcal{J})) \neq \emptyset\}$ is a SI U-approximation of \mathcal{F}_A with respect to ${}^s(\mathcal{J})$.
- (iii) If $\mathcal{B}_{\mathcal{R}}({}^s(\mathcal{J})) = \mathcal{U}_{\mathcal{R}}({}^s(\mathcal{J})) - \mathcal{L}_{\mathcal{R}}({}^s(\mathcal{J}))$.

Definition 2.11:[13]

Let \tilde{Y} be a universe, $\mathcal{F}_A \subseteq \mathcal{F}_E$ is a soft set over \tilde{Y} and ${}^s(\mathcal{J})$ is a SI on \mathcal{F}_E . Then, $(\tilde{Y}, \mathcal{F}_A, {}^s(\mathcal{J}))$ is an triplet ordered pair of SIAS and $\tilde{\tau}_R({}^s(\mathcal{J})) = \{\tilde{Y}, \emptyset, \mathcal{L}_{\mathcal{R}}({}^s(\mathcal{J})), \mathcal{U}_{\mathcal{R}}({}^s(\mathcal{J})), \mathcal{B}_{\mathcal{R}}({}^s(\mathcal{J}))\}$ is forms a topology on \tilde{Y} . We say that $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ is known as nano soft ideal topological space (NSIT) over \tilde{Y} with respect to ${}^s(\mathcal{J})$, then the members of $\tilde{\tau}_R({}^s(\mathcal{J}))$ are said to be NSIO sets in \tilde{Y} .

Definition 2.12:[13]

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ be a nano soft ideal topological space over \tilde{Y} . Then nano soft ideal closure of soft set \mathcal{F}_E over \tilde{Y} is denoted by $\mathcal{N}_{SI}Cl(\mathcal{F}_E)$. Thus $\mathcal{N}_{SI}Cl(\mathcal{F}_E)$ is the smallest nano soft ideal closed set which containing \mathcal{F}_E and is defined as the intersection of all nano soft ideal closed supersets of \mathcal{F}_E .

Definition 2.13:[15]

The soft set $\mathcal{F}_E \in SS(X)_E$ is called a soft point in X_E if there exist $x \in X$ and $e \in E$ such that $\mathcal{F}(e) = \{x\}$ and $\mathcal{F}(e') = \emptyset$ for each $e' \in E - \{e\}$, and the soft point \mathcal{F}_E is denoted by x_e .

Definition 2.14:[15]

The soft point x_e is said to be belonging to the soft set \mathcal{G}_A denoted by $x_e \in \mathcal{G}_A$, if for the element $e \in A$, $\mathcal{F}(e) \subseteq \mathcal{G}(e)$.

Definition 2.15:[15]

A soft set \mathcal{G}_B in a soft topological space $(X, \tilde{\tau}, E)$ is called a soft neighborhood (briefly: nbd) of the soft point $x_e \in X_E$ if there exists an open soft set \mathcal{H}_C such that $x_e \in \mathcal{H}_C \subseteq \mathcal{G}_B$. A soft set \mathcal{G}_B in a soft topological space $(X, \tilde{\tau}, E)$ is called a soft neighborhood of the soft set \mathcal{F}_A if there exists an open soft set \mathcal{H}_C such that $\mathcal{F}_A \in \mathcal{H}_C \subseteq \mathcal{G}_B$. The neighborhood system of a soft point x_e , denoted by $\mathcal{N}_{\tilde{\tau}}(x_e)$, is the family of all its neighborhoods.





Definition 2.16:[10]

Let (X, τ, E) be a soft topological space. A soft separation on X is a pair of non null proper open soft sets such that $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$ and $X = \mathcal{F}_E \cup \mathcal{G}_E$.

Definition 2.17:[10]

A non null soft subsets $\mathcal{F}_E, \mathcal{G}_E$ of a soft topological space (X, τ, E) are said to be soft separated sets if $Cl(\mathcal{F}_E) \cap (\mathcal{G}_E) = (\mathcal{F}_E) \cap Cl(\mathcal{G}_E) = \emptyset$.

Definition 2.18:[10]

A soft topological space (X, τ, E) is said to be soft connected if and only if X can not expressed as the soft union of two soft separated sets in (X, τ, E) . Otherwise (X, τ, E) is said to be soft disconnected.

Definition 2.19:[1]

Let (X, τ, E) be a soft topological space. A soft semi separation on X is a pair of non null proper semi open soft sets $\mathcal{F}_E, \mathcal{G}_E$ such that $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$ and $X = \mathcal{F}_E \cup \mathcal{G}_E$.

Definition 2.20:[1]

A soft topological space (X, τ, E) is said to be semi soft connected if and only if there is no soft semi separations on X . Otherwise (X, τ, E) is said to be soft semi disconnected.

Definition 2.21:[5]

Let (X, τ, E) be a soft topological space. A \star - soft separation of X is a pair of non null proper soft sets with $\mathcal{F}_E \in \tau$ and $\mathcal{G}_E \in \tau^*$ such that $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$ and $X = \mathcal{F}_E \cup \mathcal{G}_E$.

Definition 2.22:[5]

A soft topological space with soft ideal (X, τ, E, I) is said to be \star - soft connected if and only if there is no \star - soft separations on X . If (X, τ, E, I) has such \star - soft separations, then (X, τ, E, I) is said to be \star - soft disconnected.

Definition 2.23:[15]

Let (X, τ, E) and (Y, τ^*, E') be soft topological spaces. Let $u: X \rightarrow Y$ and $p: E \rightarrow E'$ be mappings. Let $f_{pu}: SS(X)_E \rightarrow SS(Y)_{E'}$ be a function and $e_f \in X$.

- (a) f_{pu} is soft pu - continuous at $e_f \in X$ if for each $\mathcal{G}_{E'} \in N(f_{pu}(e_f))$ there exists a $\mathcal{H}_E \in N(e_f)$ such that $f_{pu}(\mathcal{H}_E) \subseteq \mathcal{G}_{E'}$.
- (b) f_{pu} is soft pu - continuous on X , if f_{pu} is soft pu - continuous at each soft point in X .

Nano Soft $^s(\mathcal{J})$ Connectedness Spaces

In this section, we define nano soft $^s(\mathcal{J})$ connectedness with soft ideals and the properties are discussed. Throughout this paper we represent nano soft ideal topological space by NSITS, nano soft ideal by $NS^s(\mathcal{J})$, soft set by SS, soft ideal by $S^s(\mathcal{J})$.

Definition 3.1:

Let $(\tilde{Y}, \tilde{\tau}_R(^s\mathcal{J}))$ be a nano soft ideal topological space with soft ideal $^s(\mathcal{J})$ over \tilde{Y} . Two soft ideals \mathcal{F}_E and \mathcal{G}_E are said to be soft ideal disjoint if $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$. That is, $\emptyset = \mathcal{F}(e) \cap \mathcal{G}(e)$ for all $e \in E$.

Definition 3.2:

Let $(\tilde{Y}, \tilde{\tau}_R(^s\mathcal{J}))$ be a NSITS and $^s(\mathcal{J})$ be a soft ideal over \tilde{Y} . A nano soft $^s(\mathcal{J})$ separation of \tilde{Y} is a pair of disjoint non empty soft ideal subsets \mathcal{F}_E and \mathcal{G}_E such that $\mathcal{F}_E \cup \mathcal{G}_E = \tilde{Y}$ and $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$.





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Definition 3.3:

A nano soft ideal topological space $(\tilde{Y}, \tilde{\tau}_R({}^s\mathcal{J}))$ with soft ideal ${}^s(\mathcal{J})$ is said to be nano soft ${}^s(\mathcal{J})$ connected if there does not exist a $NS^s(\mathcal{J})$ separation on \tilde{Y} .

If $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ has such $NS^s(\mathcal{J})$ separation then $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ is said to be $NS^s(\mathcal{J})$ disconnected.

Example 3.4:

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ be a nano soft ${}^s(\mathcal{J})$ topological space where $\tilde{Y} = \{a, b\}$,
 $\mathcal{A} = \{p_1, p_2\}, \mathcal{F}_{\mathcal{A}} = \{(p_1, \{a\}), (p_2, \{b\}), (p_1, \{b\}), (p_2, \{a\})\}$ where ${}^s(\mathcal{J}) = \{\emptyset, (p_2, \{b\}), (p_2, \{a, b\})\}$ such that $\mathcal{F}(p_1) = \{a\}, \mathcal{F}(p_2) = \{b\}, \mathcal{F}(p_1) = \{b\}, \mathcal{F}(p_2) = \{a\}$ and $\mathcal{R} = \mathcal{F}(p_1) \times \mathcal{F}(p_1), \mathcal{F}(p_2) \times \mathcal{F}(p_2), \mathcal{F}(p_1) \times \mathcal{F}(p_2), \mathcal{F}(p_2) \times \mathcal{F}(p_1),$
 $\tilde{\tau}_R({}^s(\mathcal{J})) = \{Y, \varphi, \{p_2, \{b\}\}, \{p_1, \{a\}, p_2, \{b\}\}, \{p_2, \{a, b\}\}$ where $\mathcal{L}_R({}^s(\mathcal{J})) = \{p_2, \{b\}\}, \cup_R({}^s(\mathcal{J})) = \{p_1, \{a\}, p_2, \{b\}\}, \mathcal{B}_R({}^s(\mathcal{J})) = \{p_2, \{a, b\}\}$. Consider $\mathcal{F}_E = \{(p_2, \{b\})\}$ and $\mathcal{G}_E = \{(p_2, \{a, b\})\}$, there does not exist $NS^s(\mathcal{J})$ separation. Clearly $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ is a nano soft ${}^s(\mathcal{J})$ connected.

Definition 3.5:

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ be a nano soft ideal topological space and ${}^s(\mathcal{J})$ be a soft ideal over \tilde{Y} . A soft ideal subset \mathcal{F}_E of a nano soft ideal space is nano soft ${}^s(\mathcal{J})$ connected, if it is $NS^s(\mathcal{J})$ connected as a soft subspace.

Theorem 3.6:

A NSITS $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ with soft ideal ${}^s(\mathcal{J})$ is $NS^s(\mathcal{J})$ disconnected if and only if there exists non empty soft ideal subsets \mathcal{F}_E of $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ which is both soft ideal open and soft ideal closed in $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$.

Proof:

This proof is obvious from the definition nano soft ${}^s(\mathcal{J})$ disconnected.

Theorem 3.7:

The union of a collection of $NS^s(\mathcal{J})$ connected subspaces of \tilde{Y} with soft ideal ${}^s(\mathcal{J})$ that have a point in common is $NS^s(\mathcal{J})$ connected.

Proof:

Let $\{\mathcal{F}_\alpha\}$ be a collection of $NS^s(\mathcal{J})$ connected subspaces of \tilde{Y} with soft ideal ${}^s(\mathcal{J})$. Let p be a point of $\cap \mathcal{F}_\alpha$. We prove that $Z = \cup \mathcal{F}_\alpha$ is $NS^s(\mathcal{J})$ connected. Suppose that $Z = \mathcal{F}_E \cup \mathcal{G}_E$ is a $NS^s(\mathcal{J})$ separation of Z . The point p is in one of the sets \mathcal{F}_E or \mathcal{G}_E . Suppose $p \in \mathcal{F}_E$. Since \mathcal{F}_α is $NS^s(\mathcal{J})$ connected, it must lie entirely in either \mathcal{F}_E or \mathcal{G}_E and it cannot lie in \mathcal{G}_E because it contains the point p of \mathcal{F}_E . Hence $\mathcal{F}_\alpha \in \mathcal{F}_E$ for every α , so that $\cup \mathcal{F}_\alpha \in \mathcal{F}_E$ contradicting the fact that \mathcal{G}_E is non empty.

Theorem 3.8:

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ be a nano soft ideal topological space and ${}^s(\mathcal{J})$ be a soft ideal over \tilde{Y} . Two soft ideals \mathcal{F}_E and \mathcal{G}_E be a $NS^s(\mathcal{J})$ disconnected in $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ and \mathcal{H}_E be a $NS^s(\mathcal{J})$ connected subspace of $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$. Then \mathcal{H}_E is contained in \mathcal{F}_E or \mathcal{G}_E .

Proof:

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(\mathcal{J})))$ be a NSITS with soft ideal ${}^s(\mathcal{J})$. To prove \mathcal{H}_E is contained in \mathcal{F}_E or \mathcal{G}_E . Suppose \mathcal{H}_E is neither contained in \mathcal{F}_E nor in \mathcal{G}_E . Then $\mathcal{H}_E \cap \mathcal{F}_E, \mathcal{H}_E \cap \mathcal{G}_E$ are both non empty soft ideal open subsets of \mathcal{H}_E such that $(\mathcal{H}_E \cap \mathcal{F}_E) \cap (\mathcal{H}_E \cap \mathcal{G}_E) = \emptyset$ and $(\mathcal{H}_E \cap \mathcal{F}_E) \cup (\mathcal{H}_E \cap \mathcal{G}_E) = \mathcal{H}_E$. This gives that pair of $(\mathcal{H}_E \cap \mathcal{F}_E)$ and $(\mathcal{H}_E \cap \mathcal{G}_E)$ is a $NS^s(\mathcal{J})$ disconnected of \mathcal{H}_E . This contradiction proves this theorem.





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Definition 3.9:

Let $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ and $(\tilde{Z}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$ be two NSITS with soft ideal ${}^s\mathcal{J}$ and $p: \tilde{Y} \rightarrow \tilde{Z}$ and $q: E \rightarrow E^*$ be mappings, where E and E^* be the set of parameters. Let $f_{pq}: SS(\tilde{Y})_E \rightarrow SS(\tilde{Z})_{E^*}$ be a function and $x_e \in \tilde{Y}$.

- (a) f_{pq} is soft ideal continuous at $x_e \in \tilde{Y}$ if for each $\mathcal{G}_E \in N(f(x_e))$ there exists a $\mathcal{H}_E \in N(x_e)$ such that $f_{pq}(\mathcal{H}_E) \subseteq \mathcal{G}_E$.
- (b) f_{pq} is soft ideal continuous on \tilde{Y} , if f_{pq} is soft ideal continuous at each soft point in \tilde{Y} .

Theorem 3.10:

Let $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ and $(\tilde{Z}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$ be two NSITS with soft ideal ${}^s\mathcal{J}$ and $p: \tilde{Y} \rightarrow \tilde{Z}$ and $q: E \rightarrow E^*$ be mappings, where E and E^* be the set of parameters. Also the mapping $f_{pq}: SS(\tilde{Y})_E \rightarrow SS(\tilde{Z})_{E^*}$ is soft ideal continuous and surjective. If $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ is NSI connected then the image of $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ is $NS^s(\mathcal{J})$ connected.

Proof :

Let a soft mapping $f_q: SS(\tilde{Y}) \rightarrow SS(\tilde{Z})$ be soft ideal continuous and surjective. Contrarily, suppose that $(\tilde{Z}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$ is $NS^s(\mathcal{J})$ disconnected with soft ideal ${}^s\mathcal{J}$ and pair \mathcal{F}_{E^*} and \mathcal{G}_{E^*} is a soft ideal discontinuous of $(\tilde{Z}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$. Since $f_{pq}: SS(\tilde{Y})_{E^*} \rightarrow SS(\tilde{Z})_{E^*}$ is soft ideal continuous, therefore $f_{pq}^{-1}(\mathcal{F}_{E^*})$ and $f_{pq}^{-1}(\mathcal{G}_{E^*})$ are both soft ideal open in $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$. Clearly the pair $f_{pq}^{-1}(\mathcal{F}_{E^*})$ and $f_{pq}^{-1}(\mathcal{G}_{E^*})$ is soft ideal disconnection of $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ a contradiction. Hence $(\tilde{Z}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$ is $NS^s(\mathcal{J})$ connected. This completes the proof.

***- Nano Soft ${}^s\mathcal{J}$ Connectedness Spaces**

In this section, we extend the nano soft ${}^s\mathcal{J}$ connected to *- nano soft ${}^s\mathcal{J}$ connected with soft ideals and study some of the basic properties.

Definition 4.1:

Let $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ and $(\tilde{Y}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$ be two nano soft ideal topological space. A *- nano soft ${}^s\mathcal{J}$ separation of \tilde{Y} is a pair of proper soft ideals with $\mathcal{F}_E \in \tilde{\tau}_{1R}({}^s\mathcal{J})$ and $\mathcal{G}_E \in \tilde{\tau}_{2R}({}^s\mathcal{J})$ such that $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$ and $\tilde{Y} = \mathcal{F}_E \cup \mathcal{G}_E$.

Definition 4.2:

A nano soft ideal topological space with soft ideal $(\tilde{Y}, \tilde{\tau}_R({}^s\mathcal{J}))$ is said to be *- nano soft ${}^s\mathcal{J}$ connected if and only if there is no *- nano soft ${}^s\mathcal{J}$ separation on \tilde{Y} . If $(\tilde{Y}, \tilde{\tau}_R({}^s\mathcal{J}))$ has such *- $NS^s(\mathcal{J})$ separation, then $(\tilde{Y}, \tilde{\tau}_R({}^s\mathcal{J}))$ is said to be *- $NS^s(\mathcal{J})$ disconnected.

Example 4.3:

Let $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ and $(\tilde{Y}, \tilde{\tau}_{2R}({}^s\mathcal{J}))$ be two nano soft ${}^s\mathcal{J}$ topological space where $\tilde{Y} = \{a, b, c\}$, $\mathcal{A} = \{p_1, p_2\}$, $\mathcal{F}_{\mathcal{A}} = \{(p_1, \{a\}), (p_2, \{b\}), (p_2, \{c\}), (p_1, \{a, b\}), (p_2, \{a, b\})\}$ where ${}^s\mathcal{J} = \{\emptyset, (p_2, \{b\}), (p_2, \{a, b\})\}$ such that $F(p_1) = \{a\}, F(p_2) = \{b\}, F(p_2) = \{c\}, F(p_1) = \{a, b\}, F(p_2) = \{a, b\}$ and $\mathbb{R} = \{\mathcal{F}(p_1) \times \mathcal{F}(p_1), \mathcal{F}(p_2) \times \mathcal{F}(p_2), \mathcal{F}(p_1) \times \mathcal{F}(p_2), \mathcal{F}(p_2) \times \mathcal{F}(p_1)\}$, $\tilde{\tau}_{1R}({}^s\mathcal{J}) = \{\tilde{Y}, \emptyset, (p_1, \{a\}), (p_2, \{b\}), \{(p_1, \{a\}), (p_2, \{b\})\}\}$ where $\tilde{\mathcal{L}}_{\mathcal{R}}({}^s\mathcal{J}) = \{p_2, \{b\}\}$, $\tilde{\mathcal{U}}_{\mathcal{R}}({}^s\mathcal{J}) = \{p_1, \{a\}, p_2, \{b\}\}$, $\mathcal{B}_{\mathcal{R}}({}^s\mathcal{J}) = \{p_1, \{a\}\}$ and $\tilde{\tau}_{2R}({}^s\mathcal{J}) = \{\tilde{Y}, \emptyset, (p_1, \{b\}), (p_2, \{a\}), \{(p_1, \{b\}), (p_2, \{a\})\}\}$, $\mathcal{L}_{\mathcal{R}}({}^s\mathcal{J}) = \{p_2, \{a\}\}$, $\mathcal{U}_{\mathcal{R}}({}^s\mathcal{J}) = \{p_1, \{b\}, p_2, \{a\}\}$, $\mathcal{B}_{\mathcal{R}}({}^s\mathcal{J}) = \{p_1, \{b\}\}$. Consider $\mathcal{F}_E = \{(p_1, \{a\})\}$ and $\mathcal{G}_E = \{(p_2, \{a\})\}$, there does not exist *- $NS^s(\mathcal{J})$ separation. Therefore clearly it is *- $NS^s(\mathcal{J})$ connected.

Theorem 4.4:

Let $(\tilde{Y}, \tilde{\tau}_{1R}({}^s\mathcal{J}))$ be a NSITS with soft ideal and $(\tilde{Y}, \tilde{\tau}_2, E)$ be its *- soft topological space, then the following are equivalent.

- (i) \tilde{Y} is *- nano soft ${}^s\mathcal{J}$ connected.





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- (ii) \tilde{Y} cannot be expressed as a soft ideal union of two disjoint soft ideal subsets $\mathcal{F}_E, \mathcal{G}_E$ of \tilde{Y} which are $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal open and $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open respectively.
- (iii) \tilde{Y} cannot be expressed as a soft ideal union of two non null disjoint soft subsets $\mathcal{F}_E, \mathcal{G}_E$ of \tilde{Y} which are $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal closed and $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal closed respectively.
- (iv) There is no proper soft ideal subset \mathcal{F}_E of \tilde{Y} which is neither $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open and $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ soft ideal closed, nor $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal closed and $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ soft ideal open.

Proof

- (i)⇒(ii) By the definition of \star - nano soft ${}^s\mathcal{J}$ connected, \tilde{Y} cannot be expressed as a soft ideal union of two disjoint soft ideal subsets $\mathcal{F}_E, \mathcal{G}_E$ of \tilde{Y} which are $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal open and $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open respectively.
- (ii)⇒(iii) Suppose that $\tilde{Y} = \mathcal{F}_E \cup \mathcal{G}_E$ for some $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal closed set \mathcal{F}_E and $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal closed set \mathcal{G}_E such that $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$. Then $\mathcal{F}_E = (\mathcal{G}_E)^c$ which is $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal open and $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open, $\tilde{Y} = \mathcal{G}_E \cup (\mathcal{G}_E)^c$ and $\mathcal{G}_E \cap (\mathcal{G}_E)^c = \emptyset$, which is a contradiction to (ii).
- (iii)⇒(iv) Suppose that there is a proper soft ideal subset \mathcal{F}_E of \tilde{Y} , which is either $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open and $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal closed or $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal closed and $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal open. Then \mathcal{F}_E^c is $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal closed and \mathcal{F}_E is $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal closed with $\tilde{Y} = \mathcal{F}_E \cup \mathcal{F}_E^c$ and $\mathcal{F}_E \cap \mathcal{F}_E^c = \emptyset$, which is a contradiction with (iii).
- (iv)⇒(i) Suppose that $\tilde{Y} = \mathcal{F}_E \cup \mathcal{G}_E$ for some $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal open \mathcal{F}_E and $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open \mathcal{G}_E such that $\mathcal{F}_E \cap \mathcal{G}_E = \emptyset$. Then $\mathcal{F}_E = \mathcal{G}_E^c$ and $\mathcal{G}_E = \mathcal{F}_E^c$. Then \mathcal{F}_E is $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - closed soft and $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal open and \mathcal{G}_E is $\tilde{\iota}_{2_R}({}^s\mathcal{J})$ - soft ideal open and $\tilde{\iota}_{1_R}({}^s\mathcal{J})$ - soft ideal closed, which is a contradiction with (iv).

Theorem 4.5:

If $(\tilde{Y}, \tilde{\iota}_R({}^s\mathcal{J}))$ be a \star - NS ${}^s\mathcal{J}$ connected topological space with soft ideal, then $(\tilde{Y}, \tilde{\iota}, E)$ is soft connected.

Proof :

Let $(\tilde{Y}, \tilde{\iota}_R({}^s\mathcal{J}))$ be a \star - NS ${}^s\mathcal{J}$ connected space with soft ideal ${}^s\mathcal{J}$. From the definition of \star - NS ${}^s\mathcal{J}$ connected, $(\tilde{Y}, \tilde{\iota}, E)$ is soft connected.

Theorem 4.6:

Let $(\tilde{Y}, \tilde{\iota}_{1_R}({}^s\mathcal{J}))$ and $(\tilde{Z}, \tilde{\iota}_{2_R}({}^s\mathcal{J}))$ be two NSITS with soft ideal ${}^s\mathcal{J}$ and $p: \tilde{Y} \rightarrow \tilde{Z}$ and $q: E \rightarrow E^*$ be mappings, where E and E^* be the set of parameters. Also the mapping $f_{pq}: SS(\tilde{Y})_E \rightarrow SS(\tilde{Z})_{E^*}$ is soft ideal continuous and surjective. If $(\tilde{Y}, \tilde{\iota}_{1_R}({}^s\mathcal{J}))$ is \star - NS ${}^s\mathcal{J}$ connected then the image of $(\tilde{Y}, \tilde{\iota}_{1_R}({}^s\mathcal{J}))$ is \star - NS ${}^s\mathcal{J}$ connected.

Proof :

Let the mapping $f_q: SS(\tilde{Y}) \rightarrow SS(\tilde{Z})$ be soft ideal continuous and surjective. Contrarily, suppose that $(\tilde{Z}, \tilde{\iota}_{2_R}({}^s\mathcal{J}))$ is \star - NS ${}^s\mathcal{J}$ disconnected with soft ideal ${}^s\mathcal{J}$ and pair \mathcal{F}_{E^*} and \mathcal{G}_{E^*} is a soft ideal discontinuous of $(\tilde{Z}, \tilde{\iota}_{2_R}({}^s\mathcal{J}))$. Since $f_{pq}: SS(\tilde{Y})_{E^*} \rightarrow SS(\tilde{Z})_{E^*}$ is soft ideal continuous, therefore $f_{pq}^{-1}(\mathcal{F}_{E^*})$ and $f_{pq}^{-1}(\mathcal{G}_{E^*})$ are both soft ideal open in $(\tilde{Y}, \tilde{\iota}_{1_R}({}^s\mathcal{J}))$. Clearly the pair $f_{pq}^{-1}(\mathcal{F}_{E^*})$ and $f_{pq}^{-1}(\mathcal{G}_{E^*})$ is soft ideal disconnection of $(\tilde{Y}, \tilde{\iota}_{1_R}({}^s\mathcal{J}))$ a contradiction. Hence $(\tilde{Z}, \tilde{\iota}_{2_R}({}^s\mathcal{J}))$ is \star - NS ${}^s\mathcal{J}$ connected. This completes the proof.

Remark 4.7:

In NS ${}^s\mathcal{J}$ connectedness, there exists disjoint soft ideals from only one NSITS, but in the \star - NS ${}^s\mathcal{J}$ connectedness we consider the disjoint soft ideals from two NSITS.





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Definition 4.8:

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(J)))$ be a nano soft ideal topological space and $\tilde{Z}_E \subseteq \tilde{Y}$ with $y \in \tilde{Z}_E$. Then \tilde{Z}_E is said to be $NS^s(J)$ component with respect to y is the maximal of all $NS^s(J)$ connected subspaces of $(\tilde{Z}, \tilde{\tau}_R({}^s(J)))$ containing y and denoted by $C[\tilde{Z}_E, y]$. That is, $C[\tilde{Z}_E, y] = \cup \{\tilde{X}_E \subseteq \tilde{Z}_E : y \in \tilde{X}_E, \tilde{X}_E \text{ is } NS^s(J) \text{ connected}\}$.

