



## A Systematic Review to Define Features and Techniques for Crop Yield Prediction using AI

Dhanya.K<sup>1\*</sup> and B.Jayanthi<sup>2</sup>

<sup>1</sup>Research Scholar, Department of Computer Science, Rathnavel Subramanian College of Arts and Science, Sulur, Coimbatore, Tamil Nadu, India.

<sup>2</sup>HoD, Department of Computer Science, Rathnavel Subramanian College of Arts and Science, Sulur, Coimbatore, Tamil Nadu, India.

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### \*Address for Correspondence

#### Dhanya K

Research Scholar,

Department of Computer Science,

Rathnavel Subramanian College of Arts and Science,

Sulur, Coimbatore, Tamil Nadu, India.

E.Mail: dhanyakmail@gmail.com



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### ABSTRACT

India's fundamental and preeminent cultural practice has long been thought of as agriculture. Agriculture has been gradually declining ever since the advent of new cutting-edge techniques and technologies. There is no appropriate technology or methods to handle the situation. Data mining is important for forecasting crop yields as well. In this study, we carried out a Systematic Review (SR) to extract and synthesis the methods and features that have been used in crop yield prediction research. Using inclusion and exclusion criteria, we chose 13 papers from a total of 50 that met our search criteria and were found to be relevant across multiple databases. We thoroughly examined these chosen papers, evaluated the techniques and features applied, and offered recommendations for additional studies. Temperature, rainfall, and soil type are the most frequently used features while Artificial Neural Networks are the most widely used technique in these models, per our data.

**Keywords:** Crop Yield Prediction, Machine Learning, Systematic Review, Deep Learning, Artificial Intelligence

### INTRODUCTION

Agriculture has long been seen as India's primary and dominant cultural practice. Since ancient people farm their land, their requirements have been met. As a result, natural crops are grown and used by numerous organisms, including humans, animals, and birds. The greens products made on the land that the critter ate lead to a healthy

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and happy life. Since the development of new cutting-edge technology and methods, agriculture has been slowly declining. Due to these numerous inventions, individuals have focused on creating artificial and hybrid products, which can result in an unhealthy lifestyle. Modern people are unaware of the importance of planting crops at the proper time and location. Due to these cultivating methods, the seasonal climate is also changing at the expense of basic resources like soil, water, and air, which causes food poverty (E. Manjula *et al.*). Since its inception, agriculture has been the main activity in every society and civilization that has existed throughout human history. It is not only a huge part of the expanding economy, but it is also necessary for our survival. It is also a vital sector for the Indian economy and the future of humanity. Additionally, it makes up a sizable amount of employment. As time goes on, the demand for production has dramatically expanded. People use technology in an utterly incorrect manner to produce in large quantities. Every day, new hybrid kinds are created. These kinds, however, don't offer the same critical components as a crop grown naturally. These artificial methods degrade the soil. All of this causes more environmental deterioration (Anakha *et al.*).

There are no suitable solutions or technologies to deal with the predicament we confront after studying all these challenges and problems, including weather, temperature, and numerous other elements. There are numerous approaches to boosting economic growth in the agricultural sector in India. Crop output and quality can be increased and improved in a variety of ways. Data mining is important for forecasting crop yields as well. We conducted a systematic review (SR) to gain an overview of the work that has been done on the application of ML in crop production prediction. A systematic review (SR) identifies potential research gaps in a specific field of study and guides practitioners and academics who wish to do new research in that field of study. To address the research issues outlined in the study, all pertinent studies are accessed from internet databases, synthesized, and presented using a technique in SR. An SR study opens up fresh viewpoints and aids in the understanding of the state of the art for new researchers in the subject.

The entire body of research on the use of machine learning in crop production prediction problems is presented in this article. We share our empirical findings and responses to the research topics outlined in this review article in this study. The substance of this paper is ordered as follows: The background of the research is explained in Section 2. Current condition of Indian Agriculture is discussed in Section 3. The Literature Review is discussed in Section 4, and this paper concluded in Section 5.

## RESEARCH METHODS

In this section, as shown in Fig. 2.1, the key stages of the review technique (research approach, quality evaluation standards) were described.

### Research Questions

The purpose of this SR is to get knowledge about the studies that have been written about crop yield prediction using AI. Studies have been evaluated from a variety of angles to get an understanding. The following four research questions (RQs) have been established for this SR study.

RQ1: Which artificial intelligence methods have been applied to crop yield prediction in a recent field of study?

RQ2: Which features have been used to forecast crop yield using artificial intelligence in a recent field of study?

RQ3: What are the evaluation metrics available for this study?

RQ4: What are the difficulties associated with utilizing machine learning to predict crop yield?

RQ5: What are the methods used for prediction? Which approach proved most effective?

We began our analysis in January 2021 and used the majority of studies from 2017 to 2020 as well as some earlier ones as required. IEEE publications, Science Direct, and Open Access Journals were the databases we used. To make sure that the research included in this study was worthwhile, appropriate, and would help us achieve our main goal, the criteria for inclusion and exclusion were devised during the selection criteria stage.

Inclusion standards:





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- Papers published solely to forecast crop yield.
- Studies that made predictions using machine learning or neural networks.
- Papers that described the approach and its efficacy metrics.
- Papers that discussed the datasets of different crops and yields.

#### Exclusion standards

- Papers that failed to acknowledge the reliability of the results.
- The Paper was not journal or conference published.
- The classification in the paper did not make use of neural networks or machine learning.
- Lack of mention of any specific crop dataset in the paper.

#### Search Strategy

The following search terms were used to locate all previous research:

- “Crop Yield” and “ Prediction” and “Artificial Intelligence”
- “Crop Yield” and “ Prediction” and “Machine Learning”
- “Crop Yield” and “ Prediction” and “Neural Networks”
- “Crop Yield” and “ Prediction” and “Deep Learning”
- “Agriculture Yield” and “ Prediction” and “ Artificial Intelligence”
- “Different Crops” “Yields” and “Machine Learning”

#### Constraints of Indian Agriculture

The expected harvest and post-harvest loss of India's key agricultural products in 2016 was Rs 92,651 crore (\$13 billion), or about three times the agriculture sector's budget for the 2016–17 fiscal year. Almost 16% of vegetables and fruits worth Rs 4.8 crore were lost from 2012 to 2014. The main causes of the losses include the farmers' poor access to precise and current market information, the absence of supply and demand forecasting, unsatisfactory cold storage facilities and undernourishment processing facilities, the substantial middlemen standing between the agricultural producers and the buyers, poorly designed and inefficient supply chains, and these factors. Low yield is one of the greatest problems India's agricultural sector is currently facing. Compared to industrialized countries, India's farm production is 30 to 50% lower. Low agricultural production is mostly caused by average farm size, inadequate infrastructure, low utilization of farm equipments and best farming practices, the decline in soil fertility owing to excessive fertilization, and ongoing pesticide use. Given the tiny size of Indian farms (70% are under 1 hectare, compared to a national average of fewer than 2 hectares), they have limited access to assets including financial supports, credit (or lenders), sustain skills, educational services, and irrigation solutions. Yield has an immediate impact on a farmer's cash flow and capacity to react to market variations.

Long-term, yield prevents a farmer's capacity to invest in their farm's future to increase productivity and reduce crop-related risks as well as to invest in their community in areas like education, healthcare, training, and other things. The Indian Agricultural Sector is looking for technologies, goods, or services that are accessible, affordable, and simple to use to increase India's agricultural productivity. Data-driven and procedure models are the two broad categories of yield prediction models (Nishant *et al.*, 2020). The first group consists of a wide range of models, all of which include parameters that are learned directly from the data, and which solely choose the predictors and create the features using domain knowledge. Using a hybrid of data-driven and procedure techniques, the yield was predicted in nine out of the 101 investigations. The predictor that was most frequently utilised in data-driven strategies was information on crop reflectance. Growth and yield models can be used to broaden the range of predictors in data-driven models. Data-driven models can be used to predict missing input for process-based models. Data-driven models can be used to build metamodels, reducing the computational burden.





## LITERATURE REVIEW

Planning the organization of their planting, both on the farm and national scales can be done by forecasting the area of cereals, potatoes, and other energy crops. It is essential to use effective feature selection techniques to transform the raw data into a dataset that is Machine Learning friendly to guarantee that a particular machine learning (ML) model operates with a high level of precision. To anticipate the size of plant cultivations' yields, a variety of feature selection and classification algorithms were applied (Raja *et al.*, 2022). To ensure that only the most important features are included in the model, it is necessary to use optimal feature selection. The findings show that compared to the current classification technique, an ensemble technique delivers greater prediction accuracy. The system's objective (Rushika Ghadge *et al.* 2018) is to assist farmers in cultivating the right crops for higher yields. It analyses the nutrients present in the soil and crop productivity based on location to be exact and accurate in predicting harvests. Kohonen Self Organizing Map (Kohonen's SOM) and BPN (Back Propagation Network), two supervised and unsupervised learning methods, were used to attain their goals. The two algorithms' outputs are compared, and the algorithm producing the best and most accurate results has been chosen. Additionally, the end user is given accurate advice on the fertilizers best suited for each specific crop. However, the author does not provide comparison results or performance as proof.

The study (Suresh *et al.*, 2021) demonstrated the usefulness of data mining methods for forecasting agricultural yields based on climate input variables. The developed website which is user-friendly, and all additional grains and regions selected for the analysis should have the reliability of prediction above 75%, suggesting higher predictive performance. Through the use of data from that region, the website was created to forecast agricultural yield. They are forecasting crops at the district level. Dataset of 12 years' worth of soil and climate characteristics, including rainfall, temperature, humidity, and soil quality. These factors can help with the prediction of the crops by utilizing various classifiers on the given dataset. As a result, several variables are reviewed, and those that strongly support accurate crop prediction are evaluated.

Crop yield prediction studies need the use of numerous production parameters and techniques. Some people utilise algorithms to uncover the most predictive characteristics, while others use algorithms to find forecasts (Gupta *et al.*, 2022). In this part, a machine learning-enabled framework for precise and quick agricultural yield production is provided. The initial step is to collect the input data set, which contains all of the crop's data. The Relief algorithm is then used to choose features. By categorising significant elements associated with a certain real-world circumstance, feature selection aids in the production of correct findings. Then, features are extracted using the LDA technique. Then, machine learning methods like PSO-SVM, KNN, and random forest are used to do the classification process. The paper suggests (Pham *et al.*, 2022) a novel paradigm for improving agricultural yield prediction based on VCI/TCI data utilizing sICA, PCA, and ML. Before training the models, sICA separates an agricultural region into sub-regions with uniformly distributed VCI/TCI patterns, and the use of PCA and ML attempts to increase the accuracy of the outcome models in comparison to the ML-only approach. High accuracy in estimating rice yields at the sub-regional level in Vietnam was attained using the framework in the case study, which implies that confidence in the suggested framework is justified.

The research (Nishant *et al.*, 2020) predicts the yield using advanced regression techniques including Kernel Ridge, Lasso, and ENet algorithms and leverages the idea of stacking regression to improve the algorithms and provide a more accurate prediction. Utilizing the out-of-fold predictions from the other models that were used to train the primary Meta model, they build a Metamodel. The test part's predictions serve as inputs for the meta-model, a higher-level learner. Lasso Regressor serves as their Meta model. Root mean square error serves as the project's performance metric. For ENet, the application error when the models were applied individually was around 4%, for Lasso it was about 2%, for Kernel Ridge it was about 1%, and lastly after stacking it was less than 1%.



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The study (Tripathi *et al.*, 2022) was conducted in Punjab, India's Rupnagar district. Wheat crop yield was evaluated using estimated soil health metrics, SAR backscatter, and optical remote sensing satellite data characteristics. With R<sup>2</sup> values of 0.723 and 0.684 in the training and testing phases, respectively, and mean absolute errors (MAE) of 0.98 and root mean square errors (RMSE) of 1.24 for the 2019–20 seasons, the soil health-based DLMLP model outperformed all other models in terms of crop yield estimation. While the MAE and RMSE were 37.97% and 38.61% smaller than the OLS regressor for estimating wheat crop yield, the DLMLP test R<sup>2</sup> was 42.2% higher than the Ordinary Least Squares Regressor (OLS). When the soil health parameter values for the wheat seasons from 2015–16 through 2018–19 were not validated, the soil health-based DLMLP model provided a good level of yield estimation accuracy. The unique aspect of this work is that it calculates soil health parameters for the early growth stages of wheat crops when the soil is primarily exposed and uses them to predict crop output.

(Nevavuori *et al.*, 2019) Smart farming is becoming more and more popular all around the world. Crop and weed detection, biomass evaluation, and yield prediction are the key goals. The availability of yield mapping devices, which are currently not very popular among farmers, is required for the evaluation of machine learning approaches for remote sensing-based yield prediction. Convolutional Neural Networks (CNNs), a deep learning technique that excels in image classification problems, are used in this study to develop a model for crop production prediction using NDVI and RGB data collected by UAVs. For data collected during the early part of the growth season (i.e., in June 2017, growth phase 25%) with RGB data, a mean absolute error (MAE) in yield prediction of 484.3 kg/ha and a mean absolute percentage error (MAPE) of 8.8% was achieved using the Adadelta training algorithm, regularisation with early stopping, and a CNN with 6 convolutional layers. Data collected subsequently in July and August of 2017 (growth phase >25%) were used to calculate an MAE of 624.3 kg/ha (MAPE: 12.6%). Significantly, RGB data outperformed NDVI data in terms of CNN architecture performance.

The study focuses (Ramu& Sri, 2021) on the widely used wheat yield prediction utilizing two artificial intelligence (AI) models and compares them for a more accurate crop yield forecast. The two separate artificial intelligence models used in this work to forecast wheat crop yield are compared. To estimate crop output, farmers must contend with several challenges. The crofters will be able to forecast the wheat crop production thanks to our project. The artificial neural network results in a loss of 11.1782 and the random forest approach yield an R<sup>2</sup> score of 0.999. The random forest technique outperforms the artificial neural network in forecasting. Ten decision trees were utilized in the random forest as the base learners. As a final product, they used the weighted average of every base learner. And on ANN relu, a hidden layer activation function is employed, but an output layer activation function is not. The SGD optimization algorithm was utilized.

Crop variability within a field may be tracked and forecasted, which can help farmers make the best choices in various circumstances. This study (Kayad *et al.*, 2019) looked into the possibilities of analyzing corn (*Zea mays*) grain yield spatial variability at the field scale using vegetation indices (VIs) collected from Sentinel-2 photos and machine learning algorithms. To determine whether the VI (Vegetation Index) from a total of 34 Sentinel-2 photos taken at various crop ages correlated with the observed yield observations. To determine whether VIs could perhaps be utilized to model yield, correlations between VIs and yield were examined. Results are best at a specific point after crop planting, which is consistent with findings from correlations of vegetation indices but with a higher overall R<sup>2</sup> value. However, using a Random Forests model trained with a few ground samples collected between 105 and 135 days of crop age, a plausible prediction with a 10% error can be expected in a scenario with expected yields between 9 and 18 tons/ha.

The purpose of the study is to assess the effectiveness of deep neural network-based UAV-based multimodal data fusion for estimating soybean (*Glycine max*) grain yield utilizing RGB, multispectral, and thermal sensors (DNN) (Maimaitijiang *et al.*, 2020). Partial Least Squares Regression (PLSR), Random Forest Regression (RFR), Support Vector Regression (SVR), input-level feature fusion-based DNN (DNN-F1), and intermediate-level feature fusion-based DNN were used to extract and combine multimodal information to estimate agricultural grain yield (DNN-F2). The findings show that multimodal data fusion increases the yield prediction accuracy and is more adaptable to



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spatial variations. The DNN-F2 model had the highest accuracy, with an R2 of 0.720 and a relative root mean square error (RMSE%) of 15.9%. DNN-based models were also less susceptible to saturation effects and performed more adaptively when predicting grain yields. To assess the robustness, the proposed approach must, however, be evaluated for several crop kinds, a larger number of genotypes, and various developmental phases and environmental variables.

The research proposes (Khaki *et al.*, 2020) a deep learning framework for agricultural production prediction based on environmental data and management methods utilizing convolution neural networks (CNNs) and recurrent neural networks (RNNs). The proposed CNN-RNN model was used to predict corn and soybean yield across the entire Corn Belt (including 13 states) in the United States for the years 2016, 2017, and 2018 using historical data, along with other well-known techniques like random forest (RF), deep fully connected neural networks (DFNN), and LASSO. The biggest feature of this proposed model is that it has proven to be capable of generalizing yield prediction to untested environments without appreciable loss in prediction accuracy. It is also designed to capture the temporal dependencies of environmental factors and the genetic evolution of seeds over time without requiring genotype information. The model's ability to explain the variation in crop yields was then combined with the back propagation method to disclose the extent of weather conditions, accuracy of weather predictions, soil conditions, and management practices.

To predict agricultural productivity, the suggested work (Dhiya & Durairaj, 2020) builds a Deep Recurrent Q-Network model, which is a Recurrent Neural Network deep learning algorithm over the Q-Learning reinforcement learning algorithm. The data parameters feed the recurrent neural network's progressively stacked layers. Based on the input parameters, the Q-learning network creates a crop yield prediction environment. The output values of the recurrent neural network are translated into Q-values via a linear layer. The reinforcement learning agent combines a threshold and a set of parametric variables that help forecast crop yield. The agent then obtains an overall score for the actions taken, which is determined by minimizing error and maximizing forecast accuracy. With an accuracy of 93.7%, the suggested model accurately forecasts crop yield while outperforming other models and maintaining the original data distribution. From the above reviews, it is clear that the contribution done on the different domains of interest is depicted in below Table 1. From the above reviews, features needed for crop yield prediction are depicted in below Table 2. From the above reviews, the major parameters used for evaluation are depicted in the below Table 3

**CONCLUSION**

This study revealed that, depending on the size of the research and the data's availability, the selected papers employ several aspects. Every article looks at yield prediction using machine learning, however, the characteristics vary. Scale, geological location, and crop are other differences among the experiments. The dataset's accessibility and the study's objectives affect the characteristics that are chosen. Studies have also shown that models with more characteristics don't necessarily have the optimum results for yield prediction. Models with more and fewer features should be evaluated to determine the one that performs the best. Different research has employed a variety of algorithms. The most popular models are gradient-boosting tree, neural networks, linear regression, and random forest. In the majority of the research, different Machine Learning models were tested to see which one made the best predictions. We found that the most popular algorithms are Regression, Random Forest, Back propagation ANN, CNN, LSTM, and NN. Other sorts of algorithms, nevertheless, are also used to solve this issue. We believe that this work will open the door for more investigation into the topic of agricultural production prediction.

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**Table: 1. Domain of Interest**

Models	No of Papers
ML	8
DL	5
AI	13

**Table: 2. Features Used for Prediction**

Feature	Dataset	No of times used
Temperature	Other Properties related to Crop Yield	15
Rainfall		10
Humidity		11
Irrigation		5
Solar radiation		10
Precipitation		9
Climate		1
Air		5
Radiation		2
NDVI		6
Nitrogen	Nutrient Property Dataset	6
Potassium		5
Zinc		3
Magnesium		3
Sulphur		2
Boron		2
Calcium		2
Organic carbon		2
Phosphorus		2
Manganese		1
Soil type	Soil Property Dataset	13
Soil maps		12
Soil Images		8
pH-value		11
Area of production		8
Crop information	Crop Property Dataset	13
Fertilization		7

**Table: 3. Evaluation Parameter**

Key	Evaluation parameter	No of times used
RMSE	Root mean square error	10
R2	R-squared	13
MAE	Mean absolute error	8







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MSE	Mean square error	5
MAPE	Mean absolute percentage error	3
RSAE	Reduced simple average ensemble	3
ACC	Accuracy	13

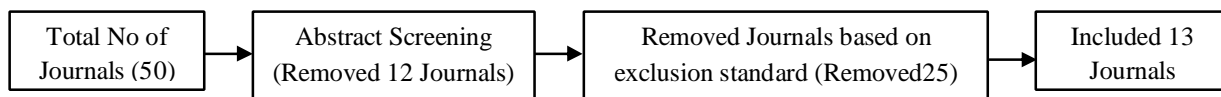


Figure.1 Review Stages





## Detection of Pathogenic Microorganisms and their Antibiotic Resistance in Fish from Mandya, India

Rajesh Venkataraman<sup>1</sup>, Jeet Bahadur Moktan<sup>2\*</sup>, Dase Gowda Venkatesha<sup>3</sup> and Yogendra Shrestha<sup>2</sup>

<sup>1</sup>Professor and Head, Department of Pharmacy Practice, Sir Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B G Nagara, Karnataka, India.

<sup>2</sup>Research Scholar, Department of Pharmacy Practice, Sir Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B G Nagara, Karnataka, India.

<sup>3</sup>Professor and Head, Department of Microbiology, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B G Nagara, Karnataka, India.

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### \*Address for Correspondence

#### Jeet Bahadur Moktan

Research Scholar,  
Department of Pharmacy Practice,  
Sir Adichunchanagiri College of Pharmacy,  
Adichunchanagiri University,  
B G Nagara, Karnataka, India.  
E. Mail : jeetmoktan98@gmail.com



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### ABSTRACT

The findings of a global assessment on the use of antibiotics in aquaculture revealed that fish were frequently treated with antibiotics, including prohibited medications. Antibiotic residues were detected in 25% of the aquaculture products. India is the second-largest fish producer in the world. In this study, we explore possible bacteria and evaluate their susceptibilities to antimicrobials in Mandya, Karnataka, India. The sample was collected from each of the seven taluks in the Mandya district. Conventional techniques for bacterial isolation include gram staining and biochemical assays (*urease test, citrate utilization, triple sugar iron test, carbohydrate fermentation, indole test, and sulfide indole motility test*) were used. An antimicrobial susceptibility test (AST) was performed based on the modified Kirby Bauer disc diffusion method on Mueller Hinton Agar and interpreted using the Clinical Laboratory Standard Guideline (CLSG) 2020. A total of 63 samples were collected from seven taluks in the Mandya district. All the fish samples were culture-positive for bacteria. The prevalence of seven different organisms was detected. More isolations were from the gills 40% (30), skin 32% (24), and viscera 28% (21). Fish samples had a high rate of *Staphylococcus aureus* contamination (36%; 27/75). The study concluded that the fish was contaminated with *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella oxytoca*, and *Citrobacter freundii*. All these pathogenic bacteria have developed resistance to at least two tested antibiotics.



**Jeet Bahadur Moktan et al.,****Keywords:** Microorganism; Antimicrobial resistance; Multidrug-Resistant Organisms; Fish; Aquaculture

## INTRODUCTION

Antimicrobial resistance (AMR) is a critical threat to public health around the world, and it is becoming more prevalent. The occurrence of antimicrobial resistance varies between regions and countries based on the quantity of antibiotics consumed [1, 2]. India is the nation that uses the most antibiotics globally and has the highest incidences of infectious diseases [3-5]. The scoping report on antimicrobial resistance in India indicated that more than 70% of the isolates of *Escherichia coli*, *Klebsiella pneumoniae*, and *Acinetobacter baumannii*, and almost half of all *Pseudomonas aeruginosa*, were resistant to fluoroquinolones and third generation cephalosporins [6]. The emergence of resistance in India has been attributed in important part to the unregulated over-the-counter availability of antibiotics and non-compliance with the recommended treatment duration [3, 7]. The other possible reason for the emergence of resistant pathogens is antibiotic misuse, overuse, and self-medication. Antibiotic overuse in India has been reported by various studies [8, 9].

Antimicrobials are frequently used to treat and prevent infections in both humans and animals. Additionally, it supports growth and feed quality most significantly at subtherapeutic levels [10]. The poultry and fish industries use the most feed, and food derived from animals was shown to have 46 different antibiotic residues [11]. Antibiotics residues were detected in 25% of the aquaculture products tested by Pham DK et al., [12]. The findings of a global assessment on the use of antibiotics in aquaculture revealed that fish were frequently treated with antibiotics, including prohibited medications [13]. Kyule DN et al. reported a wide variety of bacterial strains from fish products using phylogenetic analysis, including *Scherichia coli*, *Salmonella enterica*, *Citrobacter freundii*, *Bacillus sp.*, and *Alcaligenes faecalis* [14].

India is the second-largest fish producer in the world [15]. It is crucial to identify any possible organisms in fish products along with their susceptibility to antimicrobials. The goal of this study was to explore possible bacteria and evaluate their susceptibilities to antimicrobials in Mandya, Karnataka, India.

## MATERIALS AND METHODS

### Sampling Site

The research was done at the central lab of the Adichunchanagiri Hospital and Research Centre, Adichunchanagiri University, in India, from February 2022 to May 2022. The sample was collected from each of the seven taluks in the Mandya district: Pandavapura, Nagamangala, Maddur, Krishnarajpet Malavalli, Shrirangapattana, Mandya, and Mandya. The study was approved by the Adichunchanagiri Institute of Medical Sciences institutional ethical committee (AIMS/IEC/1875A/2020), and permission was obtained from the district health officer for the collection of samples.

### Sample Collection

The purpose of the study was explained and oral consent was taken from shop owner. The raw fishes were collected and separately packed in zip-locked bags and transported in cool boxes to the Central laboratory at Adichunchanagiri Hospital and Research Centre with in 6 hours. The location was recorded using GPS tracker smartphone applications. Samples were collected from three separate places within each taluk to minimise sampling errors. The sterile surgical knife was used to remove skin, gills, and viscera from raw fish aseptically. About 10 g of each sample was homogenized in 90 ml of buffered peptone water (HI MEDIA®). 1 ml of the mixture was taken and diluted at ratios of 1:10, 1:100, 1:1000, and 1:10,000 using sterile peptone water.





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### Microbiological Procedure

0.1 ml of each dilution was spread out on nutrient agar medium (HI MEDIA®) and incubated (OPTECH®) at 37° C for 24 hours. The distinct colonies were then chosen for additional subculturing to produce pure isolates. Traditional techniques for bacterial isolation include gram staining, and biochemical assays (*urease test, citrate utilization, triple sugar iron test, carbohydrate fermentation, indole test, and sulfide indole motility test*) were used [14, 16, 17]. After that, the pure isolate was chosen for an antimicrobial susceptibility test (AST) based on the modified Kirby Bauer disc diffusion method on Mueller Hinton Agar using the following antibiotics: amoxicillin 10 mcg (AMX), bacitracin 10 IU (B), cefalexin 30 mcg (CN), cefixime 5 mcg (CFM), chloramphenicol 30 mcg (C), ciprofloxacin 5 mcg (CIP), doxycycline 30 mcg (DO), erythromycin 15 mcg (E), gentamicin 10 mcg (GEN), lincomycin 2mcg (L), nalidixic acid 30 mcg (NA), and sulphadiazine 100 mcg (SZ) [17]. The Clinical Laboratory Standard Guideline (CLSG) 2020 was used to interpret the AST.

## RESULTS

### Prevalence Of Bacteria In Fish Products

A total of 63 samples were collected from seven taluks in the Mandya district (*fish, gills, and viscera*; each of 21 samples). A total of 75 bacteria with seven different organisms were isolated from the 63 samples. More isolations were from the gills 40% (30), skin 32% (24), and viscera 28% (21). *Staphylococcus aureus* were detected in 36% (27/75) of the total growth, followed by *Klebsiella pneumoniae* 20% (15/75), *Enterobacter cloacae* 16% (12/75), *Enterobacter aerogenes* 8% (6/75), *Escherichia coli* 8% (6/75), *Klebsiella oxytoca* 8% (6/75), and *Citrobacter freundii* 4% (3/75). All the fish samples were culture positive for bacteria. Seven organisms were identified, including three different species in the skin and viscera and four different species in the gills. At least two different bacteria were isolated from each taluk of the Mandya district. (Table 1 & 2).

### Antibiotic Resistance Profile

The antimicrobial susceptibility test of isolated bacteria was performed using twelve antibiotics. Almost all isolated organisms interpreted resistance to bacitracin 88% (66/75), erythromycin 88% (66/75), and lincomycin 100% (75/75), respectively. Antibiotics to which isolated organisms have developed at least 50% resistance include doxycycline 66.67% (50/75), and amoxicillin 56% (42/75). While isolated organisms developed resistant to cefalexin 46.67% (35/75) and sulphadiazine 28% (21/75). Isolated organisms developed slight resistance to cefixime 18.67% (14/75), nalidixic acid 14.67% (11/75), ciprofloxacin 9.33% (7/75), cefixime 18.67% (14/75), and chloramphenicol 2.67% (2/75). All the isolated organisms were susceptible to gentamicin (Table 3).

*Citrobacter freundii* and *Klebsiella oxytoca* had developed total resistance to erythromycin, amoxicillin, lincomycin, and bacitracin. *Staphylococcus aureus* had developed total resistance to erythromycin, lincomycin, and bacitracin. *Escherichia coli* had developed total resistance to erythromycin, cefalexin, lincomycin, and bacitracin. *Klebsiella pneumoniae* had developed total resistance to lincomycin and bacitracin. *Enterobacter aerogenes* had developed total resistance to erythromycin, cefixime, lincomycin, and bacitracin. *Enterobacter cloacae* had developed total resistance to erythromycin, cefalexin, amoxicillin, lincomycin, and bacitracin (Table 3).

## DISCUSSION

This study aims to identify possible microorganisms that could harm humans when exposed, and to assess their susceptibility to antibacterial drugs. To our knowledge, this is the first study in southern India that has collected a wide variety of fish samples and tested them for AST using several antibiotics. In the study, we identified the presence of *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella oxytoca*, and *Citrobacter freundii* in the fish samples. As reported in previous studies, common fish can be contaminated with a variety of harmful bacteria, including *E. coli*, *Klebsiella* spp., *Salmonella* spp., *Proteus* spp., *Staphylococcus* spp., *Shigella* spp., *Pseudomonas* spp., *Listeria* spp., *Vibrio* spp., and *Enterobacter ludwigii*, which is quite similar to the



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study [18, 19, 20]. Fish samples had a high rate of *Staphylococcus aureus* contamination (36%; 27/75), which was equally prevalent in the skin, gills, and viscera. Moktan JB et al., reported the similar finding from poultry samples [17]. A large percentage of the isolated organisms had contaminated gills (40%; 30/75). Similar to Ersoy Omeroglu E et al., we observed *Enterobacter spp.* and *Staphylococcus aureus* are highly prevalent in skin [21]. The existence of such bacterial pathogens could compromise the host's immune system by entering the body through the food chain, which is the greatest concern with regard to potential clinical consequences.

The use of antibiotics in aquaculture is entirely unregulated in many developing countries, which results to the misuse of antibiotics [22, 23]. The detection of antibiotic residues on fish was reported by Pham DK et al. and Hoa PT et al. [24, 25]. Antibiotics polluted in feeds or the environment, when exposed to bacterial pathogens prevalent in fish, encourage the development of resistant strains. Antibiotic-resistant bacteria can spread the genes that confer antibiotic resistance to other organisms [23, 26]. In this study, we observed that every isolate of bacteria had completely developed resistance to at least two of the tested antibiotics. Every other antibiotic except gentamicin is ineffective against one or more microorganisms. Hassan J et al., reported resistance of colistin, a last line of defence against infections caused on by carbapenem-resistant *Enterobacteriaceae* in the fish [27]. This might be the results of unregulated use of antibiotic in aquaculture. There is no integrated set of regulations for aquaculture, and the present Indian guidelines for antibiotics in fish and fish feed primarily borrow from those intended for coastal aquaculture [26,28].

For the prevention of cross-infection with humans, the only option left is the formation of separate guidelines for antibiotic use in aquaculture and their strict implantation. Also, the time-to-time inspection by the regulatory agencies for the antibiotic use and the prevalence of pathogenic organisms on fish. These may significantly reduce the multiple use of antibiotics by farmers because disease-causing organisms will be recognised earlier, preventing the switching of antibiotics [24].

#### Limitations

To extract the pathogenic bacterium and test its susceptibility to antibiotics, a traditional approach was used. The gene mapping could have been more efficient in terms of identifying both the pathogen and the pattern of resistance.

## CONCLUSION

The study concluded the presence of *Staphylococcus aureus*, *Klebsiella pneumonia*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella oxytoca*, and *Citrobacter freundii* in the fish samples. All the isolated bacteria are multidrug resistant, with complete resistance to at least two of the tested antibiotics.

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#### Conflict of Interest

There are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The study was approved by the Adichunchanchanagiri Institute of Medical Sciences institutional ethical committee (AIMS/IEC/1875A/2020), and permission was obtained from the district health officer for the collection of samples.

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**Table 1 Isolated organisms in different taluks.**

Organisms	Nagamangala	Pandapura	Srirangapatna	Malavalli	Mandya	Muddur	Krishnaraja Pete
<i>Klebsiella pneumonia</i>	+	+		+	+		+
<i>Staphylococcus aureus</i>		+	+	+	+	+	+
<i>Klebsiella oxytoca</i>				+		+	
<i>Enterobacter cloacae</i>	+			+	+	+	





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<i>Enterobacter aerogenes</i>			+				
<i>Citrobacter freundii</i>	+						
<i>Escherichia coli</i>	+		+				

**Table 2 Isolation of organisms from different fish samples.**

Organisms	N	Skin	Gills	Viscera
<i>Citrobacter freundii</i>	3 (4%)	0	3	0
<i>Staphylococcus aureus</i>	27 (36%)	9	9	9
<i>Klebsiella oxytoca</i>	6 (8%)	0	6	0
<i>Escherichia coli</i>	6 (8%)	0	0	6
<i>Klebsiella pneumonia</i>	15 (20%)	0	9	6
<i>Enterobacter aerogenes</i>	6 (8%)	6	0	0
<i>Enterobacter cloacae</i>	12 (16%)	9	3	0
<b>Total</b>	<b>75</b>	<b>24 (32%)</b>	<b>30 (40%)</b>	<b>21 (28%)</b>

**Table 3 Antibiotic resistance in the isolated organism**

Organisms	N	Antibiotics											
		E	GEN	CIP	NA	C	CN	AMX	L	SZ	CFM	DO	B
<i>Citrobacter freundii</i>	3	3 (100%)	0	0	1 (33.33%)	0	2 (66.67%)	3 (100%)	3 (100%)	0	0	0	3 (100%)
<i>Staphylococcus aureus</i>	27	27 (100%)	0	4 (14.81%)	9 (33.33%)	0	6 (22.22%)	6 (22.22%)	27 (100%)	12 (44.44%)	0	21 (77.78%)	27 (100%)
<i>Klebsiella oxytoca</i>	6	6 (100%)	0	0	0	2 (33.33%)	0	6 (100%)	6 (100%)	0	0	3 (50%)	6 (100%)
<i>Escherichia coli</i>	6	6 (100%)	0	1 (16.67%)	0	0	6 (100%)	3 (50%)	6 (100%)	0	2 (33.33%)	5 (83.33%)	6 (100%)
<i>Klebsiella pneumonia</i>	15	6 (40%)	0	8 (53.33%)	10 (66.67%)	0	9 (60%)	6 (40%)	15 (100%)	9 (60%)	6 (40%)	12 (80%)	6 (40%)
<i>Enterobacter aerogenes</i>	6	6 (100%)	0	0	0	0	0	6 (100%)	6 (100%)	0	6 (100%)	3 (50%)	6 (100%)
<i>Enterobacter cloacae</i>	12	12 (100%)	0	0	0	0	12 (100%)	12 (100%)	12 (100%)	0	0	6 (50%)	12 (100%)
<b>Total</b>	<b>75</b>	<b>66/75 (88%)</b>	<b>0/75</b>	<b>7/75 (9.33%)</b>	<b>11/75 (14.67%)</b>	<b>2/75 (2.67%)</b>	<b>35/75 (46.67%)</b>	<b>42/75 (56%)</b>	<b>75/75 (100%)</b>	<b>21/75 (28%)</b>	<b>14/75 (18.67%)</b>	<b>50/75 (66.67%)</b>	<b>66/75 (88%)</b>

Note: amoxicillin 10 mcg (AMX), bacitracin 10 IU (B), cefalexin 30 mcg (CN), cefixime 5 mcg (CFM), chloramphenicol 30 mcg (C), ciprofloxacin 5 mcg (CIP), doxycycline 30 mcg (DO), erythromycin 15 mcg (E), gentamicin 10 mcg (GEN), lincomycin 2mcg (L), nalidixic acid 30 mcg (NA), and sulphadiazine 100 mcg (SZ)







## Antibacterial Activity of Jackfruit Waste and Its Promising Health Benefits

K.R.Don<sup>1</sup>, K.R.Padma<sup>2\*</sup>, D. Karthikeyan<sup>3</sup> and B.Dinesh<sup>4</sup>

<sup>1</sup>Reader, Department of Oral Pathology and Microbiology, Sree Balaji Dental College and Hospital, Bharath Institute of Higher Education and Research (BIHER) Bharath University, Chennai, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of Biotechnology, Sri Padmavati Mahila Visvavidyalayam (Women's) University, Tirupati, Andhra Pradesh, India

<sup>3</sup>Senior Assistant Professor, Maxillofacial Surgery, Department of Dental Surgery, Government Stanley Medical College, Chennai-1, Tamil Nadu, India.