Theorem 4.9:

Every $NS^s(J)$ component of a nano soft ideal topological space $(\tilde{Y}, \tilde{\tau}_R({}^s(J)))$ is a maximal $NS^s(J)$ connected subset of \tilde{Y} .

Proof :

This proof is obvious from the definition 4.8.

Theorem 4.10:

Every $NS^s(J)$ component of a nano soft ideal topological space $(\tilde{Y}, \tilde{\tau}_R({}^s(J)))$ is a closed set.

Proof :

From the definition of $NS^s(J)$ component and from the fact that the $NS^s(J)$ closure of a $NS^s(J)$ connected space is a $NS^s(J)$ connected. Hence $(\tilde{Y}, \tilde{\tau}_R({}^s(J)))$ is a closed set.

Theorem 4.11:

Let $(\tilde{Y}, \tilde{\tau}_R({}^s(J)))$ be a NSITS. Then

- (i) Each element $y \in \tilde{Y}$ is contained in exactly one component of \tilde{Y} .
- (ii) Any two $NS^s(J)$ components with respect to two different elements of \tilde{Y} are either disjoint or identical.

Proof :

(i) Let $y \in \tilde{Y}$ and consider the collection, $C = \{Z_E \subseteq \tilde{Y} : y \in Z_E, Z_E \text{ is } NS^s(J) \text{ connected}\}$. Then we have

(a) $C \neq \emptyset$, for the singleton soft point y_E is a $NS^s(J)$ connected subset of \tilde{Y} containing y .

Then $y_E \in C$.

(b) $\cap \{Z_E \subseteq \tilde{Y} : y \in Z_E, Z_E \text{ is } NS^s(J) \text{ connected}\} \neq \emptyset$, since $y \in Z_E \forall Z_E \in C$.

(c) The soft set $\cup \{Z_E \subseteq \tilde{Y} : y \in Z_E, Z_E \text{ is } NS^s(J) \text{ connected}\}$, having a non null soft intersection is $NS^s(J)$ connected subset of \tilde{Y} containing y .

(d) $\cup \{Z_E \subseteq \tilde{Y} : y \in Z_E, Z_E \text{ is } NS^s(J) \text{ connected}\}$ is the largest $NS^s(J)$ connected subset of \tilde{Y} containing y , which is the $NS^s(J)$ component $C(\tilde{Y}, y)$ of \tilde{Y} with respect to y and containing y from the definition 4.8. Now, suppose $C_1(\tilde{Y}, y)$ be another $NS^s(J)$ component containing y , then $C_1(\tilde{Y}, y)$ is a $NS^s(J)$ connected subset of \tilde{Y} containing y , but $C(\tilde{Y}, y)$ is $NS^s(J)$ component then $C(\tilde{Y}, y)$ is the largest $NS^s(J)$ connected subset of \tilde{Y} containing y , consequently $C_1(\tilde{Y}, y) \subseteq C(\tilde{Y}, y)$. Similarly $C(\tilde{Y}, y) \subseteq C_1(\tilde{Y}, y)$ and hence y is contained in exactly one $NS^s(J)$ component of \tilde{Y} .

(ii) Let $C(\tilde{Y}, y_1), C(\tilde{Y}, y_2)$ be the $NS^s(J)$ components of \tilde{Y} with respect to two different elements y_1, y_2 of \tilde{Y} with $y_1 \neq y_2$ respectively. If $C(\tilde{Y}, y_1) \cap C(\tilde{Y}, y_2) = \emptyset$, then we get the proof. Let $C(\tilde{Y}, y_1) \cap C(\tilde{Y}, y_2) \neq \emptyset$, we may choose $y \in C(\tilde{Y}, y_1) \cap C(\tilde{Y}, y_2)$. Clearly, $y \in C(\tilde{Y}, y_1)$ and $y \in C(\tilde{Y}, y_2)$, which mean that $C(\tilde{Y}, y_1)$ is the largest $NS^s(J)$ connected subset of \tilde{Y} containing y , $C(\tilde{Y}, y_2)$ is the largest $NS^s(J)$ connected subset of \tilde{Y} containing y . Therefore $C(\tilde{Y}, y_1) = C(\tilde{Y}, y_2)$ and hence $C(\tilde{Y}, y_1)$ and $C(\tilde{Y}, y_2)$ are identical. This completes the proof.

CONCLUSION

This paper introduced the concept of nano soft ${}^s(J)$ connectedness with soft ideals. Also their characterization are discussed. Furthermore, we defined \star - nano soft ${}^s(J)$ separation, \star - nano soft ${}^s(J)$ connected with properties and examples.



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Nutritional and Phytochemicals Profile of *Cassia tora*, *Moringa oleifera* and *Asparagus racemosus* Pellets Formulation

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Asparagus racemosus, *Cassia tora*, and *Moringa oleifera* are just a several of the therapeutic herbs native to the Indian subcontinent. The primary goal of this study is to formulate pellets and to determine them for its nutritional value and phytochemical contents. *Asparagus racemosus*, *Moringa oleifera*, and *Cassia tora* have a lot of phytopharmacological activity. Pellets were made by Extrusion / Spheronisation is a multistage process of individual herb and evaluated for its nutritional value. Three different batches of pellets were prepared from the extracts, and it was found that the F1 batch of all the three extract shows good flow properties of pellets. So the F1 batch were selected for nutritional evaluation. These studies refer to a good prospect for herbal research to improve their contribution to the study of a drug's nutritional significance, which might help to resolve the nutritional deficiencies due to unhealthy lifestyle. In pre formulation study the crude drug, extracts were evaluated for its phytochemical screening, physicochemical parameters.

Keywords: nutritional, pellets, *Asparagus racemosus*, *Cassia tora*, *Moringa oleifera*

INTRODUCTION

Ayurveda is derived from the ancient Sanskrit terms 'ayur' (life) and 'ved' (medicine). It is one of the world's oldest surviving systems of health care (knowledge). Ayurveda is a holistic healing system based entirely on plants. These herbs have been used since Prevedic times because they are safe, affordable, and convenient [1]. Ayurveda is



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achieving popularity around the world. It has an ancient legacy of herbal medicine. Ayurveda is naturally derived healing system that is based mainly on herbal medicines as its foundation. Ayurveda has turned into a mainstream healing approach in current history. The majority of disorders for which there is no treatment in the allopathic system can be successfully treated with traditional medicines[2]. *Asparagus racemosus* has been indicated as uterine tonic, thus it cleanses, nourishes, and strengthens the female reproductive system and so it is traditionally used for amenorrhea[1]. Ayurvedic literature introduce Shatavari as the major Rasayan medication. In folk medicine, it is also known as the Queen of Herbs. [2] The roots of this plant are used as a uterine tonic, galactagogue, hyperacidity treatment, and rejuvenator[1]. Moringa oil which is extracted from seeds of *Moringa oleifera* is also called as ben oil, as it has a high amount of behenic acid. It is good for topical use on the skin and the hair[3]. Flavonoids, alkaloids, saponin, and phenolic acid are some of the phytoconstituents found in *Moringa oleifera*[4]. *Cassia tora* (*Cassia obtusifolia*) is a common annual herb that grows as a weed in India. A natural gelling agent which has industrial and food application. Cassia contains sugars, resins, and mucilage, as well as cinnamaldehyde, gum, tannins, mannitol, coumarins, and essential oils (aldehydes, eugenol, and pinene)[5]. Pelletization is an agglomeration (size-enlarging) process that converts fine powders or particles of bulk pharmaceuticals and excipients into small, free-flowing, more or less spherical units known as pellets. Pelletization is a size-enlargement process that involves the production of agglomerates with a relatively limited size range, usually with a mean size of 0.5 to 2.0 mm, which are referred to as "pellets" Most pharmaceutical industry use Extrusion-Spheronization technique to produce pellets[6].

EXPERIMENTAL WORK

Extraction process

Extraction of *Cassia tora*:-[8]

35 grams of coarse powder of Chakramarda seeds (*Cassia tora* Linn) was placed inside a thimble made from thick filter paper which was loaded into the main chamber of the Soxhlet extractor. 350ml of Ethanol as extraction solvent was taken in a distillation flask and Soxhlet extractor was placed on the flask. The 4 cycle was carried out. After extraction, the Ethanol was removed and it was later dried over water bath. The final product obtained was 2.67 gram of alcoholic extract of Chakramarda. It was solid in nature.

Extraction of *Moringa oleifera* :-[9]

In the first stage of the investigation, the dried powdered leaves were macerated with (1:10) dried powdered leaves to extraction solvent ratio for 48 hours with either 95 percent ethanol, 50 percent ethanol, or water. A glass flask was filled with 100 grammes of powdered leaves, 1000 ml of either extraction solvent, and the flask was wrapped with aluminium foil and transferred to a water bath with occasional shaking. The extracts were filtered using Whatman No.1 filter paper and concentrated by rotary evaporator to around 10% of their original volume at the end of the maceration period. The marc was extracted three times using the same procedure and solvent, and the concentrated extracts were mixed. The concentrated extracts were then dried in a drying oven at 45 °C until the dry mass weight was constant. The optimal extraction solvent was determined using the dried extracts collected.

Extraction of *Asparagus racemosus*:[10]

250 g tuberous roots of *Asparagus racemosus* were pulverised, defatted with Hexane, and macerated with 90% methanol at room temperature for 24 hours. The whole methanolic extract was evaporated over a water bath to produce a concentrated liquid syrupy mass (100 mL) that was dissolved in 10% methanol.

Phytochemical evaluation: - [11]

The obtained extract were evaluated for its phytochemical screening for carbohydrates, proteins, amino acids etc.





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TLC (Thin Layer Chromatography): [12]

The Principle of TLC is the distribution of a compound between a solid fixed phase (thin layer) placed on a glass or plastic plate and a liquid mobile phase (eluting solvent) moving across the solid phase is the basic premise of TLC.

PELLETS

Pellets are small, free-flowing, spherical particles made by agglomerating fine powders or granules of drug component and excipients with the help of appropriate processing equipment. [14]

FORMULATION OF PELLETS[6]

Extrusion / Spheronisation is a multistage process for obtaining pellets with uniform size from wet granulates (extrudates). The method involves the following main steps:

- The dry mixing of the ingredients, in order to achieve homogenous powder dispersions wet massing, in which the powders are wet mixed to form a sufficiently plastic mass.
- An extrusion stage, in which the wet mass is shaped into cylindrical segments with a uniform diameter;
- The spheronisation stage, in which the small cylinders are rolled into solid spheres (spheroids);
- The drying of the spheroids, in order to achieve the desired final moisture content;
- Screening (optional), to achieve the desired narrow size distribution.

EVALUATION OF PELLETS [8]:

Pellets are evaluated for their flow properties

Bulk density

Bulk density is defined as the total mass of the powder divided by the bulk volume and is expressed as gm/ml. This was calculated by using the formula:

$$BD = \frac{\text{Weight of powder (in gm)}}{\text{Bulk Volume of Powder (in ml)}}$$

Tapped density

It is the ratio of the powder's total mass to its tapped volume. The following calculation was used to calculate tapped density:

$$TBD = \frac{\text{Weight of powder (in gm)}}{\text{Tapped Volume of Powder (in ml)}}$$

Angle of Repose

The funnel method was used to determine it. The powder was weighed and placed in a funnel. A funnel is attached to the graph paper and fastened with its tip at a height (h) of 2 cm above the horizontal surface. The powder was carefully weighed and poured into the funnel. The powder mixture was allowed to run freely through the funnel onto the surface. The angle of repose was computed by multiplying the diameter and height of the powder cone by the following equation.

$$\theta = \tan^{-1}(h/r)$$

Where;

θ = Angle of repose

h = Height of pile cone, pile(cm)

r = Radius of the powder pile

Compressibility index /Carr's index

The Carr's index of the powder blend was determined by using the formula:

$$\text{Carr's index} = \frac{\text{tapped density} - \text{bulk density}}{\text{tapped density}} \times 100$$



**Vijaya Rabade et al.,****Hausner's ratio**

If the hausner's ratio is less than 1.25, the material is free flowing; if it is greater than 1.25, the material has poor flow ability. It was calculated using the formula:

$$\text{Hausner's ratio} = \frac{\text{tapped bulk density}}{\text{bulk density}}$$

RESULT AND DISCUSSION

All the three extracts were evaluated for phytochemical screening and it shows positive results for carbohydrates, proteins, tannins and phenolic content and alkaloids, but only *Asparagus Racemosus* shows foam test positive for saponin glycosides.

CHROMATOGRAPHIC EVALUATION OF EXTRACT

The Rf is calculated by dividing the distance the compound travelled from the original position by the distance the solvent travelled from the original position (the solvent front).

$$R_f = \frac{\text{Distance of Centre of spot from starting oint}}{\text{Distanant from solvent front from starting point}}$$

MORPHOLOGICAL EVALUATION

Crude fibre content more present in *Asparagus racemosus*(17.4%) than that of cassia tora (13.9%) and *Moringa oleifera* (7.71%). Crude protein more present in cassia tora (18.35%) than that of the *Moringa oleifera* (16.5%) and *Asparagus racemosus* (6.88). Ether extract content more present in *Cassia tora*(5.54%) than *Moringa oleifera*(2.5%) and *Asparagus racemosus*(2.14%). Total ash more present in *Cassia tora*(4.88%)and nitrogen free extract more present in *Asparagus racemosus* is about 69.52.

SUMMARY AND CONCLUSION

The detailed literature survey was done and it was found that the herbal pellets having nutritional value can be an interesting topic of research. Here nutritional pellets were prepared individually from *Cassia tora*, *Moringaoleifera* and *Asparagusracemosus* which having high nutritional profile and lower side effects. These herbal drugs are collected from DadasahebBalpande College of Pharmacy,Besa, Nagpur and authenticated from botany department Nagpur. Three batches of pellets were prepared of each drug extract and evaluated for its morphological, phytochemical, physicochemical and quantitative determination. Out of these three batches, batch F1gives best result than F2 and F3 batch. The nutritional profile of *Asparagusracemosus* contain high content of crude fibre (i.e 17.1) and *Cassia tora* has high content of crude proteins(i.e18.35).

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Table 1.

Sr.no.	Sample Extract	Solvent system	Detecting Agent
1.	Sample extract of <i>Cassia tora</i>	CHCL ₃ :CH ₃ OH (18:2)	Iodine vapours
2.	Sample extract of <i>Moringa oleifera</i>	1-butanol : methanol (9:5:0:5:0:5)	Methanol
3.	Sample extract of <i>Asparagus racemosus</i>	Ethylacetate : Methanol : Water (7:5:1:5:1 v/v)	Vanillin sulphuric acid reagent

Table 2. Formulation of *Cassia to rapellets* (extract)

Sr.	Ingredient	F1	F2	F3
1	<i>Cassia Tora</i>	4g	4g	4g
2	Mcc(Microcrystalline Cellulose)	0.7g	0.5g	0.4g
3	Talc	0.1g	0.2g	0.3g
4	Magnesium Sterate	0.2g	0.3g	0.3g
5	Total Weight(g)	5g	5g	5g

Table 3. Formulation of *Moringa oleifera pellets*(extract)

Sr. No.	Ingredients	F1	F2	F3
1.	<i>Moringa oleifera</i>	4g	4g	4g
2.	Mcc (Microcrystalline Cellulose)	.6g	0.5g	0.4g
3.	Talc	0.2g	0.1g	0.3g
4.	Magnesium Stearate	0.3g	0.4g	0.3g
5	Total Weight(g)	5g	5g	5g





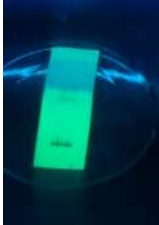
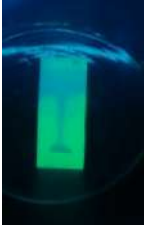
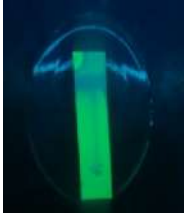
Table 4. Formulation of *Asparagus racemosus* pellets(extract)

Sr.No.	Ingredients	F1	F2	F3
1.	<i>Asparagus racemosus</i>	4g	4g	4g
2.	Mcc (Microcrystalline Cellulose)	0.5g	0.4g	0.3g
3.	Talc	0.2g	0.3g	0.4g
4.	Magnesium Stearate	0.3g	0.3g	0.3g
5	Total Weight(g)	5g	5g	5g

Table 5.Phytochemical Evaluation of Extract

Chemical test	<i>Cassia tora</i>	<i>Moringa oleifera</i>	<i>Asparagus racemosus</i>
Carbohydrate			
• Molisch test	+	+	+
• Fehlings test	+	+	+
• Benedict's test	+	+	+
Proteins			
• Biuret test	+	+	+
• Millions test	+	+	+
Saponinglycoside			
• Foam test	-	-	+
Tanninsand phenolic content			
• 5%ferric chloride solution	+	-	+
• Lead acetate test	+	+	+
• Bromine water test	+	-	+
• Acetic acid	+	-	+
• Potassium dichromate	+	+	-
Alkaloid			
• Dragandroff's test	+	+	+
• Mayer's test	-	+	-
• Hager's test	+	+	+
• Wagner's test	+	+	+

Table 6. Chromatographic evaluation of pellets

		
Fig. 1: <i>Cassia tora</i> Rf value = 0.75	Fig. 2 :<i>Moringa oleifera</i> Rf value = 0.75	Fig. 3 :<i>Asparagus racemosus</i> Rf value = 0.61





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Table 7. Morphological evaluation of pellets

Evaluation	 Fig. 4: <i>Cassia tora</i> extract Pellets	 Fig. 5: <i>Moringa oleifera</i> extract Pellets	 Fig. 6: <i>Asparagus racemosus</i> extract Pellets
Color	Yellowish Brown	Light Brownish	Orangish Brown

Table 8. Physicochemical evaluation of pellets

Sr. No.	Parameters	Crude drugs			Conclusion
		<i>Cassia tora</i>	<i>Moringa oleifera</i>	<i>Asparagus Racemosus</i>	
1.	Angle of repose	37	36	28	<i>Cassia tora</i> – fair property <i>Moringa oleifera</i> – fair property <i>Asparagus racemosus</i> – excellent property
2.	Bulk density	13	7.5	5.4	<i>Cassia tora</i> has highest bulk density than <i>moringa oleifera</i> & <i>asparagus racemosus</i>
3.	Tapped density	0.64	12	4.1	<i>Moringa oleifera</i> has highest tapped density than <i>cassia tora</i> & <i>asparagus racemosus</i>
4.	Carr’s index	40	31	23	<i>Cassia tora</i> – very poor property <i>Moringa oleifera</i> – very poor property <i>Asparagus racemosus</i> – passable property
5.	Hausner’s Ratio	1.6	1.46	1.31	<i>Cassia tora</i> - very poor property <i>Moriga oleifera</i> – very poor property <i>Asparagus racemosus</i> – passable property

Table 9. Particle size determination of pellets

Sr. no.	Name of pellets	Particle size determination
1.	<i>Cassia tora</i>	87.66µm
2.	<i>Asparagus racemosus</i>	109.34µm
3.	<i>Moringa oleifera</i>	89.44µm

Table 10. Nutritional evaluation of pellets

Sr. no.	Phytoconstituents	Result in %		
		<i>Cassia tora</i>	<i>Moringa oleifera</i>	<i>Asparagus racemosus</i>
1	Crude fibre	13.9	7.71	17.4
2	Crude Protein	18.35	16.5	6.88
3	Ether extract	5.54	2.5	2.14
4	Total ash	4.88	4.2	4.06
5	Nitrogen free extract	57.33	59.09	69.52





Prime Graceful Labeling on Some Graphs

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 06 Jun 2024

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ABSTRACT

One of the main topics of research in graph theory is graph labeling. A graph's labeling is the assignment of a number, under particular conditions, to a vertex (dots), edge (lines), or both. Important information about what the data in the graph represents is enhanced by the addition of labels. The literature defines a wide variety of labeling techniques. The most popular labeling patterns are graceful labeling, harmonious labeling, edge graceful labeling and so on. Our central focus in this paper is prime graceful labeling on shadow graphs, split graph, diamond graph, house graph, tetrahedral graph, tent graph.

Keywords: Prime labeling, Graceful labeling, Prime graceful labeling, Shadow graph and Split graph.

MSC 2010 :05C78

INTRODUCTION

Alexander Rosa initially proposed the graph labeling in 1967. α -labeling, β -labeling, and ρ -labeling are the three types of labeling that Rosa identified. Solomon Golomb later renamed β -labeling as "graceful" in 1972. More than 3000 studies have examined more than 200 graph labeling approaches throughout the internship years. A prime graceful labeling is a mathematical concept used in graph theory. Tout, Dabboucy, and Howalla invented prime labeling in 1982. While the prime graceful labeling was introduced by T.M.Selvarajan and R.Subramaniam. The study of prime graceful labeling contributes to a deeper understanding of graph properties and their mathematical structure. A graph G with p vertices and q edges is said to be prime graceful labeling, if there is an injection ϕ from





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the vertices of G to $\{1, 2, \dots, m\}$ where $m = \min(2p, 2q)$ such that $\gcd(\varphi(v_i), \varphi(v_j)) = 1$ induced injective function φ^* from the edge of G to $\{1, 2, \dots, m - 1\}$ defined by $\varphi^*(v_i v_j) = |\varphi(v_i) - \varphi(v_j)|$, the resulting edge labels are distinct. The labeling is considered "graceful" because it exhibits a harmonious distribution of labels across the graph's vertices, creating an aesthetically pleasing structure. Numerous fields, including coding theory, x-ray crystallography, communication networks, and others, use graph labeling. Prime graceful labeling finds application in various areas such as coding theory, network design and scheduling problems. In this paper we focus on prime graceful labeling which is a combination of both prime labeling and graceful labeling. The definition of both labeling are varied from each other

PRELIMINARIES

Definition 2.1

Let $G = (V(G), E(G))$ be a graph with p vertices. A bijection $f: V \rightarrow \{1, 2, \dots, p\}$ is called a prime labeling if for each edge $e = uv$, $\gcd(f(u), f(v)) = 1$. A graph which admits a prime labeling is called prime graph.

Definition 2.2

Let $G = (V(G), E(G))$ be a simple, finite and undirected graph with $|V| = p$ and $|E| = q$. An injective function $f: V \rightarrow \{1, 2, \dots, p\}$ is called graceful labeling of G if all the edge labels of G given by $f(uv) = |f(u) - f(v)|$ for every $uv \in E$ are distinct. A graph which admits a graceful labeling is called graceful graph.

Definition 2.3

A graph G with p vertices and q edges is said to be prime graceful labeling, if there is an injection φ from the vertices of G to $\{1, 2, \dots, m\}$ where $m = \min(2p, 2q)$ such that $\gcd(\varphi(v_i), \varphi(v_j)) = 1$ induced injective function φ^* from the edge of G to $\{1, 2, \dots, m - 1\}$ defined by $\varphi^*(v_i v_j) = |\varphi(v_i) - \varphi(v_j)|$, the resulting edge labels are distinct.

Definition 2.4

A connected graph G 's shadow graph $D_2(G)$ is created by making two copies of G , say G' and G'' , and joining each vertex V' in G' to the neighbors of the corresponding vertex V'' in G'' .

Definition 2.5

In order to obtain the split graph of a graph G , a new vertex V' must be added to each vertex V so that every vertex adjacent to V in G is adjacent to V' . $\text{spl}(G)$ represents the resulting graph.

MAIN RESULTS

Prime Graceful Labeling on some graphs :

Theorem 3.1

$D_2(C_n)$ admits prime graceful labeling.

Proof

The shadow graph $D_2(C_n)$ has $2n$ vertices and $4n$ edges.

$$\begin{aligned} m &= \min(2p, 2q) \\ &= \min(2(2n), 2(4n)) \\ &= \min(4n, 8n) \\ m &= 4n \end{aligned}$$

The vertices of $D_2(C_n)$ are labeled from the set $S = \{1, 2, 3, \dots, 4n - 1, 4n\}$. Choose an arbitrary vertex in $D_2(C_n)$ and label it with 1. Choose last two integers from the set S . i.e, $4n - 1$ and $4n$ label it to the adjacent vertices of vertex label 1. Choose the integers from the beginning of the set S and label with the vertex adjacent to the vertex $4n - 1$ or $4n$. So that the gcd of a two consecutive vertices is 1 and edge labels are distinct.

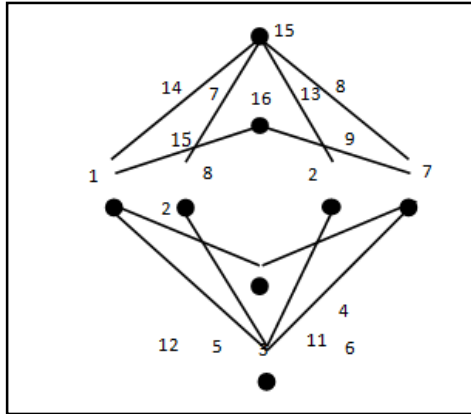




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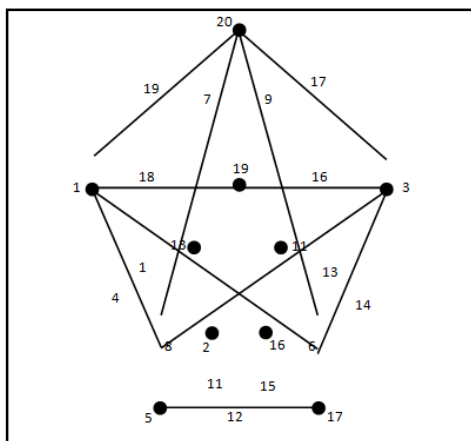
Example

Shadow graph of $D_2(C_4)$ is a prime graceful labeling.



Prime graceful labeling of $D_2(C_4)$

Shadow graph of $D_2(C_5)$ is a prime graceful labeling.



Prime graceful labeling of $D_2(C_5)$

Theorem 3.2

$D_2(K_{1,n})$ admits prime graceful labeling.

Proof

The shadow graph $D_2(K_{1,n})$ has $2n+2$ vertices and $4n$ edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(2n + 2), 2(4n)) \\
 &= \min(4n + 4, 8n) \\
 m &= 4n + 4.
 \end{aligned}$$

In $D_2(K_{1,n})$ two vertices are adjacent with remaining n vertices. Let us label the vertices of degree n with 1 and 2 and remaining with $3, 5, 7, \dots, 2n+2$. The gcd of the end vertices of each edge is 1. The edge labels $1, 2, 3, 4, \dots$ are distinct.