<sup>4</sup>Assistant Professor, Department of Dental Surgery, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India.

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### \*Address for Correspondence

**K.R.Padma**

Assistant Professor,  
Department of Biotechnology,  
Sri Padmavati Mahila Visvavidyalayam (Women's) University,  
Tirupati, Andhra Pradesh, India  
E.Mail: thulasipadi@gmail.com



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### ABSTRACT

A fruit from a tropical tree in the Moraceae family, the jackfruit (*Artocarpus heterophyllus*) is edible. The jackfruit is a huge fruit native to the southwest of India that has a thick outer skin, yellow flesh, and edible seeds. The fruit is squishy, yet it has a distinct flavour, a tonne of sweetness, and a lot of nutrients. The fruits are a good source of minerals, vitamins, proteins, and carbs. Consuming jackfruit has several positive health effects. Pureed jackfruit has been used to create a variety of food products, including jellies, jams, ice creams, and marmalades. Due to the high cellulose content of the jackfruit waste skin, a soft hydrogel can be made from it in the form of silicon sheets and cut into a variety of bandage forms and sizes. Baking yeast-produced organic compounds added afterwards have antibacterial effects. These hydrogels have a non-toxic composition and hasten the healing of wounds. Therefore, our article primary focus is on antibacterial activity of Jackfruit waste and also highlighted health benefits on consumption of this edible juicy fruit. In addition, we also have depicted the pros and cons of this fruit waste.

**Keywords:** *Artocarpus heterophyllus*, Moraceae, Jackfruit, Hydrogel, Bandage, Antibacterial activity





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## INTRODUCTION

Jackfruit is a tropical climatic fruit which is found in many regions such as Western Ghats of India, South America, Africa, South Asia specifically in Bangladesh as well as India and belong to the Family of Moraceae (Ranasinghe et al., 2019). Moreover, the fruit is available in abundance particularly in summer and spring seasons in various Indian markets. Jack fruit is yellow to brown in color when fully ripen and its sweet bulbs are soft and juicy (AKteret al., 2019). The energy content in fruit is about 2 MJ per kg/wt. (Rajneesh Srivastava et al., 2020). In figure -1 have shown the health benefits of jackfruit consumption as it has abundant levels of starch, calcium, vitamins, thiamine, magnesium and proteins (Lengbiye E. Moke et al., 2017). Moreover, nutritional content of jackfruit edible portion, perianth and also seed has been acknowledged in previous reports (Satheeshan et al., 2019 and Sajesh et al., 2015). The fruit is or can be eaten raw. The third largest harvested fruit in India in contrast to mangoes and banana. During the off-season, the fruit is quite costly but existing in adequately as well as economical when fully ripen (Jackfruit.dob.2015-9-7). Nonetheless, every year roughly about 30-50% of the total harvested jackfruit putrefy due to lack of post-importation procedures in the country (Mandhare 2020; Adnan 2021; Mitra 2018 and Khan 2021). Furthermore, jackfruit is most frequently home-grown fruit in tropical and sub-tropical countries particularly in Burma, Malaysia, Sri Lanka, Bangladesh, and Brazil (Li et al., 2018; Gardner 2018; Rana 2018 and Khan 2020). The single jackfruit is huge in size of approximately 35-40kgs. On the outer rind portion jackfruit is comprised of conical carpel which are hexagonal, thick as well as rubbery and in interior surrounded with yellowish/whitish matrix. The jackfruit flavor and taste are similar to ripen banana (Dhakar 2020; Witherup 2019 and Arung 2007).

Jackfruit has the potential to boost our immunity and strengthen our bones since they have abundant quantity of proteins and carbohydrates. Furthermore, rich in calcium ions, minerals, vitamins along with diverse essential nutrients (Table 1) (Chandrika 2004; Borgis 2020; Amadi 2018 and Ranasinghe 2019). Studies of previous literature reports have shown the phytoconstituents present in jackfruit (Waghmare 2019; Eyoh 2020; Fuad 2020; Kumar 2021; Guiné 2019; Venkataraman 2001 and Wong 1992). It contains varying concentrations of volatile acids, sterols, tannins, flavonoids and carotenoids. In table-1 have depicted the nutritional composition of jackfruit which provides health benefits on regular consumption. Nanyang Technological University (NTU Singapore) scientists have made hydrogels from discarded husk of durian fruit which is similar to jackfruit [Diane 2021]. Since, jackfruit has antimicrobial property, antibacterial gel made bandages from discarded husk was found to be beneficial. Further, research need to carried over to assess its wound healing capacity. Therefore, our article provides broad window on antibacterial bandages made from husk and further application of pharmacological activities.

### Taxonomic classification and Common names of Jackfruit

Jackfruit scientific name is *Artocarpus heterophyllus* Lam, which is an exotic tree belonging to the Moraceae family. The distribution of the plant is over the tropical & subtropical regions. The fruit is spelled with various names in different countries which is listed in table-2 & 3.

### Medicinal uses and Health benefits of Jackfruit

The tropical monoecious tree has several health benefits such as antimicrobial, antibacterial, anti-carcinogenic, anti-inflammatory, antiviral and wound healing properties (Sundaraj 2017 and Haleel 2018). The major phytoconstituents present in Jackfruit like saponins, lignins, alkaloids, isoflavones, carbohydrates, and triterpenoids. Several literature reports have revealed its antiaging, antiulcer and anticancer properties (Tewari 2021; Tramontin 2021; Cheng 2020 and Kusumaningtyas 2021). The jackfruit is regarded as a bioactive fruit which makes it not only a highly nutritious but desirable fruit crop. The diverse pharmacological benefits are represented in Table-4.





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### Repurposed Rind of Jackfruit Has Promising Antibacterial Activity

The delicious jackfruit pulp after consumption, the rind is being discarded in all countries. The repurposing of jackfruit shell acts as a promising approach for preparation of hydrogels since it contains high value of carbohydrate polymer i.e cellulose and extraction of these cellulose also was to be economical. The procedure involves:

## CONCLUSION

Our current review paper is a step toward creating hydrogels rather than using plastic bandages in the future. This is the first time that discarded jackfruit shell has been utilized to create a product that is beneficial to our society, and these hydrogels are made from jackfruit rind. It needs to be investigated further in terms of toxicity and biocompatibility, as well as how quickly the wound bed can be rehydrated.

## ABBREVIATIONS

Not Applicable

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**Table-1: Nutritional data and quantity of percent daily value**

Nutrients Present in Jackfruit	Quantity	Percentage of Daily Value
Calcium (Ca)	24 milligrams	2.4
Copper (Cu)	0.08 milligram	3.8
Iron (Fe)	0.23 milligram	1.28
Magnesium (Mg)	29 milligrams	7.2
Manganese (Mn)	0.04 milligram	2.15
Phosphorus (P)	21 milligrams	2.
Potassium, K	448 milligrams	12.8
Sodium, Na	2 milligrams	0.0
Zinc, Zn	0.13 mg	0.87
Vitamin A	110 IU	2.2
Vitamin C	13.7 milligram	22.83
Vitamin B6	0.33 milligrams	16.45
Vitamin E	0.34 milligrams	1.13
Riboflavin	0.06 milligram	3.24
Thiamin	0.1 milligram	7
Folate, DFE	24 µg	6
Niacin	0.92 milligram	4.6
Sugars	19.08 grams	1.72
Fiber	1.5 grams	6
Cholesterol	0 milligram	0
Water	73.46 grams	76.2-85.2
Carotene, alpha	6 µg	6 µg
Carotene, beta	61 µg	61 µg
Lutein Zeaxanthin	157 µg	157 µg

**Table-2: Diverse names of jackfruit with different spellings in various countries (Prakash 2009; Adan 2020; Palamthodi 2021; Jagdale 2021; Borgis 2020; Manjeshwar 2011; Azad 2000; Singh 1991; Love 2011; Favero 1993; Wetprasit 2000 and Sofowara 1993)**

S.No	Common Names of Jackfruit	Countries
1.	boluop mi	China
2.	Jacquier	French
3.	Nanka	Indonesia
4.	Jaca	Spain
5.	Vaca	Portugal
6.	Lanka	Philippines
7.	Kapiak	New Guinea
8.	Fiji, Chakka, Chakki, Kanthal, Kathar	India
9.	Jaca dura	Brazil
10.	Mit	Vietnam
11.	Khanun, Makami, Banum	Thailand





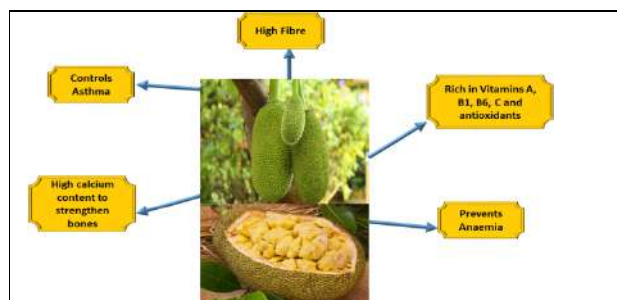
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**Table-3: Taxonomic nomenclature of Jackfruit (Baliga 2011)**

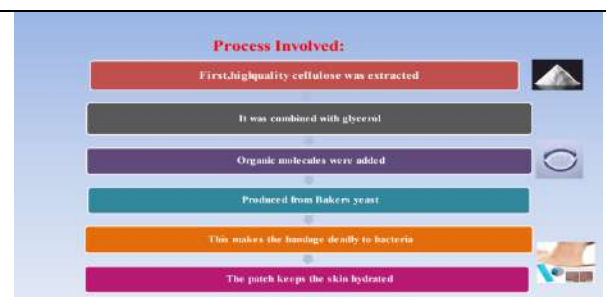
Kingdom	Plantae planta, plantes, plants, vegetal
Subkingdom	Tracheobionta, vascular plants
Super division	Embryophyta
Division	Magnoliophyta, angiosperms, flowering plants, phanérogames
Class	Magnoliophyta dicots, dicotylédones, dicotyledons
Sub-Class	Alismidae / Hamamelidae
Order	Rosales/ Urticales
Family	Moraceae, mulberries
Genus	<i>Artocarpus (breadfruit)</i>
Species	<i>heterophyllus</i>

**Table-4: *Artocarpus heterophyllus* pharmacological benefits**

Parts of Plant	Pharmacological actions	Bioactiveconstituents	References
Fruits	Anti inflammatory	Flavonoids	(Chanda 2009)
Fruit and seed	Antioxidant	Prenyl Flavones	(Gupta 2011 and Kumar 2021)
Leaf	Antidiabetic	Prenyl Flavonoids	(Kotowaroo <i>et al.</i> , 2006 and Gopal Rao <i>et al.</i> , 2021)
Bark of root and stem	Antimalarial	Prenylated Flavonoids	(Boonphong 2007)
Seed	Antiviral	Oxyresveratrol	(Adita Ayu Permanasar 2021)
Bark of Stem, Root, Leaf and Fruit	Antibacterial	Isoprenyl Flavone	(Loizzo 2010)
Leaf	Wound Healing	Lectin	(Chahud 2009)
Wood	Anticancer	Isoprenoid Flavonoids	(Arung 2010)
Leaf and seed	Antifungal	Chalcone	(Trinidad 2006)



**Figure 1: Jackfruit rich in Protein, fibers, Minerals and Vitamins which provide health benefits on regular consumption**



**Figure-2: The process of preparation of Hydrogel which helps to heal wound with natural products**





## Convex-Hull and Geometry based Support Vector Machine Classifier for Jasmine Flower Classification

S.Krishnaveni\* and A.Subramani

Assistant Professor, M.V.Muthiah Government Arts College for Women, Dindigul, (Affiliated to Mother Teresa Women's University, Kodaikanal), Tamil Nadu, India

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### \*Address for Correspondence

**S.Krishnaveni**

Assistant Professor,

M.V.Muthiah Government Arts College for Women,

(Affiliated to Mother Teresa Women's University, Kodaikanal),

Dindigul, Tamil Nadu, India

E.Mail: seetharamankrishnaveni@gmail.com



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### ABSTRACT

An image classification system is typically initiated to process data into meaningful information. The classification of jasmine image is often performed by supervised classifiers, which require an adequate amount of labeled instances to train the classifier. All of these classifiers depend upon the quality and quantity of the training set used to train the classifier, whose reliability is a fundamental issue for an accurate mapping of the investigated area. Support Vector Machines (SVMs) are one of the successful classifier for supervised learning applications. SVMs are nonparametric statistical approaches for addressing supervised classification and regression problems. Therefore, there is no assumption made on the underlying data distribution. This paper addresses two problems of SVM, one is the kernel function selection and the other is the training time. A convex-hull and geometric based SVMs are proposed here for jasmine image classification. The proposed Convex-hull & Geometry based SVM (CG-SVM) doesn't require a kernel function and a training time too. In this way, the complexity of SVM is much reduced while preserving the classification accuracy.

**Keywords:** Support Vector Machine(SVM), Convex-hull & Geometry based SVM (CG-SVM) .

### INTRODUCTION

Support Vector Machine (SVM) is a popular classification method in machine learning [7] which reduces the classification error and maximizes the margin to discriminate between classes with a hyperplane [6]. Since QPP needs  $O(n^3)$  computation time and  $O(n^2)$  memory requirement, which makes SVM isore expensive and unsuitable for higher dimension data [6]. The SVM's performance is highly depends on the kernel selection, most of the time,

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the unsuitable kernel function leads to imperfect hyperplane for a nonlinear data samples. Although the slack variable can be applied to solve the soft margin optimization, it affects the optimal performance of SVM. It is evident to obtain the optimum margin with negligible error. Another method is used to reduce convex hull. The inseparable case becomes separable case. Variant SVM (v-SVM) can make the intersection set be empty by the choice of parameters [4]. The v-SVM is similar with the reduced convex hull, and the computation process is complex. [8] proposed a Concave–Convex Procedure (CCP) that separates the energy function into a convex function and a concave (non-convex) function. But some good properties of SVM, for example the maximum margin, cannot be guaranteed [3], because the intersection parts of data sets have not satisfied convex conditions. The SVM training time is reduced by convex hull approach, however this method decreases the classification accuracy when there are outliers [2] introduced a novel method for SVM classification, called convex–concave hull. Then the SVM training is performed with these convex-concave hull vertices. This approach has a much suitable for higher dimension data, as it has shown in the simulation results that this SVM variant is able to achieve better accuracy rate with less computation effort for training.

## MATERIALS AND METHODS

Consider a binary classification problem with the training data given in the form

$$\{x_i, y_i\}, i = 1, \dots, M, y_i \in \{-1, +1\}, x_i \in \mathbb{R}^N \quad \{x_i, y_i\}, i = 1, \dots, M, y_i \in \{-1, +1\}, x_i \in \mathbb{R}^N$$

To achieve this, at first, each class is approximated with a convex hull [1]. More formally, the convex hull of samples  $\{x_i\}_{i=1, \dots, L}$  can be written as

$$H^{\text{convex}} = \{x = \sum_{i=1}^M \alpha_i x_i \mid \sum_{i=1}^M \alpha_i = 1, \alpha_i \geq 0\}$$

(1.1)

Figure 1 depicts convex hulls of two classes. The plane, orthogonal to the line fragment that bisects the line, is selected to be the separating hyperplane as shown in Figure 1.1 For the proposed Convex-Hull & Geometry based SVM (CGSVM), initially the data points are plotted and a convex hull for each class  $H_1$  and  $H_2$  has been constructed as shown Figure 2, one class samples has been shown with red points and the other with blue points.

In the next step, the centroid for each convex hull  $H_{c1}$  &  $H_{c2}$ , is estimated and connected through a straight line. Figure 3 shows the output of convex hull centroids, the green markers and connecting them with a straight line, this is to identify the direction of each convex hull. With this, the hyperplane,  $wx+b=0$ , has been made perpendicular to the line which connects the centroids. However, the slope won't be appropriate when the size of the convex hulls varies a lot. Once, after connecting the convex hull centroids, the edge from both convex hull which intersect the connecting line is identified and their end-points are stored as shown in Figure 4. Then each end-point from  $H_1$  is connected to the other end-point from  $H_2$ , whichever is closer, this would introduce two new line segments  $L_1$  and  $L_2$ , presented as dashed line in Figure 5 Further, a straight line connecting mid-points of the lines  $L_1$  and  $L_2$ , derives the hyperplane as illustrated in Figure 6.

In the last step, the support vectors are drawn parallel to the hyperplane, which passes through a vertex from  $H_1$  and  $H_2$  as shown in Figure 7. According to the support vectors, the hyperplane is adjusted to make the distance equal between the hyperplane and the soft margin.



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The following procedure summarizes the proposed CG-SVM classifier.

- a. Plots the data samples
- b. Constructs the convex hull for each sample ( $H_1$  &  $H_2$ )
- c. Finds the centroids of each convex hull ( $H_{c1}$  &  $H_{c2}$ )
- d. Connects the centroids with a straight line, and find the convex hull edges which intersect this line.
- e. Finds the end-points of the intersecting lines from  $H_1$  and  $H_2$ ,
- f. Connects the end-points of  $H_1$  to  $H_2$ , whichever is closer, results two lines  $L_1$  and  $L_2$ .
- g. Finds the mid-points of  $L_1$  and  $L_2$ , and connect them with a straight line – Hyperplane
- h. Draws a line for each convex hull, passes through any of the end-points from the intersecting edge, which is parallel to the hyperplane – support vectors
- i. Adjusts the hyperplane, so that is equally distanced from support vectors.

The advantage of the proposed CG-SVM over conventional SVM is the time complexity, and the kernel function selection. The convex-hull and geometry approach doesn't take any iterative or training procedures, hence it takes  $O(n)$  time complexity. Also it doesn't require to maintain the data samples, whereas it is enough to hold the convex hull vertices, hence it won't require more than  $O(n)$  space complexity. Comparatively the conventional SVM needs  $O(n^3)$  and  $O(n^2)$  time and space complexity respectively, the CG-SVM reduces these complexities significantly with  $O(n)$  for both time & memory requirements. Hence, the proposed CG-SVM is faster, efficient memory and improves the SVM classification performance significantly as discussed in the experimental results section.

The complete Jasmine Classification (Jas Classify) algorithm is summarized as follows: Initially the jasmine flower images are captured and segmented using a Multi-Histogram based Otsu's Thresholding (MHOT) approach. In the second step, four different feature descriptors: Average Color Differences (ACS), Color Edge Directivity Descriptor (CEDD), Local Binary Pattern (LBP), and Zernike Moments (ZM) are estimated from the segmented jasmine image [5]. In the third step, the extracted features are fused, normalized and labelled as normal/defected to form a complete feature vector, and in the last step, these features are given to CG-SVM for classification.

The following procedure depicts the proposed framework for jasmine flower classification (JasClassify)

- a) Reads the jasmine images
- b) Segments them using Multi-Histogram based Otsu's Thresholding
- c) Extracts ACD, CEDD, LBP and ZM feature descriptors
- d) Fuses, normalizes and label the feature descriptors
- e) Finds the support vectors for jasmine flower classification using Convex Hull & Geometry based SVM (CG-SVM)

## RESULTS AND DISCUSSION

The result obtained from the proposed algorithm has evaluated using a standard measure of classification accuracy such as True Positive Rate (%TP), True Negative Rate (%TN), False Positive Rate (%FP) and False Negative Rate (%FN). The True positive rate obtained from the actual findings of jasmine flower quality with the ground truth. The ground truth obtains manually with 500 types of samples. The defected flowers can have identified as False Negative Rate (%FN). The algorithm wrongly predicted the given sample which is truly defected as normal then its corresponding False Positive Rate (%FP) can be calculated. Similarly, the True Negative Rate (%TN) can also be calculated. Sensitivity and Specificity are statistical measures of the performance of a binary classification test, also known in Statistics as classification function.





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The performance of the proposed CG-SVM is compared with Reduced Convex Hull SVM (RCHSVM), Convex-Concave Hull SVM (CCHSVM) [2], and Random Forest Tree (RFT) Classifier. The classification performance is investigated with two sets of feature descriptors: {color, texture} and {color, texture, shape}.

## CONCLUSION

Flower Classification becoming a popular field owing to its importance for the Botanists and Floriculturists. Jasmine Flower Classification which has been proposed in this research provides efficient classification accuracy owing to the idea of considering many features, in order to achieve Accurate Quality Detection. The texture feature which is used to identify the defects in the Flower was extracted using Zernike Moments and LBP. The accuracy of the proposed CG-SVM classifier is 91% which is greater than the other SVM and RFT classifiers. This proves that CG-SVM classifier has excelled the other classifiers. Hence the proposed method gives prominent results of accuracy in detecting defected Flowers without using manual interaction.

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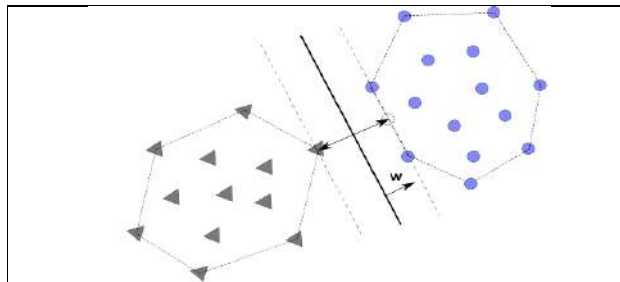
Classifiers	Features	Sensitivity	Specificity	Precision	F1-score	Accuracy
CG-SVM	Color + Texture	0.8774	0.8998	0.9121	0.8970	0.9088
	Color + Texture + Shape	0.9004	0.9121	0.9228	0.9182	0.9134
CCHSVM	Color + Texture	0.7987	0.8332	0.8761	0.8120	0.8434
	Color + Texture + Shape	0.8562	0.8977	0.9043	0.8585	0.9085
RCHSVM	Color + Texture	0.7730	0.8212	0.8419	0.7897	0.8253
	Color + Texture + Shape	0.7996	0.8641	0.8856	0.8144	0.8722



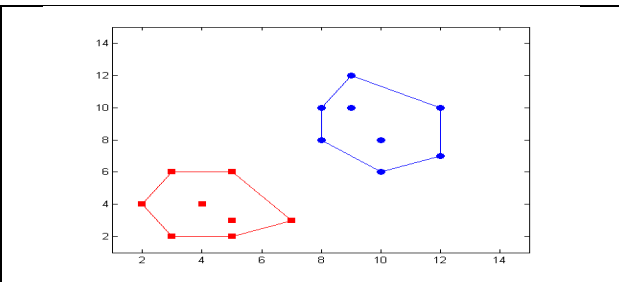


**Krishnaveni and Subramani**

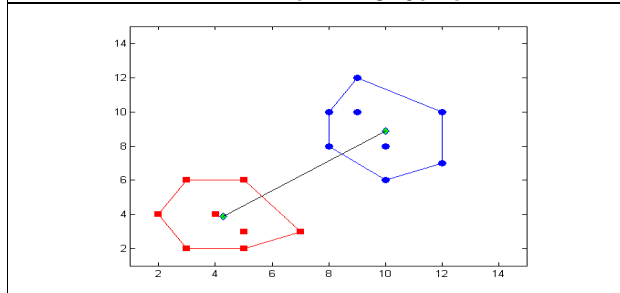
RFT	Color + Texture	0.7222	0.1667	0.2857	0.5231	0.4676
	Color + Texture + Shape	0.8000	0.3333	0.6250	0.6431	0.4329



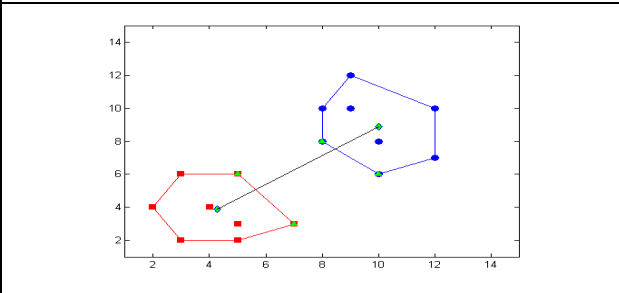
**Figure 1: Two closest points on the convex hulls determine the separating hyperplane**



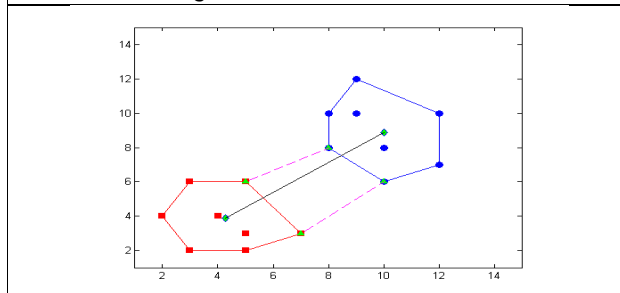
**Figure 2: Data points with Convex Hull**



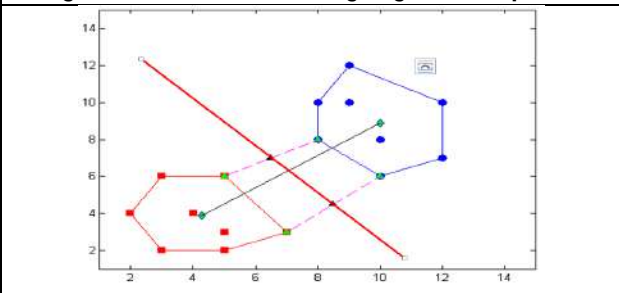
**Figure 3: Convex Centroids**



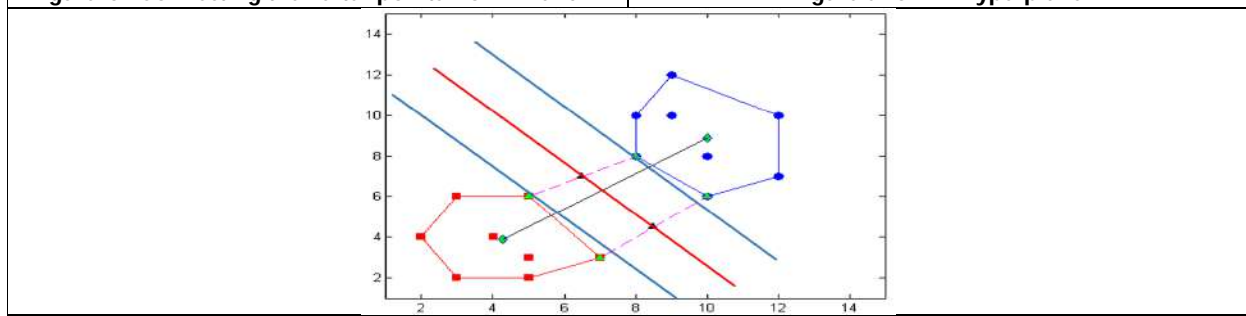
**Figure 4: Convex Intersecting Edge's vertex points**



**Figure 5: Connecting the vertex points from  $H_1$  and  $H_2$**



**Figure 6: SVM Hyperplane**



**Figure 7: Support Vectors and the Margin**





## Normative Values of Lumbar Lordosis Index Assessed by using Flexible Ruler and its Correlation with Confounding Factors

Krupa Mehta\* and Rajvi Mehta

Assistant Professor of Shree K.K. Sheth Physiotherapy College, (Affiliated with Saurashtra University), Rajkot, Gujarat, India.

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### \*Address for Correspondence

#### Krupa Mehta

Assistant Professor of Shree K.K. Sheth Physiotherapy College,  
(Affiliated with Saurashtra University),  
Rajkot, Gujarat, India.  
E.Mail: krupahmehta@gmail.com



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### ABSTRACT

Postural evaluation is an important part of assessment of spine because abnormal postures are linked with many musculoskeletal disorders. The flexible ruler is safe, inexpensive, portable, non-invasive and easy to use tool to assess index of lumbar lordosis. A cross sectional study was conducted on 400 normal individuals with age group of 18 to 30 years. First height and weight were measured then Lordotic curve of lumbar spine was measured by using Flexi ruler. The mean and SD of lumbar lordosis index is  $11.57 \pm 3.03$ . The reference range for lumbar lordosis index measured by flexible ruler is 6.50-17.80. Spearman's correlation coefficient value shows significant but weak correlation ( $p < 0.05$ ) between weight ( $\rho = 0.273$ ) and BMI ( $\rho = 0.267$ ) whereas height shows no correlation ( $\rho = 0.108$ ) with lumbar lordosis index. Normative values of Lumbar lordosis index measured by Flexi ruler is 6.50- 17.80. These values can be used as reference values for assessment of lumbar lordosis.

**Keywords:** Flexible ruler, Lumbar lordosis, Measurement, Normative value.

### INTRODUCTION

The vertebral column resembles a curved rod, which is composed of 33 vertebrae and 23 intervertebral disks. The vertebral column is divided into 7 cervical vertebrae, 12 thoracic vertebrae, 5 lumbar vertebrae, 5 sacral vertebrae and 4 coccygeal vertebrae. The 5 sacral vertebrae and 4 coccygeal vertebrae are fused together. The normal human spine is curved. There are two lordotic curves i.e., cervical lordosis and lumbar lordosis and two kyphotic curves i.e., thoracic kyphosis and sacral kyphosis [1]. The term lordosis refers to the normal anterior convexity of the cervical and lumbar vertebra in the sagittal plane [2]. A curved vertebral column provides significant advantage over a straight column so that it is able to resist much higher compressive loads. A spinal column with the normal lumbar,

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thoracic and cervical curves has a 10-fold ability to resist axial compression in comparison with a straight column.[1] Incorrect moving habits can cause deformation in spine and leads to some malformations such as thoracic hyperkyphosis or hyperlordosis [3]. Postural evaluation is an important part of assessment of spine. The identification of spine malalignment can be done through variety of non-invasive and invasive methods. Non-invasive methods used are flexible ruler, inclinometer, spinal pantograph, spinal mouse, electro set-square meter and image processing methods.[4] Invasive methods includes CT scan, MRI and radiographs for such measurement. [5]. Assess or often use vague terms to describe lumbar lordosis such as normal, decreased, increased or severe. Definitions of such terms differ from an individual to individual depending upon their experience and are questionable. At present, radiographs are considered as true measure of actual lumbosacral lordosis angle but radiographs are expensive, time consuming and cause exposure to radiations. [6] So to avoid this for clinical purpose use of reliable, valid, portable, safe and low-price measurement tool is required to assess the spine. One such method that can be used in clinical setup for measurement of lumbar lordosis is flexible ruler. Flexible ruler or flexicurve is widely used tool to measure the degree of spinal curvature in the sagittal plane such as kyphosis and lumbar lordosis in the field of physiotherapy [7].

Studies have been done to find out the reliability and validity of flexible ruler for the measurement of lumbar curve. [8-10] But there is a no evidence to state a normative value (baseline value) of measurement of lumbar lordosis by using flexible ruler. So, the purpose of the present study is to measure and to find out normative values of lumbar lordosis measurement.

## MATERIALS AND METHODS

### Study Design Cross-Sectional Study

The present study was conducted in Rajkot city on 400 normal healthy individuals with age group 18-30 years. Before testing subjects were screened for the eligibility criteria and informed consent was obtained from them before the testing. Inclusion criterias for the study were male and female subjects between 18-30 years of age group having normal BMI and willing to participate. Subjects were excluded if they had any history of back injury, localized low back pain or radiating pain to lower limbs, history of any back surgery and subjects having any spinal anomaly. Then on the basis of inclusion and exclusion criteria final subjects took part in the study. Materials used for the study were flexible ruler, weighing scale, stadiometer, measure tape, scale graph paper and pencil.

Procedure Demographic data such as name, age, gender, weight and height were taken of all the subjects. For measurement of lumbar lordosis, the subjects were asked to stand bare foot in a comfortable position with equal weight distribution on both the feet. Then 12th rib was located and T12 was marked. The spinous process of S2 was located by palpation of the posterior superior iliac spines (PSIS) bilaterally and then by locating the spinous process in the midline of the back that was closest to the same level as the PSIS. These points were marked with use of a marker.

After that the flexible ruler was placed over the spinous process and the distance between T12 to S2 was measured as the length (L). Then the ruler was pressed tightly to the body so as to avoid any hollow space between the ruler and the subject's skin and the ruler takes up the curvature of the subject's lumbar spine. Then the ruler is removed from the subject's back and the curve is drawn on the graph paper to calculate the index of lumbar lordosis. A vertical line (Lumbar length) was drawn to connect T12 to S2 landmarks and were labelled as A & B respectively. From the deepest part of the curve a perpendicular line (Lumbar width) was drawn. Maximum width and the total length of the curve were measured in centimeters. The Index of Lordosis (IL) were calculated from the width and length measures of the lumbar portions of the spine using the following formulae:

$$IL = \text{Lumbar width} / \text{Lumbar length} \times 100$$

Higher indices indicated greater degrees of lordosis and vice versa. [8,11]



**Krupa Mehta and Rajvi Mehta****Statistical Analysis**

All Statistical analysis was done by software SPSS 20.0 version, Medcalc statistical software- version 20.023. Microsoft Excel and word 2019 was used to produce graphs and tables respectively. Mean & Standard Deviation (SD) were calculated as a measure of central tendency & measure of dispersion respectively. Percentile method were used to check the distribution of data (%) at particular percentile. Spearman's correlation coefficient was used to quantify the relationship between Lumbar lordosis index with weight, height and BMI.

**RESULTS**

Data of 400 normal individuals with age group of 18 to 30 years was taken for the study. Out of 400 individuals, 64 were males and 336 were females. Then mean and SD of age, weight, height, BMI and index of lumbar lordosis were calculated. The normative range of lumbar index was calculated by percentile method i.e., 6.50 – 17.80. Correlation between lumbar lordosis index with all confounding factors except height showed weak correlation and with height there was no correlation found.

Table 1 shows gender distribution of the population i.e., 16% males and 84% females participated for the study. Table 2 shows Mean and SD of all the variables. Table 3 shows Lumbar Index value at 5, 10, 25, 50, 75, 90, 95 percentiles. Table 4 shows Normative values for Index of Lumbar Lordosis. Table 5 shows Relationship between Lumbar lordosis index and confounding factors. Graph 1 shows Normative values for Index of Lumbar Lordosis.

**DISCUSSION**

In the present study flexible ruler was used to measure the lumbar lordosis index. It is a 61 centimeter long, flexible piece of lead covered with plastic that can be bent in one plane and it attains the shape into which it is bent. For spinal measurements, the flexible ruler is placed on midline of spine between two marked points and molded according to contour of the spine. Then it is laid on graph paper and spinal curve is copied by running a pencil along the flexible ruler.[8] Many different techniques are available to measure lumbar lordosis such as spinal mouse [4], spinal pantograph,[4] CT scan [5], MRI [5] and radiographs [5] but these methods are costly and time consuming and in some of the methods there will exposure to radiations. To avoid this, flexible ruler for measurement of lumbar lordosis was used in the clinical set-up as it is non-invasive, quick, inexpensive, user friendly and harmless method.

Pamela J. Salisbury *et al.* has compared different methods of measurement of lumbar sagittal mobility and it was found that flexi ruler is the easy and time saving method compare to other methods such as in ultrasonography patients have to maintain their position for 5 minutes which is difficult to maintain and may cause error while taking the measurements if patients change the position [12]. The results of the present study show normative values for index of lumbar lordosis in healthy individuals with age group 18-30 years. Index of lumbar lordosis is assessed by using flexible ruler. No study has been done till date to find normative values of index of lumbar lordosis, this is the first study to state the normative range of lumbar lordosis i.e., 6.50-17.80. In addition to this, Weight ( $\rho = 0.273$ ) and BMI ( $\rho = 0.267$ ) show weak correlation whereas, height shows no correlation ( $\rho = 0.108$ ) with lumbar lordosis index. Porto AB *et al.*, did a review to determine referential values for thoracic kyphosis and lumbar lordosis for radiography and photogrammetry analysis and search for information about the interrater and intra-rater reliability. They found 26 articles, of which 23 studies contained values for thoracic kyphosis and lumbar lordosis and 10 tested the intra- and interrater reliability of both methods. As seen in this review the normative value of lumbar lordosis varies among different studies [13].

Rabieezadeh A *et al.*, conducted a correlational study to investigate the relationship between height, weight and body mass index (BMI) with curvature of the spine kyphosis and lordosis in 12-15-year-old male adolescents of Tehran. In that study the spinal mouse was used for spinal assessment. Pearson correlation coefficient was used to investigate the relationship between height, weight and body mass index (BMI) with spine kyphosis and lordosis. It was found



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that there was no statistically significant relationship between study variables and spinal curvature so, it can be concluded that height, weight and BMI could not be considered as an appropriate criterion for association of kyphosis and lordosis angles in the studied population [14]. These readings are inconsistent with the findings of present study which shows statistically weak correlation between weight and BMI whereas, no correlation of height with lumbar lordosis index. Limitations of the present study were that male: female ratio was not distributed equally. The data was collected only from the young adult population. So, the results cannot be generalized for children and the elderly, as these age groups were not included in the study. For future recommendations study can be done with equal gender distribution and for different age group.

**CONCLUSION**

Normative values for lumbar lordosis index are 6.50-17.80. The current method of measuring lumbar lordosis index using flexible ruler can be used as an easy tool for assessment of lumbar lordosis. These values can be used as reference values for assessment of lumbar lordosis.

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**Table 1: Distribution of population according to gender**

Gender	No. Of Participants	% Of Participants
Male	64	16%
Female	336	84%
Total	400	100%

The above table shows, gender distribution of the population i.e., 16% males and 84% females participated for the study.

**Table 2: Mean and SD of all the variables**

Sr no.	Variables	Mean ± SD
1.	Age	21.06 ± 2.61
2.	Weight	54.43 ± 9.97
3.	Height	2.04 ± 9.07
4.	BMI	21.24 ± 2.93
5.	Index of Lumbar Lordosis	11.57 ± 3.03

The above table shows, Mean and SD of all the variables.

**Table 3: The value of Percentile given at 5, 10, 25, 50, 75, 90, 95 for Index of Lumbar at 95% confidence limit**  
The above table shows Lumbar Index value at 5, 10, 25, 50, 75, 90, 95 percentiles.

Percentile	5	10	25	50	75	90	95
Value	7.00	7.85	9.37	11.33	13.59	15.70	16.99

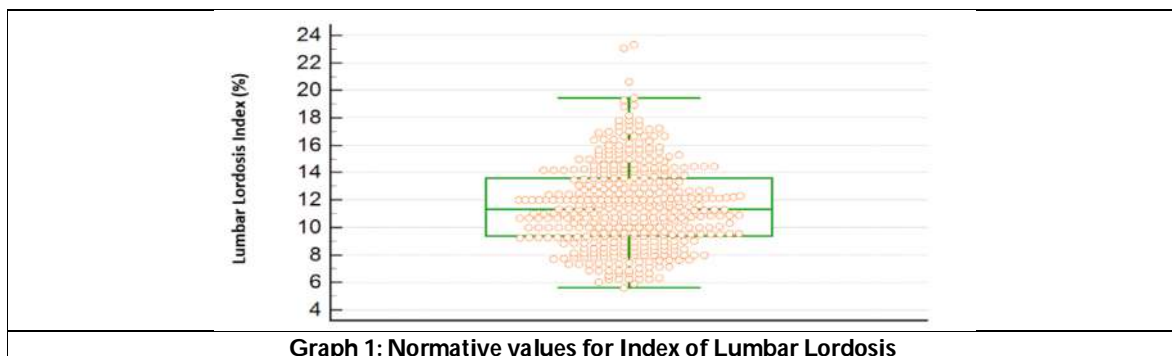
**Table 4: Normative values for Index of Lumbar Lordosis**

25th Percentile	Median (50th Percentile)	75th Percentile	IQR	Lower limit		Upper limit		Normative Values
				Value	90% CI	Value	90% CI	
9.37	11.33	13.59	4.22	6.50	6.25-6.87	17.80	17.14-19.28	6.50-17.80

SD – Standard Deviation; IQR – Interquartile Range; CI – Confidence Interval

**Table 5: Relationship between Lumbar lordosis index and confounding factors**

	Confounding Factors	Correlation Coefficient Value	P Value
Lumbar Lordosis Index	Weight	$\rho = 0.273$	$p = 0.000$
	Height	$\rho = 0.108$	$p = 0.030$
	BMI	$\rho = 0.267$	$p = 0.000$





## In Light of the ISO/IEC 9126 Model for Evaluating the Usability and Efficiency of Web-Based Enrolment Portal System Characteristics

Unife O. Cagas\*

Professor, College of Engineering and Information Technology, Surigao City, Philippines.

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Accepted: 28 Apr 2023

### \*Address for Correspondence

**Unife O. Cagas**

Professor,

College of Engineering and Information Technology,

Surigao City, Philippines.

E.Mail: unifecagas04@gmail.com



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### ABSTRACT

The Web-Based Portal design has been built and successfully served in one of the Philippines' public colleges for two semesters. However, in order to make any necessary adjustments, and to expect high satisfaction from the students, it is vital to evaluate the usability and efficiency of the system's properties. The study's objective was to evaluate system characteristics as viewed by students using ISO/IEC 9126, with an emphasis on specific software quality attributes or sub-characteristics, including usability and efficiency. The results of the usability system characteristics revealed that the system function is simple to use; its functions provide readable descriptions that are easy to learn; users learn independently with less time and effort; the system interface is well-organized and appealing; and it provides a user-friendly environment. In terms of efficiency, it was discovered that the system took less time when entering the correct user account and password; that it responded quickly when logging in and out; that it sent clear notifications or instructions on selected transactions; that it responded quickly during data entry; and that the entire process served as a support tool. The system's characteristics are concluded to be highly usable and highly efficient. It is recommended that students be permitted to view and print the temporary certificate of registration immediately after enrolment.

**Keywords:** System Evaluation, Web-Based Enrolment Portal, Usability, Efficiency, ISO/IEC 9126 Model,

### INTRODUCTION

Evaluation is becoming increasingly important, both as a part of the design of online courses and as a mechanism for quality assurance (Catura, *et al* 2019). It is for this reason that the proponents evaluated the system to assure system quality. It has been two semesters since the designed Web-Based Portal was installed in one of the state colleges in



**Unife O. Cagas**

the Philippines, catering to 1020 students in the first semester and 1050 students in the second semester. Enrolment in the two semesters was successfully served. Accordingly, it was a usable and efficient system, considering these days when the selected cities of the CARAGA region were just devastated by Typhoon Odette, aside from the occurrence of the pandemic. There is a need to measure or evaluate the usability and efficiency of the system to determine the quality of the software and to add to or modify it for student satisfaction. In the study of Jung, et al (2004), ISO/IEC 9126, "satisfaction" implies "the capability of the software product to satisfy users in a specified context of use." Satisfaction in that sense refers to the user's response to interaction with the product. It includes judgments about product use rather than about properties of the software itself.

According to Tatnall (2005), in the study of Miss (2014), a Web portal is a gateway to information and services from multiple sources in a unified way, using a single, unique user interface. A Web portal usually features specific functions, such as search mechanisms, access to databases, user registration and personalization options. Amplified by Idachaba (2015), Web portals are often designed to provide access to information from diverse sources in a uniform manner. Is a website that brings information from diverse sources in a unified way. In the existing design, an enrolment Web portal features functions like user registration and access to program courses and subjects for enrolment. The Web Based Portal is an important breakthrough for students, faculty, staff, and educational institutions. It is an important student support tool or support services tool that may enhance the learning experience of learners. According to Secreto, et al (2015), effective and responsive learner support services will help learners succeed in an open and distance e-learning (ODEL) environment as distance education students and ultimately achieve their learning goals. Learning support services are as important as providing learners with excellent academic content to guarantee their educational achievement.

Stressed out by Vikas, et al (2001), with rapid technological changes and shifts in educational practices, the education system is challenged with providing both increased educational opportunities and opportunities for lifelong learning. However, the implementation of such systems has been difficult due in part to the lack of proper organization and administration by educational institutions and student access to the useful programs. The statements are true for educational sectors like the said state college, particularly on students' access to useful programs. There is a great need to design a web-based portal so that students may no longer go to the institution for enrolment purposes but equip themselves with the gadgets necessary for online enrolment. Stated by Mansourvar, et al (2010), web portals become important because of student's need to access the required information on-line. It is vital that universities have a dynamic connection with the students by sharing the organized knowledge via the portal and help the students from messy information on the Web. However, the existing design needs to be measured or evaluated, particularly its usability and efficiency, so as to respond directly to the issues and concerns of the students who are directly involved in the system design and development. Thus, this research is very important to evaluate the system characteristics as perceived by the students in the student module, with an emphasis on specific software quality attributes such as usability and efficiency, in order to make any necessary adjustment to expect high satisfaction from students.

**Objectives**

The study generally aimed to evaluate the system's characteristics using ISO 9126 as perceived by the students in the student module, with emphasis on specific software quality attributes: usability and efficiency.

**METHODOLOGY****Research Design**

The study used a descriptive research design. This is appropriate in the study to evaluate the usability and efficiency of system's characteristics as perceived by the students, particularly in the student module. This particular module is the main design of the system to respond to the needs of the institution as a support tool for the students.



**Unife O. Cagas****Respondents**

There are forty five (45) third-year (3rd) students as the focus of the study. The 3<sup>rd</sup> students are chosen so as to get concrete and real-experienced information. This year level was able to experience both the manual and the newly implemented web-based enrolment portal. Of the total number of enrolled 3<sup>rd</sup> year students, only 28 responded or participated in the survey. The rest did not respond, most likely due to a slow internet connection, and some locations do not have internet access due to Typhoon Oddete, which hit certain cities in the Caraga Region. Figure 1 showed the online instructions with 28 responses using Google forms.

**Instruments**

There are two levels of questionnaires in reference to the student module design. These levels focus on usability and efficiency in system characteristics in reference to its subcharacteristics. The model is based on the ISO 9126 quality standard (ISO/IEC 2001). This can be used for the quality evaluation of the Web-Based Enrolment Portal from the main end-user point of view, the students. As specified by Stefani, et al. (2007), the model's structure relies on the set of quality characteristics and sub-characteristics that are directly related to quality as perceived by the end-users (referred to hereafter as "external measures"). They said further, "external measures" are those quality measures that require the involvement of the end-user to be evaluated. According to Aziz, et al. (2013), usability is one of the important characteristics that contribute to the usability and quality of products such as websites or software. Preece, Rogers, & Sharp (2015), as cited in the study of Alshehri et al. (2019), usability is a quality attribute of users' experiences when interacting with interactive technologies that assesses the easiness of the user interface. On the other hand, in the study of Hla and Teru (2015), efficiency is the optimal use of available resources in order to achieve value-added in the organization's value chain.

**Evaluation**

The designed questionnaire was answered by the selected 3rd year students of the identified Philippines' public colleges. Before the online survey of the questionnaire, the IT experts and professional researchers validated it first. The descriptive statistics were used in the computation of the mean and the weighted mean in evaluating the system's functionality and efficiency. To help interpret the responses, the upper and lower limits of a scale are used on the 5-point Likert scale as shown in Table 1.

**RESULTS AND DISCUSSION**

This part provides results and discussion in reference to the evaluation of the students in the designed modules on usability and efficiency (Tables 2-3). As shown in Table 2, the results of the evaluation on the level of usability system design characteristics as perceived by the users are shown. As shown, the system garnered (WM = 4.66), with a descriptive interpretation of "Strongly Agree." The weighted mean rating implies that the system function is easy to use; its functions provide readable descriptions that can be easily learned; users learn independently with less time and effort; it shows an organized and attractive interface; and it provides a usable module for the students. The result implies further that the system provided visible, organized, and usable modules with the highest mean rating (M = 4.93), with a verbal interpretation of "Strongly Agree." It means displaying and organizing modules with particular accounts so that only their rights to the system can be seen. Each module clears up any confusion about where to go next to complete the enrollment process as soon as possible. According to Golden (2010), in order for usability to be a first-class citizen among software quality attributes, usability design must be made cost-effective for development organizations. The statement implies that usability has to be given closer attention during development. On the other hand, it is noted that the system functions provided a readable description, which can be easily learned with the least mean rating (M = 4.50), with a verbal description of "Strongly Agree." The result is still favorable considering that the garnered meaning is still in its *strongly agreed rating*. This means there were students who did not perceive that the description provided could be learned easily. These students probably did not constantly use the internet and likely had difficulty engaging with the internet.



**Unife O. Cagas**

Table 3, the result of the evaluation on the level of efficiency in system characteristics as perceived by the users. As shown, the system garnered (WM = 4.78), with a verbal interpretation of "Strongly Agree." It shows that the system took less time when entering the correct user account and password; responded right away when logging in and out; sent clear notifications or instructions on selected transactions; responded speedily during data entry; and the whole process provided efficiency as a support tool. On the item specified, the system that responded quickly during data entry obtained the highest mean rating (M = 5.00), with the least mean rating (M = 4.60) on the item that claimed to respond right away when logging in and out. Results revealed that the system is less efficient during logging in and out. It may possibly result from the students' internet problems on the internet connection due to the present condition in the locality caused by the typhoon. This can be resolved directly when the internet connection is on its favorable services.

**CONCLUSION**

It is concluded that the system design characteristics in two different modules are highly usable and highly efficient system design characteristics. It means students are highly satisfied with the system design in usability and efficiency. The system successfully served the students during enrolment.

**Recommendation**

Since it is an important system as a student support tool or service, it is recommended that additional features such as a grading queue be added because this is also one of the important student support tools needed by the students. The online survey used should be supplemented with more comprehensive measures of quality subcharacteristics in future studies. It is further recommended that replications of the present study using other statistical tools are necessary to substantiate or clarify the present results. Likewise, students were recommended that they be allowed to view the temporary certificate of registration right away upon enrolment, even without approval from the enrolment evaluator.

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**Table 1. Numerical Rating with Descriptive Interpretation**

Numerical Rating	Descriptive Interpretation
4.50 - 5.00	Highly Usable/Efficient-Strongly Agree (SA)
3.50 – 4.49	Usable/Efficient- Agree (A)
2.50 – 3.49	Moderately Usable/Efficient-/Moderately Agree (MA)
1.50 – 2.49	Not Usable/Efficient-Disagree (D)
1.00 – 1.49	Strongly Not Usable/Efficient-Strongly Disagree(SD)

Table 2. Usability Quality System Characteristics	
<b>Usability:</b> The user perceived that the system:	Mean
1. was easy to use;	4.57
2. functions provided readable description which can be easily learned;	4.50
3. users learned independently with lesser time and effort;	4.79
4. showed organized and attractive interface;	4.54
5. provided visible and organized usable module;	4.93
<b>Weighted Mean (WM):</b>	<b>4.66</b>

Table 3. Efficiency Quality System Characteristics	
<b>Efficiency:</b> The user perceived that the system:	Mean
1. took lesser time when entering correct user account and password ;	4.60
2. responded right away when logging in and logging out;	4.70
3. sent clear notifications or instruction on selected transactions;	4.80
4. responded speedily during data entry;	5.00
5. whole process provided efficiency as a support tool;	4.80
<b>Weighted Mean(WM):</b>	<b>4.78</b>



**Figure 1. The Online Instructions With 28 Responses using Google Forms.**





## Taxonomic Orders, Societal Significance and Threat of Aquatic Insects

Shwetha Sarikar<sup>1\*</sup> and K. Vijaykumar<sup>2</sup>

<sup>1</sup>Research Scholar, Department of Zoology, Gulbarga University, Kalaburagi, Karnataka, India

<sup>2</sup>Chairman, Department of Zoology, Gulbarga University, Kalaburagi, Karnataka, India

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### \*Address for Correspondence

#### Shwetha Sarikar

Research Scholar,

Department of Zoology,

Gulbarga University,

Kalaburagi, Karnataka, India

E. Mail: shwethasarikar@gmail.com



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### ABSTRACT

Freshwater ecosystems or aquatic ecosystems carry out numerous valuable environmental functions. The structure and function of freshwater ecosystem can be measured on the basis of diversity of aquatic insects because of their high abundance, small life span, high birth rate, large biomass and rapid colonization of freshwater habitats. Mosquito and chironomid larvae are a major diet for aquatic organisms. Aquatic entomofauna are well known as a model organism to examine the structure and function of the freshwater ecosystem. Larvae and adults of aquatic insects have been consumed by humans for their health benefits and also, have a significant role in bio controlling agent. These insects play a key role in transmission of diseases to humans and animals. In this review paper an attempt has been made to focus on taxonomic orders of aquatic insects, the beneficial role of aquatic insects in food web, nutrient cycle, fishing, medicinal value, bio control agent and biomonitoring and threat caused by these insects to the society by transmission of diseases to human being and animals.

**Keywords:** Biocontrol agent, Biomonitoring, Food web, Medicinal value, Nutrient cycle.

## INTRODUCTION

Aquatic insects are well known as a model organism to examine the structure and function of freshwater ecosystem. The insects comprise the most diverse group of organisms that exist on the Earth. Aquatic insects maintain a moderately stable position in aquatic environment (Mc Cafferty and Provonsha, 1981). There are about 7,51,000 known species of insects, which is about three-fourth known species of flora and fauna on the planet. These are the only invertebrates that can fly (Voshell, 2002). About 5,000 species of aquatic insects are estimated to inhabit inland wetlands of India, constituted mainly by mayflies (*Ephemeroptera*), dragonflies (*Odonata*) and caddisflies (*Trichoptera*) (Subramanian and Sivaramkrishnan, 2017a). They are one of the important components for food web in freshwater ecosystem, they are the main prey of nekton and have a role as decomposers of organic matter (Husseiny *et al.*, 2015). Aquatic insects constitute only 3-5% of all insect species. (Daly *et al.*, 1984). They play a valuable ecological role in

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keeping freshwater ecosystem functioning properly (Hadicke *et al.*, 2017). Aquatic ecosystem health is monitored by using aquatic insects due to their different responses to stimulation in their aquatic habitats and to determine the quality of that environment. The presence or absence of some families of aquatic insects indicates whether a specific water body is healthy or contaminated (Choudhary and Ahi 2015; Merritt and Cummins, 2008). Limited number of works have been conducted on the ecological aspects of aquatic insects. Some works are those by (Thirumalai, 1999; Sivaramkrishnan *et al.*, 2000; Anbalagan *et al.*, 2004; Thirumalai, 2004; Jana *et al.*, 2008; Abhijna *et al.*, 2012; Majumder *et al.*, 2013; Murugesan, 2020; Rao, *et al.*, 2020; Wakhid *et al.*, 2020). In this review article we have mainly examined the taxonomic orders of aquatic insects and focused on the beneficial role of aquatic insects in food web, nutrient cycle, fishing, medicinal values, bio control agent and biomonitoring and threat caused by these insects to the society by transmission of diseases to human being and animals.

### Taxonomic Orders of Aquatic Insects

Aquatic insects are those which spends part of their life cycle in the water or on the surface of water (Resh and Rosenberg, 1989). Eleven orders of aquatic insects contain aquatic and semi aquatic phased species. In five of these orders (*Ephemeroptera*, *Odonata*, *Plecoptera*, *Megaloptera* and *Tricoptera*) possessed by aquatic stages, while remaining six orders contains terrestrial as well as aquatic or semi aquatic representatives. Semi aquatic species live in damp marginal habitats (e.g. some Hemipterans) or are associated with the upper surface of the air-water interface (e.g. some Collembolans). Only aquatic beetles and bugs contain species in which both adult and immature stages occur under water (Ward, 1992; Barman, 2014).

**Order 1. Collembola:** The *Collembola* are called as springtails. They are small arthropods and their fossil remains known from Devonian period over 345 million years ago. They are found in huge numbers in and on water surface where there is presence of organic detritus washed against the shore. These have special type of jumping device which are composed of furcula and tenaculum which helps them to leap many times their own length (Cipola *et al.*, 2017).

**Order 2. Ephemeroptera:** *Ephemeroptera* are commonly called as mayflies. These serve as a major diet for fish and other aquatic organisms. Their nymphs live under water before development as adults that mate and lay eggs in few days, they bear the same name as the adult nature called as ephemeral means which lasts for a very little time (Jacobus *et al.*, 2019). When these insect reaches its winged form, it molts and lives again as a winged form in water known as subimago, which again molts to the adult form (Peckarshy *et al.*, 1990).

**Order 3. Odonata:** The Odonates are the insects often called as dragonflies and damselflies (Hawking and Theischinger, 2004). Immature and adults of Odonates both acts as predators and help in reducing mosquito population by eating them. These are ancient insects that have been around since before the era of the dinosaurs. Some Odonata fossils which are found in Carboniferous period which were larger than some modern hawks (Bybee, 2008).

**Order 4. Plecoptera:** The *Plecoptera* are known as stoneflies, because nymphs are found underneath the stones of streams and rivers. These ancient order present in fast running water (Figueras, 2019). The immature of stoneflies looks alike as adults with exception of wings present in adults and nymph lacks wings (Dewalt and Ower, 2019; Marwein and Gupta, 2021).

**Order 5. Hemiptera:** *Hemiptera* are called as true bugs they ranged in various size from tiny insects known as water measures to the huge giant water bugs. These insects reach almost 7 cm in length (Abowei and Ukoroije, 2012). *Hemiptera* are predators having grasping forelegs and sharp piercing mouth parts that are capable to give out a painful bite (Haddad, 2010). Other *Hemipterans* may find in or on water surface includes the water scorpions, backswimmers, water boatman and water strider. These are found in emergent vegetation with slow moving water (Hadicke *et al.*, 2017).





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**Order 6. Megaloptera:** These insects referred to as dobsonflies and alderflies are especially remarkable both as larvae and as adults. The nymph of dobsonfly is known as hellgrammite. These larvae that can reach up to an inch long and consists of strong mandibles which helps in capturing the prey (Nair *et al.*, 2015). They appear in rocky, fast-moving catchment area of rivers, lakes and ponds and they live by consuming other aquatic insects. Excessively exaggerated jaws are seen in the adult males of alderflies (Engel, 2004).

**Order 7. Neuroptera:** The *Neuroptera* are called as nerve-winged insects. These are found terrestrial but larvae of this insects have needle-jaws to entrap the prey. These insects attach to their host sponge on their backs to escape from predators (Pennak, 1989).

**Order 8. Trichoptera:** *Trichoptera* common name is caddisfly which indicates as case-bearer (Majeed *et al.* 2020). Many of these insects construct cases to reside and they use materials which are found in river such as stones, twig, leaves and sand (Jewel *et al.*, 2018).

**Order 9. Lepidoptera:** These are some Lepidoptera the moths and butterflies that are truly aquatic (Lange, 1956). Immature of the moths live on the aquatic plants (Pabis, 2018). When these Lepidoptera emerge into adult form, they leave water and fly nearby (Pabis, 2014).

**Order 10. Coleoptera:** The *Coleoptera* is known as shield-wing these have front wings modified into hardened covers which guard the rear wings from injury. Flying beetles use their rear wings to fly. These beetles are very diverse and fascinating. Predaceous diving beetles are almost 2.0 cm in length and found in weedy ponds. The whirligig beetles are commonly seen often in large groups swimming collectively on the surface of water. These beetles adapted themselves to live in water. They are four-eyed with lone pair of eyes looking over head the water and other beneath (Allan, 1995). Other beetles which are found in lakes, rivers and ponds are elmids or riffle beetles, psephenid or water penny beetles and haliplids beetles (Lille, 1991).

**Order 11. Diptera:** *Diptera* means two wings refers to the true flies. *Diptera* mainly feed on our blood. These include the tabanids (horseflies and deerflies), the culicids (mosquitoes), ceratoponids (biting midges) and the simuliids (biting blackflies) (Courtney *et al.*, 2017).

**Societal Significance of Aquatic Insects****Food Web and Nutrient Cycle**

Aquatic insects are well known as model organisms to examine the structure and function of freshwater ecosystem. The structure and function of freshwater ecosystem can be measured on the basis of diversity of aquatic insects because of their high abundance, small life span, high birth rate, large biomass and rapid colonization of freshwater habitats (Choudhary and Ahi, 2015; Baskar *et al.*, 2021). Shredders, scrapers, piercers and predators are the different functional feeding groups important in nutrient recycling (Lamberti and Moore, 1984). Shredders helps in decomposition of organic matter and nutrient cycling (Wallace and Webster, 1996), the processing of organic matter is carried out by collectors (Hershey, 1987), scrapers are those which consume algae (Feminella and Hawkins, 1995), the cellular fluid consumption of individual cells of algae is done by piercers (Swanson, 2007), predators play important role in energy transfer to higher trophic levels (Cooper, 1990, Sundar *et al.*, 2020). The abundance of the trophic group in the ecosystem indicates that different quality of ecosystem. The greater the abundance of shredder and collectors trophic groups suggest a healthier environment than predator dominated ecosystem (Barman, 2014). Insects play a major diet for fish and other aquatic organisms. Aquatic insects firstly process leaf litter and wood which are reaching the wetland from the surrounding landscape. The nutrients which are further degraded into an absorbable form by fungal and bacterial action. This forms the base of food chain in aquatic ecosystem. Some aquatic insects filter fine particles that are floating on water surface. This helps to keep water clean and light to penetrate where algae and other plants are growing in the bottom. Other aquatic insects are useful to mix soft lowest sediments as they burrow in search of food. This makes the bottom be transformed into healthier for organisms to



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get oxygen from the water into the bottom. Predaceous beetle such as *Dytiscus* helps in reducing the organisms found in water and maintains balance in freshwater ecosystem (Khan and Ghosh, 2001; Voshell, 2002). Mosquito and chironomid larvae are a major diet for aquatic organisms (Cibrowki and Corkum, 2003). Odonates are a magnificent indicator. They feed on mosquitoes which helps in reducing mosquito population (Watson *et al.*, 1982; Watson *et al.*, 1982; Steward and Samway, 1988).

**Fishing**

The biodiversity of aquatic insect is of great interest to society because these animals are very important in the diet of many species of fish, which are usually eaten by humans. People who fish with natural or artificial baits have particularly interested in it. The species most often mimicked are mayflies, caddisflies, stoneflies and non-biting midge. Larvae, pupae and adults are imitated and presented to fish in such a way as to mimic the behavior of these forms, which grow on the lower substrate, float in the flood, emerge from the surface of the water, or return to water as egg-laying females or dying adults (Dudgeon, 1999).

**Medicinal Value and Bio Control Agent**

Entomophagy the consumption of insects (Fontaneto, 2011). Most of the insects larvae and adults have been consumed by humans for their health benefits and also, they play a significant role in bio controlling agent. As it consists of essential source of proteins, fats, minerals, vitamins and antioxidants which can be compared with meat and fish (Tiencheu, 2017). *Libellulidae* and *Aeshinidae* larvae is boiled in water to extract its flavor and medicinal properties. The extracted water is consumed to cure hypertension, kidney problems, pregnancy related relapse, beriberi and dizziness. The same extracted liquid helps in treating toothache, paralysis and gas blotting in children. On the other hand, *Aeshinidae* larvae are used to control high blood pressure (Cudera *et al.*, 2020). Water striders are used for the treatment of dog bites and mental illness (Srivastava *et al.*, 2009; Courtney, 2017). *Lethocerus indicus* and *Cybister tripunctatus* has an important source of protein and fat in diet and with strong antioxidant properties (Waltz *et al.*, 2008; Shantibalaa *t al.*, 2014; Williams, 2017). Dragonflies and damselflies have significant role in ecosystem. Both larva and adult serve as predators and are extensively prey on mosquitoes acting as biocontrol agent (Chandra *et al.*, 2006; Jacob *et al.*, 2017; May, 2019). Aquatic *Hemiptera* such as Notonectidae, Belostomatidae, Nepidae and semi aquatic such as Gerridae and Vellidae which are seen in marshes act as significant mosquito predators (Nam *et al.*, 2000; Mandal *et al.*, 2008; Ohba *et al.*, 2011; Tupinambas *et al.*, 2011; Benbow *et al.*, 2014;).

**Biomonitoring**

Biomonitoring is a usage of organisms and their biological responses to evaluate changes in the habitat. Loss of freshwater ecosystem is related to human activities (Antunes *et al.*, 2016) and is a growing phenomenon that is leading to habitat destruction, global climate change and fragmentation (Saunders *et al.*, 2002; Boyero *et al.*, 2009). Aquatic insects are the most widely used organisms in freshwater. It is important because it disclose the result of different pollutants and further changes in environmental conditions. This is used to access anthropogenic impacts to a system (Abell, 2002). Aquatic insects are a health diagnosis of freshwater ecosystem, the composition and density of aquatic insects reflects habitat status because different taxa require unique water qualities. That is why they are used as indicator species. Aquatic insects are one of the most commonly recommended species to evaluate water quality they act as an indicator species for monitoring environmental pollution (Anjinappa and Vijaykumar, 2020). A sample of aquatic insects can change several repetitive physico-chemical measurements (Habib and Yousuf, 2016). A recent assessment of water ecosystem reveals that river catchments which are found in Indian subcontinent are most globally threatened (WCMC, 2000). Loss of aquatic insects can cause negative outcome on the ecosystem stability and diversity.

**Societal Threat of Aquatic Insects**

Aquatic insects play a key role in transmission of diseases to human being and animals (Gratz, 2004; Phillips, 2008). There are many adult Diptera with effective piercing style mouth parts allowing for these flies to bite and suck blood. Due to their blood feeding habits these are natural carriers of pathogens and play important role in



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transmission of bacteria, viruses and other pathogens (Harbach, 2007). Diptera such as mosquitoes transmit diseases, such as malaria, dengue, filariasis and yellow fever. Many researchers have worked on their control measures. About 70 genera of mosquitoes transmit about 500,000 malaria cases each year. Yellow fever is transmitted by lone mosquito *Aedes aegypti*. Furthermore, few members of them can give a painful bite and causes dermatological effect on humans and animals. Dragonfly and damselfly considered as a threat to the poultry industry because they transmit a parasitic flatworm of *Prosthogonimus* species (Angel, 1973; Whiteman et al. 2005; Solanki and Shukla 2015). Blackflies transmit the filarial parasites *Dirofilaria* in bears, *Mansonella* and *Onchocera* in humans and the protozoans, *Leucocytozoon* in birds (Crosskey, 1990). Hairs of adult caddisflies or other aquatic insects can cause allergic reaction. Belostomatidae (giant water bug) can cause painful bites in humans. Buruli ulcer is a disease caused by *Mycobacterium (Mycobacterium ulcerans)* wide spread ulcer mainly in the lower limbs, *Mycobacterium ulcerans* can be isolated from water bugs in endemic areas and reproduced in the salivary glands of bugs which are transmitted by the bite of giant water bugs (Haddard, 2010).

**CONCLUSION**

To attain the environmental sustainable future, the conservation of biodiversity has become the emerging issue in the last decades. Numerous indicator species are excluded due to lack of their complete data. Study on aquatic insects can furnish the information about ecology of insects in an area for any decision making. Presently entomologist are working on the development and improvement of existing new biomonitoring tools using aquatic entomofauna. Very few professional entomologists are capable of recognizing species of aquatic organisms or interested in discovering their biological characteristics. This capacity for declining at very time in history, where there is a greatest need for biodiversity discovery before many species become extinct.

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## Recent Advances in Periodontal Therapy

Aditi Chaturvedi<sup>1\*</sup> Anurag Bhatnagar<sup>2</sup> and Amit Bhardwaj<sup>3</sup>

<sup>1</sup>Post Graduate Student, Dept. of Periodontology, Faculty of Dental Sciences, SGT University, Gurgaon, Haryana, India

<sup>2</sup>Senior Lecturer, Dept. of Periodontology, Faculty of Dental Sciences, SGT University, Gurgaon, Haryana, India.

<sup>3</sup>Professor and Head, Dept. of Periodontology, Faculty of Dental Sciences, SGT University, Gurgaon, Haryana, India.

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### \*Address for Correspondence

#### Aditi Chaturvedi

Post Graduate Student,  
Dept. of Periodontology,  
Faculty of Dental Sciences,  
SGT University,  
Gurgaon, Haryana, India  
Email: chaturvediaditi50@gmail.com



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### ABSTRACT

Our oral cavity is considered as the “Mirror of our Body”, it is hugely impacted from an array of factors such as disease, psychological stress and eating habits. It is a multifactorial disease which has the involvement of host, environment and other local factors. Probiotics, Ozone therapy, Photodynamic therapy, Microsurgery, Lasers, Piezo surgery, Nanotechnology, Periodontal vaccine, Perio protect, Tissue engineering and Molecules to resolve inflammation in treatment of periodontal disease. This Literature review highlights various advances.

**Keywords:** Recent advances, Microsurgery, Piezo surgery, Probiotics, Nanotechnology

## INTRODUCTION

Our oral cavity is considered the “Mirror of our Body”, it is hugely impacted by an array of factors such as disease, psychological stress, and eating habits. It is a multifactorial disease that has the involvement of host, environment and other local factors. As science and technology evolve, they bring out many advances which help in reducing the procedure time as well as aid in better healing. The advantages of various advances lie in the fact they use new materials and methods and bring out better chances of healing.





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Probiotics, Ozone therapy, Photodynamic therapy, Microsurgery, Lasers, Piezo surgery, Nanotechnology, Periodontal vaccine, Perio protect, Tissue engineering and Molecules to resolve inflammation are new advances used in treatment of periodontal disease.

**Probiotics**

Probiotics are available in various forms such as molds, yeast, and bacteria, the bacterial species are found more predominately. The most commonly used prebiotics used includes two genera *Lactobacillus* and *Bifidobacterium* species. Act as an adjunct to oral prophylaxis also helps in the inhibition of the periodontopathogens recolonization of periodontal pockets to achieve and maintain periodontal health. Probiotics help in the inhibition of pathogen growth and metabolism. The use of probiotics has been implicated in cariogenic lesions as well to halt the progression of periodontal diseases. There are several drawbacks of Probiotics, including changes in the carbohydrates undergo changes on cooking this was the reason why the advent of prebiotics had taken place. These are selectively fermented ingredients which allows changes in composition and activity of the GIT which renders health benefits to the host. The prebiotics are effective when released directly in the lower GIT. The carbohydrates of prebiotics do not undergo changes while cooking [7].

Probiotics work in various ways such as it could either inhibit the adhesion of the pathogenic bacteria, therefore, inhibiting its growth. The inhibiting action of the probiotic further enables the elevated production of IgA and defensins, thereby enhancing the host immune response (Fig-1).