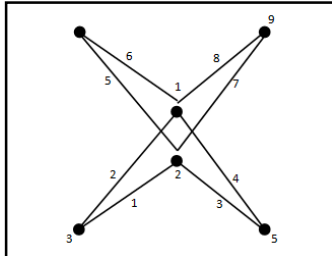




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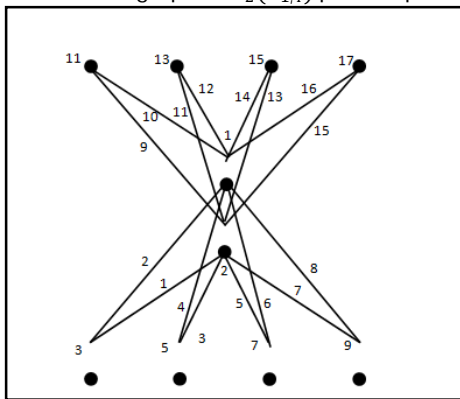
Example

The shadow graph of $D_2(K_{1,2})$ permits prime graceful labeling.



Prime graceful labeling of $D_2(K_{1,2})$

The shadow graph of $D_2(K_{1,4})$ permits prime graceful labeling.



Prime graceful labeling of $D_2(K_{1,4})$

Theorem 3.3

Diamond graph permits prime graceful labelling.

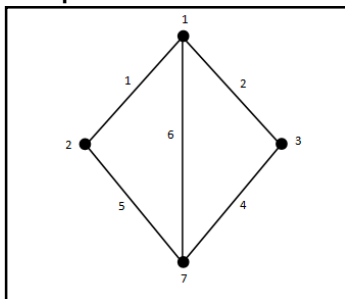
Proof

The diamond graph D is a planer undirected graph with 4 vertices and 5 edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(4), 2(5)) \\
 &= \min(8, 10) \\
 m &= 8.
 \end{aligned}$$

The vertices of the graph is labeled from the set $D = \{1,2,3,4,5,6,7,8\}$. Choose an arbitrary vertex in diamond graph and label it as 1. And label the other vertex by a prime number. So that the gcd of two consecutive vertices is 1 and edge labels are distinct.

Example





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Prime graceful labeling of Diamond graph

Theorem 3.4

House graph permits prime graceful labeling.

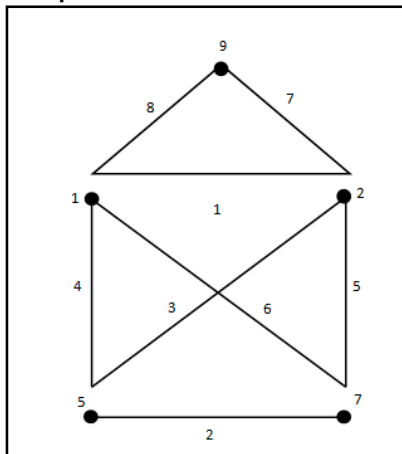
Proof

The house graph H is a simple graph with 5 vertices and 8 edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(5), 2(8)) \\
 &= \min(10, 16) \\
 m &= 10.
 \end{aligned}$$

The vertices of the graph is labeled from the set $H = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. Label the vertex, roof of the house graph H with 9 from the vertex set. And label the other vertices with prime number like 1, 3, 5, 7. So that the gcd of two consecutive vertices of each edge is 1 and resulting edge labels are distinct.

Example



Prime graceful labeling of House graph

Theorem 3.5

$Spl(K_{1,n})$ permits prime graceful labeling.

Proof

The $Spl(K_{1,n})$ contains $2n + 2$ vertices and $3n$ edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(2n + 2), 2(3n)) \\
 &= \min(4n + 4, 6n) \\
 m &= 6n.
 \end{aligned}$$

Label the vertex having degree $2n$ of $K_{1,n}$ with 1 and label the vertex having degree n with $(6n - 5)$. And label the remaining vertices with remaining numbers from the set $2, 3, \dots, 6n$. Hence the gcd of two adjacent vertices of each edge is 1. And then edges labels are $1, 2, 3, \dots, 6n$ are distinct.

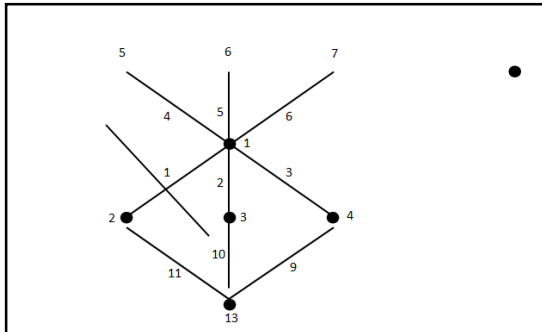
Example

The $Spl(K_{1,3})$ is a prime graceful labeling.



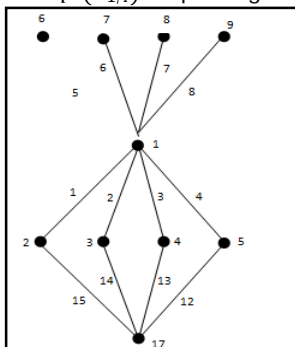


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Prime graceful labeling of $Spl(K_{1,3})$

The $Spl(K_{1,4})$ is a prime graceful labeling.



Theorem 3.6

Tetrahedral graph permits prime graceful labeling.

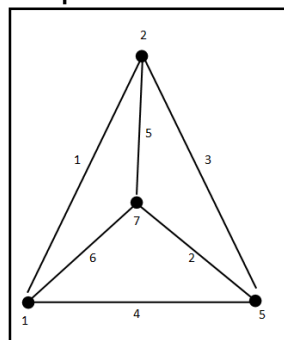
Proof

The tetrahedral graph, T is a graph with four vertices and six edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(4), 2(6)) \\
 &= \min(8, 12) \\
 m &= 8.
 \end{aligned}$$

The vertices of the graph is labeled from the set $\{1,2,3,4,5,6,7,8\}$. Label the center vertex of the graph with number 7 and labeling the remaining vertices with prime numbers from the set. Eg: 1,2,3,5. So that the gcd of a consecutive vertices is 1 and each edges are labeled with distinct numbers.

Example



Prime graceful labeling of Tetrahedral graph





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Theorem 3.7

Tent graph permits prime graceful labeling.

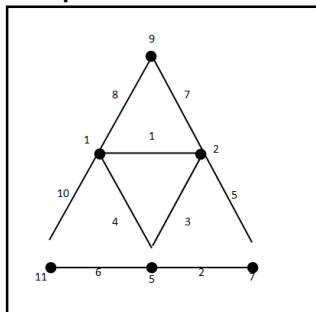
Proof

The graph is an undirected graph with six vertices and nine edges.

$$\begin{aligned}
 m &= \min(2p, 2q) \\
 &= \min(2(6), 2(9)) \\
 &= \min(12, 18) \\
 m &= 12.
 \end{aligned}$$

The vertices of the graph are labeled from the set $T = \{1,2,3,4,5,6,7,8,9,10,11,12\}$. Three vertices are of the degree four and the remaining three vertices are of degree three. The vertices with degree 4 are labeled by a prime number i.e., 1,2 and 5. The vertex with degree two are labeled by odd numbers i.e., 7,9 and 11. Hence the gcd of the any two adjacent vertices is 1 and each edges is labeled by distinct numbers from the set.

Example:



Prime graceful labeling of Tent graph

CONCLUSION

In this paper the concept of the prime graceful labeling and proof of the existence of prime graceful labeling for graphs such as shadow graph $D_2(C_n)$, shadow graph $D_2(K_{1,n})$, split graph $Spl(K_{1,n})$, diamond graph, house graph, tetrahedral graph, tent graph.

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An Eco-Friendly Biodegradable Spoon using Jackfruit Seed Powder

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Received: 28 Nov 2023

Revised: 10 Apr 2024

Accepted: 18 Jun 2024

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ABSTRACT

Plastic waste contributes to the major part of environmental pollution. In order to reduce the use of single use plastic this work has been conducted. Jackfruit is consider to cure various health issues. The raw material was collected and made into fine powder for further processing. The processed jackfruit flour was studied for both physical and functional properties. The conversion process allows the bio-degradable product to withstand the mechanical properties.

Keywords: Jackfruit seed powder, Bio-degradable, Cytotoxicity, Anti-microbial, NMR

INTRODUCTION

Plastic cutlery are produced in a large scale to meet the worldly demand of plastic utensils. About 350 million tons of plastic are produced every year world wide using the raw materials like coal, natural gas, salt and crude oil which as the great impact on environment and out of which India produces 3.4 million tons of plastic waste and only 30% of them are treated and recycled. Biodegradable plastic was one of the best alternative for plastic as they are produced using raw materials like vegetable oils and fat, corn starch, rice straw, recycled food waste and wood-chips. Bio-plastic are eco-friendly as they degrade completely when treated in a proper compost.

Sources used for biodegradable, edible Cutlery

The common food sources are basically used for production edible cutlery, some of the common raw materials include rice flour, wheat flour, corn flour, sorghum, millet and so on.





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Spoon making

The raw material and binding agent was collected and suspended in water. It is made by the method of casting or suspending the flour paste over the spoon mold and subject it to baking process. Spoon are commonly used for holding and handling the food particles. It can also be used to increase the nutritional value on bases of need, further can be developed into fork, chop sticks, plates, bowls, cups.

MATERIALS AND METHODOLOGY

Collection of the sample

The jackfruit is considered to be the largest fruit in India, and available almost in many places. It is consumed in both the form either raw or ripened. It has so many health benefits. The jackfruit seed was purchased online and then dried and made into fine powder. The binding agent gum acacia was also purchased on amazon. The binder is commonly used preparing food items to maintain the binding capacity, one of the examples include ladoo.

Preparation of sample

The jackfruit seed powder and the binder were treated using the drinking water in order to make them into a fine homogeneous mixture and the sample was casted over the mold and subjected to baking.

Phytochemical analysis

The sample plant extraction was subjected to both qualitative and quantitative analysis.

Preparation of the plant extract

The sample were extracted in two ways one was cold extraction where the sample was soaked in distilled water over night for aqueous extraction. The second is the heat extraction where the sample is subjected to heat along with the solvent ethanol, using the soxhlet and the temperature was set at 65°C. The extraction were used to study the phytochemical analysis for both qualitative and quantitative

Qualitative Analysis

Detection of alkaloid- The extract was treated with Dragendroff's reagent. Formation of red precipitate indicates the presence of alkaloids

Detection of carbohydrates- The extract was treated with 2 drops of alcoholic α -naphthol solution in a test tube. Formation of the violet ring at the junction indicates the presence of carbohydrates

Detection of glycosides- To 2ml of the extract, the glacial acid containing a drop of FeCl_3 is added in drops. Formation of brown colour ring indicates the presence of glycoside.

Detection of cardiac glycosides- The extract was treated with sodium nitropruside in pyridine and sodium hydroxide. Formation of pink to blood red colour indicates the presence of cardiac glycosides.

Detection of saponins- The froth test was done by diluting the sample with 20ml of distilled water and shaken in a cylinder for 15 minutes. Formation of 1cm layer of foam indicates the presence of saponins.

Detection of phytosterols- The extract were treated with chloroform and filtered. The filtrates were treated with few drops of conc. Sulphuric acid. The mixture was shaken and allowed to stand. Appearance of golden yellow colour indicates the presence of triterpenes.



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Detection of phenol- The sample was treated with few drop of ferric chloride solution. Formation of bluish black colour indicates the presence of phenols.

Detection of tannins- The gelatin solution containing sodium chloride was added to the extract. Formation of white precipitate indicates the presence of tannins.

Detection of flavonoids- The extract was treated with few drops of sodium hydroxide solution. Appearance of intense yellow colour, which becomes colourless on addition of dilute acid. Indicates the presence of flavonoids.

Detection of amino acid- The extract was treated with ninhydrin reagent and kept in the boiling water bath for few minutes. Appearance of blue colour indicates the presence of amino acid.

Detection of protein- The extract was treated with few drops conc. nitric acid. Formation of yellow colour precipitate indicates the presence of proteins.

Detection of diterpenes- The extract was treated with 3-4 drops of water. To which the copper acetate solution was added. Formation of emerald green colour indicates the presence of diterpenes.

Quantitative Analysis

Total tannin content determination- To 0.5ml of sample, 3ml of distilled water and 0.5ml of Folin's reagent was added. The extract was treated further with 0.5ml sodium carbohydrate and incubated for 10 minutes at room temperature. Absorbance read at 725nm

Total protein content determination- The sample was taken in an amount 0.1ml and made up-to 1ml using phosphate buffer. To which about 5ml of Bradford reagent was added. The absorbance read at 595nm

Total alkaloid content determination- To 1ml of the sample, 2ml of Dragendroff's reagent was added and centrifuged at 10,000 rpm for 10 minutes. After which thiourea is added to 1ml of the supernatant. The absorbance was read at 435nm

Total phenol content determination To 0.2ml of sample, 0.8ml of folin ciocalteu and 2ml of 7.5% sodium carbonate were added. Dilute the sample to 7ml using distilled water. Incubate the samples to dark for 2 hours. Absorbance read at 765 nm.

Total amino-acid content determination-0.2ml of the sample was made up-to 2ml using distilled water. To which 2ml of ninhydrin was added and placed on the water bath for 15minutes. After cooling to normal temperature add 3ml ethanol. The O.D was read under 570nm

Total steroid content determination- To 1ml extract, 2ml of sulphuric acid, 2ml of iron III chloride and 0.5 ml of potassium hexa cyanoferate III was added. Kept in water bath for 30 minutes. The O.D is read at 780nm.

Total flavonoid content determination- To 1ml of the sample, 4ml of distilled water, 0.3ml of sodium nitrite, 2ml of sodium hydroxide were added. The content was diluted in 10ml distilled water. And the absorbance was read at 510nm.



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Total terpenoid content determination- To 2.5ml of the extract, 2.5ml of phosphomolybdic was added. The content was incubated for 30 minutes, and then made upto 12.5ml using ethanol. Absorbance read at 700nm.

Total glycoside content determination- To 1ml of the extract, 4ml of alkaline picrate. was added. The content was boiled for 5 minutes. The absorbance was read at 490nm

Total carbohydrate content determination. The extract was treated with 5ml of anthrone reagent and mixed well. The tubes were incubated in boiling water bath for about 10 minutes. Absorbance was read at 620 nm.

Total saponin content determination- The 0.1g of freeze dried sample was diluted in methanol. To which 0.2ml of aliqurot was added for determination. After which 2.5ml of vanillin reagent and 2.5ml sulphuric acid was added to the content mixed well. Kept in water bath for about 10minutes. The content is cooled and then read at 544nm.

Preparation of the spoon

Jackfruit seed powder + acacia gum powder + water



Cast over the spoon mould



Baked at 120°C for 5-8 minutes

Anti-microbial testing

The product was tested against five different organisms to check for the potential of the product to withstand against the microbes. The MHA media was prepared in a sterile condition. All the glassware required were sterilized using autoclave. The media was poured onto the petri plates left to solidify and later streaked with the organisms. The sample were placed along the side with control Meropenem. Incubated overnight for about 24hrs, after which the result were studied.

Interaction with water

The stability of the product was tested by keeping the spoon immersed in both the hot as well as normal water and the changes occurring were noted periodically by checking the time at which it turns to be soggy. The spoons were soaked in two different beaker one having hot water and the other with normal water. The time was checked periodically to note down the stability of the spoon.

Fourier transform infrared

It is the most common type of spectroscopy that runs on the principle of infrared radiation. The IR passes through the sample and the observed radiation is recorded. The analysis was preformed to study the characteristics of the functional group present in the sample.

Nuclear mass resonance

The solid state NMR is basically used to study the structure of the compounds. It results in the orientation-dependent interaction. It runs on the principal of every magnetic spin is coupled to every other magnetic spin. The



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proton and carbon resonance frequencies were 400.07 and 100.61 MHz respectively. (Sundarraj, A.A., and Ranganathan, T.V., 2017). The sample was packed 4mm diameter zirconia rotor with Kel-F cap. Magic Angle Spinning (MAS) spectra of the sample were recorded at room temperature using a double resonance 4mm MAS probe, cross polarization or total side band suppression experiment was performed at a spinning speed of 5 kHz for the sample to get side band free spectrum. Typically, 1024 scans were acquired with a relaxation delay of 3.5s. The contact time of 3 ms and a H 90° pulse length of 4 μ s were used, SPINAL-64 decoupling sequence was used to decouple protons during the acquisition by employing radio frequency field strength of 83 kHz.

Tensile strength

The tensile strength were studied to check the period of elongation and the ability of the product to withstand the breaking force, breaking strength using the uni-axial tensile test (Perotto, G., et al 2018).

Chemical characteristics

Detection of lipid- 2 ml of the sample was taken in a test tube. To which few drops of Sudan black was added. Appearance of black colour indicates the presence of lipid

Anti-oxidant

It is to analyse the neutralizing chemicals that reduce the oxidative damage by reacting with the free radicals and letting them pass through without any harm to the biological system. About 20 μ l of sample extract was taken in an eppendorf. The extract was made up-to 40 μ l using DMSO and 2.96ml of DPPH(0.1mM). The mixture was incubated in dark at room temperature for 20 minutes. And the absorbance was read at 517nm for the sample using 3ml of DPPH as control

Cytotoxicity

The cells were maintained in minimal essential media in a humidified atmosphere of CO₂ at 37°C. 1 mg of sample dissolved in 1 ml of serum free MEM/DMSO. The stock is prepared fresh and filtered through 0.45 μ filter before each assay. Working concentration of the sample was prepared at the range between 1000 μ g - 7.8 μ g. Cells were plated in 24 well plates and incubated at 37°C with 5% CO₂. After incubation sample were removed from the well and washed using phosphate buffered saline or MEM was incubated for 4 hours. To which 1 ml of DMSO was added in all the wells. The absorbance was read at 570 nm with ELISA reader using DMSO as the blank

Bio-degradation analysis

The soil was taken out and a small size pit was made. The spoon was kept inside and covered with soil.

RESULTS AND DISCUSSION**Collection of sample**

The sample jackfruit seed powder was collected from the online mart. The jackfruit seed of 500kg was collected and acacia powder of 250kg was collected.

Preparation of sample

The sample jackfruit seed powder was mixed with acacia gum resin powder using drinking water and made into a homogeneous mixture.

Phytochemical extraction

The sample was extracted in both cold extraction, by overnight and heat extraction using soxhlet apparatus.





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Qualitative Analysis

The sample was checked for the presence alkaloid, carbohydrates, glycoside, cardiac glycoside, saponins, phytosterols, phenols, tannises, flavonoid, protein, amino acid, diterpes, are the result are tabulated below.

Quantitative analysis Table 2

Preparation of spoon

The spoon was prepared using the homogeneous mixture of the jackfruit seed powder, acacia gum and water. The mold was subjected to baking.

Anti-microbial Testing

The anti-microbial activities of jackfruit seed was evaluated by swab method against five different organisms, and found to be positive. The sample showed zone of clearance for *E.coli* 10 mm, *Aspergillus* species 14 mm, *Pseudomonas* species 6 mm. *Streptococcus* species and *Staphylococcus* species were found to be negative. The results were similar to the studies reported by (Thevivasanthi, T., et al 2011)

INTERACTION WITH WATER

The spoon was kept immersed in the hot and normal (chill) water and results were found to be positive.

Fourier transform infrared

The sample jackfruit seed was analyzed for FTIR spectrum. The peak for the functional group was obtained. The result was similar to the study obtained using nano sized powder of jackfruit seed. (Thevivasanthi, T., et al 2011).

Nuclear mass resonance

The sample jackfruit seed was subjected to C13 solid state NMR, the proton and carbon resonance frequencies were 400.07 and 100.61 respectively. The result obtained was similar to the study done using jackfruit peel. (Sundarraaj, A.A., and Ranganatham, T.V., 2017).

Tensile strength.

Tensile strength is the maximum force material can withstand when being stretched with full force. Width of the spoon was found to be 10 mm. The breaking force of the sample is 4.45 kgf, breaking strength is 4.36 mm, the extension at break is 3.85%. The work is similar to the work reported, using a universal testing machine for the bio-film produced. (Perotto, G., et al 2018)

Chemical characteristics

Detection of lipid:

The sample was tested for the presence of lipid and to be positive

Anti-oxidant

The sample was tested for anti-oxidant property and found to be 19.4%.

$$\% \text{RSA} = \frac{b_{oto} - b_{ape}}{b_{oto}} \times 100$$

Cytotoxicity

The sample was tested for cytotoxicity property and found to be 75.6%. This work is similar to the study reported for toxicity using jackfruit seed. (Efendi, K., et al 2020).

$$\begin{aligned} \% \text{ Cell viability} &= \text{A570 of treated cells} / \text{A570 of control cells} \times 100 \\ &= 0.09 / 0.119 \times 100 \\ &= 75.6\% \end{aligned}$$





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Bio-degradation testing

The sample was kept inside the soil and tested for degradation time. The time taken for the spoon to degrade was 3 weeks.

CONCLUSION

The sample of jackfruit seed powder was collected. The sample and binder was taken in correct proportion and mixed with drinking water. The homogeneous mixture was then applied on the spoon mold by applying oil, to avoid stickiness. Then the mold with sample was subjected to baking for about 5-8 minutes at 200°C. A proper spoon was made. A water absorbance test was done and the spoon was able to withstand in hot water for 20 minutes and 25 minutes in normal chill water. The spoon was further subjected to anti-microbial, anti-oxidant, and cytotoxicity. Characteristics of the spoon were analyzed through FTIR, NMR. At last the bio-degradation time for the spoon was tested by burying the spoon in soil and it took completely 3 weeks to degrade.

ACKNOWLEDGEMENT

We extend our heartfelt thanks to Dr. Anitha R. J. Singh, Dr. Anchana Devi and Dr. Preethi Jeyakumar for their wholehearted support. We also thank Dr. Lillian I. Jasper, the Principal of Women's Christian College for providing this opportunity. We would finally like to thank our families and friends for their support.

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Table 1 - Qualitative analysis

Sample	Aqueous extraction	Solvent extraction
Alkaloids	Positive	Positive
Carbohydrates	Negative	Positive
Glycoside	Positive	Positive
Cardiac glycoside	Negative	Positive
Saponins	Positive	Negative
Phytosterols	Positive	Negative
Phenols	Negative	Positive
Tannins	Positive	Positive
Flavonoid	Negative	Positive
Protein and amino acid	Negative	Positive
Diterpenes	Positive	Positive





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Table 2 - Quantitative Testing

Sample	Aqueous extract	Solvent extract
Tannin	0.13 ± 0.02	0.14 ± 0.021
Amino acid	0.086 ± 0.014	0.081 ± 0.070
Alkaloid	16.7 ± 0.16	15.2 ± 0.035
Flavanoid	4.08 ± 0.13	4.01 ± 0.212
Protein	20.10 ± 0.22	18.00 ± 0.0282
Phenol	0.31 ± 0.014	0.31 ± 0.014
Glycoside	0.445 ± 0.007	0.41 ± 0.141
Anthrone	0.81 ± 0.007	0.80 ± 0.007

Table 3 - Anti-microbial analysis

Organisms	Zone of clearance
<i>E.coli species</i>	Positive (10 mm)
<i>Aspergillus species</i>	Positive (14 mm)
<i>Pseudomonas species</i>	Positive (6 mm)
<i>Streptococcus species</i>	Nil
<i>Staphylococcus species</i>	Nil

Table 4 - Water absorbency test

Time in minutes	Nature of sample	
	Hot water	Normal (chill) water
0 minutes	Rigid and strong	Rigid and strong
10 minutes	Rigid and firm	Rigid and firm
20-25 minutes	Soggy	Soggy

Table-5 FTIR Functional group analysis

Functional group	Wave number (cm-1)	Intensity
C-Cl γ + C-S γ + O-N γ + N-H ω + N-H τ + OCN(deformation) + C-O-C γ + C-H β	762.24059	66.19405
CH β + C-O-C γ + N-H ω + N- H τ + C-N γ + O-N γ + S=O γ	840.51468	72.24447
Ring γ + CH β + O-H β + N-N γ + N-O γ	997.06287	45.85308
C-H α + C-O-C γ s + C-CO-C (skeletal) + C-CHO (skeletal) + C-N γ + N-N γ + S=O γ + C-F γ	1075.33697	56.68239
C-H α + C-O-C γ s + C-CO-C (skeletal) + C-CHO (skeletal) + C-O γ + NH ₃ + α + N ₃ γ s + SO ₂ γ s + C-F γ	1146.15638	67.97246
CH ₂ β + C-H α + C-O-C γ as + C-CO-C (skeletal) + C-CHO (skeletal) + NH ₃ + α + N=O γ + N ₃ γ s + SO ₃ γ as	1243.06717	78.73792





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CH ₃ δ (vibrations) + CH ₂ δ (vibrations) + O-H α + C-O γ + C-CHO (skeletal) + COO - γ _s + C-N γ + NO ₂ γ _s + SO ₂ γ _{as} + C=S γ	1377.25133	76.76608
CH ₃ δ _s + C-O γ + OH α + C-CHO (skeletal) + COO - γ _s + NO ₂ γ _s + N=O γ + C=S γ + C=F γ	1421.97938	77.12969
CH ₃ δ _s + C-O γ + OH α + C-CHO (skeletal) + COO - γ _s + NO ₂ γ _s + N=O γ + C=S γ + C=F γ	1459.25276	79.1241
C=C γ + C=O γ + COO - γ _{as} + N-H α + δ _{as} NH ₃ ⁺ + NO ₂ γ _{as}	1541.25420	81.70608
C=C γ + C=O γ + NH α + δ _{as} NH ₃ ⁺ + NO ₂ γ _{as} + N-O γ	1626.98297	77.01026
C=C γ + C=O γ + NH α + δ _{as} NH ₃ ⁺ + NO ₂ γ _{as} + N-O γ	1744.39411	84.55581
CH ₂ γ + N-H γ + O-H γ (- SO ₂ H)	2857.00445	79.29054
CH ₃ γ + CH ₂ γ _{as} + CH ₂ γ _s + CH γ _s + Conjugate Chelation	2925.96020	73.28743
N-H γ _{as}	3281.92097	73.12859