**Ozone Therapy**

Ozone has been used for the following reasons such as elimination of pathogens, restoration of proper oxygen metabolism, induction of a friendly ecological environment, increased circulation, activation and stimulation of immune system and simulation of the humoral antioxidant system. The application in Periodontology includes gaseous ozone used during scaling & root planning. It is very useful in eliminating periodontal pathogens such as *P.gingivalis*. It also finds its utility in its action as a cleansing agent. Others included such as helpful in reducing the pocket depth and in regeneration procedures [8]

**Photodynamic Therapy**

Photodynamic therapy being effective antibacterial technique can be used in treatment of periodontal disease such as chronic periodontitis. The application of PDT is seen in the effective treatment of periimplantitis. It is observed that PDT in conjugation with mechanical debridement can provide exceptional results in terms of reducing the bacterial load [2].

**Piezosurgery**

It is method that enables the preparation of a small part of bone by removal of small quantities. It is targeted mostly at performing osteotomies but can also be helpful in performing soft-tissue surgeries. Piezosurgery provides its usefulness in terms of surgical procedures namely maxillary sinus lifting perforation of the Schneiderian membrane. It is risk when performed using traditional rotating instruments, the risk is reduced to a minimal amount when performed using piezosurgery. Piezosurgery also finds its validation in Alveolar crest expansion. In lateralisation of the inferior alveolar nerve would allow safe osteotomy and an easy access to the underlying nerve. It provides to be useful in the removal of osseointegrated implants.

**Microsurgery**

Microsurgery involves the amalgamation of three principles namely precision of instrumentation, magnification of surgical site, and therefore refinement in surgical sites. This advancement finds its utility in root coverage procedures, papilla preservation procedures, and other aesthetic procedures of periodontology. The disadvantages of this advancement include difficulty in focusing at first and may cause strain on the operator [4].





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### **Periodontal Vaccine**

Periodontal vaccine in treatment of periodontal treatment help in decreasing the incidence of periodontal disease as it is known that periodontal disease is a multifactorial microbial disease that is said to have a systemic predisposition as well. This in turn makes the individual susceptible to various conditions which include myocardial infarction, cerebrovascular stroke, pneumonia etc [1].

### **Lasers**

Lasers have always been synonymous with cutting edge technology and have established themselves as a boon to the medical sciences. The advent of lasers in the field of Periodontology has created new avenues for treatment options. These are helpful in detoxification and bactericidal effects thereby aiding in better periodontal attachments. There are different types of lasers employed in Periodontal procedures namely Argon, Diode, Neodymium: **Yttrium Aluminum Garnet** (Nd:YAG), Erbium, Chromium: Yttrium Scandium Gallium Garnet (Er, Cr:YSGG), Carbon Dioxide Laser (CO<sub>2</sub> Laser).

Lasers help in performing an array of periodontal procedures namely initial periodontal therapy or non-surgical periodontal therapy wherein soft tissue lasers are employed in order to reduce gingival inflammation such as Diode and Nd:YAG lasers. It finds itself being used immensely in terms of surgical periodontology due to many reasons a few being, ease of use, reduced gingival aberration, faster healing rate and minimal hemorrhage. Different procedures such as Gingival sculpting, esthetic procedures such as a frenectomy, surgical crown lengthening and depigmentation [3].

### **Nanotechnology**

Nanotechnology involves a science which incorporated studies taken place at macromolecular level. It enables the study of materials at a nanoscale level.

Based on the application, use and technology there are 4 approaches of nanotechnology:

1. Top-down approach
2. Bottom-up approach
3. Functional approach
4. Biomimetic approach In Periodontology, it can be used in the form of nanorobots dentifrices wherein popularly known as 'Dentirobots'. These function in providing a continuous barrier against oral malodor. Nanotechnology could also be beneficial in controlling dentinal hypersensitivity by the use of n-HAP-containing toothpaste. Nanoparticles selectively release antimicrobial agents post attachment with oral biofilms. It involves the smart release of agents when triggered by environments comprising of acidic pH. Nanotechnology could be utilized to create surfaces with controlled topography and chemistry that would assist understanding biological interactions and developing novel implant surfaces with predictable tissue-integrative properties. Advances in the fabrication of nanoparticles for coating the implant surface and the nano-patterning of dental implants is leading to better osseointegration and improved physiologic functions of implants [5,7].

### **Tissue Engineering**

The scope of tissue engineering has provided a huge opportunity to fill the lacunae which exist in conventional periodontal therapy. For eons, scientists have been trying to find out ways and means to recreate lost tissues and methods of their regeneration. Then it was found that combining cells, growth factors, and barrier materials serve as the cornerstone of tissue engineering therapy. The current topic of focus remains regeneration with the help of a periodontal ligament. This particular dynamic tissue maintains the relationship between tooth and bone. Ligaments are a huge rage nowadays because of their longevity as a way of improving biological performance and thereby improving the prosthesis life. Gene vaccines have been useful in activating cell-mediated as well as humoral immunity by either encoding genes or RNA of a specific pathogen [7].





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## CONCLUSION

The advancement seen in every sphere of science and technology and the field of Periodontology is not far behind. Within the realms of periodontal therapy, it is very important that we have a fair understanding of the disease, the factors causing it and the involvement of local as well as systemic factors. This understanding will further widen our prospective and help us realize the true potential of this ever-changing and dynamic branch of dental sciences.

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**Table -1. Contribution of Authors In Different Fields of Advances**

Author/Year (Probiotics)	Study Type	Conclusion
Matsuoka et al in 2018	Parallel Open Label Study	Consumption of L. salivarius T1 2711 tablets 5 times a day for 8 weeks and showed a decrease in bleeding on probing and <i>P.gingivlis</i> counts.
Teughels et al in 2007	Split Mouth Study	Bacterial pellets of <i>S. sanguis</i> KTH-4, <i>S. salivarius</i> TOVE and <i>S. mitis</i> BMS were applied locally in pockets at 1,2 and 4 weeks. They showed decreased counts of anaerobic bacteria and <i>C. rectus</i> with decreased pocket recolonization and bleeding on probing when compared with controls

Author/Year (Ozone Therapy)	Study Type	Conclusion
Kshitish and Laxman in 2010	Randomized, Double-Blind,	They concluded that despite the





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	Crossover Split-Mouth	substantivity of chlorhexidine, the single irrigation of ozone is quite effective to inactivate microorganisms
Fillippi. A in 1995		Found that ozonized water applied on daily basis can accelerate the healing rate in oral mucosa.
Huth, et al. in 2011		High-concentrated gaseous and aqueous ozone merit further investigation as antiseptics in periodontitis therapy.

Author/Year (PDT)	Study Type	Conclusion
Braun et al. in 2008	Split -Mouth Study	Results were better when mechanical therapy was performed in association with PDT
De Oliveira et al in 2007	Split-Mouth Design Study	Evaluated GI & BOP after therapy using PDT , and found pronounced changes on compared with its control.

Author/Year (Piezo Surgery)	Study Type	Conclusion
Gonzalez et al. in 2017	Split -Mouth Study Design	The use of piezoelectric osteotomy in osteogenic distraction to increase the alveolar ridge height prior to the installation of dental implants is easier and less prone to intraoperative complications compared to conventional osteotomy procedures.
Esteves et al. in 2018	Split -Mouth Study Design	A higher amount of newly formed bone observed 30 days after the use of the piezosurgery device post performing osteotomy.

Author/Year (Piezosurgery)	Study Type	Conclusion
Cortellini P, Cortellini S, Bonaccini D, Tonetti MS. 2021	Retrospective study	All implants survived up to 5years with significant clinical and radiographic outcomes
Moreno Rodríguez J, Pecci-Lloret M, Ruiz E, Ruiz A. 2018	Preliminary Study	Bone augmentation was evaluated six months after preservation by computed tomography and histology, and it demonstrated positive preliminary results in bone reconstruction with reduced morbidity
Author/Year (Periodontal Vaccine)	Study Type	Conclusion





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Houri-Haddad et al in 2010	Cross sectional Study	The immune response and the resultant protection to a <i>P. gingivalis</i> infection, in <i>P. gingivalis</i> -vaccinated mice, are adjuvant- dependent.
Hardham et al. in 2005	Randomised -Control Trial	The authors concluded that a periodontal vaccine may be a useful tool in preventing the progression of periodontitis in animals.
Author/Year (Lasers)	Study Type	Conclusion
Eberhard et al in 2003	DNA probe analysis	The laser was used for twice the time as that for SRP, the percentage of root surface devoid of calculus increased to 83.3%. Both these therapy resulted in similar lowering of microbes causing pathology.
Harris and Yessikin 1997	Split-Mouth Study	Determined the in vitro ablation threshold for <i>porphyromonas gingivalis</i> for both the 810-nm diode and Nd:YAG lasers to be 48 and 96 J/cm <sup>2</sup> , respectively.
Ito et al. in 1995	Randomised Control Trial	This study showed remarkable reduction of porphyromonas gingivalis, Aggregati bacteractinomycetemcomitans, Prevotellaintermedia after using Nd:YAG laser.

Author/Year (Nanotechnology)	Study Type	Conclusion
Horowitz et al in 2004	Split -Mouth Study	The mandibular site grafted with $\beta$ -TCP mixed with the patient's blood rendered 51% vital bone with 1% graft remnant. The proposed therapy for enhancing extraction sockets led to a 100% success rate in implant placement and loading.
Masurkar SA et al. in 2012	Split -Mouth Study	Silver nanoparticles can enhance quorum quenching activity against <i>Staphylococcus aureus</i> and prevent biofilm formation.
Author / Year (Newer molecules to resolve Inflammation)	Study Type	Conclusion
Palmer et al in 2018	Cross Sectional Study	Evaluated the effects of scaling and root planning found that removal of 75% of a biofilm mass resulted in a regrowth that





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		reached 400% regeneration within three hours.
Teles et al in 2017	Longitudinal Study	Biofilms following mechanical therapy attained a growth potential that superseded pre-treatment levels within days and they demonstrated there was no significant alteration in the proportions of periodontal pathogens following conventional plaque removal.
<b>Author/Year (Tissue Engineering)</b>	<b>Study Type</b>	<b>Conclusion</b>
Semino et al in 2004		Concluded that products calibrated using Tissue engineering were further to have no untoward immune response, they were bio-degradable and shared several similar properties with natural ECM's such as 3D nanofiber matrices to support cell maintenance, proliferation and differentiation.





## Prediction of Clinical Outcomes of Patients with Covid-19 based on Extreme Learning Machine

SM Saravanakumar<sup>1\*</sup> and T.Revathi<sup>2</sup>

<sup>1</sup>Research Scholar and Assistant Professor, Department of Computer Science, PSG College of Arts and Science, Coimbatore-14, Tamil Nadu, India

<sup>2</sup>Associate Professor, Department of Computer Science, PSG College of Arts and Science, Coimbatore-14, Tamil Nadu, India.

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### \*Address for Correspondence

#### SM Saravanakumar

Research Scholar and Assistant Professor,  
Department of Computer Science,  
PSG College of Arts and Science,  
Coimbatore-14, Tamil Nadu, India  
E. Mail: smskpsgcas@gmail.com



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### ABSTRACT

In the year 2019, a new disease known as novel corona virus had started spreading from china to all over the world. The situation becomes very crucial had been spreading all over the countries in world. A lot of people in the world got affected by the disease and we are in the condition of preparing many hospitals and medications to the people who are affected by the disease. The current method used to find a person who are affected by the disease are very slow and less performing as compared to the huge population. The proposed method gives the actual number of patients who had been affected by the novel corona virus by using machine learning algorithm. A set of data has been given to the algorithm like patient's medical records and past and present patient records. The proposed algorithm finds whether the patient is affected by corona virus or not. The proposed method gives better results than the previous method.

**Keywords:** Corona Virus, Patients, algorithm, Disease

### INTRODUCTION

The novel corona virus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is spreading globally, as of March 14, 2021 as of today, 119.21 million people have been infected and 2.64 million people have died [1]. The viral disease infections are increasing day by day proportionally and this cause pressure to the medical organizations around the globe. The medical world works 24x7 to find the easiest way to identify the COVID – 19 patients at the risk who needs immediate oxygen supply for ventilation and provide early

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intervention is the major problem to be solved. The clinical data collected in this study were collected within 6 hours after the patients were admitted to the hospital. The diagnostic criteria for COVID-19 follow the 2020 WHO guidelines. Severe COVID-19 cases were defined as fever plus respiratory rate  $>30/\text{min}$ , severe respiratory distress, or oxygen partial pressure  $<93\%$ . All severe cases developed from non-severe cases, and no severe cases developed at the time of clinical data collection. Patients with no trend towards severe disease and no need for oxygen were defined as non-severe cases. All non-severe cases were discharged in a stable manner. Nasal swab and throat swab specimens were used for SARS-CoV2 virus RT-PCR detection. This study uses the dataset which was approved by the Ethics Committee of Wuhan Huoshenshan Hospital (HSSL024) and carried out in accordance with the Declaration of Helsinki.

**Literature Survey**

Currently, studies on the risk of COVID-19 are being conducted on various topics, such as risk [2-5], prediction and analysis of infection routes [6], and impact on communities and members [7]. However, studies that can quantify the risk of COVID-19 or guarantee safe activities are rarely conducted. Therefore, in this paper, we present the factors that affect the risk of COVID-19 and propose a metric to express the risk through those factors. In addition, studies [8-9] that classify patients for diseases using clustering techniques among machine learning algorithms are applied to the risk analysis of COVID-19.

It is expected that the COVID-19 risk measurement metric and analysis method presented in this paper will make a great contribution to assisting people in safe living activities from COVID-19. Alaa's study suggested a strategy to identify areas at risk of spreading COVID 19 by analyzing population density [10]. However, no solution was presented using the analysis results. Wang's study presented a method to derive the causative factors for the spread after modeling and analyzing the emergence and spread of COVID-19 in the community [11]. However, it did not suggest how to control the spread of COVID-19 by using risk factors.

Lee's study analyzed the extent of COVID-19's current impact on Korean communities and suggested future development directions [12]. However, limited measures were presented for specific groups such as government offices and media outlets. Lastly, Song's study suggested a way to strengthen social distancing through an interactive web-based mapping platform. However, no method has been suggested for users to directly feel the risk of COVID-19 [13]. Considering the current studies, the majority of studies are related to the analysis of disease risk. In addition, studies that can suggest or judge people to take safe predictions using the analysis results have not been actively conducted. Therefore, this paper presents several metrics related to COVID-19 risk and a plan to support risk analysis in prediction and safe activities using them.

**MATERIALS AND METHODS****Research Objects**

Cases from January 27 to March 8, 2020 in Wuhan Fangcai Hospital data is used for this research. The included population was confirmed as COVID-19 cases by real-time fluorescent RT-PCR detection of new corona virus nucleic acid positive or positive serum new corona virus-specific IgM antibody and IgG antibody test. The conditions for the selection of severe cases refer to the "Diagnosis and Treatment Program for Novel Corona virus Pneumonia (Trial Sixth Edition)" [14] (meet any of the following): blood oxygen saturation  $\leq 93\%$ ; respiratory rate  $\geq 30$  breaths/min; arterial blood oxygen content Pressure ( $\text{PaO}_2$ )/Oxygen uptake concentration ( $\text{FiO}_2$ )  $\leq 300$  mmHg (1 mmHg=0.133 kPa).

**Inclusion of Predictive Indicators**

A total of 49 parameters were included in the admission testing of all included cases, including demographic characteristics, vital signs, clinical laboratory monitoring parameters and CT parameters, disease and treatment characteristics, clinical characteristics and pathological variables.





**Saravanakumar and Revathi****Extreme Learning Machine (ELM) Prediction Model**

ELM is a machine learning technique [15], which builds a prediction model by assembling a weak prediction model (usually a decision tree). During the training process, a series of decision trees are generated in the way of gradient enhancement, that is, the next decision tree is progressively generated according to the current decision tree to better predict the result [16]. After training, a risk prediction system consisting of a series of decision trees can be obtained. During application, the output predicted risk is the cumulative score for each decision tree, expressed as the probability of the predicted outcome. ELM has two particular advantages. First, ELM provides an importance score for each variable, which represents the weight of the variable in the predictive model. Second, the ELM algorithm can automatically handle missing data by adding default directions for missing values in each tree node, and the default directions are learned from the training data. When there are missing values in the validation data, classify the instance as the default orientation. And this advantage is unmatched by other machine learning methods and traditional statistical models, because these models cannot automatically deal with missing values. In these models, the missing values are usually filled by means of mean substitution [17].

**Analysis Strategy**

Based on input variables such as the patient's admission detection indicators, preliminary mild and severe classifications, and dynamic changes in admission indicators (ie, the second measurement value minus the first measurement value after admission), a prediction model is established. Assess the risk of a patient suffering from severe disease after admission, taking into account not only the basic indicators of the patient (such as initial mild and severe classification, vital signs, and clinical testing, etc.), but also the dynamic indicators after admission (such as heart rate changes, blood pressure changes and Changes in clinical detection indicators, etc.). The selected patients were followed up from admission to discharge to observe their disease outcome and verify the prediction results of the model.

**Statistical Analysis**

According to the diagnostic criteria of COVID-19, a total of 143 patients were included in this study. 100 patients were randomly selected as the training set, and the data of the remaining 43 patients were used as the test set. For 49 variables, based on the principle of high predictive ability and wide availability of variables, combined with Receiver Characteristic Curve (ROC) and data defect rate to screen out candidate variables for disease outcome prediction, candidate predictor variables must meet the following conditions:  $AUC > 0.6$  and Data Defect Rate  $< 50\%$ . The pre-screened predictor variables are used as input items, brought into XG Boost for training, and the patient outcome is used as the output. Divide the original training set data (100 cases in total) into 5 groups on average, and use each subset data as a verification set, and the remaining 4 sets of subset data as training sets, and thus obtain 5 models, using these 5 The average of the classification accuracy of the final validation set of the model is used as the performance index under the five-fold cross-validation model. Among the evaluation indicators of model performance, in addition to the accuracy rate, the clinically more concerned indicator is the sensitivity, that is, the probability of detecting a positive in the gold standard judgment of a severe (positive) population, so that it can be achieved as much as possible. Avoid missed diagnosis of critically ill patients. The traditional method is used as a control, that is, the index detected for the first time upon admission and the selection criteria for severe disease are used to evaluate whether the patient is mild or severe, and compared with the XGBoost prediction model to judge the pros and cons of the prediction model.

**Processing the Previous Data**

Extreme Learning Machine (ELM), Support Vector Machine (SVM), Naive Bayes (NB), Logistic Regression (LR), and Random Forest (RF) are five machine learning algorithms (RF), were used to predict and model the clinical outcome of COVID-19 patients. The patient data of Huoshenshan Hospital was the patient information from the Optics Valley Branch of Tongji Hospital, which was used as the training set. Affiliated to Tongji Medical College of Huazhong University of Science and Technology was the test set was. Due to the uneven distribution of positive and negative values for the training set's outcome variables (68 in-hospital fatalities; 2982 alive; 2972 alive; not receiving endotracheal intubation, 58 receiving endotracheal intubation), Positive and negative values were balanced using an





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oversampling technique. After oversampling, the sample size was 5331 cases, and the ratio of hospital deaths was changed from 43.7:1 to 50:50. [18] The post-sample size was 5922 cases, and the main process is shown in Figure 1. Imbalanced classification is a type of supervised learning that deals with a much larger proportion of one class of data than the other classes, This occurs frequently in binary data. When working with unbalanced classified data, the algorithm may fail because it can't gather enough data from the classification with a small sample size to be unstable and lead to biased prediction results. Unbalanced data can be dealt with by oversampling. According to the law of less classified samples, oversampling is employed to create an excessive number of samples of this classification, resulting in more balanced data.

**METHODOLOGY**

The proposed extreme learning machine methodology is discussed here

**Extreme Learning Machine (ELM)**

Extreme Learning Machine is an efficient learning method proposed on the basis of Single hidden Layer Feed-forward Neural networks (SLFNs). Different from traditional neural networks, all hidden layer parameters in ELM are randomly generated without cumbersome iterative process; its output weights are obtained by solving the generalized inverse of the matrix. Therefore, compared with traditional SLFNs, the training speed of ELM can be significantly improved on the basis of guaranteed learning performance. Extreme learning machine is an efficient learning method proposed on the basis of single hidden layer neural network. Different from traditional neural network methods, all hidden layer parameters in ELM are randomly generated without cumbersome iterative process. Therefore, compared with traditional learning methods, ELM has the advantages of easy parameter selection and fast learning speed.

For a training sample with N samples  $\{x_i, t_i\}_{i=1}^N$  where the input is a d-dimensional vector  $x_i \in R$  output label  $t_i$ , ELM's output as

$$f_L(x) = \sum_{j=1}^L \beta_j G(a_j, b_j, x_i) = h(x_i)\beta \tag{1}$$

Where  $a_j$  is the input weight connecting the  $j^{th}$  hidden node;  $b_j$  is the bias of the  $j^{th}$  hidden node;  $\beta_j$  is the weight of the  $j^{th}$  hidden node to the ELM output node;  $G(a_j, b_j, x_i)$  is the output function of the  $j^{th}$  hidden node;  $h(x_i) = G(a_1, b_1, x_i)$ , and  $G(a_L, b_L, x_i)$  is the hidden layer's The function of the output vector,  $h(x_i)$ , is to map the sample  $x_i$  from the d-dimensional input space to the L-dimensional feature space. In order to improve the generalization ability of ELM, when using ELM to solve the classification problem, it is described as an optimization problem shown in formula (2)

$$\left. \begin{aligned} \text{Min: } L_{ELM} &= \frac{1}{2} \|\beta\|^2 + C \frac{1}{2} \sum_{i=1}^N \|\xi\|^2 \\ \text{s.t. } h(x_i)\beta &= t_i^T - \xi_i^T, i=1, \dots, N \end{aligned} \right\} \tag{2}$$

The introduction of the training error  $\xi$  is to eliminate the overfitting phenomenon, thereby reducing the test error, and C is the corresponding penalty factor. This optimization problem can be solved by solving its dual problem:

$$L_{ELM} = \frac{1}{2} \|\beta\|^2 + C \frac{1}{2} \sum_{i=1}^N \|\xi\|^2 - \sum_{i=1}^N \sum_{j=1}^L \alpha_{i,j} (h(x_i)\beta_j - t_{i,j} + \xi_{i,j}) \tag{3}$$

$$\frac{\partial L_{ELM}}{\partial \beta_j} = 0 \rightarrow \beta_j = \sum_{i=1}^N \alpha_{i,j} h^T(x_i) \rightarrow \beta = H^T \alpha \tag{4}$$

$$\frac{\partial L_{ELM}}{\partial \xi_j} = 0 \rightarrow C \xi_i, \quad i = 1, \dots, N \tag{5}$$

$$\frac{\partial L_{ELM}}{\partial \alpha_j} = 0 \rightarrow h(x_i)\beta = t_i^T - \xi_i^T = 0, \quad i = 1, \dots, N \tag{6}$$





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$$\left(\frac{I}{C} + HH^T\right)\alpha = T \tag{7}$$

$$\beta = H^T \left(\frac{I}{C} + HH^T\right)^{-1} T \tag{8}$$

Thus, the core problem of ELM is solved, and the output weight  $\beta$  is obtained. The output equation of ELM can be written as

$$f(x) = h(x)\beta = h(x)H^T \left(\frac{I}{C} + HH^T\right)^{-1} T \tag{9}$$

When using ELM to solve the binary classification problem, the decision equation is

$$f(x) = \text{sign}\left(h(x)H^T \left(\frac{I}{C} + HH^T\right)^{-1} T\right) \tag{10}$$

When solving multi-classification problems, the decision equation is

$$\text{label}(x) = \arg \max f_i(x) \quad i \in \{1, \dots, m\} \tag{11}$$

Compared with traditional classification methods, ELM greatly reduces the time spent in the training phase on the basis of ensuring a certain recognition accuracy, which makes it irreplaceable in practical applications. However, in many specific application scenarios, such as military target recognition, medical target recognition, etc., the classification performance is often unsatisfactory because of many class labels, few training samples, and insufficient description of a single feature. This paper proposes to effectively integrate the two advantages of fast ELM training and good recognition performance of data fusion methods through data fusion, making it more conducive to solving practical classification problems. The training process of Jf= is simple, "first randomly generate input weights and biases", and then calculate the output matrix of the single hidden layer feed-forward neural network." The specific training process is described as follows% of accuracy. The mathematical model of the standard single hidden layer feed-forward neural network with K hidden nodes and g(x) as the activation function can be expressed as

$$\sum_{i=1}^L \beta_i g(w_i \cdot x_j + b_i) = o_j \quad (j = 1, 2, \dots, N) \tag{12}$$

$w_i = [w_{i1}, w_{i2}, \dots, w_{in}]^T$  is the weight vector connecting the input sample to the nth hidden node  
 $w_i = [\beta_{i1}, \beta_{i2}, \dots, \beta_{im}]^T$  is the weight vector connecting the nth hidden node and the output sample "L is the bias of the nth hidden node"  
 $o_i = [o_{i1}, o_{i2}, \dots, o_{im}]^T$  is the Eth output sample of Dfi.2 %.

The standard Dfi.2 "activation function is 3 #U\$" with K hidden nodes can infinitely approximate this @sample% with zero error

$$\sum_{i=1}^L \beta_i g(w_i \cdot x_j + b_i) = t_j \quad (j = 1, 2, \dots, N) \tag{13}$$

The formula (2) can be expressed in compact form

$$H\beta = T \tag{14}$$

Here,

$$H(w_1, w_2, \dots, w_L, b, b_2, \dots, b_L, x_1, x_2, \dots, x_L) = [H_{ij}] = \begin{bmatrix} g(w_1 \cdot x_1 + b_1) & \dots & g(w_L \cdot x_L + b_L) \\ g(w_1 \cdot x_N + b_1) & \dots & g(w_L \cdot x_N + b_L) \end{bmatrix}_{N \times L} \tag{15}$$





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$$\beta = \begin{bmatrix} \beta_1^T \\ \beta_2^T \\ \vdots \\ \beta_L^T \end{bmatrix}_{L \times M} \quad T = \begin{bmatrix} t_1^T \\ t_2^T \\ \vdots \\ t_N^T \end{bmatrix}_{N \times M} \quad (16)$$

In the formula, "H" is the single hidden layer output matrix of the neural network. "T" is the output of the Eth hidden node when the corresponding input is  $x_1, x_2, \dots, x_N$ .

The least squares optimal solution of the above linear system is

$$\beta = H * T \quad (17)$$

### EXPERIMENTAL RESULTS AND DISCUSSIONS

Each prediction model is predicted on the test set, and the prediction performance of ELM, SVM, LR, KNN and NB based on the optimal feature subset is compared. It can be found from the results that the ELM prediction model has the best prediction performance, with AUC of 0.96, sensitivity of 0.90, specificity of 0.91, and F1 value of 0.91. The prediction performance of SVM is better, the AUC is 0.95, the sensitivity is 0.90, the specificity is 0.91, and the F1 value is 0.88. The worst prediction performance was the KNN prediction model, with AUC of 0.91, sensitivity of 0.80, specificity of 0.91, and F1 value of 0.82 (see Table 2).

By observing the best combination, it can be found that PR, WBC, CRP, and D-Dimer appear in all the best feature combinations, which is in line with the clinical research results. In addition, Age, RR, and ALB are also characteristic indicators with high frequency, which are also in line with the clinical research results. Through SHAP's interpretation of the ELM model, it is concluded that the greater the value of D-Dimer, TBIL, CRP, Age, PR, Creatinine, and WBC, the higher the risk of disease progression; the greater the value of LYMPH and ALB, the lower the risk of disease progression. In line with clinical research results. This can explain that the results of this study have clinical significance and can be used as an aid for clinicians in diagnosis and identification. In the above chart, the proposed extreme learning method has the higher sensitivity ratio compared to the other existing models in the AUC dataset.

The figures 2 to 5 represent the prediction results of different algorithm test sets under the optimal feature subset. By observing the best combination, it can be found that PR, WBC, CRP, and D-Dimer appear in all the best feature combinations, which is in line with the clinical research results. In addition, Age, RR, and ALB are also characteristic indicators with high frequency, which are also in line with the clinical research results. Through SHAP's interpretation of the ELM model, it is concluded that the greater the value of D-Dimer, TBIL, CRP, Age, PR, Creatinine, and WBC, the higher the risk of disease progression; the greater the value of LYMPH and ALB, the lower the risk of disease progression. In line with clinical research results. This can explain that the results of this study have clinical significance and can be used as an aid for clinicians in diagnosis and identification.

By comparing the prediction performance of ELM based on the optimal feature subset with other four machine learning methods (SVM, LR, KNN, NB) (Figure 2 – Figure 5), according to the calculation results of the five machine learning methods, it can be seen that the ELM and SVM algorithms are best methods for the prediction of the severe risk of COVID-19 patients with high performance. In terms of training speed, ELM is significantly better than SVM. Considering all aspects of the model, we recommend using the ELM algorithm as the prediction model algorithm. Age, PR, WBC, NEC, LYMPH, CRP, ALB, TBIL, Creatinine, and D-Dimer are used as indicators required for prediction to predict the risk of early COVID-19 patients progressing to severe disease.





## FINDINGS AND DISCUSSION

In this study, a prediction model for the clinical outcome of COVID-19 patients was created using five machine learning algorithms. The training set was made out of COVID-19 patient data from Wuhan Huoshenshan Hospital. The developed model worked well in predicting patients' in-hospital mortality and whether they underwent endotracheal intubation, according to the results obtained using patient data as a test set. The findings of this study also demonstrated that the optimal combination of variables for predicting in-hospital mortality in COVID-19 patients was composed of six variables: white blood cell count, albumin, calcium ion, blood urea nitrogen, myocardial creatine kinase isoenzyme, and age. Absolute lymphocyte count, high-sensitivity CRP, total bilirubin, calcium ion, and age were the six variables that best predicted whether endotracheal intubation was necessary for COVID-19 patients. From the experimental results, the extreme learning machine will predict the better results while compared to the other models.

## CONCLUSION

In conclusion, this research analyzed the factors that are strongly correlated with the clinical outcomes of COVID-19 patients, and the machine learning algorithm can better predict their in-hospital clinical outcomes, which will help direct the patients' subsequent care and help understand the course of the disease. The proposed prediction model Extreme Learning Machine (ELM) methodology finds the number of patients with the Covid 19 viral disease with the increased accuracy rate than the other machine learning algorithms like Support Vector Machine algorithm (SVM), Native Bayes algorithm (NB), Logistic Regression algorithm (LR) and the K Nearest Neighbour algorithm (KNN).

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Table.1 Missing Data of Whole Group of Cases

Variable	Missing
WBC	52(1.32)
Lymphocyte	54 (1.12)
Monocyte	54 (1.12)
Neutrophil	54 (1.12)
Eosinophil	54 (1.12)
Basophil	54 (1.12)
RBC	54 (1.12)
Hemoglobin	54 (1.12)
Hematocrit	54 (1.12)
MCV	54 (1.12)
MCH	54 (1.12)
Platelet	55(1.14)
MPV	54 (1.12)
hs – CRP	397(8.26)
ALT	150(3.12)





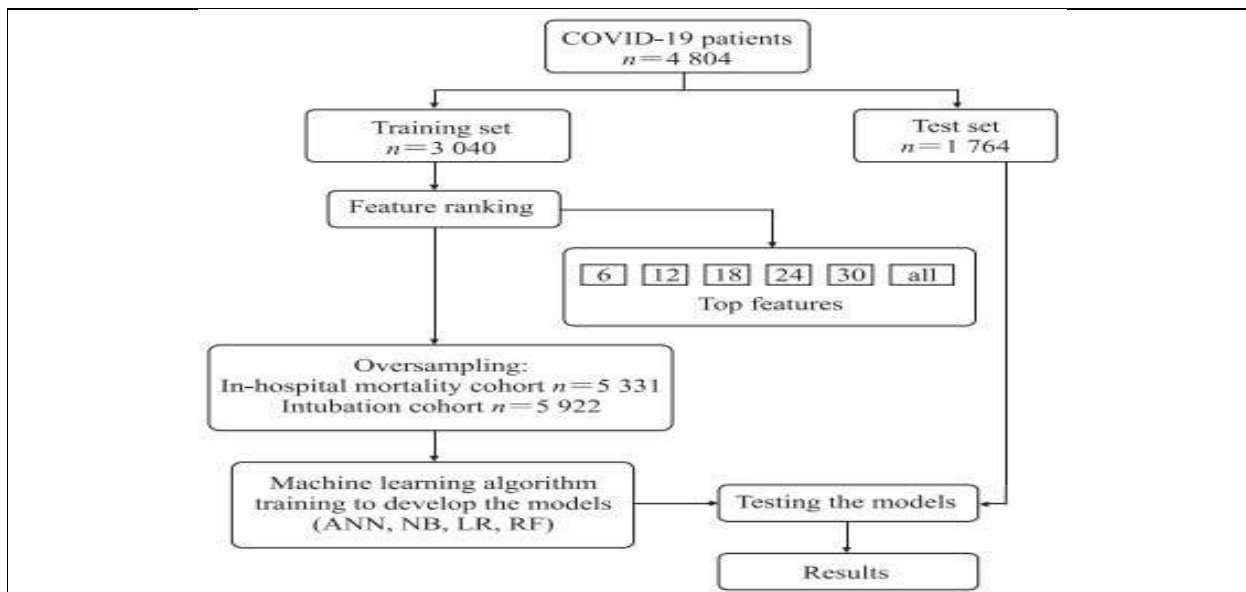
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AST	140(2.91)
ALP	146(3.04)
TP	144(3.00)
Albumin	145(3.02)
TBil	145(3.02)
DBil	158(3.29)
CO <sub>2</sub>	278(5.79)
TBA	177(3.68)
Na <sup>+</sup>	281(5.85)
K <sup>+</sup>	286(5.95)
Ca <sup>2+</sup>	286(5.95)
CL <sup>-</sup>	277(5.77)
Creatinine	205(4.27)
UA	209(4.35)
CK-MB	824(17.15)

WBC: White blood cell; RBC: Red blood cell; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MPV: Mean platelet volume; hs-CRP: Hypersensitivity C reactive protein; ALT: Alanine amino transferase; AST: Aspartate amino transferase; ALP Alkaline phosphatase; TP: Total protein; TBil: Total bilirubin; DBil: Direct bilirubin; TBA: Total bile acid; UA: Uric acid; CK-MB: Creatine kinase-myocardial band.