Table 6 - Nuclear mass resonance spectroscopy

Compounds	Assignments	ppm (Chemical shift)	Carbon environment	Functional group
Methylhexadec-9-enoate	C ₁₇ H ₃₂ O ₂	21.8		
Hexadecanoic acid, ethyl ester (CAS)	C ₁₈ H ₃₆ O ₂	24.9		
Eicosane,7-hexyl-	C ₂₆ H ₅₄	31		
Betulin	C ₃₀ H ₅₀ O ₂	34.1		
n- Butylamine	CH ₃ CH ₂ CH ₂ CH ₂ NH ₂	41.4	Alkyl Chlorides (RCH ₂ Cl); (40 - 45 ppm)	Alkyl group and Sp ³ Hybridization
Methoxide	CH ₃ O	55.1	Methanamine or amide (RCH ₂ NH ₂); (30 - 65ppm)	Alkyl or Aryl group and Sp ³ Hybridization
Methanol	CH ₂ OH	62.9	Primary Alcohol (RCH ₂ OH); (60 - 70 ppm)	Carbon bearing OH group and Sp ³ Hybridization
1,2-dimethoxyethane	CH ₃ OCH ₂ CH ₂ OCH ₃	73.1	Alkynes (R- C≡C-R); (65 - 85 ppm)	Alkyl group and Sp Hybridization
1,2-propene		74.6		
1,2-propene		76.5		
Hexane	CH ₃ [CH ₂] ₄ CH ₃	82.8	Trans - Alkene (RCH=CHR); (120 - 140 ppm)	Alkyl (or aromatic) group attached to a carbonyl function and Sp ² Hybridization








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Hexane	$\text{CH}_3[\text{CH}_2]_4\text{CH}_3$	102.3	Trans - Alkene (RCH=CHR); (120 - 140 ppm)	Alkyl (or aromatic) group attached to a carbonyl function and Sp ² Hybridization
Hexane	$\text{CH}_3[\text{CH}_2]_4\text{CH}_3$	103.9	Trans - Alkene (RCH=CHR); (120 - 140 ppm)	Alkyl (or aromatic) group attached to a carbonyl function and Sp ² Hybridization
Hexane	$\text{CH}_3[\text{CH}_2]_4\text{CH}_3$	102.3	Trans - Alkene (RCH=CHR); (120 - 140 ppm)	Alkyl (or aromatic) group attached to a carbonyl function and Sp ² Hybridization

Table 7- Tensile strength analysis

	Breaking force [kgf]	Breaking strength [N/mm]	Extension at break [mm]	Extension at break (%) [%]	Width [mm]	Direction	Sample description
1	2.11	2.07	10.93	10.93	10.00	Warp	Film
2	5.81	5.70	1.26	1.25	10.00	Warp	Film
3	7.04	6.90	0.95	0.92	10.00	Warp	Film
4	2.83	2.78	2.31	2.31	10.00	Warp	Film
Mean	4.45	4.36	3.86	3.85	10.00		

		
Figure 1 Collection of the sample	Figure 2 Collection of the sample	Figure 3 Cold extraction





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<p>Figure 4 Soxhlet set up</p>	<p>Figure 5 Solvent extraction</p>	<p>Figure 6 Jackfruit seed powder</p>
<p>Figure7 Zone of inhibition against <i>E.coli</i> species 10mm</p>	<p>Figure 8 Zone of inhibition against <i>Aspergillus</i> species 14mm</p>	<p>Figure 9. Zone of inhibition against <i>Pseudomonas</i> species 6mm</p>
<p>Figure 10 During immersion</p>		<p>Figure 11 After immersion</p>





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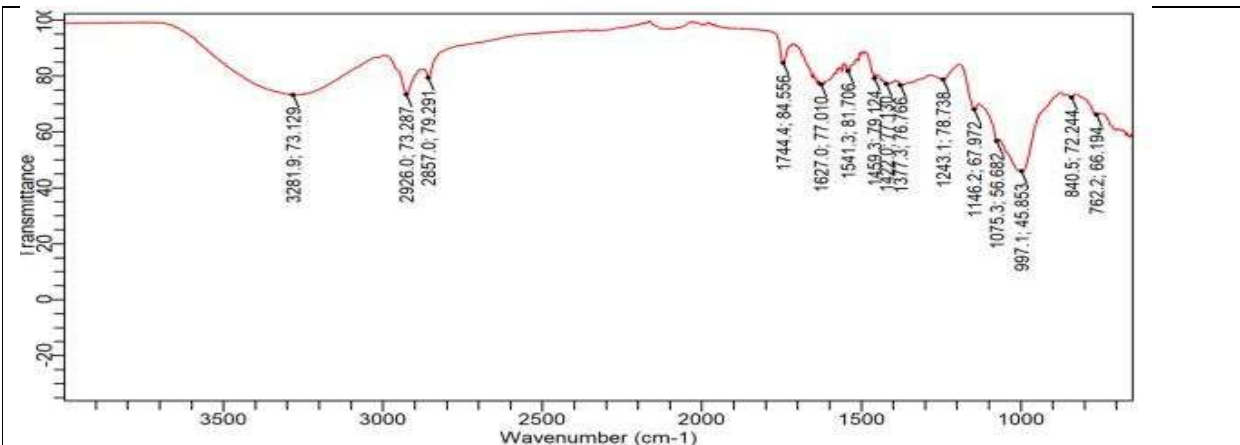


Figure 12. Fourier transform infrared

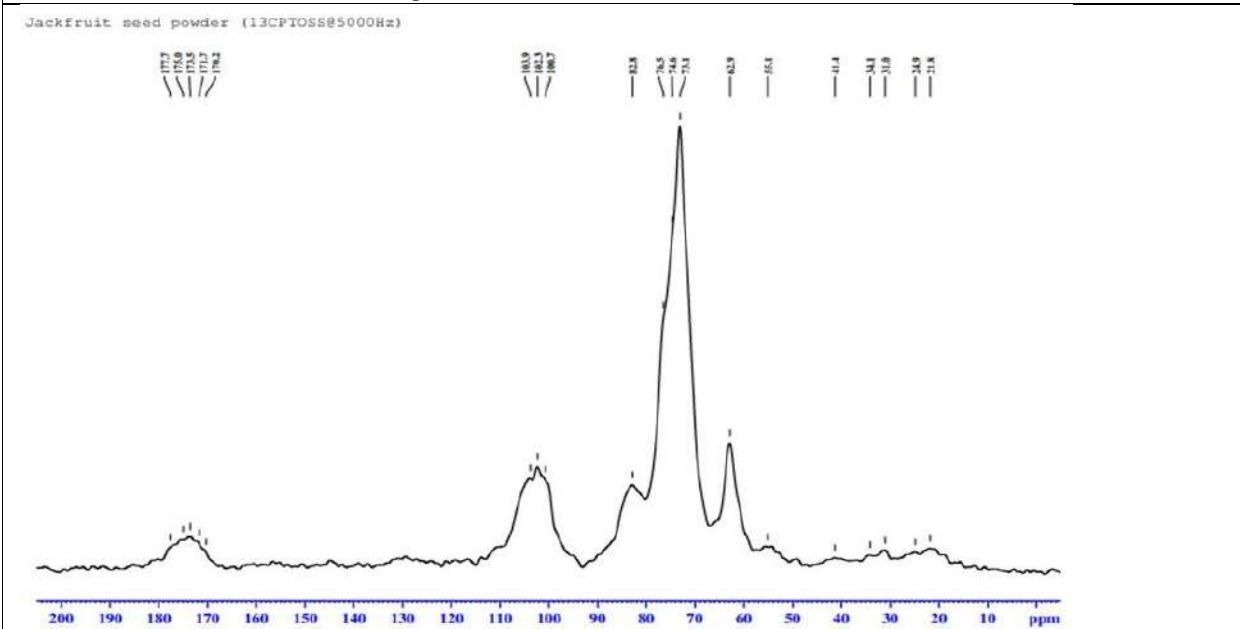


Figure 13. Nuclear mass resonance:





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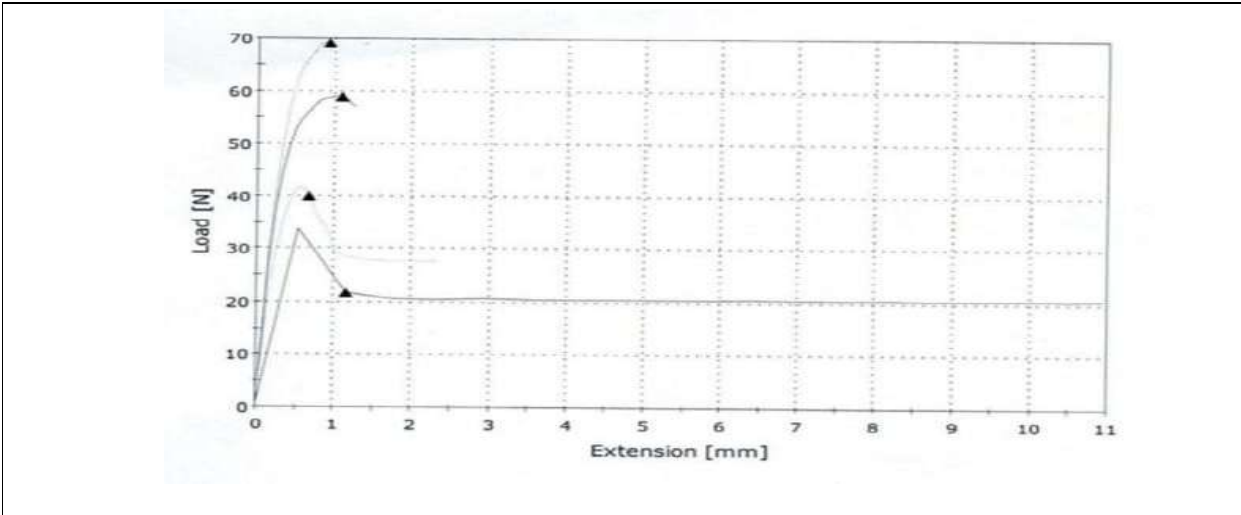


Figure 14. Tensile strength

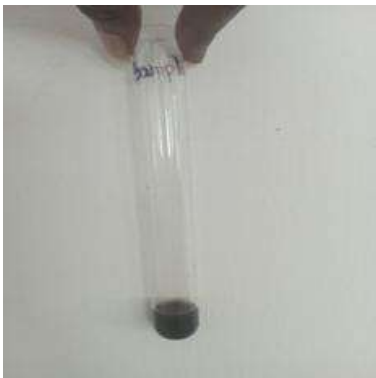


Figure 15. Presence of lipid



Figure 16. Before degradation



Figure 17. After degradation





Problems and Challenges Faced by the Farmers in using Biofertilizers: A Study of Birbhum District of West Bengal

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Received: 20 Feb 2024

Revised: 09 Mar 2024

Accepted: 18 Jun 2024

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ABSTRACT

In this article, the researcher has tried to bring the notice on "Problems and Challenges faced by the Farmers in using Biofertilizers: A Study of Birbhum District of West Bengal." Researchers conducted the study in the three blocks of Birbhum district of West Bengal. The sample size for this research was 150 including both male and female farmers. The researcher has used a questionnaire as a tool for data collection in his research. Questionnaire was divided into three main parts: - 1. General section (includes general information about farmers) 2. Chemical fertilizer (awareness and use by the farmers) 3. Biofertilizer (awareness and use by the farmers). Findings of this research are; people are more aware about using chemical fertilizer than bio-fertilizer. Here, chemical fertilizers were easily available as compared to biofertilizers and only a few of the biofertilizers were used by a lesser number of farmers. In this research the participation of male farmers is higher in overall sample and very lesser farmers having soil test card means not interested for soil health checkup.

Keywords: Problems, Challenges, Bio fertilizer, Chemical fertilize.



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INTRODUCTION

Agriculture plays a pivotal role in the growth and survival of nations in maintaining its quantity and quality is essential for feeding the population and economic exports. Over the years, agriculture has undergone various scientific innovations in order to make it more efficient (Ajmal et al., 2018). Modern agriculture involves the usage of pesticides and chemical fertilizers with an essence of increasing the world's food production, as these serve as fast food for plants causing them to grow more rapidly and efficiently. Continuous use of chemical fertilization leads to the decay of soil quality and fertility and might lead to the collection of heavy metals in plant tissues; affecting the fruit nutritional value and edibility (Farnia et al., 2015) from long time, the chemical pesticides and fertilizers have played a vital role in improving agricultural production. Although they have a short history in modern agriculture, their instant action and low cost managed to bring them quickly into the center of attention. Thus, their adverse effects on the environment, plant, animal and human life have diverted the priority to eco-friendly plant protection (Patel et al., 2014). Agriculture is the primary source of human nutrition, and rapid human population growth has led to the extreme intensification of agricultural systems. To address the increasing yield demand with a decrease in available agricultural land, farmers practicing conventional agriculture have been compelled to apply continually higher doses of harmful chemical fertilizers and pesticides (Foley et al., 2011). Soil pollution, particularly, that is caused by the excessive application of fertilizers and pesticides, has been identified as a priority that requires resolution within the next decade (Wardle et al., 2004). One of the present-day challenges in agriculture is eco-friendly practices. While the benefits of the green revolution have been reaped by us in terms of production, the other side of it, i.e., over usage of chemical fertilizers and its subsequent deterioration of soil health, has been realized these days. Hence, awareness of practicing organic agriculture has been taken to various spheres and products of organic agriculture are fetching up huge market. One of the organic agriculture practices includes the usage of biofertilizers in farming. Biofertilizers are likely called bioinoculants as they are the preparations containing living or latent cells of microorganisms that facilitate crop plants uptake of nutrients by their interactions within the rhizosphere once applied through seed or soil. Agriculture continues to be a main occupation for the livelihoods of rural people.

REVIEW OF RELATED LITERATURE

The term "Biofertilizers" or more appropriately "microbial inoculant" can be generally defined as preparations containing live or latent cells of efficient strains of nitrogen-fixing, phosphate solubilizing or cellulolytic microorganisms used for application to seed, soil or composting areas with the objective of increasing the numbers of such microorganisms and accelerating certain microbial processes to augment the extent of the availability of nutrients in a form which can be easily assimilated by plants. (Dogra, R. C., & Dudeja, 1993) added also that, in a larger sense, the term may be used to include all organic resources (manures) for plant growth which are rendered in an available form for plant abstraction through microorganisms or microorganisms plant associations or interactions. Recently, (SubbaRao et al., 1999) mentioned that biofertilizers are carried based preparations containing beneficial microorganisms in available state intended for seed or soil application and designed to improve soil fertility and help plant growth by increasing the number and biological activity of desired microorganisms in the root environment. Biofertilizers are ecofriendly and cannot at any rate replace chemical fertilizers that are indispensable for getting maximum yield from crops. In general, biofertilizers are environmentally friendly, low-cost agricultural inputs with maximum output. These biofertilizers are to play an important role in enhancing crop productivity through nitrogen fixation, phosphate solubilization, plant hormone productivity, ammonia excretion, siderophore formation and to control various plant disease (Tiwari et al., 1990). Agriculture is the primary source of human nutrition, and rapid and ever-increasing human population growth has led to the extreme intensification of agricultural systems. To address the increasing yield demand with a decrease in available agricultural land, farmers practicing conventional agriculture have been compelled to apply continually higher doses of harmful chemical fertilizers and pesticides (Foley et al., 2011). Soil pollution, particularly, that is caused by the excessive application of fertilizers and pesticides,



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has been identified as a priority that requires resolution within the next decade (Wardle et al., 2004). In other words, there is much concern to further preserve environmental integrity and public health through the use of less intensive and more sustainable agricultural practices by reducing the inputs of chemical fertilizers, pesticides, and energy demand in general (Gomiero et al., 2011) (Pineda et al., 2010). Although mycorrhizal fungi and arbuscules have long been acknowledged to increase plant growth, (Van der Heijden et al., 2008), more recent evidence highlights the roles of plant growth-promoting rhizobacteria, root endophytic fungi, and plant growth-promoting fungi for increasing plant performance (Compant et al., 2005). Therefore, integrating beneficial microorganisms as biofertilizers is attracting growing interest in sustainable agriculture (Javaid et al., 2010). Numerous studies have additionally demonstrated that the association with soil-containing microbes can increase the resistance of plants against below-ground attack, such as that caused by soilborne fungi, bacterial pathogens, and nematodes, or aboveground herbivore attack and shoot pathogens (reviewed in Azcón-Aguilar and Barea, 1996; Pozo and Azcon-Aguilar, 2007; Pineda et al., 2010). Agriculture plays a pivotal role in the growth and survival of nations; therefore, maintaining its quantity and quality is essential for feeding the population and economic exports. Over the years, agriculture has undergone various scientific innovations in order to make it more efficient (Ajmal et al., 2018).

Modern agriculture involves the usage of pesticides and chemical fertilizers with an essence of increasing the world's food production, as these serve as fast food for plants causing them to grow more rapidly and efficiently. Continuous application of chemical fertilization leads to the decay of soil quality and fertility and might lead to the collection of heavy metals in plant tissues, affecting the fruit's nutritional value and edibility (Farnia and Hasanpoor, 2015). Hence, in recent years, many organic fertilizers have been introduced that act as natural stimulators for plant growth. A particular group of organic fertilizers includes outcomes based on plant growth-promoting microorganisms identified as 'Biofertilizers'. These biofertilizers comprise efficient strains of nitrogen fixing or phosphate solubilizing microorganisms. Organic farming has appeared as a prime concern area globally in aspect of the growing demand for safe and healthy food, durable sustainability and issues on environmental pollution associated with random use of agrochemicals (Ghany et al., 2013). The intensive agricultural farming system as practical in Egypt, where the crop rotation consists of 2 or 3 crops per year, are main reasons for the high consumption of chemical fertilizers. Intensive methods of farming and food production are having unfavorable consequences on the quality of food, the environment and on animal and human health. In these systems, agriculture is treated like other industries, with an emphasis on efficiency and maximum productivity regardless of their impacts on human health and ecology. The amount of nitrogen applied to the soil in intensive agricultural systems varies considerably, depending upon the crop being grown, the soil type, and the previous cropping history of the soil. Nowadays, the harmful effects on the environment of heavy use of N-fertilizers are becoming more evident. Furthermore, the fossil fuels which are used in the production of N-fertilizers are becoming scarcer and more expensive. Therefore, there is a great need to search for all possible avenues to improve biological nitrogen fixation and its use by farmers through bio-fertilization process (Hussein et al., 1997).

Objective of the study- To find out the awareness and usage of biofertilizers and chemical fertilizers among farmers.

MATERIALS AND METHODS

Methods: - Survey and Experiments were used for Research.

Sampling: -Survey and Soil samples were collected from three different blocks of three sub – divisions of Birbhum District; namely: -

- Muhammad Bazar Block representing Suri Sub - division
- Bolpur- ShantiniketanBlock representing Bolpur Sub - division
- Rampurhat- IBlock representing Rampurhat Sub - division

The Birbhum District is situated between 23° 32' 30" (right above the tropic of cancer) and 24° 35' 0" north latitude and 87° 5' 25" and 88° 1' 40" east longitudes, and about 4,545 square kilometres (1,755 sq. mi) in area, this district is triangular. River Ajay forms the southern base and the apex of the triangle points north. The river forms the



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boundary between the districts of Birbhum and Bardhaman. The state of Jharkhand is at the northern and the western border of Birbhum and Murshidabad is at the east. Soil samples collected from three different agriculture fields from the rhizosphere region for physico-chemical analysis and pot experiment were laid out in order to study the impact of chemical and biofertilizers on the soils of three Blocks of the district covered to study the effect on growth of crop. Soil samples were collected at 15 cm depth and aseptically placed in the polythene bags, and transported immediately to the laboratory for the analysis of Physico-chemical properties like pH, EC, Organic carbon, and portion of soil was given to soil testing laboratory of agriculture deptt. Surfer for the test of N, P, K analysis. The Pot experiment was also established to study the effect of different types of chemical and biofertilizers on the germination and growth of Mung bean in plastic pots filled with different districts, soils covered under study. The above mentioned experiments were conducted in the Education Department laboratory at Vinaya Bhavana, Visva – Bharati University, Shantiniketan, India.

Tools: - A Questionnaire was used as a tool for research which was prepared researcher. Before using the tool reliability and validity was checked by the researcher.

The questionnaire was divided into three main parts

1. General section: - includes general information of farmers.
2. Chemical fertilizer, awareness and use: - by farmers of different districts.
3. Biofertilizer, awareness and use: - by farmers of different districts.

RESULTS AND DISCUSSION

In table-1: showing the survey data of farmers by gender, age and soil test. Total sample taken was 150, which contains 50 farmers from each considered block from the three Blocks of Birbhum district, of which 84% were Male and 16% were Female from Muhammad Bazar Block. Similarly, 76% were Male and 24% were Female from Bolpur-Shantiniketan Block and from Rampurhat-I Block; 64% were Male and 36% were Female farmers. So, it concludes that participation of males was higher in the overall sample. In age group of range 20-40; 40-60 and above 60 shown in table-2 indicated, 36% of 20-40 age group, 56% of 40-60 age group, 8% of above 60 ages from Muhammad Bazar Block were doing farming; Similarly, 30%, 60% and 10% of respective age groups in Bolpur-Shantiniketan Block were farmer and from Rampurhat-I Block 40%, 45% and 10% of different age group were farmer which reveal that major age group of 40-60 age people were more as compared to other two age group. From table-1, it can be concluded that soil test performed in Muhammad Bazar Block; in which 90% people responded "No" and only 10% responded "Yes" and in Bolpur-Shantiniketan Block 84% responded "No" and only 16% responded "Yes"; similarly, in Rampurhat-I only 12% responded "Yes". Hence concluded that very lesser farmers having soil test card means not interested for soil health checkup. The data depicted in Table-2 indicated that awareness about using of chemical fertilizer was 92% in Muhammad Bazar Block, 88% in Bolpur-Shantiniketan Block and 96% in Rampurhat-I Block; beside this use and awareness about biofertilizer was 4% in Muhammad Bazar, 12% in Bolpur-Shantiniketan and 4% in Rampurhat-I which was very less in number out of overall sample. Hence, found that all three blocks were more aware about using chemical fertilizer than biofertilizer. It is seen from the table-3 that the chemical fertilizers used locally in Muhammad Bazar Block mostly; Urea, Dap (di-ammonium phosphate), Bolpur-Shantiniketan Block usually; Urea, Dap, SSP (single super phosphate) and in Rampurhat-I Block; NPK, Urea, Dap, Potash is used. Similarly, In Muhammad Bazar Block Vasundhara, Bhu-shakti in Bolpur-Shantiniketan Block Rhizobium, PSB (phosphate solubilizing bacteria), Azotobacter and in Rampurhat-I Block Rhizobium, Trichoderma were some of the biofertilizers used by less number of farmers.

CONCLUSION

In developing countries, the most important challenge is to produce sufficient food for the growing population from inelastic land areas. In modern agriculture, due to heavy usage of chemical fertilizers and harmful pesticides on the



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crops, sustainability of the agriculture system collapsed, cost of cultivation soared at a high rate, income of farmers stagnated, and food security and safety became a challenge. Chemical fertilizer has very toxic effects on soil properties chemical pesticides and the unavailability of organic manures have led to considerable reductions in soil health. Biofertilizers are becoming increasingly popular in many countries and for many crops. Often organic food is included to help the microbes get established. In India, soil fertility is diminishing gradually due to soil erosions, loss of nutrition, and accumulation of toxic elements, water logging and unbalanced nutrient compensation. Organic manure and biofertilizers are the alternate sources to meet the nutrient requirements of crops. The role of biofertilizers in agriculture production is of great importance. But farmers are not aware of the toxic effects of chemical fertilizer on soil and the benefits of using biofertilizers and its productivity; lack of knowledge and availability from nearby sources, and also the cost is another obstacle to use biofertilizer by farmers in place of chemical fertilizers. So, there is a need to enhance the knowledge and skill about use and benefits of using biofertilizer and about policies and subsidies related to use of biofertilizers by government.

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Table: 1 Data of gender, age and soil test card of selected sample

Particulars	Muhamad Bazar		Bolpur-Shantiniketan		Rampurhat - I		Total (No.)
	No.	%	No.	%	No.	%	
Gender							
Male	42	84	38	76	32	112	64
Female	8	16	12	24	18	38	36
Age							
40-20	18	36	15	30	20	53	40
40-60	28	56	30	60	23	81	46
Above 60	4	8	5	10	7	16	14
Soil Test card							
Yes	5	10	8	16	6	19	12
No.	45	90	42	84	44	131	88

Table 2 - Use and awareness about the type of fertilizer

Fertilizer Type	Muhammad Bazar Awareness and Use		Bolpur-Shantiniketan Awareness and Use		Rampurhat-I Awareness and Use		Total No.
	No.	No.	%	%	No.	%	
Chemical	46	44	92	88	48	96	138
Biofertilizer	4	6	8	12	2	4	12

Table 3: Types of Chemical fertilizers and biofertilizers used locally

Fertilizer Type used Locally	Muhammad Bazar	Bolpur-Shantiniketan	Rampurhat-I
Chemical	Urea; Dap mostly	SSP ;Dap ;Urea	;Dap ;Urea ;NPK Potash
Biofertilizer	Vasundhara,Bhu-shakti	phosphate)PSB ;Rizobiumsolutubilizing ;(bacteria Azotobacter	Rizobium; Trichoderma





Cost-Effective Real-Time Agri-Environment Monitoring System based on Esp-32"

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 04 Jul 2024

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ABSTRACT

This paper presents the development and working prototype based on ESP-32 for real-time monitoring of diverse agri-environmental variables using cost-effective sensors. Temperature, humidity, CO₂, light intensity, and rainfall are continually monitored using this system, which enables easy analysis and preventive actions for unfavourable conditions. Different sensors acquire data and broadcast it through the internet. The system is reliable and cost-effective for real-time monitoring of Agri-environment parameters.

Keywords: ESP-32, MQ-135, DHT22, LDR, Rain Sensor-KG004, IoT.

INTRODUCTION

The Earth's environment determines all living beings' health and long-term viability. Temperature, humidity, and air quality are examples of physical environment variables. Quality light and rain considerably impact health, lifestyles, and surrounding factors. These are also related to several aspects of the environment. Human health is intertwined with agri-environmental health. From various perspectives, habitat for safe living is critical, and its monitoring cannot be overstated [1]. When nations locked down and economies paused, CO₂ emissions decreased by a historic 1.9 billion tonnes in 2020, a 5.4% decrease. The World Carbon Project's research predicts that emissions will have increased by 4.9% in 2021. The study estimated that 36.4 billion tonnes of CO₂ would be emitted globally [1][2]. Worldwide, intercontinental travel and ozone-induced hemisphere air pollution put agricultural and natural



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ecosystems in danger and significantly impacted climate. Globally dispersed aerosols have a significant regional imbalance that alters the environment through direct and indirect radiative forcing effects [3]. Apart from that, the issues mentioned earlier significantly impact agriculture and associated fields. Temperature, humidity, air pollution, light intensity, and rain are all studied using conventional methods, which take longer, cost more and are frequently inaccurate. Furthermore, such monitoring may not be carried out on a single platform. As mobile communication networks have expanded into rural areas, real-time monitoring of environmental variables, including temperature, humidity, air pollution, light intensity, and rain, has been an economically and technologically viable option. Suppose the ecological characteristics are effectively monitored using an integrated system. In that case, it will have a wide range of applications, including agriculture, for monitoring crop health and helping make more straightforward decisions for better yields.