**Table 2 Prediction Results of Different Algorithm Test sets under the Optimal Feature Subset**

Prediction Models	AUC	Sensitivity (Sn)	Specificity (Sp)	F1- Score
ELM	0.96	0.90	0.91	0.91
SVM	0.95	0.90	0.91	0.88
NB	0.91	0.86	0.91	0.86
LR	0.91	0.90	0.91	0.83
KNN	0.91	0.80	0.91	0.82

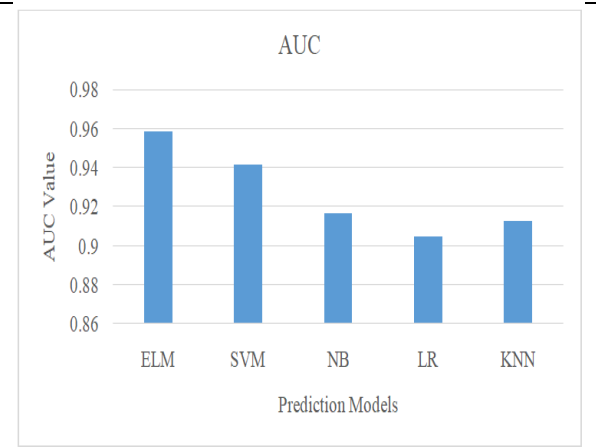


**Figure 1. Flow Chart of Data Training and Testing**

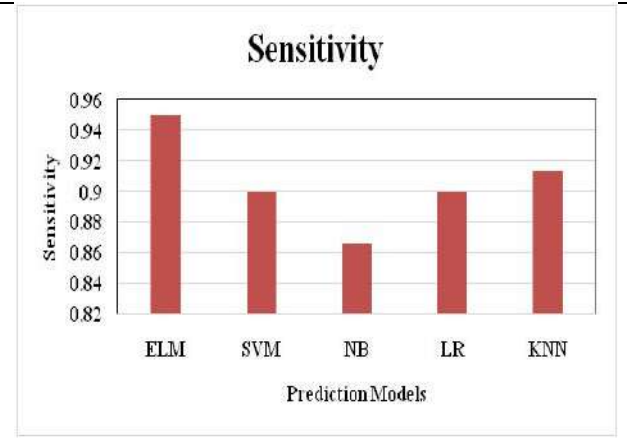




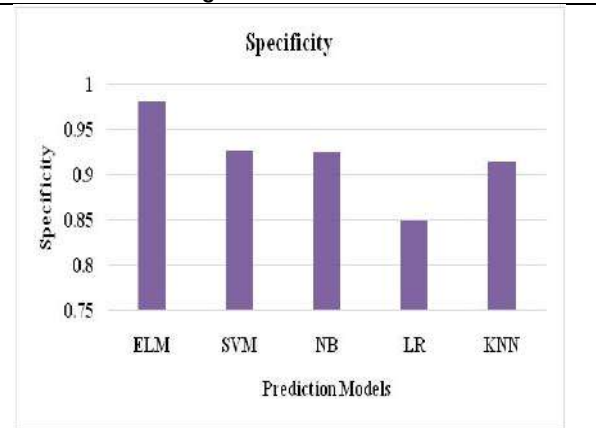
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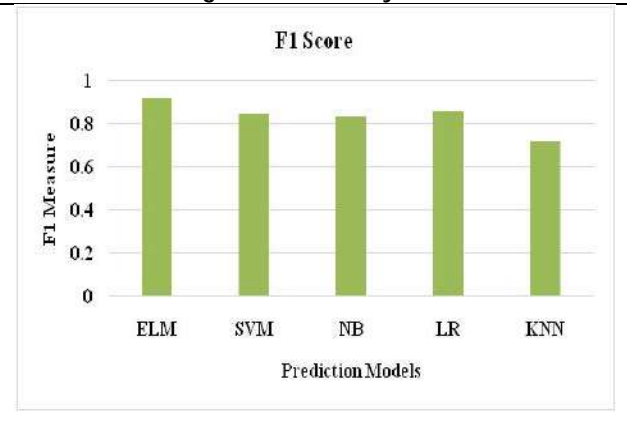
**Figure 2. AUC Values**



**Figure 3. Sensitivity Plot**



**Figure 4. Specificity Plot**



**Figure 5. F1 Measure**







## Influence of Socioeconomic Status on Balance Performance in Healthy School - Going Children - a Cross-Sectional Study

Dhwani Chanpura<sup>1\*</sup> and Lata Parmar<sup>2</sup>

<sup>1</sup>Assistant Professor, College of Physiotherapy, Sumandeep Deemed to be University, Piparia, Waghodia Road, Vadodara, Gujarat, India. 391760.

<sup>2</sup>Former Principle, College of Physiotherapy, Sumandeep Deemed to be University, Piparia, Waghodia Road, Vadodara, Gujarat, India. 391760.

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### \*Address for Correspondence

#### Dhwani Chanpura

Assistant Professor,  
College of Physiotherapy,  
Sumandeep Deemed to be University,  
Piparia, Waghodia Road,  
Vadodara, Gujarat, India. 391760.  
E.Mail: dhwanichanpura232@gmail.com



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### ABSTRACT

**Socioeconomic status along with, dietary patterns, physical activity, gender, and age have strong influences on the development of childhood obesity.** studies have found that compared to normal-weight children, obese children have **lower postural stability, greater sway area with greater instability, and, different postural strategies with reduced balance capabilities.** There were eight Government & Private schools were selected from Vadodara city. Total 10 students were selected from each class randomly; the anthropometric measurements of the students were taken. Each participant then completed timed unipedal balance test on both right and left foot, and tandem stance. For two balance test, each subject completed 3 trials on each leg. A 60 second rest was given between trials set to avoid fatigue. Total 556 school children among them male students were 282 and female students were 274 who were selected and performed two balance test. And the results of present study found mean difference in both the balance testes between private and government-going school going children. Strong influence can be seen between socioeconomic status and childhood obesity, which leads to alteration in balance tests of the normal healthy school going children of 6-12 years.

**Key words:** Socioeconomic status, Balance, school children, BMI



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## INTRODUCTION

Socioeconomic status (SES) is measured by the social and economic status of the family members [1]. People generally believe that there is a strong and stable correlation is present in between SES with children's achievement and development. **Studies have reported that socioeconomic status along with, dietary patterns, physical activity, gender, and age have strong influences on the development of childhood obesity [2]. Childhood obesity was so far thought to be a problem of the developed world, but it is increasingly being reported from middle- and low-income countries, especially from urban areas [3,4] Studies have found many reasons for childhood obesity now a days as, children and youth find watching television or playing video games more desirable and easier than physically participating in activities themselves. Even school systems have changed, which contributes to a sedentary lifestyle by devoting fewer resources to physical activity instructions, playgrounds, and after-school sports programs. In addition, it is known that urban life brings a more inactive lifestyle rather than rural life [5].** There are a lot of clinical consequences of childhood obesity which include asthma, type 1 diabetes, low-grade systemic inflammation, sleep apnea, musculoskeletal disorders, pain, discomfort and joint stiffness, lower muscular strength, and postural problems, particularly of lower limbs and feet [6]. According to Corbeil et al (2001) postural control model indicates that obesity is associated with a high risk of falls. Balance, which is the ability of the body to maintain the center of gravity within its base of support, is essential in preventing falls during day-to-day activities [7]. Studies have found that compared to normal-weight children, obese children have lower postural stability, greater sway area with greater instability, and different postural strategies with reduced balance capabilities [8,9]. So the aim of the present study was to see the influence of socioeconomic status on the development of childhood obesity and the effect of obesity on balance performance in school-going children.

## MATERIALS AND METHODS

**Study Design:** Cross-sectional, observational.

### INCLUSION CRITERIA

All School going children – age group between 6-12 years

### EXCLUSION CRITERIA

- Children with any neurological, or musculoskeletal problems in lower limbs, and cardiovascular deficit.
- Any history of balance impairment.
- Loss of vision or uncorrected reduced visual acuity.

### METHODOLOGY

After the approval by Institute Ethical Committee, the number of schools from each area of the city was selected on the basis of the stratified randomized sampling; by lottery method. The principals of the selected schools were explained about the study and asked for their official permission. The total number of schools to be included in the survey from all four zones of the city was eight, 556 normal school-going subjects in the age group between 6-12 years were recruited.

From each class of school total 10 students (5 boys & 5 girls) were selected (i.e. from standard 2 to standard 8), randomly. The selected subjects from each school were explained about the nature & purpose of the study. The participants completed a written informed consent form. Each participant was enquired of baseline questions regarding previous history of injury, etc. Following this each child was explained about the complete procedure. This study was carried out in School's class room, where source of light was good and also in secured place so that risk of fall during tests was prevented. The tests were performed barefoot on a floor surface. The order of leg examination (right /left) for each subject was same, selected for each test. For two balance tests, each subject completed 3 trials on





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each leg. A 60 second rest was given between trials set to avoid fatigue. For all trials, the participants placed their hands across the chest and time start upon elevation of the opposite foot from the floor. Participants were asked to focus on a target placed at eye level, the measurements were timed using a stopwatch. First step, the anthropometric measurements of the subjects were taken prior to balance testing, participants were familiarized with the balance test and provided practice sessions on the testing procedures to decrease the chance of a learning effect occurring during testing. Each participant then completed timed unipedal balance test on both right and left foot, and tandem stance on child's dominant leg. Dominant limb was selected by asking the child to kick a ball placed on the floor in front of him.

For tandem stance, participants were made to stand with feet in a heel-to-toe position on straight line drawn with chalk stick on the floor, and arms across the chest, with eyes open as shown in the figure 1. Three trials of this test were timed with stopwatch till the subject can maintain / hold the position. Time commences when the subject place the dominance foot in front of non- dominance foot on the straight line and time ending when the subject either: (1) use his arms (i.e., uncrossed arms), (2) displace any foot,(3) movement of the foot from original position/ stepping. The procedure was repeated 3 times and for each trial time was recorded on the data collection sheet. The mean of the 3 trials were recorded (Figure 1).

For Unipedal stance, participants were asked to stand barefoot on the limb of their choice, with the other limb raised so that the raised foot is near but not touching the ankle of their stance limb. Prior to raising the limb, the subject was instructed to cross his arms over the chest as shown in figure 2. The investigator using a stopwatch to measure the amount of time the subject is able to stand on one limb. Time commences when the subject raised the foot off the floor and time ending when the subject either: (1) use his arms (i.e., uncrossed arms), (2) use the raised foot (moved it toward or away from the standing limb or touched the floor), (3) move the weight-bearing foot to maintain his balance (i.e., rotated foot on the ground).The procedure was repeated 3 times and for each trial time was recorded on the data collection sheet. The mean of the 3 trials were recorded (Figure 2).

## RESULT

Data was collected from a total of 556 school children. Students of a Government school were 278 and private school was 278.

**Table 1: Independent t-test for comparison of BMI in total (combined) government and private schools:**

	Type_School	N	Mean	Std. Deviation	Std. Error Mean	t value	P value
BMI	Govt.	278	14.5390	2.68756	.16119		
	Private	278	16.3177	4.15753	.24935	-5.990	.000

**Table: 2 Independent t-test for comparison of Tandem stance value in total (combined) between government and private schools:**

	Type_School	N	Mean	Std. Deviation	Std. Error Mean	t value	P value
Ln TS	Govt.	278	5.2065	.68772	.04125	1.966	0.05
	Private	278	5.0849	.76795	.04606		

(TS – Tandem stance).





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**Table 3: Independent t-test for comparison of unipedal stance of right and left leg between government and private schools:**

	Type_ School	N	Mean	Std. Deviation	Std. Error Mean	t value	P value
Ln	Govt.	278	4.1370	.64037	.03841	1.372	.171
USR	Private	278	4.0587	.70382	.04221		
Ln	Govt.	278	4.1023	.61840	.03709	1.340	
USL	Private	278	4.0308	.63915	.03833		.181

USR- Unipedal stance right. USL- Unipedal stance left.

## DISCUSSION

In the present study mean of total BMI was 15.4283 of normal school going children of 6-12 years. The results of present study shows the significant difference in mean of BMI between students from standard 2 -8<sup>th</sup> standard students. ( $p$ -value < 0.01), also Mean BMI was significantly higher in private school as compare to government school ( $p$  value <0.05)Table 1. Several studies support this findings. The various reasons as put forward by these studies are that children attending private schools probably enjoy a higher socio economic status, therefore they are better nourished. Also change in the life style, motorized transport, high caloric junk food, and eating habits could be contributing factor. These studies also state similar reasons for rising obesity among children these days [10, 11, 12, 13,14].

It has been suggesting that balance control is strongly coupled to visual information very early in infancy. Furthermore, this coupling seems to require little experience of standing or even sitting upright. It is said continuous fine tuning of the interaction between the movements of different joints is needed to maintain stable vertical posture, with relatively small BOS and with COM high above the BOS. Thus maintaining stability in a standing position is actually not a static task [15]. Tandem stance is the ability to stand in a heel to toe position, this reflects degree of postural steadiness when the BOS in the medial/lateral direction is narrow [15]. In the present study mean tandem stance was 5.1457 in normal school going children in 6 to 12 year. The results of present study shows the significant difference in mean of tandem stance between students from standard 2 -8. ( $p$  value < 0.01) well in agreement with the literature. In comparison between students of Private and Government, we found statistical significant difference with marked change in the mean values (Table 2). Task of standing on one leg requires voluntary shift of COM to the standing leg, followed by maintenance of postural orientation in space by controlling weight, supporting the vertical alignment of different segments of the body and equilibrium [15]. Well in agreement with the literature the present study too found both the static balance tests (tandem stance and unipedal stance) significantly related to age. Based on the results of table 3 it can be concluded that the mean value of the Unipedal stance values are lower in private school children as compared to the government school.

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## CONCLUSION

Mean difference has been found in the values of BMI, Tandem, and Unipedal stance in Private and Government school children. so there is a strong influence of socioeconomic status on childhood obesity which affects the balance skills of normal healthy school-going children of 6-12 years.



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<p><b>Figure 1: Tendam stance</b></p>	<p><b>Figure 2:Unipedal stance</b></p>





## Approach Models for Planning Merchandise in Fashion Retailing

Vinothkumar K.R.<sup>1\*</sup> and D.Maria Pon Reka<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Business Administration, Mannar Thirumalai Naicker College (Autonomous), Madurai, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Business Administration, Sri Meenakshi Government Arts College for Women (Autonomous), Madurai, Tamil Nadu, India.

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### \*Address for Correspondence

**Vinothkumar K R**

Assistant Professor,  
Department of Business Administration,  
Mannar Thirumalai Naicker College (Autonomous),  
Madurai, Tamil Nadu, India.



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### ABSTRACT

A merchant uses the process of merchandise planning to make sure that the proper product is offered to the customer at the ideal location, time, quantity, and price. This procedure entails deciding which products the business will stock and how much of each product to order. Due to changes in the retail business like consolidation, worldwide sourcing, increased levels of competition, growing product diversity, shortened life cycles, and less predictable demand, merchandise has become more complex. Improvements in manufacturing, distribution, and information technology have the ability to lessen the industry-wide significant markdowns brought on by excess inventory and lost sales opportunities as a result of sellouts. We examine two issues with retail merchandising in this chapter. By deciding how many and in which locations to test new products, as well as how to translate test sales into a prediction for the entire season across the chain, we establish a system to increase the accuracy of merchandise testing in the first problem. In the second issue, we look at replenishment based on real sales, a tactic the store can use to reduce the risk of having an assortment of products in stock. We create models for both of these issues and use actual sales data to compare them to these stores' current procedures. When we compared our methods to those currently used, we discovered that they could decrease markdowns brought on by excess inventory and margin losses caused by stock outs to the point where profits were increased by more than 100% in each application. Future study directions are presented, along with general suggestions for how to improve this procedure.

**Keywords:** Fashion Retailing ,Merchandise, Market, Industry



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## INTRODUCTION

Aesthetic merchandising and retail formats. The dynamic nature of the fashion retail industry this chapter explains how the retailing of fashion has changed over time and continues to do so. Understanding the forces at play and the evolving trade patterns that are guiding the sector is crucial [1]. The activities of the fashion buyer and merchandiser, as well as how fashion is marketed, are being significantly impacted by many of these changes. In addition to the fact that fashion changes, it's also vital to note that the method fashion is currently sold and shown is evolving at a rapid pace. How much fashion retailing has changed in Europe over the past fifty years can be challenging to comprehend at times. Prior to the First World War, the bulk of the people wore clothing that was custom made. The majority of individuals had very little clothing, and those who did likely sewed their own garments or had them made by a local tailor or seamstress. In order to furnish millions of military outfits for use in battle, the idea of factory-made clothes was born. Millions of returning troops from the First World War also needed civilian apparel at that time. Such businesses as Burton Tailoring, now known as Burton Menswear, and later Arcadia were motivated by this desire. In what were known as "bespoke" or "made-to-measure" tailoring factories, Burton produced millions of clothes.

Suits and other made-to-measure apparel have been less popular as trends have become less formal since the Second World War. Since the 1960s, a fundamental shift toward casual clothing and rising personal wealth has resulted in a revolution in high street fashion. Numerous smaller independent clothing stores have closed as a result of the expansion of big fashion chains like Arcadia and Marks & Spencer [2]. All around Europe, this pattern is still being reproduced. One could argue that the fashion consumer now has fewer options due to the demise of smaller independent retailers. Contrarily, it may be argued that consumers have benefited from decreased retail costs thanks to economies of scale brought about by large-scale purchasing, but many would disagree.

### Models for Merchandise Planning in Fashion Retailing

A merchant uses the process of merchandise planning to make sure that the proper product is offered to the customer at the ideal location, time, quantity, and price. This procedure entails deciding which products the business will stock and how much of each product to order [3]. Due to changes in the retail business like consolidation, worldwide sourcing, increased levels of competition, growing product diversity, shortened life cycles, and less predictable demand, merchandise has become more complex. Improvements in manufacturing, distribution, and information technology have the ability to lessen the industry-wide significant markdowns brought on by surplus inventory and missed sales opportunities as a result of sellouts.

We examine two issues with retail merchandising in this chapter. By deciding how many and in which locations to test new products, as well as how to translate test sales into a prediction for the entire season across the chain, we establish a system to increase the accuracy of merchandise testing in the first problem. In the second issue, we look at replenishment based on real sales, a tactic the store can use to reduce the risk of having an assortment of products in stock. We create models for both of these issues and use actual sales data to compare them to these stores' current procedures. When we compared our methods to those currently used, we discovered that they could decrease markdowns brought on by excess inventory and margin losses caused by stockouts to the point where profits were increased by more than 100% in each application. Future study directions are presented, along with general suggestions for how to improve this procedure.

### Customer-focused Atmospheric Effects of Online Stores: Implications for Store Brand Management and First Scaling Methods for the Indian Market

Online stores are commonplace today, and for merchants, using this channel is a crucial part of their distribution and communications strategy [4]. The display of goods and services, the overall presentation, and the connection with customers are all very important issues that retailers must address in the context of online commerce. Research on Online Visual Merchandising (OVM), an area with drastically rising importance, specifically since traditional





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(physically existent) stores are increasingly being displaced or supplemented by online retailers, addresses this precise issue.

**Retailers of clothing should use visual merchandising techniques.**

This article explains how visual merchandising is becoming a competitive tactic for fashion shops. This article introduces three research studies for the 2014 visual merchandising special edition of the Journal of Global Fashion Marketing. The retail fashion industry is evolving more quickly than any other industry, and this shift is revolutionary rather than slow-moving. The development of online shopping, which includes all sorts of non-brick-and-mortar commerce via mobile devices, television, and kiosks, is one of the most significant drivers driving this transition. Customers now have higher expectations and more sophisticated shopping habits, and fashion merchants who still operate physical stores must adapt to these changes while still allowing customers to shop online from anywhere in the world. Retailers' responses to the difficulties of the evolving environment of fashion selling are demonstrated by the increased emphasis given to visual merchandising strategy by both retailers and retail scholars. Brick-and-mortar retailers are placing a lot of attention on in-store experiences and exploration in order to increase competitiveness versus online channels. The emphasis has switched to optimising the entire visual merchandising and store execution process as the pervasiveness of technology has made it impossible to differentiate products.

It is getting more and more crucial that fashion retailers get it right in order to effectively express their brand to customers, especially as many fashion retail firms alter their floor plans 4–12 times a year in addition to seasonal adjustments. This nonverbal communication will eventually aid in the development of a dominant posture. Unexpectedly, the focus on visual merchandising as a successful retail approach is not new. Charles J. Dirksen's book review of the Visual Merchandising Research Series was published in 1951 by Journal of Marketing, the most prestigious publication for marketing research.

The scale and methods used in the book, which said that "1,291,442 persons were observed and evaluated as they passed store windows in national scope," seemed to impress Dirksen. It took until the late 1990s for visual merchandising to regain popularity. Janiszewski conducted significant research on the effects of display attributes on consumer behaviour in the Journal of Consumer Research in 1998. (1998). UK fashion merchants were chastised by Lea Greenwood (1998) for failing to create a visual merchandising strategy. To track the trend of visual merchandising research published since 1990, we searched important retailing journals (Journal of Retailing, Journal of Retailing and Consumer Services, International Journal of Retail & Distribution Management, Journal of Fashion Marketing and Management, and Journal of Global Fashion Marketing). Since there weren't enough studies with just the keyword "visual merchandising," we also included the search terms "store environment" and "visual environment .But interestingly, 19 papers have only been published after 2011, supporting the idea that visual merchandising has emerged as a major area of study for retail researchers. Notably, the Journal of Global Fashion Marketing, which has published three papers in the last three years and will add another three as a result of this special issue on visual merchandising, is playing a crucial role in supporting these creative studies.

We are delighted to provide these three recent efforts to pinpoint the special significance of visual merchandising elements as a fashion retail strategy. These studies offer substantial practical implications due to their methodological approaches and industry-driven study designs. Nobbs, examine the function of window displays as a brand-identity distribution method for luxury fashion marketers in the first piece. We would like to thank Karinna Nobbs, the lead researcher, for her work on fashion retail studies: An active researcher, Karinna Nobbs has written intriguing studies on significant topics like fast fashion (Sheridan, Moore, & Nobbs, 2006), branding (Ballantyne, Warren, & Nobbs, 2006; Kontu, Nobbs, Montecchi, & Duffy, 2013), luxury marketing (Manlow & Nobbs, 2013; Nobbs, Moore, & Sheridan, 2012), and visual merchand (Nobbs, McColl, Shearer, Canning, & McBride, 2011). The study by Lee et al. (2014) explores consumers' expectations of the business as a mediator and evaluates the impact of colour and size of sale signage on consumers' propensity to visit a store (2014). The creation of external stimuli was done with the use of 3D design tools.



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This study is significant not only because it was the first to evaluate the impact of sale signs but also because it used 3D simulation to demonstrate that impact. The final project makes an effort to offer more dynamic viewpoints of a store setting from various angles. The evaluation of the store environment and the S-O-R paradigm, which includes VM attribute evaluation, emotion and behavioural responses toward the store, produced different results when different items were displayed along with the manipulation of various VM components like lighting, colour, and props. According to the study, VM tactics that emphasise a "visual theme" rather than the actual product allow customers to feel arousal and pleasure while shopping, increasing the likelihood that they will spend more time and money there.

**Online clothing stores using visual merchandising**

This study adopts an exploratory methodology to look at the present online visual merchandising techniques of garment e-merchants in the US and India based on the empirical literature. The websites' content was examined in terms of presentation style, presentation methodology, and product elements. The selected clothing websites from the US and India revealed some notable disparities. Additionally, this study aims to offer early data and recommendations that will enable apparel e-retailers in developing nations to make initial strides in the right path. The Internet has recently grown in importance as a source of information for consumers and as a means of communication for businesses. Many retailers of clothing have switched from using traditional retail channels to selling their products online. The total expansion of online-shopping homes in the US may decrease over the next five years given that roughly two-thirds of North American households are online. In contrast to wealthy nations, India has a comparatively low percentage of online shoppers at only 40%. Nearly 64% of Internet users say they will try doing their shopping online. Researchers predict that through 2007, annual Asia e-commerce sales will increase 38% annually, surpassing India's 61% growth (Ref.[3]).

India appears to have enormous potential for the growth of internet commerce markets. There is a critical need for apparel e-merchants in India to understand the significance of visual merchandising and the key factors influencing consumers' purchasing intention and behaviour given the enormous potential of the online apparel market in India and the relatively low level of online visual merchandising compared with US apparel websites. However, there is little material now available that compares US with Indian procedures. In order to explore the differences between US and Indian apparel e-retailers as well as the current practices of online visual product presentation in India and the US, this study adopts an exploratory approach.

**Conceptual context**

Visual merchandising online Visual merchandising is the process of coordinating efficient product selection with efficient product display. According to visual merchandising is one of the visible components of positioning strategy at a period when fashion merchants were sophisticating their efforts as a result of the boom before the recession and a conceptual approach to shop design and merchandise display. In the context of online shopping, effective and pleasing methods of product presentation, which primarily consist of visuals, can pique consumers' desire to purchase, boosting sales and generating revenue for e-merchants. 2.2. Clothing visual merchandising Clothing is regarded as an experiential good one that must be examined physically, including feeling and trying on, in order to be judged.

Participants were therefore more likely to buy clothes online if they experienced sensory pleasure from the product and/or display. Because of the inaccuracy and ambiguity of garment colour, fabric, and details, online customers may refrain from buying clothing. It is vital to develop better visual product presentation because online garment purchases are risky in and of themselves. For all sorts of in-home clothing buying, sensory factors including fabric type, garment fit, colour, and quality are crucial considerations. Purchase intentions and visual merchandising Purchase intention may also be influenced by visual merchandising. What we intend to acquire is referred to as our purchase intention. Successful product presentation must be realised by external information (such as website information), incorporating product information. Overall and accurate information can lower consumers' perceived risks associated with online transactions, especially for touch-and-feel products (like clothing). To reduce risk



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perceptions and boost purchase intent, it has been suggested that online retailers of clothing should include more comprehensive information about their products and customer services on their websites. Product information that is known to influence a consumer's purchase intention can be presented visually (e.g., through product movement or a huge graphic).

**Procedure**

Example The US was chosen for this study above other industrialized nations since it is home to the most well-known clothing e-commerce sites (e.g., LandsEnd.com, Tommy.com). From the list of the 50 websites for 2006 that was published in Internet Retailer in 2005, six clothes retailers were chosen: anthropologie.com, eddiebauer.com, macys.com, tommy.com, and talbots.com. These websites, according to Kurt T. Peters, editor of Internet Retailer, are the ones that innovate to advance online retailing. India was chosen for this study out of a large group of emerging nations due to its potential for the growth of online apparel selling. In India, e-commerce for clothing products is still in its infancy.

The majority of successful and well-known online merchants (such as joyo.com) don't now sell apparel. In addition, this study includes six e-retailers that have included clothes as one type of product because there are no rankings for garment websites in India: stplaza.com.cn, iog5.com, inshops.net, dl.com.cn, store.sohu.com, and 8848.com. According to India General Chamber of Commerce's list of the top 100 retailers, the previous two retailers were among them (2004). The following four websites were more well-known and broader in scope in India for online clothing purchasing. Instrument 3.2 A coding sheet for the three aspects of visual presentation was created based on the literature: (a) manner of display presentation technique product components. Then, these three elements were separated into their component parts.

The characteristics in greater depth. The coding sheet had ten statements (variables). To confirm the suitability of the coding criteria created for this study, the coding instrument was pre-tested on 20 already-existing clothing websites (such as JC penny.com and Gap.com). 3.3 Practice As a tool for web exploration and search, Internet Explorer was employed. The same kind of clothing was selected to code visual merchandising on these 12 apparel websites in order to preserve uniformity. 20 pieces of clothing were chosen at random to represent various visual presentation methods utilised on each website. There were 240 presentations of clothing products in all. The practise of visual product display as it currently exists on clothing websites in India and the US was investigated using content analysis.

The data from the clothing e-shops in the US and India were both analysed using the statistical software for the social sciences (SPSS 10.0 for Windows). The components of online visual merchandising across the clothes retail websites in the US and India were compared using the t-test to look for statistically significant differences. 4. Findings and analysis To display the current practise of online visual merchandising of clothes e-retailers in the US and India, frequencies calculated using SPSS tailed independent sample t-test was employed to look at statistically significant variations between the two nations 4.1. Online visual commerce in the US and India: a content analysis Presentation style Only approximately 17 percent of the 120 garment demonstrations in India were displayed on a human model. The majority of the clothing was displayed on hangers and flat surfaces. Presenting products on human models should be encouraged in India since a flat surface or a hanger may restrict the clients' ability to view the silhouette of the item and its 3-dimensional effect on a human body. In contrast, no websites utilised hangers to showcase clothing, while 86.7% of the apparel e-retailers chosen in the US used human models to show their wares. To cater to customers' demands for visual information, numerous supermarkets in India have featured human models in their promotional leaflets.

**Future**

As a result, achieving the goal is not difficult for Indian clothing e-shops. 95.8% of the time in India and 98.3% of the time in the US, the product image was placed mostly in the upper left corner of the screen. Additionally, websites with more than five product photos were not accessible in the Indian clothing e-shops that were under investigation.



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In contrast, the majority of websites in the US utilised three to five product photographs to display the clothing, and 34.2% of them even used more than five. Therefore, compared to their American counterparts, Indian websites convey less information through visuals. As a result, the desired information may not be as readily available. Presentation strategy One 2-D view of every item of clothing sold on Indian e-stores was available. One retailer (Endlands.com) under investigation, though, furthermore offered a 3-D rotatable view, enabling shoppers to see the garments on a virtual mannequin. Generally speaking, an image displayed on a virtual model may help buyers feel less uncertain and risky while making selections about purchases (Ref.[12]). On around 27% of the presentations in India, enlarged images of the garment were not available. The figure is greater than the 17% seen on US clothing e-stores. Product components 4.1.3 Almost 77 percent of the clothing presentations in the Indian group had no colour descriptor at all.

**CONCLUSION**

In contrast, in the US sample population, about 80% displayed photos of the entire outfit in a variety of colours as well as colour samples. Customers need a lot of information about colour because it has always been an important factor in apparel in order to reduce their uncertainty when faced with the absence of an actual product. Not every product investigated in the Indian sample had garment coordination with other items. Items that go together should be offered separately, like a handbag and a pair of pants that go with a certain woman's coat. Indian online clothing sellers, in contrast to their American counterparts, are not aware of the value of coordination suggestions, which may pique customers' interests in making purchases. In addition, despite the fact that a number of customers expressed worries about fit and size (Ref.[13]), 33 percent of product presentations in India that were recorded on all American websites lacked information on the product's size. In 60% of the Indian sample's product presentations, there were specifics about the clothing. The majority of the information was, however, only provided in written form. Including the image descriptions (16.7%), all websites in the US study used comprehensive descriptions. Particularly in the early stages of online clothes retail in India, garment details, which are the specific components that give a silhouette its form or shape, such as trimmings, shoulder or sleeve treatment, can reduce perceived risk and assist decision-making. One background setting was used for all product presentations. The ability to picture the item being worn in various circumstances may be aided by different backgrounds. 4.2. Differences between India's and the US's online product presentation The statistically significant differences in online visual merchandising between the clothing retail websites in the US and India were examined using an independent sample t-test (two-tailed) (see Table 2). The t-test result for the way of presenting dimension revealed a significant difference between India and American presentation styles.

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## Pharmacognostical and Phytochemical Studies on the Leaves and HPTLC Profiling of the Aqueous Extract of *Pterocarpus marsupium* Roxb.

Jyothi M Joy<sup>1,2\*</sup>, Alexander S<sup>3</sup>, Kumar M<sup>3</sup> and Venkateswarlu BS<sup>3</sup>

<sup>1</sup>Professor, National College of Pharmacy, Kozhikode, Kerala, India.

<sup>2</sup>Research Scholar, Vinayaka Missions College of Pharmacy (Vinayaka Mission's Research Foundation Deemed to be University), Salem, Tamil Nadu, India.

<sup>3</sup>Professor, Vinayaka Missions College of Pharmacy (Vinayaka Mission's Research Foundation Deemed to be University), Salem, Tamil Nadu, India.

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### \*Address for Correspondence

**Jyothi M Joy,**

Associate Professor,

National College of Pharmacy,

Kozhikode, Kerala, India.

E.Mail: jyothimjoympfarm@gmail.com



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### ABSTRACT

*Pterocarpus marsupium* Roxb. also known as Indian Kino Tree is an important herbal drug which possess various pharmacological properties especially antidiabetic activity. Plant belongs to the family Fabaceae also known as Venga in Malayalam. People in Kerala use the leaves of *Pterocarpus marsupium* to control blood sugar level. This works involves pharmacognostic characters, preliminary phytochemical analysis and HPTLC profiling of the aqueous extract of the leaves of *Pterocarpus marsupium*. Pharmacognostical study comprises of taxonomical and anatomical characters. Physicochemical analysis like loss on drying and total ash value also performed. Preliminary phytochemical analysis revealed the presence of alkaloids, glycosides, tannins, phenolic compounds and saponins. HPTLC profiling of the aqueous extract of leaves showed the presence of five phytoconstituents.

**Keywords:** *Pterocarpus marsupium*; taxonomy; anatomy; Phytochemistry; HPTLC; phytoconstituents.

### INTRODUCTION

Many plants have long been known to have medicinal uses that have a noticeable positive impact on health. Plant metabolites have a significant role in both the creation of new drugs and the prevention and treatment of many diseases [1]. *Pterocarpus marsupium* is a well-known plant used for various purposes, including treating various





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illnesses at home. This tree's many segments display a variety of biological traits. It is traditionally used as a diuretic, astringent, to treat urinary problems, to regulate blood sugar levels, anti-inflammatory, anthelmintic, etc., to name a few uses [2,3]. This herb is extensively used in alternative medical practices like Ayurveda, Unani, and Homoeopathy. The people of Kerala utilize it to regulate their blood sugar levels. It is a key component of many ayurvedic remedies, particularly those used to treat diabetes. Leaf decoction is being used by some people to regulate their blood sugar levels. These natural materials can be used in a number of ways, including as dietary supplements, nutraceuticals, and botanicals. Modifications can be made and further used to produce new markers while considering the conventional information [4]. Except for the leaf component, there is a wealth of scientific evidence supporting the pharmacological characteristics of numerous plant sections. The current work describes the pharmacognostic, phytochemical, and HPTLC profiling of the herb's aqueous leaf extract.

### Plant Description

**Botanical name:** *Pterocarpus marsupium* Roxb.

**Family:** Fabaceae

### Synonyms [3]

**Sanskrit:** Asanaka, Bijasara, Bijaka, Pitasara; **Bengali:** Piyasala, Pitasala; **English:** Indian Kino Tree; **Gujrati:** Biyo; **Hindi:** Vijyasara, Bija; **Kannada:** Bijasara, Asana; **Malayalam:** Venga; **Marathi:** Bibala; **Orissi:** Piashala; **Punjabi:** Chandan Lal; **Tamil:** Vengai; **Telugu:** Yegi, Vegisa

### Taxonomical Classification[5]

**Domain:** Eukaryota; **Kingdom:** Plantae; **Subkingdom:** Viridiaeplantae;

**Phylum:** Magnoliophyta; **Subphylum:** Euphyllophytina; **Class:** Magnoliopsida

**Subclass:** Rosidae; **Superorder:** Fabanae; **Order:** Fabales; **Family:** Fabaceae

**Genus:** *Pterocarpus*; **Species:** *marsupium*

### Distribution

*Pterocarpus marsupium* Roxb. commonly called as Indian Kino tree is seen in deciduous and evergreen forests of central, western and southern regions of India, especially in the Western Ghats area and Kerala- Karnataka region. Also found in Gujarat, Madhya Pradesh, Bihar and Orissa [3,6].

### Botanical Description

Deciduous trees that can reach a height of 30 m, with bark that is 10-15 mm thick, rough, deeply vertically cracked, and with small, irregular, fibrous exfoliations; the blaze is pink and the exudate is red. imparipinnate, alternating leaves; tiny, lateral, caudex-like stipules; Lamina measures 3.5-12.5 x 2-7 cm, is elliptic-oblong, oblong-ovate or oblong, base acute or obtuse, apex obtuse and emarginate, margin entire, glabrous, coriaceous; lateral nerves are 9-20 pairs, parallel, prominent, ascending, secondary laterals are prominent; intercostae are reticulate, prominent. The Flowers are bisexual, yellow, in terminal and axillary panicles, 10-12 mm long; bracts are small, dioecious; bracteoles are two; the calyx tube is campanulate, lobes are short, and the upper two are frequently connate; the corolla is exserted; petals are five; standard is orbicular; wings are oblique, obovate; and the petals are crisped along the margin. Stamens 10, monadelphous; filaments subequal; anthers uniform; keel petals oblique, tiny, and slightly connate; Shortly stalked, inferior, 1-celled, tomentose ovary with two ovules; filiform, incurved, beardless style; capitate stigma. Fruit is a subreniform, orbicular-shaped pod that is 2.5–5 cm in diameter [3,5,6].

### Ethnomedical Uses

*P.marsupium* has been traditionally used in the treatment of leucoderma, elephantiasis, diarrhoea, cough, discoloration of hair and rectalgia. It is also effective in treating jaundice, fever, wounds, diabetes, stomachache and ulcer [2,3].





## MATERIALS AND METHODS

### Collection And Authentication

The leaves of *Pterocarpus marsupium* Roxb. (Fabaceae) were collected from Kozhikode, Kerala, India in the month of November 2021 and it was identified and authenticated. The taxonomical identification and authentication of the plant were done by Dr. A. K Pradeep, Assistant Professor, Department of Botany, University of Calicut, Kerala. The voucher specimen was preserved in the laboratory, Department of Botany, University of Calicut with specimen No. 148278 for further reference.