The Internet of Things (IoT) is rapidly growing, enabling the creation of intelligent environments, bright cyber worlds, and innovative applications [4]. The number of connected IoT devices is increasing from 9 % to 12.3 % billion globally, and cellular IoT is now surpassing the 2 billion mark [5]. This advancement is due to wireless devices, which have given rise to the Internet of Things (IoT) and allow systems to be connected and data to be communicated between them. The ability of IoT to be used for continuous observation is one of the reasons for its recent growth and appeal. This is the cornerstone for the promising work on an Internet of Things-based system for monitoring specific environmental parameters, including temperature, humidity, air pollution, natural light intensity, and rain. The proposed system acquires values of different parameters, making them accessible online as a web application. All parameter values are pushed on the web application in real-time.

SYSTEM HARDWARE

The system monitors environmental conditions and transmits the data to the cloud. More importantly, the real-time environmental parameter values are shared. Any deviation in the environmental parameters can be updated in the cloud, and anyone online can view the status. If the environmental conditions deteriorate, this mechanism can be exploited for human intervention

The block structure of the system is shown in Figure 1(a). In contrast, the circuit diagram of the system, which includes a microcontroller board, sensors, and a wireless communication protocol, is shown in Figure 1(b). At the core of the system lies the ESP-32 module. It is the only controlling component of the system and is responsible for periodic data acquisition from sensors and transmission of the same to web applications through the API gateway. Four sensors, namely, a rain sensor, a CO₂ sensor, a Light Dependent Resistor, and a temperature cum humidity sensor DHT22 are interfaced with the ESP-32 controller. Data from all sensors are read periodically and sent to the server for further visual and data analysis. The system consists of sensor networks, a processing unit, and a web server to store data that can further help enable decision-making. A description of various hardware components used is given below:

ESP-32

One of the development boards made to test the ESP-WROOM-32 module is the ESP-32 (devkit) v1. It is based on the ESP-32, a 32-bit microprocessor boasting low power consumption radio supporting Wi-Fi, Bluetooth, and Ethernet in a single chip. ESP-32 contains an on-board RF antenna, balun, power amplifier, low noise amplifier, filter, and power management module, making it a fully autonomous system [6]. The board adopts TSMC's 40nm low power technology 2.4GHz dual-mode Wi-Fi and Bluetooth chip, with the best power and radio frequency characteristics. It is safe and reliable and can be employed for various applications. Its specifications are as follows: Ten silica 32-bit Single-/Dual-core Xtensa CPU, 25 Digital I/O Pins, 6 Analog Input Pins (ADC), 2 Analog Outputs Pins (DAC), 3 UARTs, 2 SPIs, 3 I2Cs, 4 MB Flash Memory, 520kB SRAM, 80-240 MHz Clock Speed, Wi-Fi: IEEE 802.11 b/g/n/e/i.[6]



**Bhavesh Pithadiya et al.,****DHT-22**

DHT-22 comprises a high-performance 8-bit microcontroller, a humidity sensor, and an NTC-based temperature sensor. It offers excellent quality, quick response time, interference resistance, and cost-efficient temperature and humidity measurement. The measured temperature and humidity are converted to digital and calibrated before sending the duplicate serial data packets to the user. This eliminates the requirement for data conversion from analogue to digital form and calibration and, in turn, saves time and money in the process. The operating range for humidity is 0-100%RH, and for temperature, it is 40°-80°Celsius. Accuracy of humidity is $\pm 2\%$ RH and temperature ± 0.5 °Celsius [7]. The application is simple, but the data collection requires careful planning.

Light Dependent Resistor

"Photo resistor" refers to a light-activated variable resistor, an LDR or photo-conductive cell. When the intensity of the incident light increases, a photo resistor's resistance decreases(photoconductivity). A photoresistor is built of semiconductors such as Cadmium selenide or Cadmium sulphide, which have a high resistivity when not energised (with illumination). Still, the electrons are quickly activated when photons are incident, and the resistance drops [8].

MQ-135

MQ-135 Gas sensor for air quality detection or NO_x, NH₃, CO₂, Benzene, Alcohol and smoke measurement. The sensor has a digital output pin that allows the sensor to be used with or without a microcontroller, which is ideal for use with a specific gas. To measure gas in PPM, an analogue pin must be used. The sensor operates at 5 V to be used with most common microcontrollers [9].

Rain sensor-KG004

The rain sensor module includes a sensing pad and two copper tracks coated with nickel. This pad contains two header pins, which are connected internally to the copper tracks of the pad. The primary function of these two header pins is to connect the Sensing Pad with the rain sensor module with the help of two wires. Here, the rain sensor module's one pin provides a +5 V power supply toward the one path of the sensing pad, whereas the other pin gets the return power from another path of the pad[10].

SOFTWARE

Software significantly impacts the integration and operation of embedded hardware designs. Our software development is divided into hardware initialisation, configuration, and user interface development. Programming of the microcontrollers was executed in embedded C using Arduino IDE. The flow chart, shown in Figure 2, initialises sensors and then processes and conditions the signal with data acquisition. A Wi-Fi-enabled microcontroller is used as an edge device for communication with the cloud. Online monitoring systems using Wi-Fi serve as the central controller. Even by creating an HTTP link between the cloud and the edge device, measurements from multiple sensors were analysed, sampled, and saved in the server—an API [11] concatenated for sending data to web servers. The website's programming used HTML, CSS, PHP, and JAVA SCRIPT. We have used APACHE architecture MySQL for the database [12], APACHE for designing the web server and C-Panel as an operating system for the web server. It is considered the data repository, and devices with specific credentials—which establish the data's access rights—can access it. The data on the page is local and stored in the database.

RESULT

According to the input of different sensors, the results of other environmental conditions, such as rain, temperature, humidity, CO₂ gas, and light intensity, can be measured. Table 1 shows real-time values of the sensors that will help to take further action.

The results of different environmental conditions, such as temperature, humidity, CO₂ and light intensity, can be monitored based on inputs from various sensors.



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Table 1 depicts the response values of sensors monitored in a closed environment on the 8th day of February 2022. All stabilised points are considered to understand the adequate response. It is a continuous observation for about 20 minutes. Data was recorded by the system for a constant temperature of 24°C with 56% humidity. The highest CO₂ concentration within this duration is 342 ppm at 4:47, while the lowest was at 15:01 with 309 ppm concentration. The light variation was also monitored, with values reaching 4095 lux. Table 2 depicts the response values of sensors monitored in the closed environment at specific intervals of 24 hours for 5 consecutive days in April 2022. All stabilised points are considered to understand the adequate response. It is continuous observation, and data is recorded by the system for temperature and humidity variation. The highest CO₂ concentration within this duration was 449 ppm on 17-4-2022 at 13:30, while the lowest was on 16-4-2022 at 13:30 with 190 ppm concentration. The light variation was monitored with values almost the same for three days, 4095 lux.

CONCLUSION

The present work is based on ESP-32 module which enables wireless connectivity for monitoring different agri-environment parameters. The results obtained from the measurement have shown promising capability to monitor temperature, Relative humidity, CO₂ and rain remotely; apart from that, the system performance is quite reliable with low power consumption to monitor multiple parameters of agri-environmental. Overall, the system is simple and cost-effective, providing flexibility with the Internet of Things.

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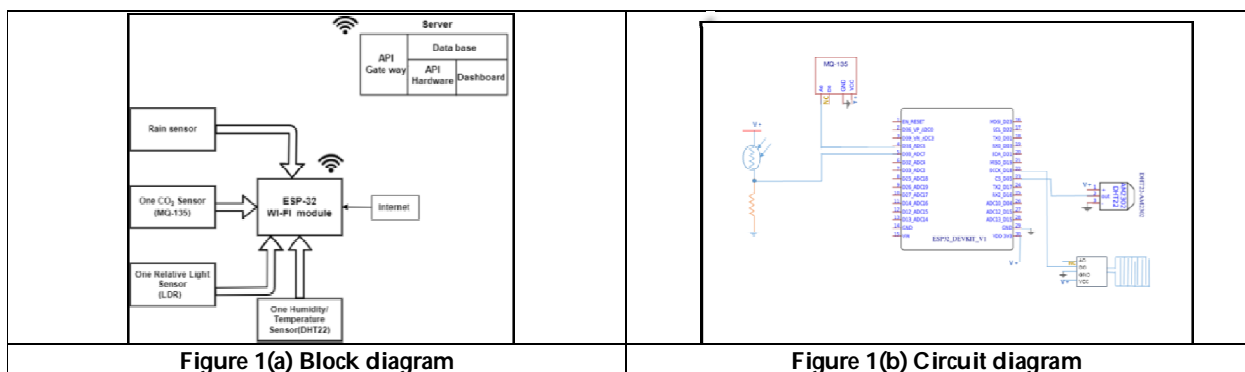
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Table 1 – Sensor Parameter values obtained for one day for about 20 minutes

Sr. No.	Time (Hr: Min: Sec)	CO ₂ (ppm)	Temperature (°C)	Humidity (%)	Light (Lux)
1	14:46:56	340	24	56	3805
2	14:47:03	342	24	56	3967
3	14:48:04	339	24	56	3805
4	14:49:06	336	24	56	3792
5	14:50:00	336	24	56	3801
6	14:51:02	332	24	56	3660
7	14:52:02	325	24	56	3848
8	14:53:04	326	24	56	3783
9	14:54:05	331	24	56	3792
10	14:55:00	322	24	56	3792
11	14:56:01	320	24	56	3766
12	14:57:02	317	24	56	3781
13	14:58:03	316	24	56	4029
14	14:59:05	318	24	56	3764
15	15:00:06	313	24	56	4095
16	15:01:01	312	24	56	3135
17	15:01:35	309	24	56	3763
18	15:02:02	313	24	56	4095
19	15:03:03	313	24	56	3766
20	15:04:05	310	24	56	3696

Table 2 – Sensor Parameter values were obtained for a specific interval of 24 hours for 5 consecutive days.

Sr. No.	Date & Time (Hr: min)	CO ₂ (ppm)	Temperature (°C)	Humidity (%)	Light (Lux)
1	13-04-2022 13:20	399	31	42	3628
2	14-04-2022 13:20	354	35	35	4095
3	15-04-2022 13:20	322	35	41	4095
4	16-04-2022 13:20	190	38	32	4095
5	17-04-2022 13:30	449	33	36	3542





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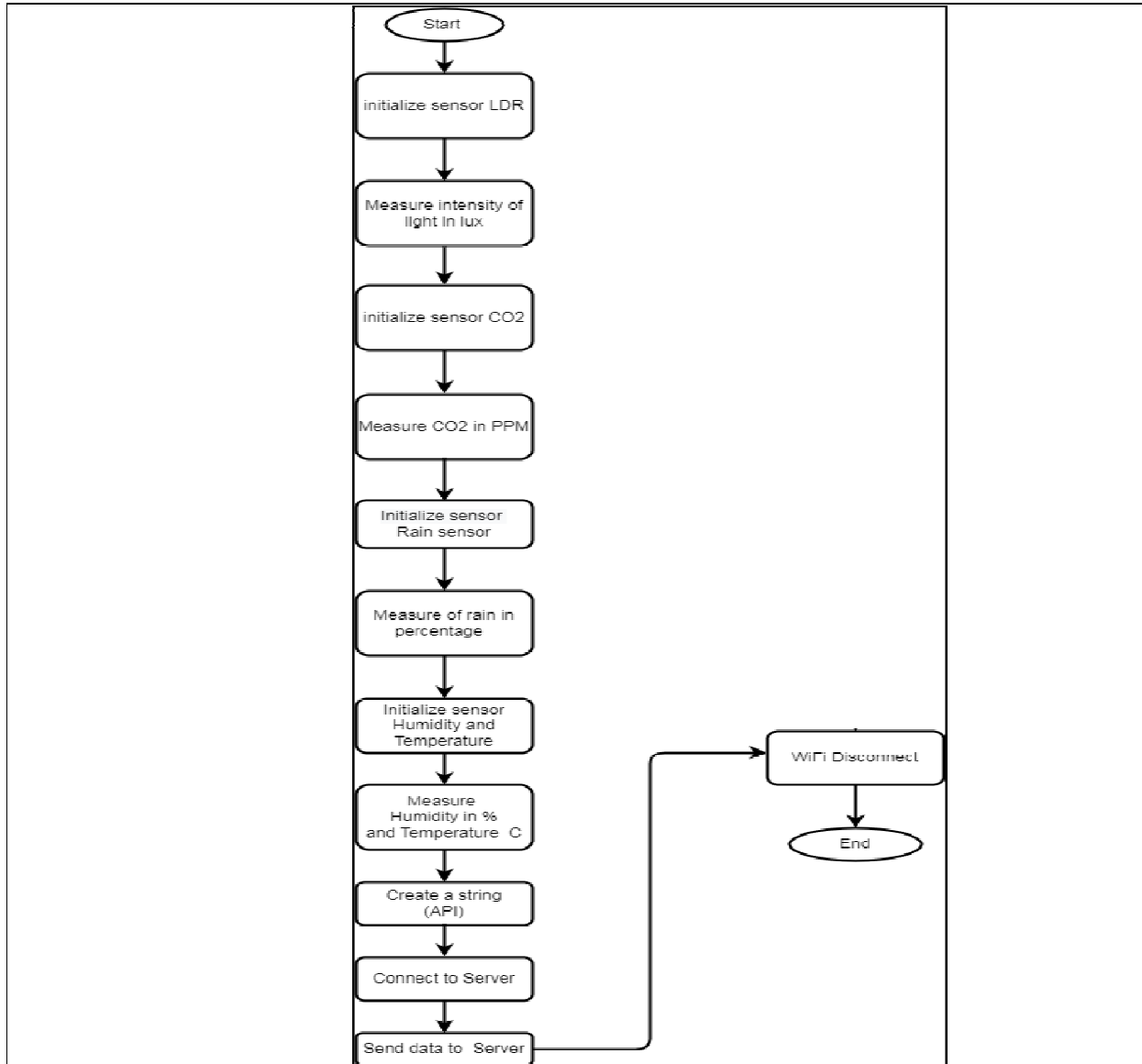


Figure 3.Flow chart

ENVIRONMENT SENSOR VALUE			
TEMPERATURE	23 °C	RAIN	raining
CO2	236 PPM	LIGHT	3561 LUX
RELATIVE HUMIDITY	50 %		

Figure 4. web application shows real value





Leveraging Artificial Intelligence for Social Work: Opportunities and Challenges

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

Artificial Intelligence (AI) presents immense potential for transforming the field of social work by enhancing efficiency, improving decision-making processes, and extending services to more individuals. This work explores the opportunities and challenges associated with integrating AI into social work practice. The prevalence of artificial intelligence (AI) in social work is on the rise, with applications ranging from risk assessments and crisis intervention to strengthening preventive measures and identifying biases in social service delivery. AI is also playing a role in social work education, predicting outcomes, and addressing issues like burnout among social workers. While there is a substantial body of literature detailing how AI aids human service professionals in assisting vulnerable populations, the ethical dimensions of practitioners' AI use within social work have not been extensively explored. This article aims to fill this gap by delving into the ethical considerations associated with the use of AI by social workers. By examining key ethical issues, such as informed consent, client autonomy, privacy, confidentiality, transparency, client misdiagnosis, abandonment, surveillance, plagiarism, dishonesty, fraud, misrepresentation, algorithmic bias, unfairness, and the use of evidence-based AI tools, we seek to shed light on the ethical implications. The article also endeavours to apply relevant ethical standards and outline a strategic framework for social workers to ensure the ethical use of AI in their practice. Through this exploration, we aim to contribute to a more comprehensive understanding of the ethical dimensions surrounding the integration of AI in social work.

Keywords: AI use within social work have not been extensively explored.





INTRODUCTION

Artificial Intelligence (AI) is increasingly permeating various facets of social work practice, presenting both opportunities and challenges. While AI holds promise in streamlining processes, improving service delivery, and enhancing outcomes for vulnerable populations, its integration raises important ethical considerations that demand careful examination. Despite the growing presence of AI in social work, there remains a notable gap in the literature regarding the nuanced ethical implications of its use by practitioners. This paper aims to address this gap by exploring the emerging ethical issues associated with the incorporation of AI in social work practice. By delving into key ethical dimensions, such as informed consent, privacy, transparency, bias, and accountability, we seek to provide insight into the complexities inherent in the intersection of AI and social work. Through an analysis of relevant literature and case studies, we aim to elucidate the ethical dilemmas faced by social workers utilizing AI tools and technologies. Furthermore, we endeavour to propose strategies and guidelines for navigating these ethical challenges, promoting responsible and ethically sound AI integration in social work practice. As AI continues to evolve and shape the landscape of social work, it is imperative for practitioners, researchers, policymakers, and stakeholders to engage in critical dialogue and reflection on the ethical implications of its use. By fostering a deeper understanding of these issues, we can strive towards harnessing the potential of AI to advance social justice, equity, and well-being while upholding the ethical principles fundamental to the profession of social work.

History and Development of AI

The history and development of artificial intelligence (AI) trace back to ancient times, but significant advancements have occurred in the past century. Here's a condensed overview of key milestones: Early Concepts (Antiquity to 20th Century): The idea of artificial beings with human-like intelligence dates back to ancient civilizations, with myths and folklore featuring automatons. In the 17th century, philosophers like René Descartes pondered the concept of mechanical thought. However, it wasn't until the 20th century that AI as a field began to take shape. Foundational Concepts (20th Century): The birth of modern AI can be traced to the Dartmouth Conference in 1956, where the term "artificial intelligence" was coined. Early pioneers like Alan Turing developed theoretical frameworks for machine intelligence, while others, such as John McCarthy, proposed the concept of AI as a scientific discipline. Early AI Systems (1950s-1960s): The 1950s and 1960s saw the development of the first AI programs, including programs that could play games like chess and checkers. The Logic Theorist, developed by Allen Newell and Herbert A.

Simon in 1956, was one of the first AI programs capable of proving mathematical theorems. Expert Systems and Knowledge Representation (1970s-1980s): In the 1970s and 1980s, AI research focused on expert systems, which utilized rules and knowledge bases to simulate human expertise in specific domains. This era also saw advancements in natural language processing and knowledge representation techniques. AI Winter (1980s-1990s): Despite initial optimism, AI research faced setbacks in the 1980s and 1990s due to overhyped expectations and underwhelming results. Funding for AI projects dwindled, leading to a period known as the "AI winter." Revival and Machine Learning (1990s-Present): The late 1990s and early 2000s witnessed a resurgence of interest in AI, driven by breakthroughs in machine learning and neural networks. Innovations such as deep learning, reinforcement learning, and big data fueled advancements in AI applications, including image recognition, natural language processing, and autonomous vehicles. Current Trends and Challenges: In recent years, AI has become increasingly integrated into various aspects of society, from healthcare and finance to transportation and entertainment. However, ethical concerns, such as bias in algorithms and the impact on employment, have emerged as significant challenges facing the field. Future Prospects: Looking ahead, the future of AI holds immense potential, with ongoing research in areas like explainable AI, AI ethics, and human-AI collaboration. As AI continues to evolve, it is poised to shape the future of technology and society in profound ways. Overall, the history of AI reflects a journey marked by innovation, setbacks, and resurgence, ultimately leading to the development of increasingly sophisticated AI systems with diverse applications and profound implications for humanity.



**Subhasheni and Sahana Fathima****AI In Social Work**

AI holds significant promise for revolutionizing various aspects of social work practice, offering opportunities to enhance efficiency, effectiveness, and accessibility of services. Here are several ways AI is being applied in social work:

1. **Risk Assessment:** AI algorithms can analyze large datasets to identify patterns and indicators of risk factors such as child abuse, domestic violence, or substance abuse. By predicting potential risks, social workers can intervene proactively to prevent harm and provide targeted support to at-risk individuals and families.
2. **Crisis Intervention:** AI-powered chatbots or virtual assistants can provide immediate support and resources to individuals in crisis, such as those experiencing mental health crises or facing homelessness. These virtual agents can offer empathetic listening, crisis de-escalation techniques, and referrals to appropriate services.
3. **Case Management:** AI systems can assist social workers in managing caseloads by automating administrative tasks, scheduling appointments, updating records, and organizing documentation. This allows social workers to focus more on direct client engagement and intervention.
4. **Decision Support:** AI-driven decision support systems can help social workers make informed decisions by analyzing complex data and providing evidence-based recommendations. For example, AI can assist in matching clients with appropriate interventions, services, or resources based on their unique needs and circumstances.
5. **Predictive Analytics:** AI algorithms can analyze historical data to predict outcomes such as recidivism rates, foster care placements, or service utilization. By forecasting future trends, social workers can allocate resources more effectively, prioritize interventions, and tailor services to meet emerging needs.
6. **Natural Language Processing (NLP):** NLP techniques can be used to analyze text data from client interviews, case notes, or social media to extract valuable insights. This can help social workers identify emerging trends, understand client sentiments, and tailor interventions accordingly.
7. **Training and Education:** AI technologies can enhance social work education by providing simulated learning environments, virtual case studies, and interactive training modules. This allows students to develop clinical skills, practice decision-making, and engage in realistic scenarios before entering the field.
8. **Ethical Considerations:** While AI offers numerous benefits, it also raises important ethical considerations in social work practice. These include issues related to privacy, confidentiality, transparency, algorithmic bias, accountability, and the potential for dehumanization or displacement of human workers.

Overall, AI has the potential to transform social work practice by improving outcomes for individuals and communities, enhancing the effectiveness of interventions, and promoting social justice and equity. However, it is essential for social workers to approach the integration of AI with careful consideration of ethical principles, human-centered values, and the unique needs and circumstances of the populations they serve.

CONCLUSIONS

In conclusion, the integration of artificial intelligence (AI) in social work holds immense potential to revolutionize the delivery of services, enhance client outcomes, and address pressing societal challenges. From risk assessment and crisis intervention to decision support and predictive analytics, AI offers a diverse range of applications that can streamline processes, improve efficiency, and expand access to resources for vulnerable populations. However, as social workers navigate the adoption of AI technologies, it is imperative to remain vigilant about the ethical considerations inherent in their use. Issues such as privacy, confidentiality, transparency, algorithmic bias, and accountability must be carefully addressed to ensure that AI interventions uphold the values of social work practice and prioritize the well-being and dignity of clients. Furthermore, social workers must approach the integration of AI with a critical lens, acknowledging its limitations and potential pitfalls. While AI can augment human capabilities and support informed decision-making, it should not replace the essential role of human empathy, compassion, and cultural competence in social work practice. As AI continues to evolve and shape the landscape of social work, ongoing research, collaboration, and dialogue are essential to navigate the complex ethical, social, and legal





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implications of its use. By leveraging AI responsibly and ethically, social workers can harness its transformative potential to create positive change, promote social justice, and empower individuals and communities to thrive. In essence, AI in social work represents a powerful tool for advancing the profession's mission of promoting human well-being, social justice, and systemic change. By embracing innovation while upholding ethical principles, social workers can leverage the benefits of AI to better serve the needs of those they support and advocate for a more equitable and inclusive society.

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Transient Solution and Busy Period Analysis of FM/M/2/∞ Interdependent Stochastic Feedback Arrival Model with Interdependent Catastrophic Effect

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 07 Jun 2024

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ABSTRACT

In this paper, the FM/M/2/∞ interdependent stochastic feedback arrival model with catastrophic effect is considered. The transient solution, busy period analysis, and system characteristics are derived for this model. Using Maple software, the analytical results are numerically proven. The impact of the nodal parameter on the system's features and graphical representation is investigated.

Keywords: interdependent feedback arrival rate, interdependent catastrophic effect, infinite capacity, two-server.

INTRODUCTION

The mathematical analysis of waiting lines or queues is known as "queueing theory." In general, it is considered a branch of operations research. Data transmission, telecommunications, and so on are the applications of queueing theory. When arrival and service rates are correlated, the queueing model is said to be an "interdependent queueing model." Antline Nisha and Thiagarajan obtained results for the single server finite capacity queueing model [1]. Rakesh Kumar and Bhavneet Singh Soodan introduced the concept of correlated reneging and obtained a transient solution using the Runge-Kutta method [8]. Sasikala and Thiagarajan studied a multi-server model with finite





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capacity in steady-state behaviour [11]. In this paper, we consider the whole system as a feedback queueing system. Also, the expected length and busy period are analysed for this model.

DESCRIPTION OF THE MODEL

$p(\lambda - \epsilon) > 0$ (average feedback arrival rate) denotes the feedback customers arrive at a counter. While the system is not empty, $(v - \epsilon)$ (average rate) denotes the interdependent catastrophic effect according to the feedback Poisson process. $2(\mu - \epsilon)$ (independently identically distributed random variables) denotes the service rates. The system's state is zero when the service begins at time $t=0$. The occurrence of the catastrophe destroys all of the available customers and has an impact on the system. The system's correlated and bivariate feedback Poisson processes are $\{X_1(t)\}$ and $\{X_2(t)\}$. The feedback Poisson distribution is,

$$Pr\{X_1(t) = px_1, X_2(t) = x_2\} = e^{-(p\lambda_i + 2\mu_i - \epsilon)t} \sum_{j=0}^{\min(px_1, x_2)} \frac{(\epsilon t)^j (p(\lambda_i - \epsilon)t)^{px_1-j} (2(\mu_i - \epsilon)t)^{x_2-j}}{j! (px_1 - j)! (x_2 - j)!}$$

$$x_1, x_2 = 0, 1, 2, \dots, i = 1, 2, \dots, 0 \leq p \leq 1$$

- (a) When the system size increases to $R-1$ from below, the feedback arrival rate is $p(\lambda_0 - \epsilon)$.
- (b) When the system size increases from R to ∞ , the feedback arrival rate is $p(\lambda_1 - \epsilon)$.
- (c) When the system size decreases from above to $r+1$, the feedback arrival rate is $p(\lambda_1 - \epsilon)$.
- (d) When the system size decreases from r to 0 and decreases from $r+1$ to $R-1$, the feedback arrival rate is $p(\lambda_0 - \epsilon)$. This process is repeated.

" $X(t)$ denotes the number of customers in the system at time t and $Q_n(t) = Pr\{X(t) = n\}$ "

The differential-difference equations of $Q_n(t)$ are,

$$Q'_0(t) = -(p(\lambda - \epsilon) + (v - \epsilon))Q_0(t) + (\mu - \epsilon)Q_1(t) \tag{1}$$

$$Q'_1(t) = -(p(\lambda - \epsilon) + (\mu - \epsilon) + (v - \epsilon))Q_1(t) + p(\lambda - \epsilon)Q_0(t) + (2(\mu - \epsilon))Q_2(t); n = 1 \tag{2}$$

$$Q'_n(t) = -(p(\lambda - \epsilon) + 2(\mu - \epsilon) + (v - \epsilon))Q_n(t) + p(\lambda - \epsilon)Q_{n-1}(t) + (2(\mu - \epsilon))Q_{n+1}(t); n \geq 2 \tag{3}$$

Let $Q_n^*(z)$ denote the Laplace transform of $Q_n(t)$.

From the equations (1), (2) and (3),

$$(z + p(\lambda - \epsilon) + (v - \epsilon))Q_0^*(z) = (\mu - \epsilon)Q_1^*(z) \tag{4}$$

$$(z + p(\lambda - \epsilon) + (\mu - \epsilon) + (v - \epsilon))Q_1^*(z) = (p(\lambda - \epsilon))Q_0^*(z) + (2(\mu - \epsilon))Q_2^*(z) \tag{5}$$

$$(z + p(\lambda - \epsilon) + 2(\mu - \epsilon) + (v - \epsilon))Q_n^*(z) - \delta_{2n} = (p(\lambda - \epsilon))Q_{n-1}^*(z) + (2(\mu - \epsilon))Q_{n+1}^*(z); n \geq 2 \tag{6}$$

From the equations (4) and (5), we get

$$Q_1(t) = \begin{cases} (p(\lambda - \epsilon))e^{-(p(\lambda - \epsilon) + (\mu - \epsilon) + (v - \epsilon))t} Q_0(t) \\ + ((2\mu - \epsilon))e^{-(p(\lambda - \epsilon) + (\mu - \epsilon) + (v - \epsilon))t} Q_2(t) \end{cases} \tag{7}$$

$$Q_2(t) = \left(\left(\frac{e^{(2(p(\lambda - \epsilon) + (v - \epsilon)) - (\mu - \epsilon))t}}{2((\mu - \epsilon))^2} \right) - \left(\frac{p(\lambda - \epsilon)}{2(\mu - \epsilon)} \right) \right) Q_0(t) \tag{8}$$

From the equation (6), we get

$$Q_{c+r}(t) = \left(\frac{1}{(p(\lambda - \epsilon))^2 I_0(at)} \right) \left((2(\mu - \epsilon))Q_c(t)C - (1 + (p(\lambda - \epsilon))Q_{c-1}(t)D) \right) \tag{9}$$

$$C = \left((2(\mu - \epsilon))^{r+1} \frac{\sqrt{\pi}}{\Gamma^{\frac{r+1}{2}} \left(\frac{t}{2a} \right)^{\frac{r}{2}} I_{\frac{r}{2}}(at)} \right)^{-1}; a = 2\sqrt{(p(\lambda - \epsilon))(2(\mu - \epsilon))}$$





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$$\begin{aligned}
 D &= \left((2(\mu - \varepsilon))^r \frac{\sqrt{\pi}}{\Gamma(\frac{r}{2})} \left(\frac{t}{2a}\right)^{\frac{r-1}{2}} I_{r-1}(at) \right)^{-1}; c = 2; r = 1, 2, 3, \dots \\
 Q_0(t) &= \left(1 + \left(\frac{e^{(p(\lambda - \varepsilon) + (v - \varepsilon))t}}{(\mu - \varepsilon)} \right) + E \right. \\
 &\quad \left. + \left(\frac{1}{(p(\lambda - \varepsilon))^2 I_0(at)} \right) \left((2(\mu - \varepsilon))EC - (1 + (p(\lambda - \varepsilon)) \left(\frac{e^{(p(\lambda - \varepsilon) + (v - \varepsilon))t}}{(\mu - \varepsilon)} \right) D) \right) \right)^{-1} \\
 E &= \left(\left(\frac{e^{(2(p(\lambda - \varepsilon) + (v - \varepsilon)) - (\mu - \varepsilon))t}}{2((\mu - \varepsilon))^2} \right) - \left(\frac{p(\lambda - \varepsilon)}{2(\mu - \varepsilon)} \right) \right)
 \end{aligned} \tag{10}$$

ASYMPTOTIC BEHAVIOR OF THE EXPECTED LENGTH

Theorem 1

If $(v - \varepsilon) > 0$, the expected length's asymptotic behavior of $L_{S(p_i)}(t)$ is

$$L_{S(p_i)}(t) = \left(\frac{1}{v - \varepsilon} \right) \left((2n - 3)(\mu - \varepsilon) \frac{(p(\lambda - \varepsilon))^n}{n!} Q_0 \right); n \geq 2, i = 0, 1$$

$$Q_0 = \left(\sum_{n=0}^1 \frac{(p(\lambda - \varepsilon))^n}{n!} + \frac{(p(\lambda - \varepsilon))^2}{2!(\mu - \varepsilon)^3((\mu - \varepsilon) - (p(\lambda - \varepsilon)))} \right)^{-1}$$

as $t \rightarrow \infty$

Proof

The expected length $L_{S(p_i)}(t) = \sum_{n=0}^{\infty} nQ_n(t) = Q(x, t)$ at $x = 1$

Denote $Q(x, t) = \sum_{n=0}^{\infty} Q_n(t)x^n$

Adding equations (1), (2), multiplying by x^n and taking summation from $n = 0, 1$, we get

$$\sum_{n=0}^1 Q_n'(t)x^n = \begin{cases} -(p(\lambda - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon)) \sum_{n=0}^1 Q_n(t)x^n \\ + (p(\lambda - \varepsilon))x \sum_{n=0}^1 Q_{n-1}(t)x^{n-1} + (n - 2)(\mu - \varepsilon) \sum_{n=0}^1 Q_n(t)x^n \\ + \frac{(n + 1 - 2)(\mu - \varepsilon)}{x} \sum_{n=0}^1 Q_{n+1}(t)x^{n+1} + \frac{2(\mu - \varepsilon)}{x} \sum_{n=0}^1 Q_{n+1}(t)x^{n+1} \end{cases} \tag{11}$$

Multiplying equation (6.3) by x^n and taking summation from $n = 2, 3, 4, \dots$

$$\sum_{n=2}^{\infty} Q_n'(t)x^n = \begin{cases} -(p(\lambda - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon)) \sum_{n=2}^{\infty} Q_n(t)x^n \\ + (p(\lambda - \varepsilon))x \sum_{n=2}^{\infty} Q_{n-1}(t)x^{n-1} + \frac{2(\mu - \varepsilon)}{x} \sum_{n=2}^{\infty} Q_{n+1}(t)x^{n+1} \end{cases} \tag{12}$$

Adding equations (11), (12), and using the final value theorem, we get

$$L_{S(p_i)}(t) = \left(\frac{1}{v - \varepsilon} \right) \left((2n - 3)(\mu - \varepsilon) \frac{(p(\lambda - \varepsilon))^n}{n!} Q_0 \right); n \geq 2, i = 0, 1$$

$$Q_0 = \left(\sum_{n=0}^1 \frac{(p(\lambda - \varepsilon))^n}{n!} + \frac{(p(\lambda - \varepsilon))^2}{2!(\mu - \varepsilon)^3((\mu - \varepsilon) - (p(\lambda - \varepsilon)))} \right)^{-1}$$

as $t \rightarrow \infty$





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DIFFERENTIAL DIFFERENCE EQUATIONS FOR THE BUSY PERIOD ANALYSIS

"Probability that n feedback utilities exist in the system at times t_0 and t_1 when the feedback arrival rates in faster and slower are $q_n(t_0)$ and $q_n(t_1)$ respectively. While $n = 0, 1, \dots, r - 1$, $q_n(t_0)$ exists; While $n = r + 1, r + 2, \dots, R - 1$, both $q_n(t_0)$ and $q_n(t_1)$ exist; While $n = R, R + 1, \dots$, $q_n(t_1)$ only exists. $q'_0(t_0)$ and $q'_{r+1}(t_1)$ (faster and slower rates of feedback arrivals) denote the probability density function of the busy period."

"The differential-difference equations control the system size with absorbing barriers established at zero and $r+1$ (faster and slower rates of feedback arrivals)."

$$q'_0(t_0) = -(2(\mu - \varepsilon))q_1(t_0) \tag{13}$$

$$q'_1(t_0) = -(p(\lambda_0 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_1(t_0) + 2(\mu - \varepsilon)q_2(t_0) \tag{14}$$

$$q'_n(t_0) = -(p(\lambda_0 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_n(t_0) + 2(\mu - \varepsilon)q_{n+1}(t_0) + p(\lambda_0 - \varepsilon)q_{n-1}(t_0), \quad n = 2, 3, \dots, r - 1 \tag{15}$$

$$q'_r(t_0) = -(p(\lambda_0 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_r(t_0) + 2(\mu - \varepsilon)q_{r+1}(t_0) + p(\lambda_0 - \varepsilon)q_{r-1}(t_0) + 2(\mu - \varepsilon)q_{r+1}(t_1) \tag{16}$$

$$q'_n(t_0) = -(p(\lambda_0 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_n(t_0) + 2(\mu - \varepsilon)q_{n+1}(t_0) + p(\lambda_0 - \varepsilon)q_{n-1}(t_0), \quad n = r + 1, r + 2, \dots, R - 2 \tag{17}$$

$$q'_{R-1}(t_0) = -(p(\lambda_0 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_{R-1}(t_0) + p(\lambda_0 - \varepsilon)q_{R-2}(t_0) \tag{18}$$

(because of the absorbing barrier)

$$q'_{r+1}(t_1) = -(2(\mu - \varepsilon))q_{r+2}(t_1) \tag{19}$$

(because of the absorbing barrier)

$$q'_{r+2}(t_1) = -(p(\lambda_1 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_{r+2}(t_1) + 2(\mu - \varepsilon)q_{r+3}(t_1) \tag{20}$$

(because of the absorbing barrier)

$$q'_n(t_1) = -(p(\lambda_1 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_n(t_1) + 2(\mu - \varepsilon)q_{n+1}(t_1) + p(\lambda_1 - \varepsilon)q_{n-1}(t_1), \quad n = r + 3, r + 4, \dots, R - 1 \tag{21}$$

$$q'_R(t_1) = -(p(\lambda_1 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_R(t_1) + 2(\mu - \varepsilon)q_{R+1}(t_1) + p(\lambda_1 - \varepsilon)q_{R-1}(t_1) + p(\lambda_0 - \varepsilon)q_{R-1}(t_0) \tag{22}$$

$$q'_n(t_1) = -(p(\lambda_1 - \varepsilon) + 2(\mu - \varepsilon) + (v - \varepsilon))q_n(t_1) + 2(\mu - \varepsilon)q_{n+1}(t_1) + p(\lambda_1 - \varepsilon)q_{n-1}(t_1), \quad n = R + 1, R + 2, \dots \tag{23}$$

Let $\rho_0 = \frac{p(\lambda_0 - \varepsilon)}{2(\mu - \varepsilon)}$ and $\rho_1 = \frac{p(\lambda_1 - \varepsilon)}{2(\mu - \varepsilon)}$ (faster and slower rates of feedback arrivals) denote the traffic intensities.

Multiplying (13) to (18) by z^n , and taking the summation from 0 to $R-1$, it is found that

$$E(T_0) = \frac{1}{\left(1 + \frac{v - \varepsilon}{2(\mu - \varepsilon)}\right) - \rho_0} \left(\frac{1}{p(\lambda_0 - \varepsilon)} + r \left(\frac{1}{\rho_0}\right)^r \right) \tag{24}$$

Multiplying (19) to (23) by z^n , and taking the summation from $r+1$ to ∞ , it is found that

$$E(T_1) = \frac{1}{2(\mu - \varepsilon) \left(1 + \frac{v - \varepsilon}{2(\mu - \varepsilon)}\right) - \rho_1} \left((r + 1) \left(\frac{1}{\rho_1}\right)^{r+1} + p(\lambda_0 - \varepsilon) \left(\frac{1}{\rho_1}\right)^R R \right) \tag{25}$$

PARTICULAR CASE

"Ignoring the interdependent catastrophic effect and the feedback arrival rate $p(\lambda - \varepsilon) = \lambda$, service rate $2(\mu - \varepsilon) = 2\mu$, and $p=1$, the transient solution of this model will become the M/M/2/ ∞ model."

NUMERIC EXAMPLES

EXPECTED LENGTH

FASTER RATE OF FEEDBACK ARRIVALS

"By changing the values of p and n , $L_{s(p_0)}(t)$ are calculated."

SLOWER RATE OF FEEDBACK ARRIVALS

"By changing the values of p and n , $L_{s(p_1)}(t)$ are calculated."





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BUSY PERIOD ANALYSIS

FASTER RATE OF FEEDBACK ARRIVALS

"By changing the values of p and r , $E(T_0)$ are calculated."

SLOWER RATE OF FEEDBACK ARRIVALS

"By changing the values of p and R , $E(T_1)$ are calculated."

CONCLUSION

It is observed from the tables 2, 3, 4, 5, 6, 7, 8, and 9 that the asymptotic behaviour of expected length increases for both faster and slower rates of feedback arrivals by increasing the values of p and n while keeping the other parameters fixed. It is observed from the tables 10, 11, 12, and 13 that the expected length of the busy period decreases in a faster rate of feedback arrivals by increasing the values of p and r while keeping the other parameters fixed. It is observed from the tables 14, 15, 16, and 17 that the expected length of the busy period decreases in a slower rate of feedback arrivals by increasing the values of p and R while keeping the other parameters fixed.

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Table 1: Sets and Direction of the Movement of Feedback Arrivals

Sets	Movement's Direction	Interdependent Feedback Arrival Rates
$S_1 = \{0, 1, \dots, r, \dots, R-1\}$	↑	$p(\lambda_0 - \varepsilon)$
$S_2 = \{R, R+1, \dots, k, \dots\}$	↑	$p(\lambda_1 - \varepsilon)$
$S_3 = \{\dots, k, k-1, \dots, R, R-1, \dots, r+1\}$	↓	$p(\lambda_1 - \varepsilon)$
$S_4 = \{r, r-1, \dots, 1, 0\}$	↓	$p(\lambda_0 - \varepsilon)$
$S_5 = \{r+1, \dots, R-1\}$	↑	$p(\lambda_0 - \varepsilon)$

Table 2: $p = 0.8; v = 1; \varepsilon = 0.5; n = 2$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_0)}(t)$
1.2	5	0.380
2.8	9	1.058
4.4	13	1.757
6	17	2.465
7.6	21	3.174

Table 3: $p = 0.8; v = 1; \varepsilon = 0.5; n = 4$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_0)}(t)$
1.2	5	0.018
2.8	9	0.085
4.4	13	0.168
6	17	0.256
7.6	21	0.346

Table 4: $p = 0.85; v = 1; \varepsilon = 0.5; n = 2$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_0)}(t)$
1.3	5	0.419
3	9	1.162
5	13	1.930
6.4	17	2.706
8	21	3.490





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Table 5: $p = 0.85; v = 1; \varepsilon = 0.5; n = 4$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_0)}(t)$
1.3	5	0.023
3	9	0.106
5	13	0.208
6.4	17	0.317
8	21	0.430

Table 6: $p = 0.8; v = 1; \varepsilon = 0.5; n = 2$

$p(\lambda_1 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_1)}(t)$
0.4	3	0.083
2	7	0.713
3.6	11	1.407
5.2	15	2.113
6.8	19	2.818

Table 7: $p = 0.8; v = 1; \varepsilon = 0.5; n = 4$

$p(\lambda_1 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_1)}(t)$
0.4	3	0.001
2	7	0.049
3.6	11	0.126
5.2	15	0.212
6.8	19	0.301

Table 8: $p = 0.85; v = 1; \varepsilon = 0.5; n = 2$

$p(\lambda_1 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_1)}(t)$
0.4	3	0.092
2.1	7	0.784
3.8	11	1.546
5.5	15	2.320
7.2	19	3.099

Table 9: $p = 0.85; v = 1; \varepsilon = 0.5; n = 4$

$p(\lambda_1 - \varepsilon)$	$2(\mu - \varepsilon)$	$L_{s(p_1)}(t)$
0.4	3	0.002
2.1	7	0.06
3.8	11	0.156
5.5	15	0.262





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7.2	19	0.373
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Table 10: $p = 0.8; v = 1; \varepsilon = 0.5; r = 2$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$E(T_0)$
1.2	5	41.344
2.8	9	28.376
4.4	13	25.112
6	17	24.290
7.6	21	23.439

Table 11: $p = 0.8; v = 1; \varepsilon = 0.5; r = 3$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$E(T_0)$
1.2	5	253.311
2.8	9	135.467
4.4	13	109.678
6	17	103.295
7.6	21	97.058

Table 12: $p = 0.85; v = 1; \varepsilon = 0.5; r = 2$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$E(T_0)$
1.3	5	36.155
3	9	25.760
5	13	23.077
6.4	17	21.583
8	21	21.310

Table 13: $p = 0.85; v = 1; \varepsilon = 0.5; r = 3$

$p(\lambda_0 - \varepsilon)$	$2(\mu - \varepsilon)$	$E(T_0)$
1.3	5	204.133
3	9	115.448
5	13	95.154
6.4	17	84.483
8	21	82.463

Table 14: $p = 0.8; v = 1; \varepsilon = 0.5; r = 2; R = 1$

$p(\lambda_1 - \varepsilon)$	$2(\mu - \varepsilon)$	$E(T_1)$
0.4	3	413.987
2	7	25.119





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3.6	11	12.567
5.2	15	8.658
6.8	19	6.824

Table 15: $p = 0.8; v = 1; \epsilon = 0.5 r = 2; R = 2$

$p(\lambda_1 - \epsilon)$	$2(\mu - \epsilon)$	$E(T_1)$
0.4	3	454.817
2	7	35.797
3.6	11	21.283
5.2	15	16.663
6.8	19	14.496

Table 16: $p = 0.85; v = 1; \epsilon = 0.5 r = 2; R = 1$

$p(\lambda_1 - \epsilon)$	$2(\mu - \epsilon)$	$E(T_1)$
0.4	3	343.651
2.1	7	21.711
3.8	11	11.037
5.5	15	7.772
7.2	19	6.186

Table 17: $p = 0.85; v = 1; \epsilon = 0.5 r = 2; R = 2$

$p(\lambda_1 - \epsilon)$	$2(\mu - \epsilon)$	$E(T_1)$
0.4	3	381.857
2.1	7	31.880
3.8	11	19.354
5.5	15	15.473
7.2	19	13.566

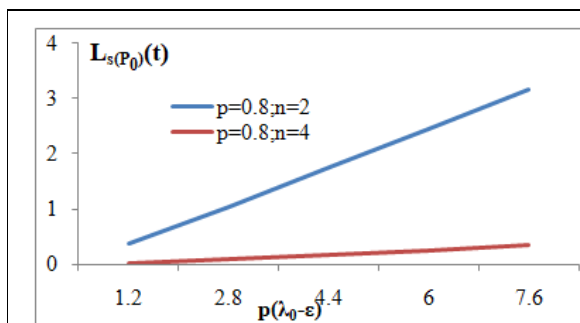


Fig.1

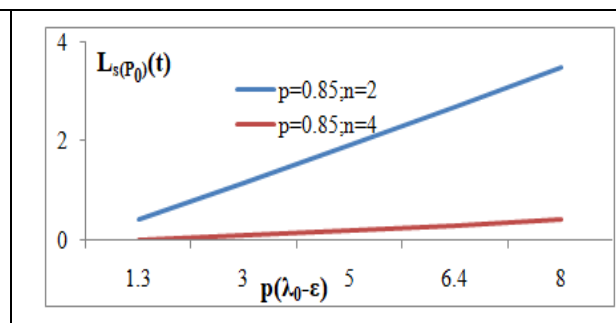
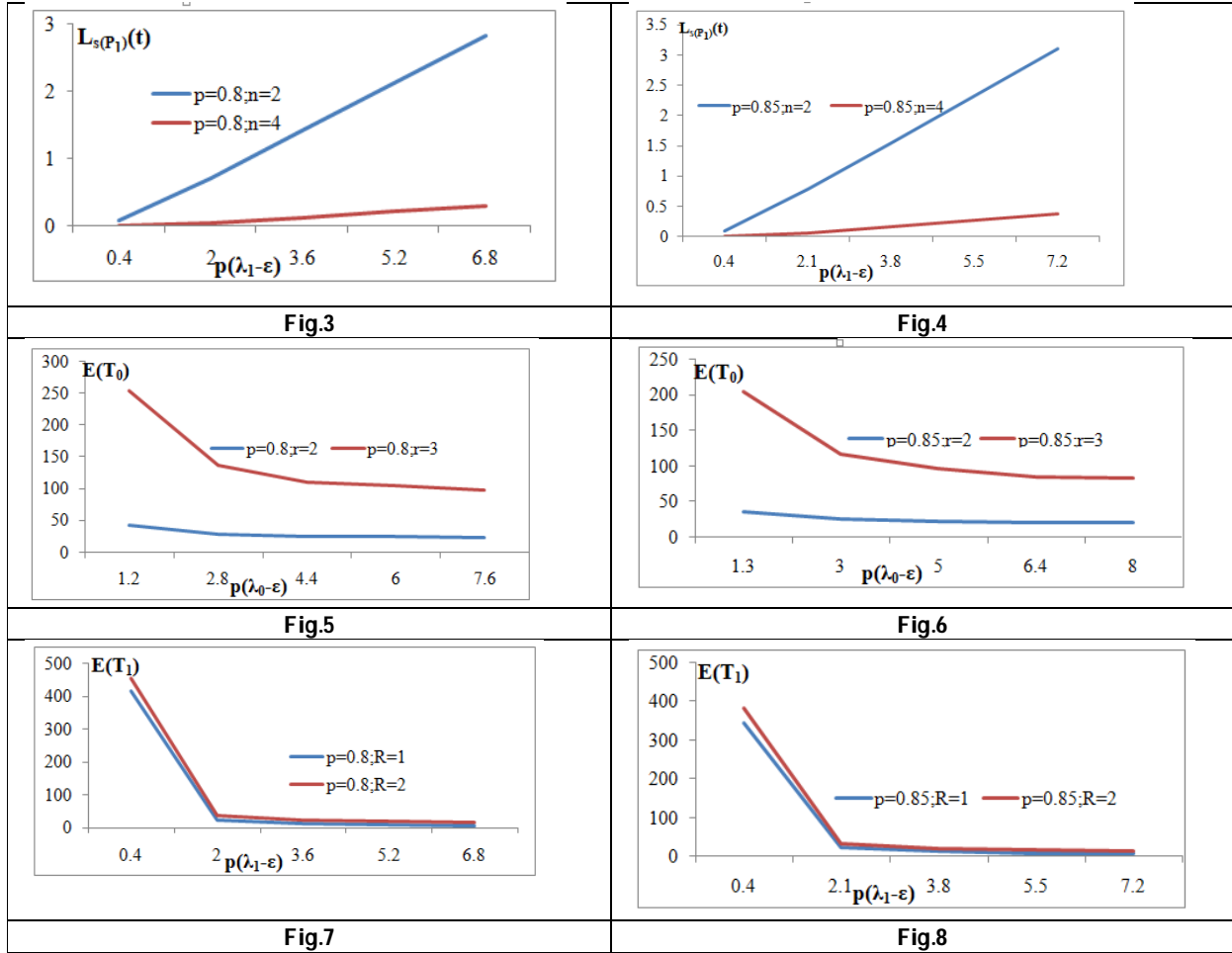


Fig.2





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Unscrambling Type-3 Fuzzy Shortest Cycle Route Problem by Intuitionistic Fuzzy Branch and Bound (Penalty)

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 16 Jul 2024

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ABSTRACT

Using a predetermined set of cities and their bilateral distances, the Shortest Cycling Route Problem (SCRP) seeks for the shortest route that stops in each city exactly once. Following the issues with transportation and assignment, the difficulty of the travelling salesman is covered in the assertiveness hypothesis. The shortest cycle route problem can be used to shorten a network's path. With the simplified matrix technique employed in this research, the shortest cyclic route problem with crisp, fuzzy, and intuitionistic fuzzy numbers as cost coefficients was resolved. A numerical problem is resolved by using technique, and its effectiveness is illustrated.

Key words: Type-3 Fuzzy Shortest Cyclic Route Problem, Triangular intuitionistic fuzzy numbers, and mixed constraints

Mathematics Subject Classification: 90C05, 90C10, 90C70, 03E72, 94D05

INTRODUCTION

The first person to initiate SCRPs was W.R. Hamilton in the 19th century. A sizable SCRPs has been identified as the solution by Dantzig and Fulkerson [5]. The Ones Assignment Method was introduced by Hadi Basirzadeh [6] to tackle the travelling salesman problem. In order to solve SCRPs, Sudhakar and Navaneetha Kumar [15] developed an innovative technique called as the zero-suffix technique. The SCRPs has many engineering implementations,





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including communications in the design of computing networks, radio electronic devices, and planning hardware devices.

Uncertainty and exactness are triggered by variations in measurement, deviations in precision, and computation inaccuracies. We use fuzzy assignment issues rather than traditional assignment problems to distribute with this uncertainty. The extension of Zadeh's [16] fuzzy set is the intuitionistic fuzzy set (IFS) proposed by Atanassov [3,4]. Angelov[2] predicted optimization in intuitionistic fuzzy domains. The Intuitionistic fuzzy set can be utilized if it is not feasible to clarify an unclear concept by manipulating the typical fuzzy set. An element's membership in a fuzzy set is represented as a single value with an acceptance level between zero and one. Vimala et al[8] suggested three distinct approaches to explain the intuitionistic fuzzy assignment problem. Nirmala and Anju [10] developed the Traveling Salesman Problem (SCR) using Fuzzy Quantifier. Sagaya Roseline and Henry Amirtharaj [11] gave new ranking of Intuitionistic.

FuzzyNumbers.Genetic algorithms were utilized by Shweta Rana [14] to tackle the Traveling Salesman problem. Assignment and travelling salesman problems were tackled by Amit Kumar and Anila Gupta [1] leveraging coefficients as LR Fuzzy parameters. A novel method was offered by Senthil Kumar and Jahir Hussain[12,13] for tackling the Type-3 fuzzy assignment problem. Jeyalakshmi et al [7, 9] proposed RMM and OAM for disentangling Type-3 Fuzzy Shortest Cycle Route Problem.

The structure of this article is as follows. Section 1 gives an intro about SCR and literature review. Basic definitions are provided in Section 2, along with some basic interpretation on TrIFN'S, and IFS. Algorithm to Type-3 Fuzzy Shortest Cyclic Route Problem has been explained in Section 3. The aforementioned procedure is illustrated with a numerical example in section 4. The paper is concluded in Section 5.

Preliminaries

Intuitionistic fuzzy number:

Sorted exactitudes for Intuitionistic fuzzy sets were delineated from[3,4,11,12,13].