### Macroscopic Studies

The macroscopical examination was carried out on freshly collected leaves and on their powder. Colour, odour, shape, size and taste of the leaves were observed.

### Microscopic Studies

The fresh samples were cut into small pieces and preserved in a Formalin solution. The preserved samples were used for section cutting. Freehand sections were taken with a sharp blade and transferred the sections to a watch glass containing water with the help of a brush. The thick and oblique one was rejected. The staining of the sections is done with Phloroglucinol and Conc. HCl solution. Photomicrographs were done on a Projection microscope Leica ATC 2000. Descriptive terms of various observations are as found in standard Anatomy books [7,8].

### Physicochemical and Phytochemical Analysis

Powdered drug is used for physicochemical analysis. Various parameters like ash value, extractive value and moisture content were determined. The concentrated extracts of leaf material are prepared by maceration processes and are subjected to chemical tests [9,10,11,12].

### HPTLC Analysis

CAMAG HPTLC system equipped with Linomat V applicator, TLC scanner 3, CAMAG Visualizer with Digital camera type DXA252 for photo documentation, controlled by Win CATS- 4 software was used for the present study. HPLC grade solvents procured from MERK were used for the analysis. Precisa XB 12A digital balance was used for weighing the samples and chemicals. 20 X 10 cm Camag twin trough chamber was used for developing the plate. Overnight saturation is done for all the HPTLC studies with Whatmann filter paper lining. HPTLC aluminium sheet precoated with silica gel 60 F<sub>254</sub>. (4.0 X 10cm) is used as stationary phase, obtained from E. MERCK KGaA [13,14,15].

### Preparation of Aqueous Extract for HPTLC

1gm of the sample is extracted with 10ml of methanol by heating at 50-55°C for 10 min. The filtered extract is used for the study [16].

### HPTLC Profile of Aqueous Extract

5.0µl of aqueous extract solution was applied on precoated aluminium TLC plate as 8.0mm band using Linomat V applicator with a Hamilton syringe. Applied plate was placed in a twin trough chamber containing Toluene: ethylacetate (9.3:0.7) for development. The plate was developed for a migration distance of 80.0mm. The plate was then post-derivatized with Anisaldehyde Sulphuric acid reagent. It was then scanned under 254 and 365 nm using Deuterium and Tungsten lamps respectively and photo-documented using Reprostar.

## RESULTS AND DISCUSSION

### Macroscopy of the Leaf

Figure:1. *Pterocarpus marsupium* tree, leaves and bark





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Leaf dorsiventral, cuticle present, upper epidermis single layered, parenchymatous, slightly chlorophyllated, mesophyll differentiated into palisade and spongy tissue, palisade cells columnar, chlorophyllated, spongy tissue parenchymatous, intercellular spaces present, less chlorophyllated, transfusion tissue in between palisade and spongy, endodermis thick, 3 – 4 layered, sclerenchymatous, thick walled, cortex parenchymatous in midrib, phloem thin, hyaline, arranged in bundles, surrounded by parenchyma, towards the periphery, xylem arranged layers of 6-8 cells, metaxylem towards the periphery, large, thick walled, protoxylem towards the centre, thick walled, protoxylem lacuna present, lower epidermis parenchymatous, less chlorophyllated, cuticle present, irregular in the midrib

**Physico-Chemical Parameters**

The phytochemical analysis helps in formulating pharmacopoeial standards. The chief phytochemicals present in the aqueous extract of *P. marsupium* were flavonoids, polyphenols, alkaloids, glycosides, tannins, carbohydrates, saponins and aminoacids.

**HPTLC Report**

HPTLC analysis of aqueous extract of *Pterocarpus marsupium* was performed. The aqueous extract revealed 6 phytoconstituents at Rf 0.02, 0.04, 0.12, 0.18, 0.30 and 0.78 under 254nm. Out of these, peaks at Rf 0.02, 0.04 and 0.30 were most prominent spots and others were less prominent under 254 nm (Fig: 5). Under 366 nm the extract revealed 5 phytoconstituents at Rf 0.01, 0.08, 0.26, 0.32, 0.30 and 0.46. Out of these, peaks at Rf 0.01 and 0.08 were most prominent spots and others were less prominent under 366 nm (Fig: 6).

**CONCLUSION**

The identification of plant material taxonomically and pharmacognostically is important to provide pharmacognostical standards and to avoid spurious or adulterated drugs. Specific diagnostic characters can be identified by performing detailed botanical and pharmacognostical studies which help in the identification of plants/drugs in the field. Microscopical characters presented in the result part help in the identification of the drug. The physicochemical and phytochemical analysis helps in formulating pharmacopoeial standards. Phytochemical analysis of aqueous extract represents the presence of flavonoids, polyphenols, alkaloids, glycosides, tannins, carbohydrates, saponins and amino acids Further studies on the isolation and identification of specific chemical constituents can be done only after preliminary organic analysis. HPTLC profiling of the aqueous extract of leaves showed six clearly separated spots which may help in determining the biomarker compound of the drug.

Standardization of drugs and formulations of the traditional system of medicine is of utmost importance to assure uniform quality and optimum biological efficacy. The plant must be identified and distinguished from other species using scientific criteria based on taxonomical, pharmaceutical and phytochemical investigations. These parameters along with physiochemical constants not only help in the standardization of these drugs but also aid in formulating pharmacopoeial standards of drugs. The exomorphic characters have been found to be useful tools to identify the species taxonomically. The qualitative phytochemical investigation provides valuable insights into many phytoconstituents present in diverse extracts, assisting future researchers in choosing an extract for more study. HPTLC profiling of aqueous extract exhibited a number of phytoconstituents which will be a fruitful hope for the isolation and characterization of compounds.

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**Table:1. Physico-chemical parameters of powdered leaves of *P. marsupium***

SI. No.	Parameters	Average % W/W
1.	<b>Ash values</b> a) Total ash	4.4
2.	<b>Loss on drying</b>	9.4

**Table:2. Extractive values of leaves of *P. marsupium***

Solvent	Extractive value %w/w	Colour	Odour	Consistency
a) Pet. Ether	2.83	BG	Characteristic	greesy greesy nongreesy sticky nongreesy
b) Benzene	0.80	DG	Characteristic	
c) Chloroform	3.02	BG	Characteristic	
d) Methanol	12.08	Black	Characteristic	
e) Water	13.62	Brown	Characteristic	

BG- black green, DG- dark green

**Table:3. Preliminary Phytochemical Analysis of aqueous extract of *P. marsupium***

SI.No.	Test	Water
1.	Carbohydrates	+
2.	Alkaloids	+
3.	Glycosides	+
4.	Tannins	+

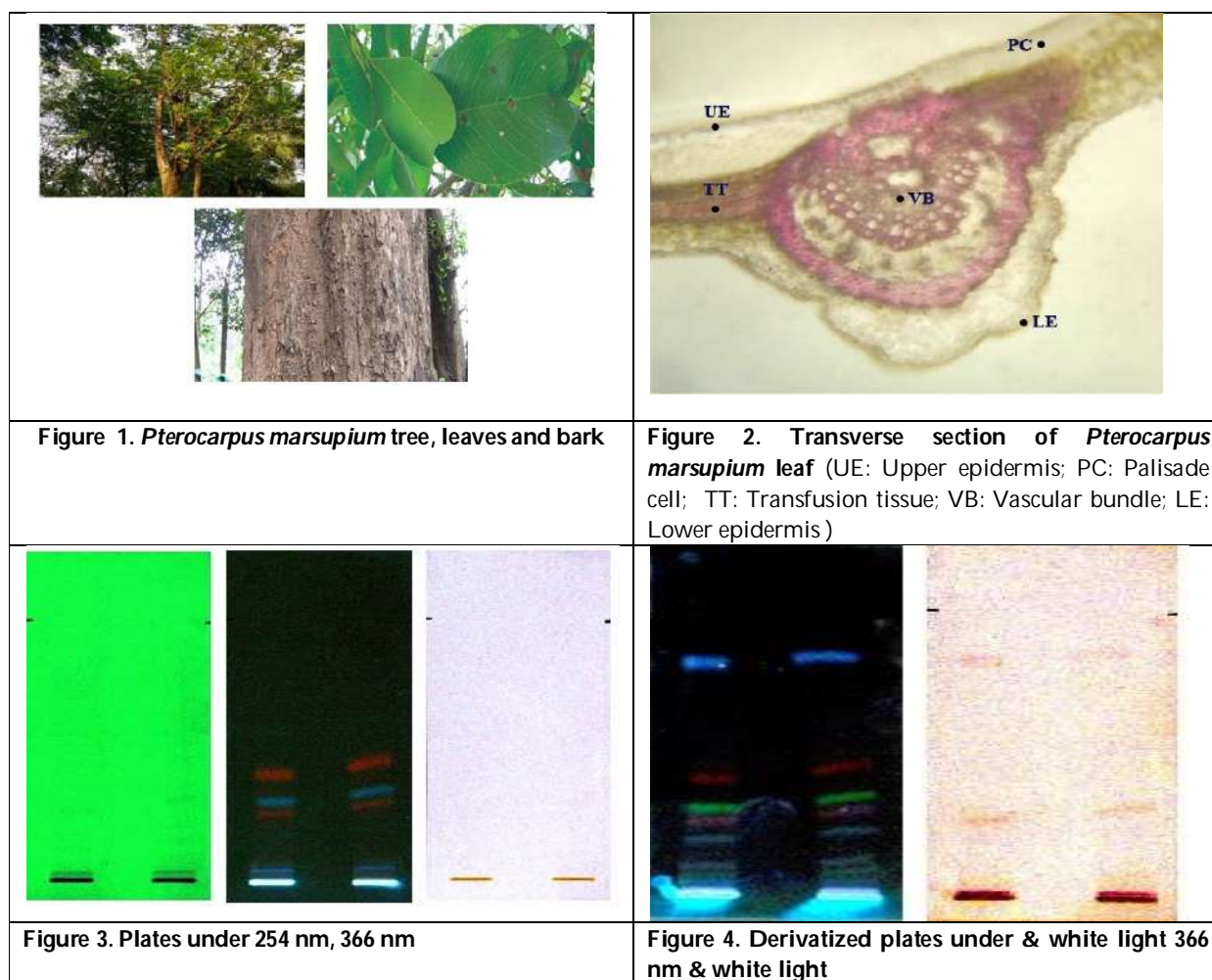




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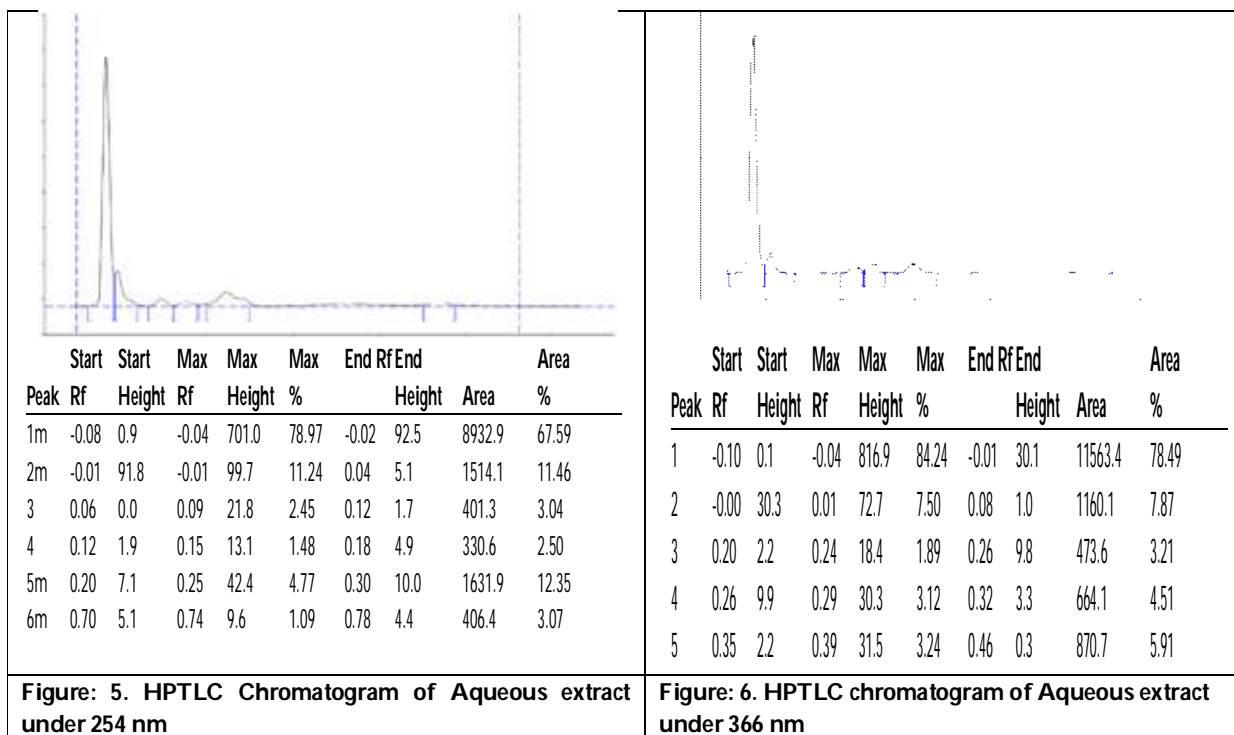
5.	Steroids	-
6.	Triterpenoids	-
7.	Volatile oils	-
8.	Fats and fixed oils	-
9.	Flavanoids	+
10.	Polyphenols	+
11.	Saponins	+
12.	Aminoacids	+
13.	Gums and mucilages	+

"+" represents **Presence** "-" represents **Absence**





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## An Overview of Sea Buckthorn

Athira K J<sup>1</sup>, Ayesha Fathima A, Jayashree R, J.Suresh<sup>2</sup>, Asha Spandana K M<sup>3</sup> and Haripriya G<sup>4\*</sup>

<sup>1</sup>B.Pharm, Department of Pharmacognosy, JSS College of Pharmacy, Mysuru, JSS Academy of Higher Education and Research, Mysuru, Karnataka, 570015, India.

<sup>2</sup>Professor, Department of Pharmacognosy, JSS College of Pharmacy, Mysuru, JSS Academy of Higher Education and Research, Mysuru, Karnataka, 570015, India.

<sup>3</sup>Lecturer, Department of Pharmaceutics, JSS College of Pharmacy, Mysuru, JSS Academy of Higher Education and Research, Mysuru, Karnataka, 570015, India.

<sup>4</sup>Lecturer, Department of Pharmacognosy, JSS College of Pharmacy, Mysuru, JSS Academy of Higher Education and Research, Mysuru, Karnataka, 570015, India.

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### \*Address for Correspondence

**Haripriya G**

Lecturer,

**Department of Pharmacognosy,**

**JSS College of Pharmacy,**

**Sri ShivarathreshwaraNagara,**

**Mysuru- 570015, India.**

E-mail: haripriyag@jssuni.edu.in



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### ABSTRACT

Sea buckthorn (*Hippophae rhamnoides* L.) is an indigenous plant of northwest Europe, Central Asia, India at Himalayan region. It is also known as Siberian pineapple, sand thorn, sallow thorn, and sea berry. Considering sea buckthorn as a shrub it is significant among other shrubs, because almost every part of the sea buckthorn such as leaves, berries, seeds, and flowers, contain certain essential chemical compounds such as vitamins, minerals, fatty acids, flavonoids, phenolic acids, and complex lipids, which can be used in pharmaceutical industries such as nutraceuticals, cosmeceutical, as well as food and animal feed production. Because of its high vitamin and polyphenol content, it can be used as an anti-oxidant. Sea buckthorn oil, pulp, juice, and sludge can be extracted from crushed leaves or seeds using the cold pressing method. The dry form of pulp can be used as a supplement in the food industry to increase the nutritional value, and since flavonoids are present in sea buckthorn, it can also be used as a flavouring and colouring agent. Sea buckthorn is also used as anti-diabetic, anti-distress, anti-aging, cardioprotective, atherogenic, hepatoprotective, immunomodulatory, anti-cancer, gastrointestinal ulcer, wound healing, and anti-hypertensive. As a result, sea buckthorn is thought to be rich in bioactive substances. In the present review the origin, classification, morphological characteristics, microscopical characteristics, extraction methods and therapeutic uses of the sea buckthorn oil is overviewed and various medicinal, cosmeceutical, nutraceutical uses of the sea buckthorn have been discussed along with their chemical composition and their classes.

**Keywords:** Sea buckthorn, Chemical composition, Nutraceuticals, Therapeutical uses.





## INTRODUCTION

Sea buckthorn (*Hippophae rhamnoides*), belongs to a dicot family of Elaeagnaceae, is native to Europe and Asia. *Hippophae rhamnoides* is a thorny tree or shrub that gets its name from the Latin words "hippo" (horse) and "phaos" (gloss or flare) [1, 2, 3, 5, 34]. It is a bushy tree (1.5-4.5m tall) with large thorns on the branches which grows to a height of 2000 m in Europe, 4500 m in Tibet, and 5000 m in the Himalayas [53]. It is found in the temperate zone of central Asia, primarily in the cold arid zone of Leh Ladakh, and is well grown in some places of the Himachal Pradesh, Sikkim, Arunachal Pradesh, Jammu & Kashmir, as well as in Europe and the northern regions of Pakistan, as well as over the subtropical zones, particularly at high altitudes [2, 3, 4, 15]. This plant has been cultivated by ancient plant breeders, the traditional Greeks utilized in diet for race horses hence, this is often the rationale for its botanical name [4]. It is widely used in human life due to its availability of biologically active compounds, which contribute to its health-promoting potential. The biologically active substances include carotenoids and various phenolics such as proanthocyanidins, ursolic acid, caffeic acid, coumaric acid, ferulic acid, catechins, and epicatechin derivatives, and also consist of flavonoids, phospholipids, tannins, macro elements, microelements (K, B, Fe, Mn) vitamins (Retinol, thiamine, riboflavin, ascorbic acid, tocopherol, phytonadione) volatile derivatives, phytosterols, phenols, lipids, soluble sugar primarily composed of glucose, fructose, and xylose with 3.9 percent organic acid, malic acid, and carboxylic acid. Sea buckthorn seed oil consist of saturated and unsaturated fatty acids, (Palmitic acid, Palmitoleic acids, Oleic acids, Linoleic acids, Myristic acid, Stearic acid) riboflavin, niacin, pantothenic acid, quercetin (isorhamnetin glycoside derivatives), myricetin, kaempferol, triacylglycerol, glycerophospholipids, zea xanthin esters, alpha tocopherol. The aroma of sea buckthorn is due to esters, and total plant sterol containing beta-sterols [57-83 percent] [1,2,3,4,5,6,7,8,9,10,11]. Sea buckthorn pharmacologically acts as anti-oxidant, anti-atherogenic, hepatoprotective, immunomodulatory, tissue repair properties, and anti-inflammatory, anti-hyperlipidemic, anti-cancer. It also cures cardio-vascular disease, cirrhosis, and skin injury, cold, strengthen blood vessels, improves eye sight, obesity [4,13,14].

### Taxonomical Classification [22]

<b>Kingdom</b>	:	Plantae
<b>Division</b>	:	Magnolophyta
<b>Class:</b>	:	Magnoliopsida
<b>Subclass</b>	:	Rosidae
<b>Order</b>	:	Elaeagnales
<b>Super order</b>	:	Celastraneae
<b>Family</b>	:	Eleagnaceae
<b>Genus</b>	:	Hippophae L.
<b>Species</b>	:	Hippophaerhamnoides L.

### Morphological Characteristics

Sea Buckthorn is a perennial plant flourishes well and grow in sandy loam soils with a pH of 5.5 to 8.3, it prefers well-draining, light with a pH of 6 to 6.7. As it cannot tolerate shadow at any stage of growth, plant should be grown at sunny areas [26]. The plant is also useful as fuel wood, fence fodder, erosion control, soil enrichment through organic processes in roots, and shelterbelts. The plants have extremely powerful root systems, with tap roots up to 1.1 m depth and horizontal roots up to 2.58 meters [27]. The plant can survive temperature fluctuations ranging from -43°C to 55°C (surface) and thrives in extreme drought with annual rainfall of 250-800mm. It can also tolerate a pH range of 5.8-9.5 in the soil [27].

### Microscopic Characteristics

#### Seed

The sectioned sea buckthorn seed observed under scanning electron microscope showed dark brown and shiny seed coat. The seed measured about 4.5mm in length, 2.33mm in width, and 0.01-0.2nm in thickness. A seed's ends were





slightly pointed, revealing a furrow throughout the body and one side of the seed was slightly smaller than the other. It revealed two distinct layers of the testa derived from the ovule's outer and inner integument. The seed coat's outer layer was thick and hard, while the inner surface was thin and fibrous. [26].

#### Leaves

The sea buckthorn leaves were cut transversely, stained with phloroglucinol and hydrochloric acid, and examined under a microscope. It exhibited upper and lower epidermis as well as submerged stomata and a thin cuticle. The lower epidermis is entirely composed of pressed stellate trichomes, vascular bundles and spongy parenchyma. The leaf's midrib consists of few layers of collenchyma cells beneath the upper epidermis, 3-4 layers of phloem cells beneath the xylem vessels, and 6-7 layers of spongy parenchyma above the lower epidermis[31].

#### Berries

The dried and crushed sample of sea buckthorn berries are observed under the luminescent microscope. The outer covering of the berry is yellow color. It showed a group of the phenolic compound [38]. Fragments of the berry are brownish in color and seed peel without their own luminescence.

#### Seabuckthorn Oil Extraction

There are many methods employed for the extraction of sea buckthorn oil. They are,

- i. Solvent extraction method
- ii. Super critical fluid extraction method
- iii. Screw press method
- iv. Aqueous extraction method
- v. Cold pressing method

The cold pressing method obtains a high availability of unsaturated fatty acids, making it the most widely used of all of these methods [12].

#### Cold Pressing Method

The cold pressing method can be used to extract sea buckthorn oil from seeds and berries, with seeds containing up to 12.5% oil by weight. The oil extracted from the fruit pulp contains up to 8-12% oil by weight. Filtration is performed on the obtained oil fractions. Both oils have a high percentage of unsaturated fatty acids [34, 36].

#### Oil Analysis

Since harmful solvent residues can be left behind in the extracted oil, solvent extraction is unsuitable for SB oil extraction. The supercritical carbon dioxide (CO<sub>2</sub>) method extracted seed and pulp oils with high concentrations of all nutritional compounds. The addition of co-solvents to CO<sub>2</sub> may improve the extraction of additional nutritional components. In terms of extracting oil from pulp, the aqueous phase extraction method outperforms the screw press. Because the screw press method has a higher concentration of tocopherols and carotenoids, whilst screw press method has a lower concentration of sterols [34, 33].

#### Chemical Constituents of Sea Buckthorn

The most recognised part of *Hippophae rhamnoides* are its fruit and seed oil, which are rich in unique fatty acids (saturated and unsaturated fatty acids), complex lipids, plant sterols and 190 bioactive substances. The chemical classification with their important chemical constituents and therapeutic effect are given in Table.2. The berries of a specific subspecies *rhamnoides* had a higher proportion of oil in the seeds (11.3 percent vs 7.3 percent,  $p < 0.01$ ), berries (3.5 percent vs 2.1 percent,  $p < 0.001$ ), and seedless parts (2.8 percent vs. 1.7 percent,  $p < 0.01$ ) than subspecies berries [35].





### Preclinical Studies of Sea Buckthorn

#### Cardiovascular Activity

According to Zhang, Wen, et al., isoproterenol (ISO)-induced cardiac toxicity (85mg/kg, subcutaneous injection every 24 hours) was used to test the cardiotoxicity of sea buckthorn oil (5, 10, and 20 ml/kg per day) in rats for one month. They discovered stroke, increased lipid peroxidation, depletion of cardiac injury marker enzymes, and anti-oxidant activity in rats with isoproterenol-induced cardio toxicity on the 31st day. The ultrasound revealed myocardial necrosis, oedema, and inflammation. Histopathological and ultra-structural examinations confirmed SBT oil's protective role against isoproterenol-induced cardio toxicity. Thus, the study demonstrates that SBT oil reduces myocardial damage in rats with isoproterenol-induced cardio toxicity [45].

#### Anti-Diabetic Activity

The effect of anti-diabetic activity in streptozotocin-induced diabetic rats was studied by administering an aqueous extract of sea buckthorn seed residue (ASSR) to three groups of Male-Sprague-Dawley rats and determined the effect of serum glucose, lipid profile, and anti-oxidant parameters, according to Gęgotek, Agnieszka, et al. To persist the study, three groups of rats were divided; for the normal control group, vehicle (distilled water), 5mg/kg glibenclamide, and 400mg/kg ASSR were given orally once a day for four weeks. Vehicle (distilled water), 5mg/kg glibenclamide, and 400mg/kg ASSR were administered orally once a day for 4 weeks to diabetic control rats. Vehicle (distilled water), 5mg/kg glibenclamide, and 400mg/kg ASSR were given to diabetic rats, along with an intraperitoneal injection of streptozotocin (45mg/kg body weight). Thus, the study of the ASSR has a hypoglycemic, hypotriglyceridaemic, and anti-oxidant effect in streptozotocin-induced diabetic rats [47]

#### Wound Healing Activity

Sea buckthorn (SBT) oil was administered orally and topically at a dose of 200 L for 2.5ml/kg body weight, and burn-wounded rats were given silver sulphadiazine (SS) ointment. The comparison of SBT oil and SS ointment revealed that SBT oil is more effective in curing wounds. SBT oil has anti-oxidant properties, as evidenced by a significant increase in reduced glutathione levels and a decrease in reactive oxygen species production in wound granulation tissue. There is no negative effect of sea buckthorn seed oil in acute and subacute oral toxicity studies. The observations by Gao, Ze-Li, et al revealed that SBT seed oil has wound healing properties [48].

#### Anti-Oxidant Activity

The anti-oxidant activities of sea buckthorn in rabbits were studied by administering total flavones for two weeks previous to light exposure and one week following light exposure till sacrifice, according to Wang, Yong, et al. The rabbits' retinal function was assessed using an electroretinogram one day before light exposure, as well as one, three, and seven days after light exposure. The thickness of the extraretinal nuclear layer and TUNEL were measured on the seventh day after light exposure to determine the degree of retinal degeneration. Western blotting analysis, enzyme-linked immunosorbent assay, and immunohistochemistry were used to evaluate the antioxidant mechanisms of the whole flavones from sea buckthorn in the process of light-induced retinal degeneration. Total flavones from sea buckthorn reduced the oxidative stress caused by light exposure in the retina, as measured by glutathione peroxidase (GSH), Catalase (CAT), total antioxidant capacity (T-AOC), and malonaldehyde levels (MDA). Furthermore, GSH and CAT activities were significantly lower in the retinal injury model group than in the control group ( $p < 0.05$ ). Overall, this study discovered that sea buckthorn flavones have antioxidant properties and indirectly inhibit retinal cell apoptosis [24]. Although sea buckthorn has shown many activities in animal experiments it tends to show comparatively high anti-oxidant property.

#### Mechanism of Action of Polyphenols Present in Sea Buckthorn

Diet therapy with antioxidant foods is a simple and effective way to supply endogenous antioxidants to reduce free radical damage. Phenolic compounds are secondary metabolites with antioxidant activity. Their structural properties, interactions with other compounds, solubility, absorption, and metabolism all influence their biological activity. The antioxidant mechanisms of polyphenols derived from hippophae species are summarised in Fig.3.







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**Other Benefits of Seabuckthorn Oil****Cardioprotective And Anti-Atherogenic Effects**

Cardiovascular conditions are cardiac and blood vessel defect that kills nearly 23.6 million people worldwide. The effect of Sea buckthorn will be strongest in people with poor heart health is high in flavonoids and other bioactive compounds that aids in the treatment of cardiovascular diseases like coronary heart disease, atherosclerosis, stroke, myocardial infarction, peripheral arterial disease and arrhythmia. Isorhamnetin and quercetin, two major flavonoids found in sea buckthorn fruit and leaves, have been shown to defend against myocardial ischemia and reperfusion, cancers, oxidative damage and ageing. The effects may be strongest in people with poor heart health [44, 53].

**Hepatoprotective Effect**

Liver disorder are one of the world's leading causes of death. The effect of sea buckthorn oil has proven effects to safeguard liver cells from damage. As, sea buckthorn contains healthy fats, vitamin E and carotenoids [42]. According to Ren, Ruru, et al. Sea buckthorn compounds can help to prevent liver fibrosis by inhibiting HSC activation and reduces uniform liver metabolites, serum bile acids and SBT oil also protects the liver from the harmful effects of toxic synthetic compounds [53].

**Skin Therapy**

Sea buckthorn is regarded as a highly useful expert in treatment of wounds when applied directly. Shah, R. K., Idate, A., & Poorva, V. U, identified that animal studies of SBT oil may help stimulate skin regeneration, helping wounds heal more quickly [54]. The unsaturated fatty acids of the sea buckthorn oil may benefit the skin when consumed orally. Sea buckthorn oil is often used topically for absorbs, atopic dermatitis, reducing inflammation and psoriasis-like lesions and it has UV-blocking property, emollient property and it aids in tissue regeneration [53].

**Cancer Therapy**

Sea buckthorn oil contains phenolic compounds that have been shown to have anti-cancer properties. Quercetin, flavonoids, kaempferol, and isorhamnetin, which appears to kill cancer, are all found in sea buckthorn oil. These phenol compounds are derived from the seeds and juice of sea buckthorn. According to Geetha, S., et al. whether sea buckthorn is a "golden mean" for cancer treatment: It inhibits cell proliferation, induces apoptosis, and stimulates the immune system. Many of the side effects of chemotherapy are mitigated by sea buckthorn oil, which restores kidney and liver function, increases appetite, and keeps patients in general good health. Despite numerous in vivo and animal in vivo studies confirming sea buckthorn's anticancer activity, treatment and prophylactic doses for humans are unknown. As a result, greater emphasis should be placed on the development of high-quality, well-controlled clinical experience in this area [51, 53].

**Immuno Modulatory**

Sea buckthorn oil is said to be effective against the measles virus [52]. The flavonoid content of sea buckthorn oil is high, which strengthens our immune system by increasing resistance to illness [42]. Using the standard disc diffusion method, researchers examined the anti-bacterial activity of sea buckthorn berries and leaves against methicillin resistant staphylococcus aureus (MRSA). Chloroform, n-hexane, and aqueous extracts of plant parts were used in this study. Doses of 2mg/ml, 4mg/ml, and 6mg/ml were tested against the microorganism and compared to the zone of inhibition against the standard drug vancomycin, revealing that n-hexane and chloroform extracts of berries and n-hexane extract leaves demonstrated significant anti-bacterial activity when compared to vancomycin [51]. According to the findings of the above study, sea buckthorn oil derived from the berries and leaves has anti-bacterial activity against (MRSA) [52].

**Gastro Intestinal Ulcer Therapy**

Sea buckthorn oil is found to be effective against gastric ulcers. The sea buckthorn oil has the capacity that could include monitoring favourable to fiery go between to standardize gastric corrosive yield and reduce irritation. The indomethacin, tension and ethanol both of which lead to the production of gastric ulcers, they are inhibited hexane extract from sea buckthorn. The extract also helps to prevent duodenal ulcers [53].





## CONCLUSION

The significant properties of sea buckthorn (*Hippophae rhamnoides* L.) have captivated people all over the world. According to the overview, polyphenols which is the predominant composition present in the sea buckthorn produce an anti-oxidant activity. It also demonstrates that the berry of the sea buckthorn contains greater unsaturated fatty acid content than other portions of the plant, which is essential to maintain cholesterol levels elicit protective effects on cardiovascular health. The value of this plant is reinforced by its anti-inflammatory, anti-tumor, antioxidant, as well as its anti-cancerous, immunomodulatory, and wound-healing effects. When developing safe and appetizing food models, there are prospects for commercialization.

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Table 1: Morphological Characters of Sea Buckthorn Oil

Parts/ organoleptic characters	Colour	Shape	Size	Phytoconstituents	Reference
Leaves	Green on top and silvery ash on the bottom.	Leaves are elongate, spatulate (or) Oblongate	2.8 to 0.8cm in size	3.85% of saccharide, 0.2% of protopectin 1.1% of organic acids, 170 mg/100 g of catechin Vitamin C	16,22,32,25,1
Flower	Brown	Solitary, axillary, cluster or racemes	14-15 length, 2.61-3.08cm width	Minerals	21,22,32
Berries	Orange/red in color or may be Yellow/ light Yellow	Small round	6.64 – 9.14mm in size	Vitamin A, K, C, B Carotenoids, flavonoids, Carbohydrates, proteins, Organic acids, amino acid, Polyphenols, minerals.	20,23,01,32,22, 25,27,24.
Seeds	Dark, glossy	Ovoid to Elliptical	2.8 to 4.2mm	Sodium, potassium, zinc Phosphorous, calcium Magnesium, proteins.	18,22

Table 2: The Chemical Classification Of The Compounds Present In The Sea Buckthorn Along With Their Chemical Structure.

Chemical classification	Constituents	Reference
Vitamin	Vitamins (Retinol, Thiamine, Riboflavin, Ascorbic acid, Tocopherol, Phytonadione, B complex vitamins (B1,B2, B6), omega-3 and omega-6 fatty acids.	5,40,34,39,1,41
Fatty acids	Palmitic acid, lauric acid, pentadienoic acid, stearic acid, oleic acid, palmitoleic acid, myristic acid, Linoleic acid, $\alpha$ -linolenic acid, $\gamma$ – linolenic acid.	34,39,41,14,43,35,9,10,40,42,5
Carotenoids	Beta-carotene, Zeaxanthin, Lycopene, Cryptoxanthin, Physalinen.	1,5
Phytosterol	Camphosterol, $\beta$ -sitosterol, stigmasterol.	40,34,43,5
Triterpenoids	Oleanolic acid	54
Flavanoids	Iso-rhamnetin	1,34
Phenols	Proanthocyanidins Gallic acid	54
Mineral elements	Phosphorus, Potassium, Iron, Magnesium, Calcium, Copper, Manganese, Cadmium.	37





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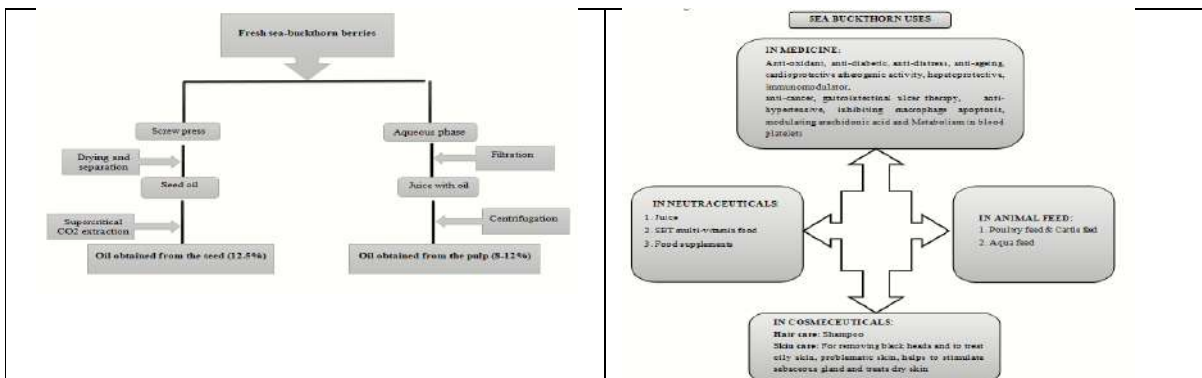


Figure 1: Method for extraction of sea buckthorn oil from sea buckthorn berries.