Definition 2.1.1: An IF Set Γ in X is given by $\Gamma = \{ x, \mu_{\Gamma}(x), \nu_{\Gamma}(x) / x \in X \}$ where the functions, $\mu_{\Gamma}, \nu_{\Gamma} : X \rightarrow [0, 1]$ are functions such that $0 \leq \mu_{\Gamma}(x), \nu_{\Gamma}(x) \leq 1, \forall x \in X$. For each, the numbers $\mu_{\Gamma}(x)$ and $\nu_{\Gamma}(x)$ portray the degree of membership and degree of non-membership of the element $x \in X$.

Definition 2.1.2:

A TrIFN $\tilde{\Gamma}^f$ is an intuitionistic fuzzy set in R with the subsequent membership function $\mu_{\Gamma}(x)$ and non membership function $\nu_{\Gamma}(x)$

$$\mu_{\Gamma}(x) = \begin{cases} 0 & \text{if } x \leq \alpha \\ \frac{x-\alpha_1}{\alpha_2-\alpha_1} & \alpha_1 \leq x \leq \alpha_2 \\ 1 & x = \alpha_2 \\ \frac{\alpha_3-x}{\alpha_3-\alpha_2} & \alpha_2 \leq x \leq \alpha_3 \\ 0 & x > \alpha_3 \end{cases} \quad \text{and} \quad \nu_{\Gamma}(x) = \begin{cases} 1 & x < \alpha' \\ \frac{\alpha_2-x}{\alpha_2-\alpha_1} & \alpha_1 \leq x \leq \alpha_2 \\ 0 & x = \alpha_2 \\ \frac{x-\alpha_2}{\alpha_3-\alpha_2} & \alpha_2 \leq x \leq \alpha_3 \\ 1 & x \geq \alpha_3' \end{cases}$$

Where $\alpha_1' \leq \alpha_1 \leq \alpha_2 \leq \alpha_3 \leq \alpha_3'$ and $\mu_{\Gamma}(x), \nu_{\Gamma}(x) \leq 0.5$ for $\mu_{\Gamma}(x) = \nu_{\Gamma}(x), \forall x \in R$.

This TrIFN is represented by $\tilde{\Gamma}^f = (\alpha_1, \alpha_2, \alpha_3) (\alpha_1', \alpha_2, \alpha_3')$

Definition 2.1.3: The SCR is supposed to be Type-3 F SCR or mixed FSCR if all the parameters of the TSP are crisp numbers, triangular fuzzy numbers or intuitionistic triangular fuzzy numbers.

Ranking Techniques:

Defuzzification: Defuzzification is the procedure of detecting singleton value (crisp value) which delineates the average value of the TrIFNs.





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Yager’s Ranking Technique

Yager’s ranking technique which gratifies recompense, linearity, additivity properties and presumes verdicts which consists of human intuition. For a convex fuzzy number \tilde{a} , the Robust’s Ranking Index is interpreted by,

$$R(\tilde{a}) = \int_0^1 (0.5)(a^L_\alpha, a^U_\alpha) d\alpha \dots\dots\dots (1)$$

Where $(a^L_\alpha, a^U_\alpha) = \{(b - a)\alpha + a, c - (c - b)\alpha\}$ which is the α – level cut of the fuzzy number \tilde{a}

Ranking of triangular intuitionistic fuzzy numbers

The Ranking of a TrIFN $\tilde{\Gamma}^I = (\alpha_1, \alpha_2, \alpha_3) (\alpha'_1, \alpha'_2, \alpha'_3)$ is expounded by

$$R(\tilde{\Gamma}^I) = \frac{1}{3} \left[\frac{(\alpha'_3 - \alpha'_1)(\alpha_3 - 2\alpha'_1 - 2\alpha'_3) + (\alpha_3 - \alpha_1)(\alpha_1 + \alpha_2 + \alpha_3) + 3(\alpha'_3 - \alpha'_1)}{\alpha_3 - \alpha_1 + \alpha_3 - \alpha_1} \right] \dots\dots\dots (2)$$

The ranking technique [4] is: If $\mathcal{R}(\tilde{\Gamma}^I) \leq \mathcal{R}(\tilde{\Upsilon}^I)$, then $\tilde{\Gamma}^I \leq \tilde{\Upsilon}^I$ i.e, $\min\{\tilde{\Gamma}^I, \tilde{\Upsilon}^I\} = \tilde{\Gamma}^I$

Mathematical Formulation of SCRP

Mathematically a SCRP can be framed as given bellow:

Optimize

$$\sum_{i=1}^n \sum_{j=1}^n d_{ij} x_{ij} \quad (i)$$

subject to

$$\sum_{j=1}^n x_{ij} = 1, i = 1, 2, 3, \dots, n.$$

$$\sum_{i=1}^n x_{ij} = 1, j = 1, 2, 3, \dots, n.$$

$$x_{ij} = 0 \text{ or } 1, i=1, 2, 3, \dots, n. j = 1, 2, 3, \dots, n. \quad (ii)$$

Where d_{ij} is the distance from the city ‘i’ to city ‘j’, and x_{ij} is to be some positive integer or zero, and the only possible integer is one, so the condition of $x_{ij} = 0 \text{ or } 1$, is automatically satisfied .

Intuitionistic Fuzzy Branch and Bound (Penalty)

Step 1: Use the outlined ranking algorithms (1) and (2) to defuzzify the Type-3 fuzzy cost matrix (T-3 FCM) for the specified SCRP and convert the cost to precise integers..

Step 2: Locate the lowest element in each row, then take it away from that row. Row minimum refers to each element in a row that is minimum. Locate the lowest element in each column, then take it away from that row. Column minimum refers to each element in a row that is minimum.

Step 3: lower bound = row minimum + column minimum.

Step 4: Calculate the penalty of all 0’s

penalty (of each 0) = minimum element of that row + minimum element of that column.

Step 5: Find the highest possible penalty from all of these. And this will be the starting point for the new branch. If there are multiple such places, pick whichever one you want at random.

Step 6: Let branch will occur at XA, D .

There are two branches.

1. If $XA, D=0$, then we have an additional cost of say t and the lower bound becomes $LB + t$

2. If $XA, D=1$, then we can go $A \rightarrow D$

So we can't go $D \rightarrow A$, so set it to M .

Now we leave row A and column D .

Repeat steps 2 and 3 using the smaller matrix until the entire path is determined..

Step 7: Hence, we ultimately determine the final path and distance.





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Arithmetical Exemplar:

Consider the given example,

	<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>	<i>T</i>
<i>P</i>	–	(17,37,57)	(45,65,85)(25,65,105)	25	(17,37,57)
<i>Q</i>	37	–	(35,55,75)	25	37
<i>R</i>	(45,65,85)	(37,57,77)(17,57,97)	–	(45,65,85)(25,65,105)	45
<i>S</i>	25	25	(45,65,85)	–	(45,65,85)(25,65,105)
<i>T</i>	(15,35,55)	35	(27,47,67)(17,47,77)	(45,65,85)	–

Step 1:

The fuzzy numbers are renovated to crisp numbers by applying (1) and (2),

$$\begin{pmatrix} \infty & 37 & 65 & 25 & 37 \\ 37 & \infty & 55 & 25 & 37 \\ 65 & 57 & \infty & 65 & 45 \\ 25 & 25 & 65 & \infty & 65 \\ 35 & 35 & 47 & 65 & \infty \end{pmatrix}$$

The number of rows = 5 and columns = 5

	A	B	C	D	E
A	∞	37	65	25	37
B	37	∞	55	25	37
C	65	57	∞	65	45
D	25	25	65	∞	65
E	35	35	47	65	∞

We know that the sum of row minimum gives us the lower bound.

Step-2: Find out the each row minimum element and subtract it from that row

	A	B	C	D	E	
A	∞	12	40	0	12	(-25)
B	12	∞	30	0	12	(-25)
C	20	12	∞	20	0	(-45)
D	0	0	40	∞	40	(-25)
E	0	0	12	30	∞	(-35)

So, row minimum will be 155. (25+25+45+25+35=155)

Find out the each column minimum element and subtract it from that column

	A	B	C	D	E
A	∞	12	28	0	12
B	12	∞	18	0	12
C	20	12	∞	20	0
D	0	0	28	∞	40
E	0	0	0	30	∞
	(-0)	(-0)	(-12)	(-0)	(-0)

So, column minimum will be 12. (0+0+12+0+0=12)

Step 3: we get the lower bound = 155+12=167

Step 4: Calculate the penalty of all 0's





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	A	B	C	D	E
A	∞	12	28	0(12)	12
B	12	∞	18	0(12)	12
C	20	12	∞	20	0(24)
D	0(0)	0(0)	28	∞	40
E	0(0)	0(0)	0(18)	30	∞

Step 5: Here maximum penalty is 24, occur at XC,E , so we choose XC,E to begin branch

Step 6: There are two branches.

1. If XC,E=0, then we have an additional cost of 24 and the lower bound becomes 167+24=191

2. If XC,E=1,

we can go C→E

So we can't go E→C, so set it to M.

Now we leave row C and column E, so reduced matrix is

	A	B	C	D
A	∞	12	28	0
B	12	∞	18	0
D	0	0	28	∞
E	0	0	∞	30

Find out the each column minimum element and subtract it from that column

	A	B	C	D
A	∞	12	10	0
B	12	∞	0	0
D	0	0	10	∞
E	0	0	∞	30
	(-0)	(-0)	(-18)	(-0)

So, column minimum will be 18. (0+0+18+0=18)

we get the lower bound = 167+0+18=185

Calculate the penalty of all 0's

	A	B	C	D
A	∞	12	10	0(10)
B	12	∞	0(10)	0(0)
D	0(0)	0(0)	10	∞
E	0(0)	0(0)	∞	30

Here maximum penalty is 10, occur at XA,D or XB,C , so we choose XA,D to begin branch

There are two branches

1. If XA,D=0, then we have an additional cost of 10 and the lower bound becomes 185+10=195

2. If XA,D=1,

we can go A→D

So we can't go D→A, so set it to M.

Now we leave row A and column D, so reduced matrix is

	A	B	C
A	∞	12	10
B	12	∞	0
C	10	0	∞





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B	12	∞	0
D	∞	0	10
E	0	0	∞

Here we have 0 in every row and column. So, the lower bound remains the same i.e, $185+0=185$
Calculate the penalty of all 0's

	A	B	C
B	12	∞	0(22)
D	∞	0(10)	10
E	0(12)	0(0)	∞

Here maximum penalty is 22, occur at XB,C , so we choose XB,C to begin branch

There are two branches.

1. If $XB,C=0$, then we have an additional cost of 22 and the lower bound becomes $185+22=207$

2. If $XB,C=1$,

we can go $B \rightarrow C$

Now we leave row B and column C , so reduced matrix is

	A	B
D	∞	0
E	0	0

Here we have 0 in every row and column. So, the lower bound remains the same i.e, $185+0=185$
Calculate the penalty of all 0's

	A	B
D	∞	0(0)
E	0(0)	0(0)

we can go $D \rightarrow B$

and $E \rightarrow A$

Step 7: So our final path is $C \rightarrow E \rightarrow A \rightarrow D \rightarrow B \rightarrow C$

and total distance is $45+35+25+25+55=185$

CONCLUSION

A Type 3 IFSCR in the midst of crisp, fuzzy and Intuitionistic fuzzy is explored in this exertion. The fallouts disclose that the proposed strategies can effectively unravel the Type 3 IFSCR. This scheme is effortless to recognize and it gives a systematic procedure for unraveling SCR. These routines can be implemented in postal deliveries, television relays, job scheduling, to assign fleets of aircrafts, or assigning routes, or networking computers etc.

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Evaluation of Antiulcer Activity of the Poly-Herbal Combination Extract

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Received: 11 Mar 2024

Revised: 25 Apr 2024

Accepted: 26 Jun 2024

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ABSTRACT

Antiulcer activity of a poly-herbal combination (PHCE) containing extracts of *Gymnema sylvestre*, *Momordica charantia*, *Syzygium cumini*, *Trigonella foenum*, *Psidium guajava*, *Tinospora cardifolia*, *Boerhavia diffusa*, *Coriandrum sativum*, *Andrographis paniculata*, *Mixture of Haritaki*, *Bibhitaki* and *Amalaki*, *Mixture of black pepper*, and *dry ginger* and *Withania somnifera* was assessed in rats' model. The antiulcer activity of the poly-herbal combination extract (PHCE 300 and 500 mg/kg) was tested, as well as the therapeutic efficacy of PHCE. When the results of the evaluations were compared to the control group and standard medicine, PHCE (300 and 500mg/Kg-1, p.o.) dose was found to be particularly protective against ethanol-induced, indomethacin-induced, and aspirin-induced ulcer models. *Gymnema sylvestre*, *Momordica charantia*, *Syzygium cumini*, *Trigonella foenum*, *Psidium guajava*, *Tinospora cardifolia*, *Boerhavia diffusa*, *Coriandrum sativum*, *Andrographis paniculata*, *Mixture of Haritaki*, *Bibhitaki* and *Amalaki*, *Mixture of black pepper*, and *dry ginger* and *Withania somnifera* were discovered to have antiulcer action in PHCE. According to the findings, the PHCE can be employed in the treatment and management of stomach ulcer illness.

Keywords: Gastric ulcer; Ulcer index; Poly-herbal formulation; Indomethacin; Ethanol





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INTRODUCTION

People are currently taking interest towards herbal medicine due having low toxicity, low cost, and ease of access to herbs. Allopathic medications, on the other hand, have a long list of drawbacks, including stomach ulcers, liver toxicity, skin rashes, and other side effects [1]. The gastrointestinal condition of peptic ulcer disease is fairly frequent. It is caused by an imbalance between greater stomach acid secretion and defensive gastric mucosal protective function, as well as an irregular lifestyle. The goal of peptic ulcer treatment is to either reduce excess acid output or strengthen the protective effect of the stomach's gastric mucosal layer [2]. Commonly proton pump inhibitors and H₂ receptor antagonists' medicines are highest selling drugs in market which is using for the treatment and management of gastric ulcer disorders; however, both drugs have a high rate of recurrence, adverse effects, and drug interactions [3]. Ayurvedic practitioners have employed bioactive ingredients for the treatment and management of gastric ulcer disease. Secondary metabolites of natural plants, such as flavonoids, saponins, tannins, gums, and mucilage, are all bioactive substances [4]. To treat ulcers, natural medications are very effective, safer, and cost-efficient [5]. In rats, the antiulcer activity of a poly-herbal combination extract (PHCE) containing leaf extracts of *Gymnema sylvestre*, *Momordica charantia*, *Syzygium cumini*, *Trigonella foenum*, *Psidium guajava*, *Tinospora cardifolia*, *Boerhavia diffusa*, *Coriandrum sativum*, *Andrographis paniculata*, Mixture of Haritaki, Bibhitaki and Amalaki, Mixture of black pepper, and dry ginger and *Withania somnifera* was assessed [6]. Selected poly-herbal combinations have never been employed before by any researcher, and there are currently no research publications available from a literature survey. As a result, these PHCE were chosen for the treatment and management of ulcer disease. These PHCE contain a variety of therapeutically active compounds. All of these putative bioactive compounds may have good stomach ulcer protective effect and can be utilised for the management or prevention of gastric ulcer disease, according to the hypothesis behind the selection of this combination

(List of potential antidiabetic bioactive molecules having plants were given in Table 1)

MATERIALS AND METHODS

All the chemicals were analytical grade.

Collection of plant material

The plant materials like *Gymnema sylvestre*, *Momordica charantia*, *Syzygium cumini*, *Trigonella foenum*, *Psidium guajava*, *Tinospora cardifolia*, *Boerhavia diffusa*, *Coriandrum sativum*, *Andrographis paniculata*, Mixture of Haritaki, Bibhitaki and Amalaki, Mixture of black pepper, and dry ginger and *Withania somnifera* were purchased from the local market of Mandsaur, Madhya Pradesh. The plant material was authenticated by Pharmacognosist, Dr. Sandeep Kumar Singh. Plant materials were used for poly-herbal formulation (entral Ayurvedic Research Institute, Jhansi, Uttar Pradesh). Plant material was collected and washed under tap water and shade dried.

Extraction of poly-herbal formulation

Dried plant materials were coarsely grinded into a coarse powder. The coarse powder of plant material was macerated in an airtight container in 70:30 ratio of ethanol to distilled water for 15 days with regular shaking. The resulting solvent was filtered and evaporated at 40 degrees Celsius using a rotary vacuum evaporator, resulting in a poly-herbal hydroalcoholic crude extract of 150 grams after filtering and concentration of the residue. The extracted substance was chosen for the study of hepato-protective activity and stored in a cool place for further analysis. The composition of the poly-herbal materials used in the extraction process is provided below [16-18] (composition of herbal plants given in table -2)

Preliminary Phytochemical Screening

Herbal plants comprise a diverse array of bioactive compounds, such as alkaloids, glycosides, volatile oils, tannins, saponins, flavonoids, and other secondary metabolites, which are responsible for their therapeutic effects. In order to





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identify the presence of both primary and secondary metabolites, the extract was subjected to a series of chemical tests [19-20].

Experimental animals

The experimental protocol involving the use of male albino Wistar rats weighing between 200 and 230 g was approved by the Institutional Animal Ethics Committee. The animals were housed in an animal facility that was sanctioned by the Committee for Control and Supervision of Animal Experiments.

Screening Models for Anti - ulcer Activity Evaluation

Acute Toxicity Studies

In compliance with animal ethical guidelines, an acute toxicity study of PHCE was conducted on adult Wistar rats. Three rats were administered a single oral dose of PHCE at a concentration of 2000 mg/kg, p.o body weight. The rats were then monitored for 1, 2, 4, 8, and 24 hours for any toxicological manifestations such as changes in behaviour, locomotion, convulsions, or mortality. Subsequently, the rats were observed for 14 days, during which their behaviour and activity patterns were closely scrutinized. No signs of toxicity were detected during the course of the study [21].

Antiulcer activity

To evaluate the antiulcer activity, the animals were divided into eight groups, each group consisting of six animals (n=6).

Ethanol-induced gastric ulcers model [22-24].

The experimental animals were allocated into four groups, each comprising six rats. Gastric ulceration was induced by administering absolute ethanol (1ml/200gm), and to prevent coprophagy, the animals were placed in specially designed cages.

Group I (Control) received 1% SCMC and ethanol.

Group II (Standard) received 10mg/kg of Omeprazole.

Group III received 300mg/kg of ethanolic polyherbal extract orally.

Group IV received 500mg/kg of ethanolic polyherbal extract orally.

Albino Wistar rats weighing between 180-250gm were individually housed in separate cages, with each cage containing six rats. The animals were fasted for 24-36 hours with unrestricted access to water before ethanol administration. Peptic ulcers were induced by administering total ethanol (1ml/200gm). Group 1 was administered only 1% SCMC, while group 2 received regular omeprazole at a dose of 10mg/kg. The third and fourth groups were given the poly-herbal hydroalcoholic extract of the polyherbal formulation at doses of 300mg and 500mg/kg, respectively. The treatment was repeated for seven days to evaluate the antiulcer activity of the compounds. On the 8th day, the drugs were orally administered 30 minutes before the administration of ethanol. After 6 hours, the rats were anesthetized with ether, and the stomach and greater curvature were incised. The stomach was then gradually cleaned under fresh water, and the inner surface was checked for any signs of ulceration. The frequency and rating of ulcers were determined microscopically using a 10X magnification lens. The mean ulcer score for each animal was expressed as the ulcer index [25] [Table 4].

Calculation of Ulcer index (UI) and percent inhibition (% I)

$$\text{Ulcer Index (UI)} = \frac{\text{Number of ulcer in control} - \text{Number of ulcer in test}}{\text{Number of animals}}$$

$$\text{Percent Inhibition (\% I)} = \frac{\text{UI of control} - \text{UI of test}}{\text{UI of control}} \times 100$$



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The experimental animals were allocated into four groups, each comprising six rats. Gastric ulceration was induced by administering absolute ethanol (1ml/200gm), and to prevent coprophagy, the animals were placed in specially designed cages.

Group I (Control) received 1% SCMC and ethanol.

Group II (Standard) received 10mg/kg of Omeprazole.

Group III received 300mg/kg of ethanolic polyherbal extract orally.

Group IV received 500mg/kg of ethanolic polyherbal extract orally.

In the pre-treatment phase, omeprazole (20 mg/kg) or an extract at a dose of 300mg and 500mg/kg was administered orally (gavage) to rats daily for 21 days. On the final day, these rats were given indomethacin, a single gavage of 3mg/kg body weight for ulcer induction, 2 hours after the omeprazole or extract dose. Rats in Groups 1 and 2 were respectively dosed with vehicle or indomethacin in parallel (on the final day). Prior to indomethacin oral treatment, all rats were fasted for 24 hours and kept in wide wire mesh-bottom cages to avoid coprophagia. In addition, water access was prevented for 2 hours prior to indomethacin dosing. Four hours after the indomethacin/vehicle gavage, all rats were euthanized by chloroform and their stomachs were excised [Table 4].

Aspirin Induced Model [26-27]

The experimental animals were allocated into four groups, each comprising six rats. Gastric ulceration was induced by administering absolute ethanol (1ml/200gm), and to prevent coprophagy, the animals were placed in specially designed cages.

Group I (Control) received 1% SCMC and ethanol.

Group II (Standard) received 10mg/kg of Omeprazole.

Group III received 300mg/kg of ethanolic polyherbal extract orally.

Group IV received 500mg/kg of ethanolic polyherbal extract orally.

The animals were administered with aspirin (150 mg/kg) orally to induce ulcers, followed by 45 minutes of PHCE and the administration of omeprazole to selected animal groups as a standard medication for ulcer protection. After 5 hours, the animals were euthanized, and lesions in the gastrointestinal mucosa were observed and recorded using a microscope (10x). Gastric mucosa samples were subjected to histopathological tests, and the ulcer index was calculated to determine the ulcer score. The results obtained are presented in the table below [Table 4] [Figure 1, 2 and 3].

Histopathology

After collecting the gastric mucosa contents from each group of animals and cutting them into small pieces, the stomachs were cut into little pieces. Small stomach fragments were encased in paraffin wax and implanted. Microtome was used to cut 5m thick stomach sections, which were then mounted on glass slides using normal procedures. The tissues on the mounted slide were stained with hematoxylineosin stain (H&E), and the resulting slides were examined under a light microscope.

Statistical Analysis

The data was presented as Mean SEM. One-way ANOVA multiple comparison tests were used to analyse the results.

RESULTS AND DISCUSSIONS**Phytochemical screening [28]**

Carbohydrates, proteins, saponins, flavonoids, tannins, and glycosides were discovered in preliminary phytochemical screening of the PHCE. The outcomes are listed in the table below [Table 3].

Pharmacological Activities [29-30]**Acute Toxicity Studies**

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Acute Toxicity Studies under observation study no signs & symptoms of toxicity were found during the acute toxicity study of PHCE after oral administration of dose up to 3000 mg/kg.

Effect of poly-herbal formulation (PHCE) on ethanol-induced gastric ulcers

Acute Toxicity Studies under Observation During the acute toxicity investigation of PHCE following oral administration of doses up to 3000 mg/kg, no signs or symptoms of toxicity were seen.

Gastric lesions induced by ethanol

PHCE concentrations of 300 and 500 mg/kg were used in the experiments. The ulcer index and % inhibition were used to calculate the anti-ulcer (ulcer preventive) activity. In comparison to control, an acute dose of PHCE 300 and 500mg/kg of body weight inhibited ulcers by 63.42 and 69.80 percent, respectively, and the ulcer index was found to be 14.700.036 and 7.0180.248. The anti-ulcer activity of the PHCE was comparable to that of a conventional medication. The conventional Sucralfate (100 mg/kg p.o.) significantly (P0.05) reduced ulcer formation, with an ulcer inhibition rate of 76.29 percent and a UI of 5.5080.164, which was similar to the PHCE 500mg/kg treated group. The PHCE-treated group had a UI of 7.0182.48 and 69.80 percent inhibition. These results indicated that PHCE was most potent as compared to other treated groups; results are shown in [Table 4] [Figure 1].

Effect of poly-herbal formulation (PHCE) on indomethacin-induced gastric ulcers [31-34]

Gymnema sylvestre, Momordica charantia, Syzygium cumini, Trigonella foenum, Psidium guajava, Tinospora cardifolia, Boerhavia diffusa, Coriandrum sativum, Andrographis paniculata, Mixture of Haritaki, Bibhitaki and Amalaki, Mixture of black pepper, and dry ginger and Withania somnifera were studied for their pharmacological potential. When PHCE and standard misoprostol (100 mcg/kg, p.o) were compared to control, the ulcer index PHCE and standard misoprostol (100mcg/kg, p.o) revealed a substantial reduction in ulcer index. The conventional misoprostol considerably (P0.05) reduced ulcer formation, with a 65.30 percent ulcer inhibition rate and a UI of 7.980.249, which was very close to the PHCE 500mg/kg treated group. The PHCE group had a 64.23 percent inhibition rate and a UI of 8.2260.231.

The anti-ulcer activity of PHCE was investigated, and it was found to be suitable for the treatment and management of GIT problems. The outcomes of the investigation backed up PHCE's pharmacological potential. The purpose of the trial was to see if PHCE could protect against gastric/peptic ulcers, the results are shown in [Table 4].

Aspirin Induced Model

The emergence of stomach lesions was suppressed in a dosage-dependent manner when PHCE was given orally at various dose levels. When compared to the negative control group, a higher dose of PHCE at 500 mg/kg b.w. showed 52.87 percent ulcer prevention with a higher dose, there was an increase in ulcer prevention. The conventional omeprazole considerably (P0.05) reduced ulcer formation, with an ulcer inhibition rate of 63.85% and a UI of 7.6850.248, which was similar to the PHCE 500mg/kg treated group. The PHCE-treated group had a UI of 8.2260.231 and a 59.96 percent inhibition. The outcomes are listed in the table below [Table 4].

Histological results [35-37]

The antiulcer efficacy of PHCE was further validated by histopathological study of rat stomach samples, which showed that it reduced congestion, oedema, and bleeding in the gastric mucosa (Figure 1). The protective effect of PHCE was investigated using histopathology of an isolated stomach. All animal groups of lesion and epithelial erosion had their histological results examined. The histological tissue observation investigation revealed that PHCE was shown to be significantly ulcer protective when compared to conventional treated animals. The number and severity of stomach ulcers in treated mice treated with PHCE extract (500 mg/kg) were compared to control and PHCE (300 mg/kg) in untreated animals, and after standard medication, histopathology results showed that PHCE 500mg provided the highest protection. The outcomes are listed in the table below [Figure 1].