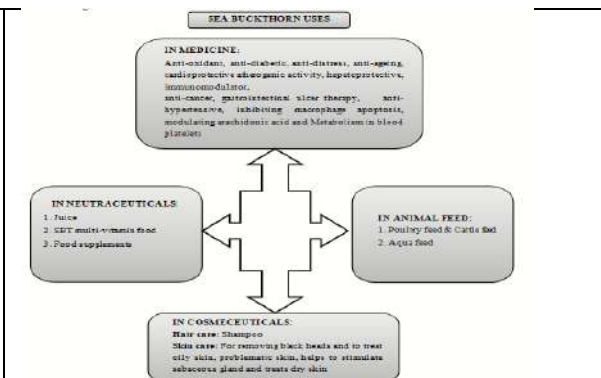


Figure 2: Structural Outline of Sea Buckthorn uses

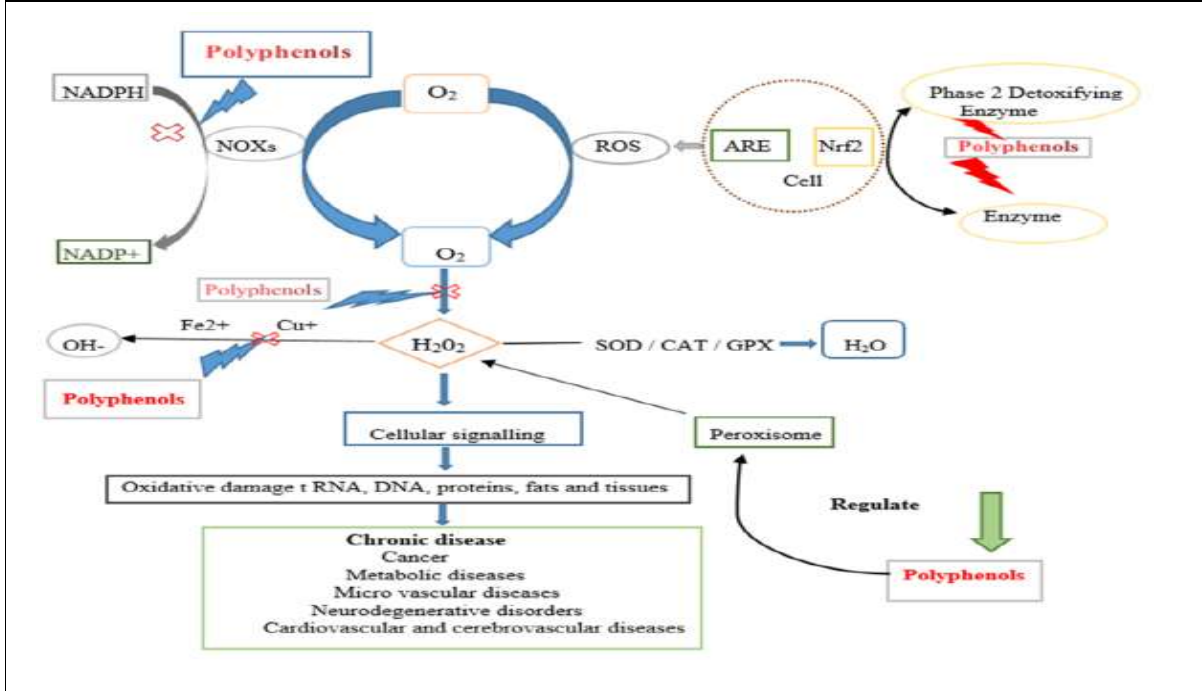


Figure.3: The antioxidant mechanism of polyphenols from *Hippophae* species. (NADPH: nicotinamide adenine dinucleotide phosphate; NADP: nicotinamide adenine dinucleotide phosphate; NOXs: NADPH oxidase; SOD: superoxide dismutase; CA: catalase; GPX: glutathione peroxidase).





## Management of Self -Mutilating Habit in Lesch - Nyhan Syndrome

Vidhyasagar Mopagar<sup>1\*</sup>, Deepti Musmade<sup>2</sup>, Sourabh Joshi<sup>3</sup>, Vikranth Shetty<sup>4</sup>, Hrushikesh Hadpe<sup>5</sup>, Prajwal Sonawane<sup>5</sup> and S.Sruthi<sup>5</sup>

<sup>1</sup>Head and Professor, Dept. of Paediatric and Preventive Dentistry, Rural Dental College, Loni, Maharashtra, India.

<sup>2</sup>Senior Lecturer, Dept. of Paediatric and Preventive Dentistry, K.B.H. Dental College, Nashik, Mumbai, Maharashtra, India.

<sup>3</sup>Reader, Dept. of Paediatric and Preventive Dentistry, Rural Dental College, Loni

<sup>4</sup>Professor, Dept. of Orthodontics, TKDC, Kolhapur, Maharashtra, India.

<sup>5</sup>PG Student, Dept. of Paediatric and Preventive Dentistry, Rural Dental College, Loni, Maharashtra, India.

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### \*Address for Correspondence

#### Vidhyasagar Mopagar

Head and Professor,

Dept. of Paediatric and Preventive Dentistry,

Rural Dental College, Loni,

Maharashtra, India.

E. Mail: vidhyasagar9@gmail.com



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### ABSTRACT

Lesch-Nyhan syndrome which is initially described by lesch and nyhan in two brothers, is a rare X-linked recessive, inherited Mendelian genetic disorder of purine metabolism associated with uric acid overproduction. A two and half year old male child with previously biochemical and neurological diagnosis of LNS referred to the dental opd. On perioral and intraoral examination revealed a well-defined, deep laceration injuries & some scarring all over the lower lip. Under general anaesthesia upper and lower alginate impression was made. Laceration injuries of the lip cleaned and suturing was done. acrylic occlusal splint was fabricated & cemented on the lower occlusal surface using zinc phosphate cement.

**Keywords:** Self-Mutilation, HPRT Deficiency, Uricemia.

### INTRODUCTION

Lesch-Nyhan syndrome (LNS) is a rare X-linked recessive, inherited Mendelian genetic disorder of purine metabolism associated with uric acid overproduction [1]. Patients with LNS are characterized by minimal or zero



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enzymatic activity of HPRT in erythrocyte, which is a protein present in all cells essential for the purine metabolism [2]. This deficiency of enzyme is caused by the mutation of gene HPRT1 present on the long arm of X chromosome at Xq26. LNS was initially described by Michael Lesch and William Nyhan in 1964 in two brothers with crystals in the urine and self-mutilation at John Hopkins hospital [Lesch and Nyhan, 1964] [1]. Children with LNS presented with features such as generalised increase uric acid levels in blood and urine which results in gout, neurological features starts to appear at the first year of life include facial grimacing, hypotonia, lack of muscle tone, spasticity, mental retardation, intellectual disability, involuntary repetitive movements of arms and legs and in the beginning of the second year of life, self-mutilation [1,2,3]. It has a prevalence of one in 380,000 live births. Most commonly affects male and carried by females. one third of the cases arises from new mutation, such cases do not have any family history. Females are very rarely affected [4].

At birth, child with LNS appears to be normal but as age advances they are unable to sit properly and cannot lift their head [3,5,6]. The most distinguishing symptom is the uncontrollable self-injury behaviour. The concerned children seen normal for the first months of life but with the eruption of deciduous teeth, they show self-mutilative behaviour which includes biting their oral/ perioral tissues and their fingers. This leads to partial or total destruction of perioral tissue especially the lower lip, fingers and toes. The finger nails may be completely ripped, and the self-destructive process involves the bone. Also leads to the secondary infection which complicates and retards the healing of traumatic lesions [7]. Most patients die in their childhood as the life expectancy is very less which is about two decades [6,7]. Children with LNS experiences pain and compunction when they mutilate themselves, but they are helpless to control their behavior Nyhan (1997) [7,8]. when children with LNS have physical restraints, they are relaxed but when detached the patients become excited and there is an increase in their compulsive actions. The relationship between the enzyme deficiency and the neurological manifestations in Lesch-Nyhan syndrome is not so clear but may be associated with deficits in dopaminergic activity in the basal ganglia as many neurochemical studies of LNS patients show large reductions in DA levels, elevated numbers of DA receptors, and decreased levels of DA transporters [9,10].

The diagnosis of LNS may be verified by a detailed and profound clinical evaluation, in addition to a complete and point by point history of patient and specific blood and urine tests. Blood and urine test for uric acid levels are the screening test for LNS. The confirmatory test for LNS includes measurement of HPRT gene and protein activity. Also, the absence of the HPRT enzyme in cells from any tissue confirms the diagnosis. Molecular genetic testing for the HPRT1 gene is available to determine the specific disease-causing mutation. Prenatal diagnosis can also be done by enzyme analysis if family history is present [6,7,10]. In this case report, we present a case of a child with symptoms of LNS and management of the trauma caused by self-mutilation.

**Case Report****Patient History and General Examination**

A two and half year old male child with previously biochemical and neurological diagnosis of LNS referred to the dental OPD with chief complain of self-mutilating habits and severe injuries to perioral and intraoral tissues. The patients' earlier records indicated that he was diagnosed with LNS at second year of life. His blood and urine report showed the elevated values for the uric acid and also HPRT enzyme assay showed the deficiency of enzyme. According to the parents, child had been very quiet and did not response to many stimuli till first year of life but after the age of one year, he start to show involuntary repetitive movements of arms and legs, unable to sit properly and cannot lift his head. After the eruption of primary teeth, he started to bite his thumbs and perioral structure very aggressively. The parents reported to the paediatrician in private hospital with the same complaint where he undergone multiple neurologic and serologic assays which diagnosed him with LNS.

On clinical examination, he presented with features such as facial grimacing, hypotonia, spasticity and unable to lift his head and sit properly, mental retardation, involuntary repetitive movements of arms and legs and laceration injuries on the lower lip and both the thumbs were seen. perioral and intraoral examination revealed a well-defined, deep laceration injuries all over the vermillion zone and vermillion border of the lower lip. Also, some scarring was





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present on the lower lip. (Fig.1) All primary teeth were present. Then the Patient was referred to the department of paediatrics for general examination and medical fitness for the dental procedure. On examination, he was considered medically unfit to be treated on the chair because of his aggressive behaviour and his systemic disorder. They categorise the patient under American society of anesthesiologists (ASA) 4 category. As patient would not be able to manage on the dental chair it was decided to do further treatment under general anaesthesia. Patient was admitted in the Pediatric ward under department of pediatrics for preanesthetic evaluation and multidisciplinary management of the patient.

**Preanaesthetic Evaluation**

On blood and urine test, he was found to have elevated uric acid level (9 mg/dl) and low Hb (10.9mg/dl). The optimization of the patient was done by starting him on the injection Alopurinol (allopurinol sodium) once a day. Also, started with preanesthetic medication i.e. Inj. Augmentin prior to the procedure.

**Anaesthetic Consideration**

Our patient due to his condition was considered under ASA category 4. As the procedure would be performed intraorally, nasal intubation was done. Once the patient was confirmed stable, intraoral procedures were carried out.

**Procedure**

The treatment plan included the prevention of the further trauma to the perioral soft tissue including fabrication of a mouth guard. Under general anaesthesia upper and lower alginate impression was made using perforated impression trays. Laceration injuries of the lip cleaned with the help of betadine (Povidone iodine, 10%) and suturing was done using vicryl 3-0 (Ethicon vicryl plus)(FIG.2). Study model was made using dental stone and acrylic occlusal splint was fabricated (FIG.3) This occlusal splint was cemented on the lower occlusal surface using zinc phosphate cement (Harvard cement) (FIG.4). The parents were instructed about the oral prophylaxis and cleaning of the appliance. Primarily, child could not tolerate the appliance inside the mouth, but with time he accepted it. The child was recalled after 1 week for re-examination and revealed the biting of the lip and thumbs was reduced. Healing of the laceration injuries was evident. suture removal was done. Patient was recalled after 3 weeks for follow up and modification of the occlusal splint, on examination the lesion had resolved completely. Child had accepted the appliance which result in reduced self-inflicted damage. Chlorhexidine mouth rinses were prescribed.(fig.5)

**DISCUSSION**

Lesch-Nyhan syndrome is a sex linked disorder of purine metabolism which exclusively affects males. This patients shows decreased or absent activity of hypoxanthine-guanine phosphoribosyl transferase biochemically, which characterised by excessive purine production and shows symptoms of *juvenile gout* such as increased uric acid concentrations throughout the body [1,2,3]. Extraction of primary teeth and permanent teeth has been advocated as a satisfactory solution in young patients as the problem of subsequent recurrence of lip biting is inevitable [11]. The extraction of the incisors has not been proven effective in preventing further self-injury. Permanent canines and perhaps premolars and molars may also be involved [12].

Many intraoral appliance designs have been suggested to limit soft tissues injury to avoid extractions. Budnick was the first one to use a flat acrylic overlay splint which was cemented to the mandibular teeth to relieve the occlusion [13]. He also suggested a second technique, in which anterior open bite was created using a posterior splint. because of creating open bite, The child would suck on his lower lip but was unable to bite it. A lower lip guard fabricated by Evans showed favourable results in very short period (Evans et al. ) [14]. According to the Evans et al, as the appliance was placed, the potentiality to cause trauma ceased [14]. Although, some authors had delineated the limited success of a lip bumper design constructed to displace the lower lip away from the anterior teeth [15]. The appliance was very fragile such that it was unsuitable for the masticatory forces generated by the Lesch-Nyhan patients. Also, many author reported that the lip trauma and inflammation was caused by daily removals of the





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guard . [15,16]. In conclusion, LNS is very rare but easy to diagnose. Currently, there are no permanent treatment for management of self-mutilation and prevention from the perioral trauma in Lesch–Nyhan syndrome patients. Appropriate preventive methods have to be developed for each individual patient based on close observation. A suitable oral appliance could be tried initially before employing more invasive approaches.

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**Fig.1 Showing Well-Defined, Deep Ulcer With Ragged Margins And Some Scarring Over The Lower Lip**



**Fig.2 showing under general anaesthesia upper and lower alginate impression made using perforated impression trays. Laceration injuries of the lip cleaned with the help of betadine and suturing was done using vicryl 3-0.**





Fig.3 Showing Study model made using dental stone and acrylic occlusal splint was fabricated.

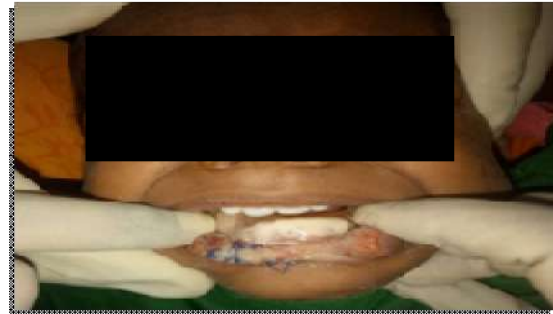


Fig. 4 Showing cementation of occlusal splint using



Fig.5 Showing healing of wounds after three week follow up





## Regulatory Review in Rest of the World Market – Chile

Rohit S. Gahilod<sup>1</sup> and Balamuralidhara .V<sup>2\*</sup>

<sup>1</sup>Department of Pharmaceutics, Pharmaceutical Regulatory Affairs Group, JSS College of Pharmacy, Mysuru, Karnataka, India.

<sup>2</sup>Associate Professor and Head, Department of Pharmaceutics, JSS College of Pharmacy, Mysuru, Karnataka, India.

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### \*Address for Correspondence

#### Balamuralidhara .V

Associate Professor and Head,  
Department of Pharmaceutics,  
JSS College of Pharmacy,  
Mysuru, Karnataka, India.  
E. Mail : baligowda@jssuni.edu.in



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### ABSTRACT

The pharmaceutical market in terms of regulation is divided into two categories: regulated and non-regulated. The regulated market is mostly made up of countries with a lot of rules and regulations, as well as well-established drug regulatory agencies. Aside from the regulated market, the other category is known as the Rest of the World market, which has fewer rules and regulations as compared to the regulated and is easier to obtain market authorization. When discussing the global market, the Rest of the World market plays a significant role. In this review, we will discuss the overall regulatory perspective in one of the most important countries in the Latin American region. Chile is typically not considered a top priority in Latin America due to its small size, especially when compared to the continent's two most populous nations, Mexico and Brazil. With 9% of its total GDP allocated to healthcare, it is the nation in Latin America with the highest relative healthcare spending. Patented drugs make up the majority of the pharmaceutical market, but the generics sector has the greatest growth potential. The Chilean Public Health Institute (ISP) upholds high standards of excellence and quality while promoting and protecting the general public's health. The overall characteristics of the Chilean pharmaceutical market are covered in the review that follows. The review is conducted with the aid of numerous country-specific guidelines as well as the guidelines given by Chile's regulatory body. The review combines data from institutions like the ISP, OECD, the Ministry of Health, and others. The purpose of the following review is to shed light on the regulatory environment in other developed nations where information has received very little in-depth analysis. The review concentrates on the novel pharmaceutical elements that have just been introduced. The reader will ultimately be able to comprehend how the country's market and regulatory status compares to others.

**Keywords:** Regulatory, Rest of the World, Patent, ISP





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## INTRODUCTION

Although Chile is regarded as Latin America's economic powerhouse, some claim that it is a forgotten paradise because it is the region's most politically and economically stable nation and does not garner as much media attention as some of its neighbours.

### The Pharmaceutical Landscape

The Andes and the ocean, which give Chile its distinctive shape and geography, have an effect on how healthcare is delivered. When doing so, it's crucial to take Chile's size and geography into account. Chile's geography is incredibly varied because it stretches from the ocean on the west to the Andes on the east, from a latitude of 17° South to Cape Horn at 56°. Chile is a country in South America that is surrounded by the South Pacific and a small portion of the South Atlantic Oceans. The total area of the land is 756,102 km<sup>2</sup>. With 6,435 km (3,999 mi) of coastline, the country has the eleventh-largest exclusive economic zone (3,648,532 km<sup>2</sup>) [1].

## DISCUSSION

### Population

In 2017, 17,574,003 people were living in Chile. Since 1990, the rate of population growth has been decreasing due to a decline in the birth rate. By 2050, it's predicted that there will be about 20.2 million people living there. Greater Santiago, which has an urban population of 85% of the total, is home to 40% of the country's residents. The largest agglomerations, as determined by the 2002 census, are Greater Santiago, with 5.6 million residents, Greater Concepción, with 861,000, and Greater Valparaíso, with 824,000 [2].

Over the past few decades, health spending has increased significantly while life expectancy has increased across the country. According to international standards, Chile has also raised the requirements for the approval of generic medications. Chile's public health issues would strain any health system despite all of these efforts, and there are still problems to be solved. This Assessment examines important issues Chile must deal with to guarantee a fruitful and effective pharmaceutical industry, with a particular focus on two key areas.

1. Processes for registering medicines should be improved.
2. Generics should be interchangeable and bioequivalent [3].

On the one hand, the Pan American Health Organization (PAHO) considers Chile's drug regulatory agency (ISP, Instituto de Salud Pública), which evaluates the efficacy, safety, and quality of medications, to be a reference NRA and has assigned it a level IV National Regulatory Agency rating.

But like any NRA, ISP might experience difficulties performing its duties. Chile must specifically satisfy patient demands for faster access to novel medications and business demands for quick market entry. It is necessary to have a successful and efficient marketing approval procedure to guarantee that medicines are promptly available on the market. The necessary regulatory framework, human and technical capacity, and other resources must be in place to ensure the quality, safety, and effectiveness of medicines that are introduced to the market. Resources and capacity constraints can be major roadblocks and may exacerbate the backlogs in the processes for approving new medicines. Making sure that technical resources are utilized effectively is essential.

On the other hand, the generic drug market presents significant challenges for Chile as well. For instance, confusion over the definition and quality of generic drugs prevents a greater uptake of these medications, and many producers do not follow the bioequivalence requirements outlined in the most recent Law on Pharmaceuticals (2014). The Assessment provides a description and evaluation of Chile's generics laws with special attention to the terminology for multisource drugs and the current therapeutic equivalence standards. Examples of other nations' approaches to



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managing generics and approving pharmaceuticals are given, which may offer thoughts and recommendations for enhancing Chile's regulatory policies and procedures.

These include developing, maintaining, and distributing a list of interchangeable multisource products, amending relevant regulations to harmonize terminology with local and international standards, and implementing strategies to further promote prescribing by INN. The execution of public health policies needs to be closely examined to help achieve these important policy goals. To ensure rapid and widespread change, Chilean stakeholders must also be actively involved in the process. The note also offers suggested short- and medium-term timelines, accountable parties, and progress milestones to help implement the suggested policy actions. These policy actions are further explained at the end of each chapter.

The implementation of public health policies must be carefully scrutinized to support the achievement of these important policy objectives. Chilean stakeholders must also be actively involved in the process to ensure that change occurs quickly and broadly. The note also offers suggested short- and medium-term timelines, accountable parties, and progress milestones to help implement the suggested policy actions. These policy actions are further explained at the end of each chapter.

### **The Chilean Health System**

According to the Organization for Economic Cooperation and Development, Chile has made significant progress toward a well-functioning health system and public health architecture over the last few decades. Chile has been able to achieve a level of quality of life that is comparable to the OECD average in terms of the overall health status of the population while also significantly improving key health indicators. (OECD, 2018) [5] Chile's average life expectancy, for example, has increased 17 years faster than the OECD average over the last 40 years, a difference of ten years. Women were 76.5 years old in 2015, while men were 79.1 years old. The average life expectancy in the OECD is 80.6 years; for men, it is 77.9 years, and for women, it is 83.1 years (OECD, 2019). Furthermore, while most OECD countries had achieved full universal health coverage by the 1970s and 1980s, Chile had not.

In Chile, access to healthcare has increased by 6.5% over the past ten years, but a significant portion of the population—around 8% in 2015—remains unmet in terms of needs, compared to an average of 2% globally. (OECD, 2017) [6]. Between 2009 and 2016, real health spending per person increased by 5.9%, which is significantly higher than the 1.4% OECD average. Even though this is the case, health spending per person in 2016 was 1,977 USD PPP, less than half the OECD average of 4,003 USD PPP and in line with GDP levels. In addition, Chile's health expenditures as a percentage of GDP are lower (8.5%) than the OECD average (9%) (OECD, 2017). In the interim, the majority of household out-of-pocket expenses are still used to pay for healthcare<sup>1</sup>. Out-of-pocket costs make up 32% of all health spending in Chile, which is 50% more than the OECD average (OECD, 2017).

A mandated insurance requirement, employee contributions set at 7% of payroll income, and a set of basic benefits that are guaranteed make up Chile's healthcare financing system. Outside of the basic package, Chileans have a varying selection and quality of health care services available to them. Medical care is paid for by Institutions of Health Provisional, a private insurance program, or Fondo Nacional de Salud, also referred to as FONASA<sup>7</sup>, the government-funded National Health Fund (ISAPRE). About 78% of the population is covered by FONASA, 17% to 18% by ISAPRE, and the remaining 3-4% by the Armed Forces insurance program. High earners typically fall under ISAPRE, while FONASA protects the vast majority of the population. ISAPREs compete in an unregulated market, selecting low-risk enrollees and varying the premiums they pay, despite recent improvements (such as the elimination of age- and gender-based price discrimination).

Chile's healthcare system includes both public and private medical services. Employees must pay a mandatory contribution equal to a set percentage of their salaries to both healthcare systems to participate. Estimates show that the public system covers 75.2% of beneficiaries, the private system 18.5%, and other healthcare systems 6.3%. FONASA contributors have the option of receiving care from a private provider with a co-payment or from the

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public system. In addition to FONASA, the government organizations tasked with safeguarding population health, developing and implementing public health policies, and enhancing Chileans' health status include:

The Ministry of Health establishes health policies and oversees the operation of the healthcare system. The Ministry is divided into two Under secretariats:

- The Public Health Under-secretariat; and
- The Healthcare Networks Under-secretariat [9]

By carrying out regulatory duties to ensure access, quality, and long-term population health improvement, the Under-secretariat of Public Health defends the right to health of every Chilean. Hospitals and primary care networks are two examples of healthcare networks that are governed and managed by the Under-secretariat of Healthcare Networks [8] Within the framework established by the national authorities, regional health authorities (Secretarías Regionales Ministeriales, SEREMI) in Chile conduct and coordinate epidemiological surveillance and outbreak responses, safeguard populations from environmental risks, and guarantee adherence to national health standards, plans, programs, and policies.

The Laboratory Examinations, Quality Control, and Marketing Approval of Medicines, Medical Foods, and Other Sanitary-Controlled Goods are handled by the Institute of Public Health (Instituto de Salud Pública, ISP). Along with managing medical labs, approving and registering pharmaceuticals and other products, and monitoring and reporting antimicrobial resistance surveillance to the Ministry of Health, the ISP is also in charge of these tasks. The National Medicines Agency (ANAMED), which is part of ISP, handles a lot of these responsibilities [10]

The majority of Chile's public pharmacies and other healthcare providers have access to medications and medical supplies thanks to the Central Nacional de Abastecimiento (CENABAST) organization. Hospital equipment procurement is governed by Chile Compra, the online system for public institutions run by the Ministry of Finance. The Superintendency of Health (Superintendencia de Salud) monitors healthcare providers' compliance with accreditation requirements as well as social security institutions' legal and financial obligations.

**Market Overview**

Pharmaceutical products are defined as "any substance, natural or synthetic, or a mixture of both, intended for human consumption for the healing, attenuation, treatment, prevention, or diagnosis of diseases and their symptoms, to modify physiological systems or states of mind for the benefit of the person to whom it is administered" in Supreme Decree 3/2010, Section 7. The following criteria will be used to classify pharmaceutical products for this survey:

- Over-the-counter (OTC) medications are those that are sold directly to the public without a doctor's prescription.
- Prescription-only medications (POM): pharmaceuticals that may only be distributed to customers who have a current prescription

**Prescription-only medicaments (POM) will be categorized as follows**

- **Brand-name medications:** pharmaceuticals sold by the research facility that holds the corresponding patent.
- After a patent has expired, **copycat medications** are pharmaceuticals that are sold by a different lab than the one that originally developed the drug. These goods are offered for sale under an alternative brand to the original.
- Medications that are marketed using their chemical name or primary pharmaceutical ingredient are referred to as "**generics**," also known as "generic drugs." Bioequivalent products, which are medications whose Clinical evidence of a therapeutic effect is established and approved by a suitable body, are included in this category.
- **Private labeled medications** (also known as a private labels) are those that are marketed by pharmacies. It includes medications that are mass-produced or under prescription in pharmacies' laboratories [11].



**Rohit et al.,****Pharmaceutical Market Size**

Chile accounts for 3% of sales in Latin America and has a 0.14% market share worldwide. Around 1.2% of the country's GDP is accounted for by the drug trade in Chile. IMS Health estimates that Chile's pharmaceutical market generated US\$ 2.400 million in sales in 2015, a 12.4% increase from the year before. Out of them, institutional sales—to private hospitals and clinics as well as the public sector—accounted for the majority of the remaining funds, while retail sales made up US\$ 1.600 million (mostly to pharmacies). Instead of an increase in volume over the past few years, the retail market has grown due to the introduction of new products and presentations as well as price increases. Prices have increased primarily due to higher costs, new regulations, and an increase in currency exchange rates. Notably, because more than half of medicines, as well as the majority of the chemical components used in domestic production, are imported, the prices of medicines are extremely sensitive to changes in exchange rates. Despite the aforementioned, generic drugs have acted differently lately. Price and volume have contributed less to the market's expansion than volume.

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**Total Pharmaceutical Retail Sales**

In terms of volume and value, prescription-only medicines (POM) make up nearly 65% and 77%, respectively, of all retail sales. Keep in mind that prescription-only medications usually cost more than non-prescription items (OTC). Almost half of all retail sales are accounted for by the top 20 therapeutic classes or categories of drugs (out of a total of 266), based on a study produced by the Ministry of Economy.

In Chile, the top-selling prescription-only medications (POM) are

1. Antiepileptic medications (3.1%)
2. Non-steroid anti-rheumatic drugs (4.4%),
3. Contraceptive hormones (8.3%),
4. Antidepressants (4.4%).

**Bestsellers among over-the-counter (OTC) items include**

1. Skincare items (23.3%)
2. Antipyretics and non-narcotic painkillers (9.8%) as well as
3. Flu medications (50.8%)

The three main product categories for 2014, according to IMS Health, are traditional chronic illnesses, women's health, and semi-chronic illnesses. Each person only spends an average of US\$82 per year on medications, according to the same report. Even though it is anticipated to rise in the coming years, Chilean spending per capita is lower than that of Argentina (\$123) and Brazil (\$110), and quite far from that of Europe (\$800) and the United States (\$1.042). [13] The most recent National Health Survey shows that medication accounts for 55% of all household health out-of-pocket spending. In low-income households, this percentage rises to 67.6%. The same survey shows that this most recent group uses more medication than high-income households. The sales of drugs exhibit a strong seasonality, with a volume increase of twofold during the fall and winter, which is worth mentioning (March to September).







## Health Overview of Chile

### Health and demographic indicators for Chile

According to World Health Organization (WHO) statistics from 2016, Chile's life expectancy has increased significantly over the last ten years, reaching 80.5 years in 2015 (the second highest in the Americas, after Canada), in line with Chilean health spending growth and improvements in access to higher quality healthcare. In addition, the country has the fifth-lowest child mortality rate in the Americas and the fourth-lowest maternal mortality rate (22 per 100,000 live births) (8.1 per 1,000 live births) [14]

Despite the aforementioned, Chile exhibits several risk factors for the four major non-communicable diseases,

1. Chronic Respiratory Diseases,
2. Cancer
3. Diabetes,
4. Cardiovascular Diseases.

The World Health Organization (WHO) estimates that each person in Chile consumes 9.3 liters of alcohol annually, which is roughly 50% more than the average for the world. Chile still has the second-highest rate of tobacco use (38%) in the Americas, even though the prevalence of tobacco use has decreased as a result of tax increases and anti-smoking campaigns.

Furthermore, the prevalence of obesity and overweight in Chile is rising, with women and children being particularly affected. According to an FAO-PAHO report, with 63% of the population overweight in Latin America and the Caribbean, Chile has the third-highest percentage of adult overweight people. Chile is the top-ranked country in Latin America and the sixth-highest country globally when it comes to childhood obesity and overweight. Recent government initiatives (such as campaigns to promote healthy lifestyles and control the labeling and advertising of unhealthy food products) are meant to change this, but the results are still hardly discernible [15]. It is important to note that Chile's rapidly increasing elderly population can be attributed to low birth and mortality rates. Nearly 22.3% of the total population is under the age of 14, 68.1% is between the ages of 15 and 64, and 9.6% is 65 or older. By 2044, it's expected that the older population will account for 20.8% of the total.

### Health Spending

Chile had the highest health spending of any OECD country in 2015 (at constant prices), totaling US\$ 28.730 million, according to OECD statistics. The primary cause of this growth was an almost doubling in government spending over the previous five years. Regarding this, the state's involvement in the delivery of healthcare and medications has increased as a result of Healthcare reform and sector investment in Chile [16]. Despite this, Chile's per capita health expenditure in 2014 was the fifth lowest and roughly half the OECD average, at US\$1.750 versus an OECD average of US\$3.440. However, compared to an OECD average of 8.9%, health spending as a percentage of GDP was 7.7% in 2015. (Capital expenses not accounted for. Chile is the OECD country with the third-highest share of out-of-pocket costs, with direct household out-of-pocket spending accounting for one-third of all health expenditures in 2013, despite a slight decline since 2009 [15])

### Drug Marketing Authorization in Chile [19]

All Chilean pharmaceuticals require marketing authorization from the Chilean Institute of Public Health (ISP). To sell and distribute their medications in Chile, all pharmaceutical producers and businesses that sell pharmaceutical products are required to submit a marketing authorization request to the ISP. Applications for marketing authorizations were handled using one of three procedure types up until the first half of 2019: ordinary, simplified, or abbreviated [18]. The majority of new drugs seeking marketing authorization (i.e., products with a new active ingredient) adhere to the established procedure (Ministry of Health, 2011). To prove the new product's efficacy and safety, an informational dossier with data from pre-clinical and clinical trials must be submitted. Merchandise subject to customary procedure marketing authorization decisions must be made within six months (Ministry of Health, 2011) [17]. On the other hand, the streamlined procedure is typically applied to generic drugs, "similar" medications, and extensions of indication and formulation. According to DS No. 3/2010, unless the ISP determines otherwise, data from pre-clinical and clinical trials, as well as original data on safety and efficacy, are not required to



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be submitted for copies of originator medicines evaluated using the streamlined procedure. In less than 180 days, products that go through streamlined processes should be approved for marketing. Manufacturers must provide relevant bioequivalence studies and demonstrate therapeutic comparability with the original medication for some active substances that have been "listed" by the ISP (Ministry of Health, 2011). To demonstrate the efficacy and safety of pharmaceutical products that have undergone extensive testing, applicants may submit a literature-based submission.

Last but not least, Article 51 of DS No. 3/10 outlines a streamlined procedure (proceso de Registroabreviado). The majority of the products that will be used in Ministry of Health programs will go through this fast-track-like mechanism. This process takes less time—no more than four months—and is identical to both the standard and the simplified procedures (depending on the application) (Ministry of Health, 2011). Products that qualify for the expedited marketing authorization process include the following:

The National Formulary, and Ministry of Health (MINSAL) program, or both (corresponding to a list of mandatory medications).

To further shorten the time it takes to approve new medicines, the ISP has proposed an amendment to DS No. 3/2010 in addition to the current expedited registration procedure (proceso de registroabreviado). The current proposal would create a new accelerated registration procedure (proceso de registroacelerado) to shorten the amount of time it takes to evaluate medications that meet one (or more) of the criteria below.

It is the first biosimilar or generic drug to be approved by the FDA and EMA, and it has already entered the market. The National Supply Center (CENABAST), by MINSAL's programs, must supply the nation's public health system. is mandated by the Ministry of Health (because medicine is a component of MINSAL's technical standards and health programs, it is relevant to public health).

Decree No. 54 of November 7, 2019, amended Ministry of Health Decree No. 3 of 2010 to establish guidelines for an accelerated registration procedure for medicines that already have a favorable health registration with another strict Medicines Regulatory Agency. The ISP has also requested a priority evaluation process for goods that are thought to represent therapeutic innovations based on encouraging preliminary research findings for the treatment of serious or life-threatening conditions (such as Phase I and II trials). The ISP has a specific application format for each procedure, which can be submitted online via the "GICONA" system. The general steps in this process are listed below and depicted in Figure.

### Marketing Authorization Procedure

**Acceptability** - Before an application is submitted, the dossier's completeness is evaluated. Ten days is the maximum amount of time for this procedure. If all requirements are satisfied, an admissibility minute is issued within five days.

**Submission** of an admissible application signifies that the application has been formally received for review.

**Evaluation:** Each piece of the submitted information is evaluated separately in terms of quality, safety and efficacy, legality, and administrative requirements. Several components make up the evaluation phase:

**Process validation**, quality, bio-equivalence (for a streamlined procedure for listed generic medicines), and legal considerations are all up for review. Evaluation: Each piece of un submitted information is evaluated separately in terms of quality, safety and efficacy, legality, and administrative requirements. Several components make up the evaluation phase:

Quality, legal issues, bio-equivalence (for a streamlined procedure for listed generic medications), and process validation are all evaluated. A knowledgeable staff member of the Pharmacology Society (an outside expert) **evaluates** data on safety and efficacy gathered during clinical trials for new medications.

The Bioequivalence and Therapeutic Equivalence Unit evaluates the bioequivalence study for "generic" medications that must show bioequivalence, and the Process Validation Unit evaluates the findings.

The Quality & Pharmaceutical Equivalence Unit for non-biological products and the Biological Products Unit for biological products evaluate the quality of all medications.



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The ISP's Legal Advice Unit evaluates compliance with the administrative, legal, and regulatory requirements outlined in DTO 3/10 that govern pharmaceutical product marketing. These requirements include WHO registration or certification, drug manufacturing plant authorization, and Good Manufacturing Practice (GMP) certification.