PHCE 500mg has been shown to have strong ulcer-protective properties. The phytochemical analysis of PHCE revealed that it includes a wide range of beneficial chemicals. The inclusion of phenolics, flavonoids, saponins, and tannins in this PHCE may explain its anti-ulcer preventive properties. In general, we've discovered a slew of anti-



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ulcer bioactive chemicals that have been previously identified in studies. Ethanol is often used to produce gastric ulcers in albino rats. When ethanol reaches the location of gastric mucosa, it causes vascular injury and triggers cell necrosis via increasing mucosal permeability and the release of bioactive chemicals. The effects of PHCE and standard on ethanol- and stress-induced gastrointestinal damage were studied. PHCE reduced gastrointestinal damage caused by ethanol and stress. In hcl-ethanol; indomethacin; and aspirin produced ulcer models, PHCE showed the best gastro-protection of ulcers at different doses of 300 mg/kg and 500 mg/kg, respectively. In a hcl-ethanol generated ulcer model at 500mg/kg, the best meaningful protective ulceration inhibition findings were determined to be 69 percent. The outcomes of the stomach mucosa tissue protection were validated by histological investigation. The outcomes are listed in the table below [Figure 1].

A stomach ulcer is caused by anti-*Helicobacter pylori* bacteria. It has been observed that several bioactive substances such as genistein, hesperidin, pancreatin, irisolidone, and cabreuvin have anti-ulcer action. The presence of flavonoids in PHCE could explain its gastroprotective properties. The flow of sodium and potassium ions in the lumen is increased by flavonoids, which improves ulcer healing. The tannin concentration of PHCE-500mg had an astringent effect and helped ulcers heal faster. Both of these phytoconstituents work together to improve anti-ulcer healing and protection, and tannins may compete with H₂ receptor antagonists. PHCE-500mg lowers gastric secretion and prevents acid secretion triggered by histamine production and gastric hormone in the same way that H₂ receptor antagonists like Ranitidine do. The anti-ulcer activity of PHCE could be mediated in part by its anti-acid secretion and protective effect, according to the results of the experiments. Thus, the anti-secretory and cytoprotective effect of PHCE extract can be explained in part by the presence of flavonoids and tannins. Finally, the findings of the anti-ulcer activity investigation revealed that PHCE-500mg can help with the treatment and management of gastric and intestinal ulcers [38-41].

CONCLUSION

It has been established that peptic ulcers are primarily caused by an imbalance between protective and destructive biological components. Gastric ulcers, in particular, are attributed to the misalignment of protective biological components. Based on the results of the ulcer model investigation, PHCE has demonstrated potential as a therapeutic agent in various ulcer-induced models. The cytoprotective properties of PHCE are believed to stem from the presence of bioactive chemicals with potentially therapeutic effects. However, a comprehensive investigation is necessary to elucidate the actual mechanism responsible for PHCE's antiulcer efficacy.

ACKNOWLEDGEMENT

We are grateful to the Department of Pharmaceutical Sciences, Mandsaur University, Mandsaur, Madhya Pradesh (M.P), India, for providing laboratory facilities that allowed us to conduct our research in a timely and efficient manner.

Conflict of interest

All of the authors disclose that they have no competing interests.

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Table 1 List of potential antidiabetic bioactive molecules having plants

Name of plants	Phytochemicals	Pharmacological properties
<i>Gymnema sylvestre</i>	flavones, anthraquinones, d-quercitol, gymnemic acid, gymnemosides, gymnemasaponins, lupeol, β-amyrin related glycosides and stigmasterol	Antidiabetic, hepatoprotective and anti-inflammatory activities, etc [9, 10].
<i>Momordica charantia</i>	triterpenoids, saponins, polypeptides, flavonoids, alkaloids and sterols	Antifertility, antiulcer, antihyperglycemic, hepatoprotective immunomodulation, antioxidant, antimutagenic, antilipolytic, etc [11-13]
<i>Syzygium cumini</i>	anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin	Antidiabetic, throat infection, asthma, hepatoprotective, dysentery and ulcers, etc [14-15].
<i>Trigonella foenum</i>	ederagin glycosides. Alkaloids such as	Antidiabetic, antioxidant, anticarcinogenic,





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	trigocoumarin, nicotinic acid, trimethyl cou-marin and trigonelline	hypocholesterolemic, hepatoprotective, and immunological activities, etc [16-17].
<i>Psidium guajava</i>	iso-caryophyllene, veridiflorene, farnesene, dl-limonene, δ-cadinene, α-copaene, α-humulene, τ-cadinol .	Used in problems of dental, sleeping, liver, convulsion, respiratory, wound healing, pain and treatment of diabetes mellitus, etc [18-19].
<i>Tinospora cardifolia</i>	Alkaloids, Terpenoids, Lignans, Steroids and others	Reported antioxidant, hepatoprotective, anticancer, wound treatment, anticancer and immunomodulating activity, etc [20-21].
<i>Boerhavia diffusa</i>	Alkaloids (punarnavine), rotenoids (boeravinones A to J) and flavones.	Reported used in treatment of inflammatory, stone, microbial, asthma, urine, liver, and diabetic treatment, etc [22-23].
<i>Coriandrum sativum</i>	Linalool, α-Pinene, β-Pinene, γ-Terpinene, α-Cedrene, α-Farnasene, p-Cymene, Limonene, Citronellal, Camphor Geraniol, Anethole.	Reported activity against of microbial, liver toxicity, diabetic, fatty condition, convulsion, cancer, and inflammation [24-25]
<i>Andrographis paniculata</i>	Andrographolide, and 14-deoxy-11, 12-didehydroandrographide, etc.	It is having anti-inflammatory, liver protective and management of blood pressure property, etc [26-27].
Mixture of Haritaki, Bibhitaki and Amalaki	flavonoids, alkaloids, phenols	Cardiovascular disease, blood pressure disease, poor liver function, large intestine inflammation, hepatoprotective and ulcerative colitis [28-29].
Trikatu (Mixture of <i>Piper nigrum</i> (kali mirch), <i>Zingiber officinale</i> (adhrakh) and long <i>Piper longum</i> (pippali)	Piperine, gingerols, shogaols, and paradols, oleoresins, and alkaloids.	Bioavailability enhancer, fevers, gastric and abdominal disorders, urinary difficulties, hepatoprotective, neuralgia and boils etc [30-33].

Table: 2 Composition of herbal plants for Poly-herbal extraction

Name of plants	Biological name	Quantity
1. Gudmar leaves	<i>Gymnema sylvestre</i>	100gm
2. Karela seed	<i>Momordica charantia</i>	100gm
3. Jamun seed	<i>Syzygium cumini</i>	100gm
4. Methi seed	<i>Trigonella foenum</i>	100gm
5. Amruda leaves	<i>Psidium guajava</i>	100gm
7. Giloya	<i>Tinospora cardifolia</i>	100gm
8. Punarnava	<i>Boerhavia diffusa</i>	100gm
7. Coriander leaves	<i>Coriandrum sativum</i>	100gm
8. Kalmegha leaves	<i>Andrographis paniculata</i>	100gm
9. Triphala	Mixture of Haritaki, Bibhitaki and Amalaki	100gm
10. Trikatu	Mixture of black pepper, and dry ginger	100gm
11. Aswagandha	<i>Withania somnifera</i>	100gm





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Table 3: Results of Preliminary Phytochemical Screening

Sr. No	Phyto-Constituent Category	Inference
1	Carbohydrate	Positive
2.	Cardiac glycoside	Negative
3	Flavonoids	Positive
4	Alkaloids	Positive
5.	Tannin and phenolic component	Positive
6.	Protein	Positive
8.	Saponin	Positive

Table 4: Effect of PHCE on Ethanol, Indomethacin and Aspirin induced ulcer models

Groups	Parameter	Control	Standard Control	PHCE 300mg/kg	PHCE 500mg/kg
Ethanol	Ulcer Index	23.24±0.05	8.508±0.164*	14.70±0.036*	7.018±0.248*
	% Ulcer Inhibition	-----	63.42	36.74	69.80
Indomethacin	Ulcer Index	23±0.576	7.98±0.249*	14.82±0.308*	8.226±0.231*
	% Ulcer Inhibition	-----	65.30	35.56	64.23
Aspirin	Ulcer Index	21.26 ±0.371	7.685±0.248*	15.78±0.208*	10.536±0.223*
	% Ulcer Inhibition	-----	63.85	25.77	50.47

Data are expressed as mean± S.E.M. (n = 6), **p < 0.01; ns: not significant vs. control.

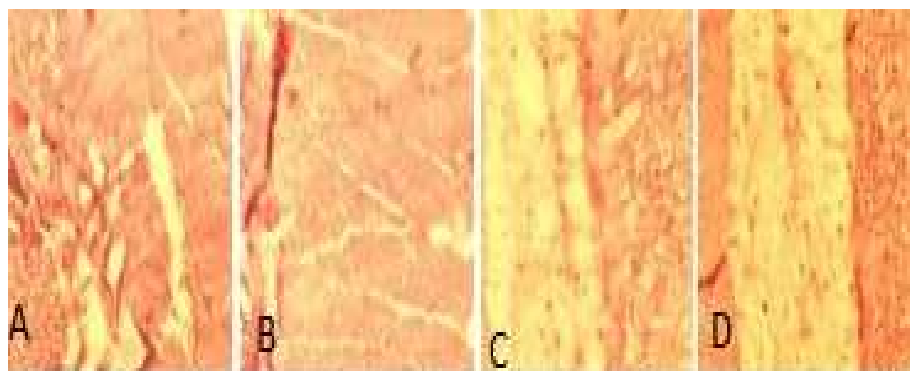


Figure.1: Ethanol-induced scenario, histopathology of rat stomach mucosa samples.

- A) Negative Control, which indicates that the structure is normal.
- B) Sucralfate 100mg/kg as a standard control
- C) PHCE (300 mg/kg) shows the usual structure
- D) PHCE (500 mg/kg) indicates that the structure is normal





Agrarian Economy in Early Medieval Kashmir: A Study of Crop Cultivation and Irrigation

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Received: 21 Feb 2024

Revised: 03 Mar 2024

Accepted: 16 Jul 2024

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ABSTRACT

The study attempts to explore the agricultural practices in early medieval Kashmir with special reference to the Karkotas, which were based on a diverse range of crops, including rice, barley, pulses, oilseeds, saffron, vegetables, grapes, and cotton. It explores the irrigation system in Kashmir, which was based on the use of rivers, lakes, and springs. The earliest irrigation systems in Kashmir were relatively simple, but they became more sophisticated over time. The early medieval period saw significant advancements in irrigation, with the construction of canals, dams, and embankments. The study provides an examination of the implications of these irrigation enhancements on agricultural output in Kashmir, asserting that the expansion of irrigation methods facilitated the cultivation of an augmented array of crops while simultaneously amplifying yield rates. It posits that the implementation of these irrigation systems provided a safeguard against the detrimental effects of droughts and flooding on agricultural produce. The study explores the significance of these irrigation systems in bolstering agricultural productivity within the valley. It provides an examination of the progressive advancements in irrigation practices, elucidating the transformation from basic to advanced irrigation structures over time.

Keywords: Kashmir, agriculture, irrigation, early historical period, early medieval period





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INTRODUCTION

In the realm of historical studies, the agrarian economies of ancient civilizations provide a rich reservoir of data and inference. The present study takes an in-depth look at one such example, the early medieval Kashmir, which was characterised by a robust agricultural system. The essence of this study is to reconstruct the agrarian economy of that era with a particular focus on crop cultivation and irrigation techniques. The era is known for some of the revolutionary rulers like Lalitaditya, Avantivarman and their agricultural measures. With the agrarian economy being the bedrock of this society, understanding the intricacies of crop cultivation and irrigation techniques employed is critical. The agricultural practices of the period under review were well-developed and intricate, characterised by a wide array of crops and efficient irrigation methods. Through a rigorous examination of historical texts, archaeological records, and palynological evidence, this study aspires to draw a comprehensive picture of the early medieval Kashmiri agrarian economy.

Agrarian Practices and Cultivation

The prevalence of agricultural practices held significant sway in the valley, a fact derived from the manifold agricultural rituals delineated in the Nilamata Purana. It imparts a comprehensive description of various ceremonies and rites intimately linked with agricultural undertakings. Sources like *Nilamata Purana* and *Ksriparasara* mention several rituals associated with agriculture. *Ksriparasara* refers to the rituals related to the use of manures in fields and the auspicious dates for ploughing [1]. Following this, offerings were made to an extensive pantheon of deities prior to the initiation of the ploughing process in rice fields. [2] The act of sowing paddy was also interwoven with the performance of a myriad of rituals. Notably, the paddy seeds were subject to a unique purification process before sowing, involving their immersion in water, and gold was also put there for some time for the purification of the seed [3]. Analysing the agricultural potential of the valley, it becomes apparent that the terrain was highly conducive to such activities. From a literary standpoint, it is indicated that the agrarian window was predominantly limited to the summer season due to the climatic conditions of the region [4]. Despite this restriction, the valley proved remarkably prolific, producing all crops within this single season. Diversification in the type of agricultural land found in the valley is observed, reflected by the varying produce it offered [5]. The Nilamata Purana paints a vivid picture of the Kashmiri land as *adevamatrka*, signifying its potential to yield a multitude of grains without the necessity of rainfall and being resistant to the threat of famines [6]. This depiction may seem somewhat hyperbolic given the existence of references to famines [7], yet it serves to underline the extraordinary properties of certain parts of the land capable of retaining moisture, even in the absence of rains.

It is of particular interest that both the *Rabi* (winter) and *Kharif* (summer) crops in Kashmir are cultivated within the same period, commencing in March and concluding in November. This practice yields a unique agricultural framework, referred to as *ekfasli*, wherein only a single crop is harvested annually [8]. With the onset of heavy snowfall during the winter months, agricultural pursuits are restricted from March to October. Kashmir's fertile soil and plentiful water resources have long established it as a notable contributor to agricultural output, producing a surplus of food to sustain its inhabitants. Studies investigating the land system of Kashmir suggest that the valley exhibited superior agricultural conditions during the early medieval periods compared to subsequent eras [9]. This is attributed to a more efficient irrigation system during the aforementioned periods [10], resulting in reduced impact from famines [11]. It should be recognised that the aforementioned factors contributed to a higher population density and an increased number of villages during the early medieval period of Kashmir compared to later eras [12]. The process of rice cultivation involved an initial ploughing of the fields [13], with seeds sown in March and harvesting carried out in September or October [14]. Following the harvest, the valley was typically abandoned by its inhabitants [15]. The techniques employed in rice husking remain remarkably consistent with contemporary practices. Prior to the removal of the outer husk, the paddy must undergo a drying process. Evidence of this can be sourced from the Rajatarangini, where a woman is depicted observing rice drying under the sun in an outdoor courtyard [16]. Besides, the Kuttanimata refers to the *dehusking* of *sali* utilising a pestle [17] Barley, referred to as *Yava*, is among other notable crops cultivated in the valley. Unlike paddy, barley cultivation does not require particular



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attention and typically thrives on higher mountain slopes.¹ Its sowing season spans from October to December, with harvesting usually taking place in June and July [18]. Other prominent agricultural products include pulses, oilseeds, saffron, vegetables, grapes, and cotton, as referenced extensively in Kashmiri texts [19]. Despite the lack of detailed references in early texts regarding the cultivation of these products, late accounts attest to their presence. The fact that these crops are frequently mentioned in regional texts indicates their cultivation during the early medieval periods. A comprehensive account is provided by Walter Lawrence, who chronicled the valley in the nineteenth century. He details the sowing of *mung* (*Phaseolus aureus*), *mah* (*Phaseolous mungo*), and *mothi* (*Phaseolus aconitifolius*) in the months of April and May [20]. These crops were often planted in rice fields not currently used for rice cultivation and ripened in September [21]. Oil seeds, particularly *tila* (*Sesamum indicum*), were sown in April and did not require manure [22]., although their yield was contingent upon soil fertility and moderate rainfall [23].

The cultivation of saffron, one of the valley's most valued crops, was largely limited to a specific area. This region, known as Padmapura (presently Pampore) [24], remains the exclusive saffron producing area, despite advances in agricultural technology. The reason for this can be attributed to the particular type of soil required by saffron plants, comprising a light ferruginous clay near the river Jhelum [25]. The Nilamata Purana employs the term 'Sa' as a general term for vegetables [26]. However, the available texts do not provide comprehensive details regarding the different varieties of vegetables cultivated in the valley during the early medieval periods. Nevertheless, the high consumption of vegetables leads to the assumption that a diverse array of leafy vegetables was grown, including cauliflower, carrot, leafstalks of the Pamposh, nymphaea lotus, and horned walnuts, among others[27]. Regarding grape cultivation, the Martand region was the primary grape-growing area in earlier times, although this later shifted to the Dal shores [28]. Cotton is mentioned in the Kuttanimata by Damodaragupta [29], but most references to its cultivation pertain to more recent periods[30]. It is grown, albeit on a smaller scale, in May, predominantly on the *Udars*, as it doesn't require significant irrigation [31] Harvesting usually occurs in September and October. It is understood that during the earlier period, cotton was produced in considerable abundance and was generally of good quality.

Advancements in Irrigation and Agricultural Practices

The agricultural output in early India was primarily reliant on the monsoon season, and irregular and insufficient rainfall led farmers to rely on irrigation. Irrigation involves the artificial application of water to soil in regions with inadequate rainfall. It reduces farmers' dependence on rainwater for agricultural purposes and plays a crucial role in the agricultural production process. Storage facilities such as large tanks and reservoirs have existed since ancient times to meet the water requirements of cultivators in different seasons. The erratic and inequitable distribution of precipitation necessitated the excavation of wells and the establishment of water conduits for irrigation purposes. In Kashmir, irrigation systems have a long-standing historical presence. The cultivation of agricultural land necessitated a systematic water infrastructure. Fortuitously, the valley is rich in water resources, which are instrumental in its economic advancement. The ancient text, *Nilamata Purana*, indicates the absence of a systematic irrigation network in Kashmir[2]. However, the phrase '*adevamatrika*' used within the text implies that the predominant sources of irrigation in the valley were lakes, rivers, and springs[3] The physical geography of Kashmir likely simplified land irrigation due to the plentiful availability of water. Supporting this notion, Lawrence observes that "due to the elevations from which water can be derived, there is scarcely any portion of the valley which cannot be irrigated" [4]. Notwithstanding this, water shortages were experienced in certain areas. Seasonal flooding in the valley, often occurring in summer when snowmelt resulted in a surge of water from the mountains, led to the banks of the river being overflowed. This resulted in the destruction of field crops, precipitating famines[5].The rulers of Kashmir took measures to protect cultivable lands from flood disasters and conserve water for irrigation. King Suvarna built the *Suvarnamanikulya* canal [6], which irrigated part of the *advin pargana* on the alluvial plateau south of the *Ramgar* river in the Kulgam district. His successor, King Damodar II, extended the irrigation system by building long stone dykes to protect against inundations[7] and constructing the *guddasetu*[8] dam to bring water into the town he built on the Damodara Suda [9]. Embankments were also erected by a minister of King Baladitya[10]to guard cultivable lands against floods, and the water was later used for irrigation. Artificial irrigation channels from ancient times can also be found on other alluvial plateaus, mainly on the *udars*[11] of Martand and Zainpur[12].



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However, the work of irrigation was impeded when Mihirkula, the ruler of the sixth century AD, redirected the Chanderkulya river due to rocks in the river's course[13]. Raja Baka also built the Bakavati canal for irrigation purposes[14]. The early medieval period in Kashmir's history is renowned for significant advancements in irrigation systems, primarily driven by the region's various rulers. Among these, Lalitaditya of the Karkota dynasty has a prominent place in the annals of Kashmir for his innovative irrigation methods. His reign was characterised by the initiation of numerous schemes aimed at developing agriculture, safeguarding the country from recurring floods, and boosting production activity. Although existing historical sources do not provide a detailed account of the canals constructed during Lalitaditya's reign, they do indicate that the flourishing agriculture of the period relied heavily on regular water streams. As such, it is reasonable to conclude that Lalitaditya was instrumental in advancing the management of these water resources to enhance agricultural productivity[15]. The rulers of Kashmir faced a considerable challenge due to the region's geographical constraints, which made it challenging to create canals in certain areas. To overcome these obstacles, they sought alternatives and introduced new technological methods for water management and distribution. Lalitaditya, in particular, developed special provisions for irrigating Chakradhara (modern Tasakdar) Karewa, which involved lifting water from the river Jhelum. Kalhana, provides additional insights into these arrangements. He refers to the specific measures taken to channel the water of the Vitasta at Chakradhara [16] Moreover, he offers a comprehensive account of the construction and distribution of a series of water wheels, known as 'arhatta,' to various villages [17] These measures were conceived to augment agricultural productivity, thereby shielding the country from the devastating effects of frequent floods. Lalitaditya's wife, Ishanadevi, also contributed to the welfare of the people by digging a well known for its therapeutic properties, thereby providing relief to those afflicted with various diseases [18]. Unfortunately, the successors to Lalitaditya's throne did not continue his legacy of improving irrigation systems. This neglect led to a resurgence of flooding in the valley, highlighting the importance of sustained attention to irrigation systems for maintaining agricultural productivity and preventing natural disasters.

The significant strides made during Lalitaditya's reign in managing water resources have left an indelible mark on Kashmir's history. His innovative approaches to irrigation, combined with the implementation of new technologies, paved the way for a vibrant agricultural sector despite the region's challenging geographical constraints. Moreover, his measures to protect the country from recurring floods underscore the importance of a proactive and strategic approach to managing natural resources. Although the successors to Lalitaditya's throne failed to uphold his commitment to improving irrigation activities, the developments during his reign provide a valuable blueprint for managing water resources in regions with similar geographical constraints. Thus, Lalitaditya's contributions extend beyond the historical context, offering insights and lessons for modern resource management practices. During the Utpala Dynasty, King Avantivarman implemented a series of changes to help the suffering people. He brought the water of the Vitasta river under control to save the valley from depletion. His rule was known for introducing an agricultural revolution to the region, which had previously suffered from insufficient production and frequent floods. Suyya, the irrigation minister of King Avantivarman, made significant changes to the irrigation system. He was called the Lord of Food (annapati)[19] and was responsible for draining the Vitasta river and controlling it by constructing a stone dam and clearing its bed. This allowed him to shift the junction of the Vitasta and the Sindhu rivers[20]to their current position near Srinagar and combine the two rivers that flow through Wular lake.

Suyya built protective stone embankments for seven yojanas along the river and circular dykes to protect villages[21] His efforts, under King Avantivarman, brought new lands under cultivation and increased production, benefiting both the state and the people. They also saved the country from recurring floods and famines[22]. Frequent famines were a grim consequence of recurring floods in Kashmir. As previously mentioned, King Lalitaditya made commendable efforts to manage and utilise the accumulated water. Regrettably, his successors disregarded these public welfare initiatives, leading to devastating floods that ravaged the region. The scarcity of resources caused the price of a khari of rice to inflate to 1050 dinars in famine-stricken areas, a sum far beyond the reach of an ordinary citizen[23]This grim situation persisted until Suyya intervened. Suyya discerned that the valley's flooding was primarily due to the inadequate flow of the Vitasta river through the constricted passage near Baramulla, which was persistently being obstructed by debris falling from the adjacent hillside. The challenge lay in clearing these



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obstructions and widening the river passage. To address this issue, Suyya employed a straightforward strategy. He filled many pots with money (dinars) and set sail towards Madavarajya[24] Upon reaching a village named Nandaka, which was submerged in floodwaters, he threw some of the money into the water and retreated.[22] He repeated this action at another location, Yakshadara, dispensing a large sum of money into the river[25] His actions were deemed irrational by the ministers and the public[26] However, this unusual strategy provided an unexpected opportunity for the local people to acquire money. Therefore they jumped into the river and searched for money while doing so dragged out of the river rocks[27] In a critical juncture in Kashmir's history, the region's inhabitants, spurred on by their quest for fortune, inadvertently participated in a large-scale engineering endeavour, designed and led by the clever Suyya. Enticed by pots of money that Suyya had strategically deposited in the river, people willingly plunged into the water. In their frantic searches for this unexpected windfall, they removed rocks and other debris obstructing the river's flow, clearing the mud, slush, and stone from its banks. This process was repeated for several days, gradually reducing the impediments in the river. Suyya, recognised for his engineering acumen, then constructed a temporary dam made of stones at a particular location, which allowed for the removal of the silt from the river[28] To further prevent debris from falling back into the water, embankments were erected on both sides of the river[29] This phase of the operation took an additional week, culminating in the destruction of the temporary dam[30]. Upon completing these tasks, new river beds were designed and constructed in places frequently impacted by flooding. This redirected the flow of the river towards the Mahapadma lake (known today as Wular Lake), thereby lowering the water levels. As a result, the irrigation system was enhanced, ensuring that all inhabitants received an equitable distribution of water.

Kalhana's historical account reveals that Suyya first surveyed different types of land and the specific needs of the villages, particularly those areas that were no longer reliant on rainfall [2]. This resulted in an efficient water allocation system, providing each area with water according to its unique needs and requirements. This well-planned initiative boosted agricultural output considerably[2] Suyya's efforts were not merely aimed at preventing famines but also sought to increase agricultural production on a large scale. Kalhana's records indicate a significant decrease in the price of dhanya (rice) from two hundred dinaras to just thirty-six dinaras during Avantivarman's reign, marking the lowest price ever witnessed in the valley[3] Kalhana praises Suyya's ingenuity and virtue, stating, 'neither Kashayapa nor Samkarsana (Balabhadra) bestowed those benefits which the virtuous Suyya produced with ease in that land.'[4] Moreover, Harsha, from the Lohara dynasty, is credited with the creation of Pampa Lake, identified by Stein with the present-day Pampasar[2]. This lake, home to diverse species of birds and animals, extended to the curved shores of the horizon, symbolising a milestone in the region's progress toward managing its water resources effectively[2]. The collective efforts of visionary leaders and active participation of the local people transformed the land, overcoming geographical challenges and turning them into agricultural opportunities. This period marked significant advancements in irrigation and agricultural practices, playing a pivotal role in shaping the socio-economic fabric of Kashmir.

CONCLUSIONS

The agricultural practices in Kashmir have evolved over time, with a diverse range of crops being cultivated. The irrigation system in the valley also evolved, with significant advancements being made during the early medieval period. Irrigation allowed farmers to grow a wider range of crops and increased crop yields. Irrigation also helped to protect crops from drought and flooding. The study explored the importance of astrological considerations in determining the auspicious time for commencing agricultural operations. The study analysed the role of various rituals and ceremonies in the agricultural process, including the purification of paddy seeds, the offerings to deities, and the ploughing of fields. The study finds the advancements that have been made in irrigation over time, particularly during the reigns of Lalitaditya, and Avantivarman and the measures taken by Suyya. These rulers made significant contributions to the development of irrigation in Kashmir, and their efforts helped to improve agricultural productivity and food security in the valley.





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