**In the following evaluation, evaluators produce technical reports**

The Evaluation Commission meets to evaluate each of these technical reports. This group evaluates safety and effectiveness data and makes recommendations for acceptance or rejection. The committee is made up of four outside experts who are either pharmaceutical chemists or surgeons with training in pharmacology, surgery, or academia, including the director of the National Medicines Agency (ANAMED), members of the marketing authorization sub-department, clinical trials department, new products department, pharmacovigilance, and the ANAMED's scientific advisor. (Chilean Institute of Public Health, 2012). Every month, the committee meets to discuss the technical reports produced by the people who evaluate new medications. Members of the working group and outside experts make up the committee. Once a week, experts from the Pharmaceutical Registry unit get together to discuss technical evaluation reports made for other products. The Evaluation Commission publishes meeting minutes following each meeting. The recommendations in this minute, which have been accepted by the head of the Marketing Authorization subdivision (Jefatura de subdepartamento de Autorizaciones y Registro Sanitario) and confirmed by the head of ANAMED, form the basis for the decision.

If a product is rejected at the Evaluation Commission meeting, a decision known as a "Probationary Term" is made, and the applicant is given six weeks to provide more information. If the applicant fails to provide this information or does so in an unacceptable manner, the application will be rejected. The application might be given another look if the applicant provides this information [19]. Resolution and Registration - If the application is accepted and after the evaluation, approval conditions are set, and the product is registered with a special identification number.

**Resources for reviewing applications for marketing authorization; [19]**

The National Medicines Agency, or ANAMED, is in charge of evaluating medications and obtaining marketing authorizations for the ISP (See Annex B).

- Seven staff departments make up the organization:
- Only one administrative division
- Six departments of technology and science

It has 195 employees. Currently, 45 employees review requests for drug marketing authorization.

The personnel include:

- 14 evaluators who are in charge of judging the technical, administrative, and safety standards (seven for novel molecular entities and seven for generic drugs);
- 14 quality-control evaluators, seven of whom are in charge of biologic products and seven of whom are in charge of non-biologic products (new molecular entities and generic drugs);
- 6 evaluators who are in charge of determining bioequivalence;
- 5 assessors in charge of process validation;
- 6 employees who have legal backgrounds;
- 6 outside experts (associates of the assessment commission);
- Outside experts, such as doctors and pharmacists from the Chilean society of pharmacy

**Registration of Pharmaceutical Products**

The national health authority's prior authorization should be required for pharmaceutical products. The Sanitary Registry of Pharmaceutical Products (also known as the "Registro Sanitario de Productos Farmacéuticos") is a special registry within the Institute of Public Health where they must be registered. The patent registration of a drug and/or other characteristics of a pharmaceutical product is not related to this sanitary registration (presentation, formulas, production processes, etc.). When sanitary registration is granted, neither a request for patent information on a new drug nor a verification of that information is made.



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It should be noted that while FDA or EMEA approvals from international agencies provide a solid foundation for the registration process, they do not obviate or bypass it. Pharmaceutical product registration applications submitted to the Sanitary Registry must adhere to a specific process. General data, technical data, pharmaceutical quality data, safety and efficacy data, and general data are typically included.

In the following circumstances, the registration process is streamlined:

- Products delivered through the same route of administration, with the same active ingredients, as already-registered products
- Products with adequate descriptions of their adverse reactions in the scientific literature, as well as descriptions of their active ingredients, efficacy, and user safety.
- Products with active ingredients that must adhere to a list of standards to prove their therapeutic equivalence and that they are pharmaceutically equivalent to another product that has already received registration
- Goods produced in Chile with the sole intention of being exported.

The Institute of Public Health's online GICONA system or on paper are both acceptable methods of registration, information and document submission, and payment of any associated fees [20]

A new pharmaceutical product's registration procedure typically takes six to eighteen months. The cost of registration ranges from \$2,500 to \$3,500 depending on the product [21].

#### **Labeling for bioequivalent products: Important Factor**

When it comes to quality, efficacy, and safety for patients, generic or comparable products with active ingredients from a predetermined must be listed, as of 2012, prove this through the use of relevant studies and strict procedures. The Institute of Public Health has recognized 1.458 products as bioequivalent as of this writing. Products should have a specific logo and text on their secondary packaging if they are bioequivalent [22]. At least four of the six major sides of the packaging's underside should have the logo printed on them, taking up at least 20% of the surface area. See the illustration below: According to the relevant Harmonized System (HS) code chapters, the pharmaceutical products listed in the import and export statistics are [23].

#### **Imports by country: India [23]**

Imports of pharmaceutical products are quite dispersed geographically, coming from 74 different nations. The top two importers in 2017 (in terms of CIF value) were the United States (14.5%) and Germany (12.3%), which accounted for 63.9% of all imports. As the primary countries of origin for pharmaceutical imports over the past five years, both nations have maintained their positions. In 2017, India's imports totaled \$71.5 million, a notable increase of 30.7% from the previous year. India rose from position 7 to position 5 in the 2017 list of Chilean import countries of origin for pharmaceuticals. On the other hand, Brazil, Venezuela, Mexico, Colombia, and Chile are the countries that receive the most Indian pharmaceutical exports to Latin America. Except for 2016 (-2.2%), when imports from India decreased sharply, they have steadily increased over the past five years, mirroring the trends in Chile's pharmaceutical imports that have been on the decline. In terms of product type, the majority of pharmaceutical imports from India in 2017 were finished goods that fall under HS chapter 30.4 (91.4%), reflecting the rising trend of value addition by Indian exporters. The second-highest import category, HS chapter 30.02 (3.3%), which primarily consists of vaccines, has increased by 2.5 times over the previous five years. The graph is below.

#### **Imports by Company**

Pharmaceutical products were imported by nearly 725 Chilean businesses and natural persons in 2017, indicating a fairly fragmented overall market. Around 42.8% of all imports were accounted for by these ten importers. In total, 66 companies and natural persons imported medicines from India in 2017. However, Laboratorio Hospifarma, Ascend Laboratories Recalcine, and Opko Chile owned roughly half of them collectively. Generics matched imports in every case. Dr. Reddy's Laboratories, Lupin, Ranbaxy, Torrent, Celofarm, Glenmark Pharmaceuticals, and IPCA Laboratories are among the Indian companies with local production facilities in Argentina, Brazil, and Mexico. Given that some of these Latin American companies export, it's possible that some of their imports into Chile aren't recorded as coming from India.



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Pharmaceutical exports from Chile over the past five years have not been very significant, making up only one-sixth of all imports and roughly 1.1% of all drug production in Chile. Saval, Laboratorio Chile, and Recalcine (owned by Abbott) were the primary regional labs that exported goods in 2017. Chile exported the majority of its pharmaceutical products to countries in Latin America. The main ones were Bolivia, Equator, and Peru. The majority of exported goods were pharmaceuticals, which fall under HS chapter 30.04.

**Procedures for Imports**

Chilean Customs requires that the following documents be submitted with each customs entry for any import:

- Commercial Invoice - Origin Certificate
- ITD (International Transport Document) (Bill of Lading or Air Way Bill)
- when necessary, a packing list; a value declaration
- Additional Documents (i.e. safety certificates)
- Every import valued at more than USD 1,000 (FOB) requires the assistance of a customs broker. A streamlined procedure allows importers to clear minor imports worth less than \$1,000 FOB directly.
- Authorities do not request prior import licenses. This holds for all kinds of goods.

**Patents on Pharmaceutical Products**

The patentability of pharmaceutical drugs is governed by Law 19.039/1991 and its subsequent amendments. Chile's intellectual property legal framework was now by TRIPS (the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights).

Chile also adopted the Patent Cooperation Treaty (PCT) system in 2009, which makes it easier to file patent applications abroad. By filing a single international patent application, applicants can simultaneously request protection for a pharmaceutical product in 148 different countries [24]

**Opportunities**

- The overall market is anticipated to keep expanding in the years to come.
- Possibilities for generic drugs that exhibit bioequivalence.
- Generic drug opportunities for which bioequivalence is not necessary.
- Rapid growth of specialty stores and food services.
- Government spending has increased for social programs (e.g., vaccines, Ley Ricarte Soto).
- Natural products and Ayurvedic medicines.

**CONCLUSIONS**

It is anticipated that the generic drug segment will continue to dominate the Chilean pharmaceutical market. In line with the recent economic slowdown, Chilean consumers will increasingly prefer less expensive medications. Given that elderly people typically have lower disposable income and higher medication consumption, the aging of the Chilean population will also help to increase the demand for generic drugs. As a result, generic products have great potential. Indian manufacturers ought to be able to provide all the technical data and lab analysis required for medications containing the active ingredients covered by the Chilean bioequivalence regulation. It's even possible that importers will demand that manufacturers in India contribute a portion of the cost associated with carrying out the bioequivalence certification process. Since generic medications are exempt from the bioequivalence proof requirement, restrictions are less stringent in this case. However, importers must follow good manufacturing practices and use premium ingredients and packaging to receive product registration and sale authorization from the Institute of Public Health.

There are also advantageous opportunities in the context of government purchases, given that public health spending is anticipated to rise in the upcoming years. Because some of the biggest Chilean laboratories produce their pharmaceutical ingredients, Indian exporters have the opportunity to sell these products. Not to mention, the rapidly



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growing preference for a natural lifestyle among Chilean consumers will drive up the price of natural products like food, herbal remedies, and vitamins. In this regard, the Indian medical system of Ayurveda has a bright future in Chile. Even though the majority of Chileans are still ignorant of it, ayurveda is growing in acceptance. This is primarily because it is inexpensive and has few side effects.

## ACKNOWLEDGEMENT

This study was supported by JSS College of Pharmacy, Mysuru. We thank our colleagues from the Regulatory Affairs department who provided insight and expertise that greatly assisted the study, although they may not agree with all of the conclusions of this paper. We would also like to show our gratitude to Dr. Balamuralidhara V. Associate Professor -Department of Pharmaceutics JSS College of Pharmacy, Mysuru for sharing their pearls of Wisdom with us during the course of this research.

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**Table 1. Resources for reviewing applications for marketing authorization**

Country	NRA	MA Validity	MA Approval Time per Regulation	Applicable Regulations
Chile	ISP	5 years	180 days	D.S. 3 Norma Técnica N° 131
Mexico	COFEPRIS	5 years	180 days	NOM-177-SSA1-2013 Regulation of Health Products (RIS)
United States	FDA	No cap, but MA maintenance costs are yearly	180 days (generics & priority review) (generics & priority review) 300 days (standard review)	21 CFR 320 21 CFR 314 MAPP 5241.3
European Union	EMA	5 years	210 days (150 days accelerated assessment)	Directive 2001/83/EC- Procedures for the marketing authorization Regulation (EC) No 1394/2007
Australia*	TGA	No cap, but MA maintenance costs are yearly	255 days	Therapeutic Goods Act 1989- Therapeutic Goods Regulations 1990

**Table 2. Labeling for bioequivalent products: Important Factor**

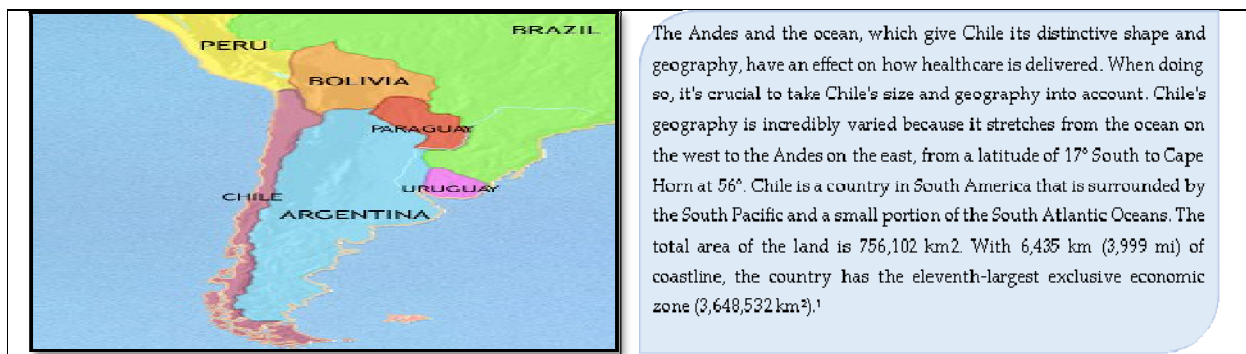
Chapter	Description
Chapter 30.01	Heparin and its salts, other human or animal substances for therapeutic or preventative purposes, glands and other organs (extracts, secretions) for use in organotherapeutics, dried, powdered, or not
Chapter 30.02	Human blood, antisera, other blood fractions, immunological products modified by or obtained through biotechnological processes, vaccines, toxins, cultures of microorganisms (other than yeasts), and so on are all examples of blood used for therapeutic, preventive, or diagnostic purposes.
Chapter 30.03	Medicines; not in dose measurements, forms, or retail packaging; not products classified as 3002, 3005, or 3006; combining two or more constituents for therapeutic or preventive use.
Chapter	Medication; (not items falling under headings 3002, 3005, or 3006) consisting of mixed or unmixed



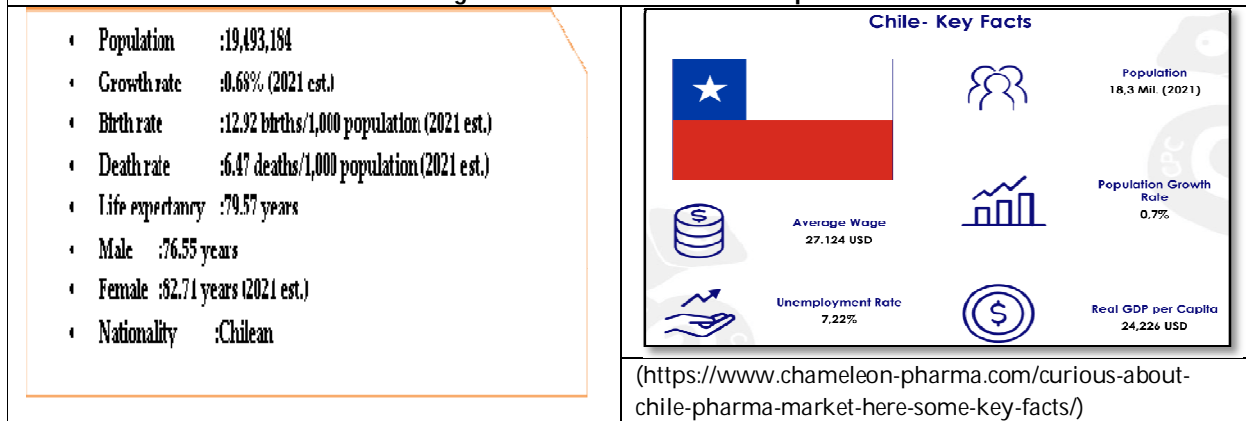


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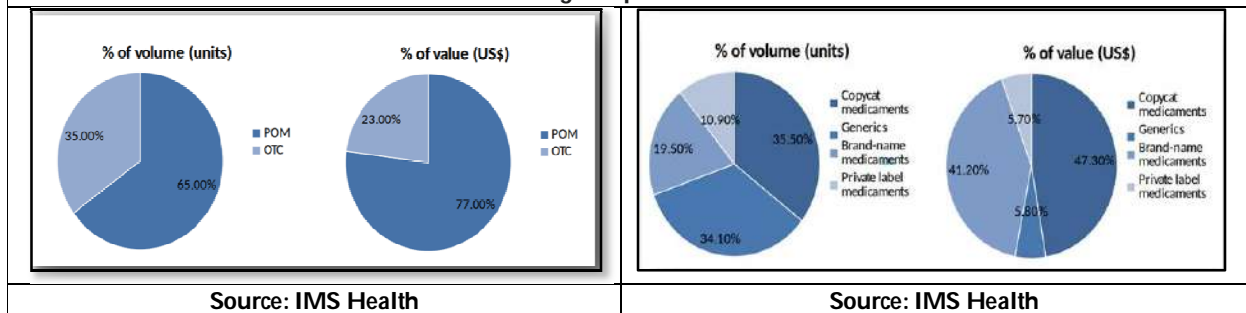
<b>30.04</b>	products for therapeutic or prophylactic use, administered in measured doses, including those in the form of transdermal administration systems, or packaged for retail sale
<b>Chapter 30.05</b>	Medication (excluding items falling under headings 3002, 3005, or 3006), consisting of combined or uncombined products for therapeutic or prophylactic use, administered in measured doses, including those in the form of transdermal administration systems, or packaged for retail sale.
<b>Chapter 30.06</b>	prescription drugs



**Fig.1.The Pharmaceutical Landscape**



**Fig.2.Population**



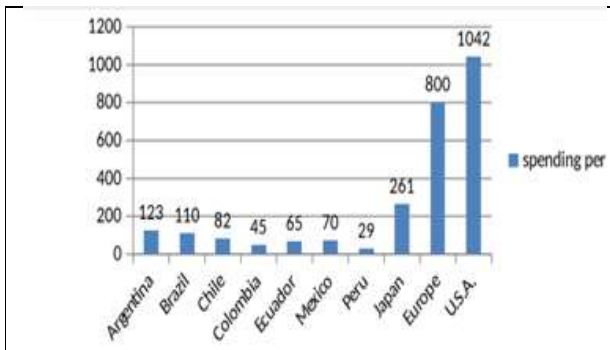
**Fig. 3. Total Pharmaceutical retail sales**



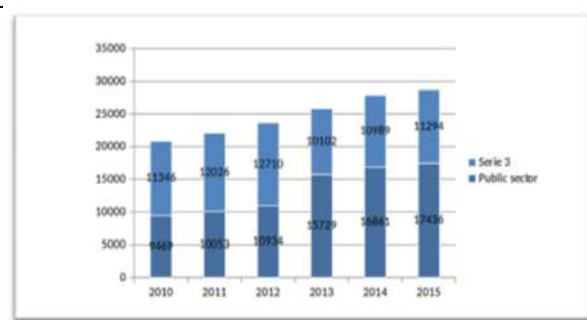




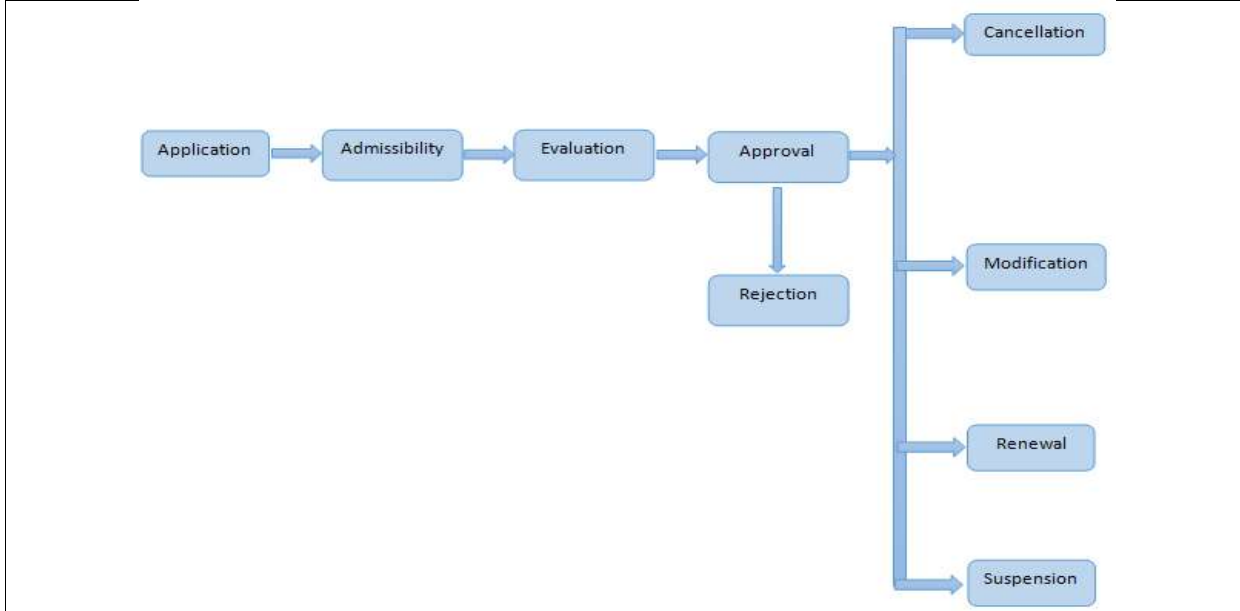
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**Fig.4. Medicament spending per capita per year**  
Source: IMS Health, World Review, Cartagena 2012



**Fig.5. The Health total expenditure – Private and Public (in US \$ million)(Source- OECD Statistics Database)**



Source- ISPL official, website

**Fig.6. Marketing Authorization Procedure**



**Fig.7.** <https://www.semanticscholar.org/paper/Strategies-and-Steps-for-the-Accomplishment>

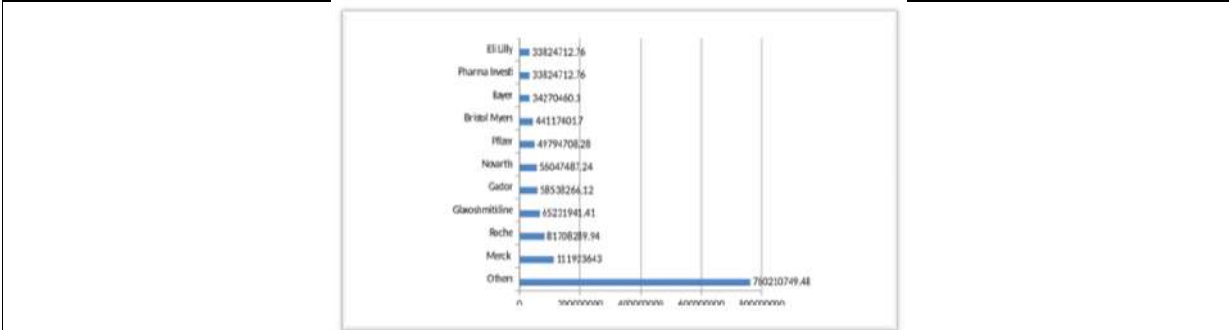


**Fig. 8.** Source: [https://www.oecd.org/economy/surveys/CHL\\_OECD\\_policy\\_actions\\_affordable\\_and\\_accessible\\_pharmaceuticals.pdf](https://www.oecd.org/economy/surveys/CHL_OECD_policy_actions_affordable_and_accessible_pharmaceuticals.pdf)





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**Fig.9. Source- Pharmaceutical Imports by Company – 2017 (CIF Value)- In M(US\$)**





## Pharmacognosy, Phytochemistry and Pharmacological Properties of *Albizia odoratissima* : Review

Gudi Jagadeesh<sup>1</sup>, Kanala Somasekhar Reddy<sup>2\*</sup>, Lingam Srikanth<sup>1</sup>, Akkiraju Sudheer<sup>3</sup> and Vijay R Chidwar<sup>4</sup>

<sup>1</sup>Research Scholar, Raghavendra Institute of Pharmaceutical Education and Research (RIPER) – Autonomous, Anantapur, Andhra Pradesh, India.

<sup>2</sup>Associate Professor and Head of Pharmacology Raghavendra Institute of Pharmaceutical Education and Research (RIPER) – Autonomous, Anantapur, Andhra Pradesh, India.

<sup>3</sup>Associate Professor, Raghavendra Institute of Pharmaceutical Education and Research (RIPER) – Autonomous, Anantapur, Andhra Pradesh, India.

<sup>4</sup>Professor, Raghavendra Institute of Pharmaceutical Education and Research (RIPER) – Autonomous, Anantapur, Andhra Pradesh, India.

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### \*Address for Correspondence

#### Kanala Somasekhar Reddy

Associate Professor and Head of Pharmacology,

Raghavendra Institute of Pharmaceutical Education and Research (RIPER) – Autonomous,

Anantapur, Andhra Pradesh, India.

E.Mail : somu.reddyvaru@gmail.com



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### ABSTRACT

Herbal medicines derived from plants are used in traditional medicine and are a great source of modern bioactive compounds. *Albizia odoratissima* (L. f.) *Bentha* member of the Fabaceae family is one of the significant plant among them. Large portions of China, Bhutan, Vietnam, Thailand, Bangladesh, Laos Myanmar, Nepal, and Sri Lanka, where it is known as Ceylon rosewood, and India, where it is known as Kali siris or black siris are its native countries. It was located in plains and dry deciduous woodlands. A crude extract of the leaves and bark reveals the presence of carbohydrates, phytosterols, tannins, lipids, glycosides, phenols, fixed oils, flavonoids, alkaloids, triterpenoids, and saponins. Flavone derivatives such as 7,8-dimethoxy-3',4'-methylenedioxyflavone 7,2',4-trimethoxy- flavone 7,4'-dimethoxy-3'-hydroxyflavone were found. Effective pharmacological properties like antimicrobial, hepatoprotective, antioxidant, and anti-diabetic activity have been reported for it. It is used in treating hyperglycemia, rheumatism, bronchitis, erysipelas, rheumatoid arthritis, and burning sensations. Commercially it is utilized as fodder, gums, and fuel. This review mainly focuses on the overview of the pharmacognostic features, phytochemistry, and pharmacological activities of extracts from *Albizia odoratissima*.

**Keywords:** *Albizia odoratissima*, Antimicrobial activity, rheumatism, saponins, phytochemistry





## INTRODUCTION

Medical plants are considered to be an essential resource in the treatment and prevention of a variety of diseases [1]. Every plant has a variety of vital elements that are important to the medical field and can be used to create different kinds of drugs [2]. Plant-derived substances have recently attracted a lot of attention because of their numerous applications as a rich bio-resource of drugs for traditional systems of medicine, pharmaceuticals, food supplements, herbal remedies, alternative therapies, contemporary medicine, nutraceuticals, and chemical substances for synthetic drugs[3]. These are crucial components of India's native healthcare system that are both very beneficial and significant. Ayurvedic medical systems, which strongly emphasize bioactive substances, have recently gained importance on a global scale[4]. A huge population relies on herbal therapy to meet their basic medical needs, which advances research on therapeutic herbs. Despite the availability of contemporary medications, plant products are favoured since they have fewer adverse effects. According to various reports, many people rely on the traditional medical system [5].

*Albizia odoratissima* is a member of the Fabaceae family (fig.1)[6]. It is native to large parts of China, Bangladesh, Sri Lanka, and India[7]. It is commonly known as Kali siris or black siris, Ceylon rosewood[8]. The genus *Albizia* (Leguminosae - Fabaceae) contains 150 species that are distributed throughout Asia, Africa, Australia, and tropical and subtropical America[9]. Some of the species are *A. subdimidiata*, *A. falcataria*, *A. myriophylla*, *A. versicol*, *A. grandibracteata*, *A. julibrissin*, *A. procera*, *A. chinensis*, *A. lebeck*, *A. inopinata*, *A. gummifera*[10]. These species are widely used to treat melancholy, insomnia, wounds, fever, abscesses, diabetes, headache, stomachache, diarrhea, cough, rheumatism, snake bite, malaria, and parasite infection in traditional and local medicine[11]. Leprosy, ulcers, and cough are all treated using the bark of *A. Odoratissima* in conventional Indian medicine. The bark is beneficial for treating skin conditions, cough, rheumatism, erysipelas, bronchitis, diabetes, and burning sensations. It is also acrid, cooling, astringent, depurative, and expectorant [12].

Alternate names include Bhusirisah (Sanskrit), Kalasiras (Marathi), Kala siris (Hindi), Kadu bage (Kannada), Karuvagai, Poovusalai (Tamil), Chinduga, Ganara (Telugu), Tinja, Sarsi tentura, Sirish, (Oria), Karivaka, Karinthakara, Kunniva (Malayalam). It was found in dry deciduous forests and also in plains, widely distributed in all districts of Kerala, and Tamilnadu. In Andhra Pradesh it was distributed in West Godavari district, Srikakulam district, Vishakapatnam district, and Kurnool district, in Karnataka only in Tumakuru district, Belagavi district, Hassan district, Mysuru district, Kodagu (Coorg) district, Udipi district, Davanagare district. Geographically it was distributed in India, Sri Lanka, Indo-China, Myanmar, West Malaysia, the Himalayas, and Thailand [13].

### Habitat and Distribution

It is a huge, erect, deciduous tree that grows quickly. It typically reaches heights of 15 to 25 meters and diameters of 120 to 150 cm[14]. Although it can survive in a broad range of soils, loamy, moist soils are its preferred environment. It grows well in regions with an average annual rainfall of 635 to 3048 mm and is found 1500 meters above sea level [15].

### Botanical Description

**Leaves:** As shown in the fig.2 [16] leaves are Bipinnate, alternating, stipulated leaves with free, lateral, and caducous stipules that have rachises that are 20 to 30 cm long.

**Bark:** It is tough, unevenly fractured, and between 10 and 15 millimeters thick and the blaze is reddish-pink.

**Flowers:** These are hermaphrodite with globose heads that form terminal panicles; peduncle is slender and pubescent; calyx tube is cup-shaped, 1-1.5 x 1-1.3mm, teeth are minute, deltoid, pubescent; corolla is broadly funnel-shaped, with 5 lobes that are ovate-lanceolate and pubescent; stamens are numerous, 1.2-2 cm long; the ovary is stipitate.





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**Fruit:** It is a pod that is 15-20 cm by 2.5–3.7 cm, is flattened, strap-shaped, with equal margins or commonly has some of the edges constricted, rounded to rostrate at the top, glabrous, usually glossy, reddish–brown to dark brown, and fine, reticulately veined.

**Seeds:** These are 6-12, oblong, orbicular, and compressed.

### Biology of Reproduction and the Breeding System

*A. odoratissima* is bisexual having a leafless season from December to February. Typically, new leaves emerge before the old ones. In northern India, March-April has fallen or shed. The blooming season lasts from March through June. Early August sees the appearance of fruits, which begin to ripen by the end of October. Flowers begin to bloom in South India in March and continue through June, usually in great profusion in April and May. The ripened pods are 13 to 30 cm long and 2.54 to 3.3 cm broad and are reddish brown in color. They contain 8 to 12 reddish-brown individual seeds. The fruits begin to form in the month of July and mature primarily in November and December[17].

### Ecology

Temperatures and precipitation can both be tolerated by this plant. The lowest shade temperature is 0 to 15 degrees Celsius, while the highest shade temperature is between 37 and 50 degrees Celsius. A 4–5-month dry season with regular rainfall ranging from 650 to 3000 mm occurs between November and March. It occasionally grows between sea level and 1,500 m in both dry and moist deciduous forest zones. When dwelling in tropical settings, the species is not gregarious. It typically grows on hill slopes and is only occasionally found in valleys. Although it cannot endure flooding, it can withstand hot, humid conditions. Seedlings and young plants are susceptible to frost[18].

### Phyto Chemical Constituents

#### Leaves

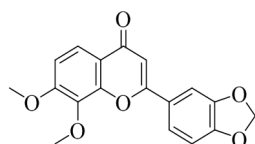
Leaves were extracted using petroleum ether and chloroform, which revealed the presence of phytosterols, glycosides, flavonoids, phenols, tannins, fixed oils & fats, and fats these carbohydrates were observed in chloroform extract. While ethanol and ethyl acetate extract yielded positive results for the presence of Glycosides, phytosterols, Flavanoids, Tannins & phenolic compounds, additionally carbohydrates were observed in ethanol extract [19].

#### Bark

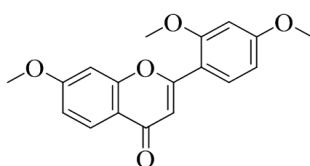
Phytochemical investigation of bark in chloroform extract reveals that the presence of Sterols, glycosides and partially alkaloids, carbohydrates were present. In petroleum ether extract sterols, and triterpenoids were present. Whereas in alcoholic extract saponins, triterpenoids, flavonoids alkaloids, carbohydrates, and tannins were present. In water extract saponins, triterpenoids, flavonoids, and tannins were present. Proteins are absent in all extracts [14].

### Derivatives of Flavones

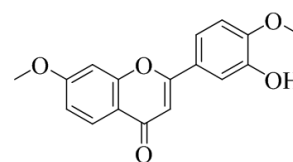
From root bark two novel 5-deoxy flavones such as 7,8-dimethoxy-3',4'-methylenedioxyflavone, 7,2',4'-trimethoxyflavone and other 7,4'-dimethoxy-3'-hydroxy flavone were isolated[20].



7,8-dimethoxy-3',4'-methylenedioxyflavone



7,2',4'-trimethoxyflavone



7,4'-dimethoxy-3'-hydroxyflavone

Thus, *Albizia odoratissima* was reported for the presence of various phytoconstituents. This review will focus on recent studies and/or updates on the pharmacological potential of *Albizia odoratissima* (Table 1).





### Pharmacological Profile

#### Hepatoprotective Activity

The current study examines the protective effect against paracetamol-induced hepatotoxicity in rats by *Albizia odoratissima* bark methanolic extract when administered at doses of 250 and 500 mg/kg. Due to the presence of phenolic compounds and flavonoids, which act as hepatoprotective agents, *Albizia odoratissima* has this effect. One of the most popular analgesics and antipyretics is paracetamol. It is regarded as the safest drug if used in therapeutic doses. Hepatotoxicity caused by paracetamol is evidenced by elevated levels of biochemical markers like ALP, total bilirubin, SGOT, total protein, SGPT, liver volume, liver weight, blood urea, blood creatinine, lipid profile except for HDL, and decreased levels of antioxidants and blood albumin in comparison to the control group [12].

#### Antimicrobial Activity, Antioxidant Activity

Ethyl acetate and methanol extracts exhibited excellent antibacterial efficacy in the micro broth dilution assay. To all pathogenic species, the leaf extracts exhibited antibacterial action. The findings of this investigation showed that *E. coli*, *K. pneumonia*, *P. aeruginosa* and *S. aureus*, *P. vulgaris* growth was inhibited by extracts of ethyl acetate and methanol. MICs for hexane and chloroform extracts ranged from 859 to 15000 mg/mL, whereas those for methanol and ethyl acetate extracts ranged from 136 to 546 lg/mL. hence, extracts from methanol and ethyl acetate showed nearly identical antibacterial efficacy against all of the microorganisms. Hexane and chloroform extracts, on the other hand, had very little to no antibacterial action.

The current study's results showed that leaf extracts have strong free radical-scavenging capabilities. There are plenty of phenolics in the four different leaf extracts as well as adequate flavonoid components. The four organic extracts of *A. odoratissima* could have the potential to decolorize free radicals. The antioxidant activity was assessed using the DPPH, H<sub>2</sub>O<sub>2</sub>, and ABTS scavenging assays. Higher quantities of polyphenols in the extract may be the cause of its antioxidant capabilities. Results indicate that the extract of ethyl acetate had higher activity than methanol, hexane, and chloroform extracts. The four *A. odoratissima* extracts were analyzed for their antioxidant potential using the FRAP (Ferric Reducing Antioxidant Power test). The ethyl acetate extract revealed the highest reducing power, according to the FRAP assay results [21].

#### Anti-diabetic Activity

The findings of this study reveal that bark extracts have a hypoglycemic impact on alloxan-induced diabetic mice, one possible mechanism of action is related to higher insulin secretion and improved glycogenesis. At concentrations of 250 and 500 mg/kg body weight, bark extract significantly reduced blood glucose levels in mice with alloxan-induced diabetes (P 0.01), as indicated by the percentage reduction in blood glucose levels (49.4% & 51.89%) on the 28th day after extract administration at both doses. The extracts were successful in reducing total proteins, SGOT, SGPT, alkaline phosphatase, triglycerides, cholesterol, and other biochemical indicators of diabetic mellitus [8].

#### Antimicrobial Activity

Only Gram-positive bacteria were susceptible to the extract, which had an inhibitory zone that ranged from 12 to 21 mm. At an 80 g/ml dose, *S. mutans* was inhibited with a maximal inhibition zone of 21 mm. No inhibitory effect of the extracts was seen against Gram-negative bacteria (*P. aeruginosa*). At the three concentrations (80 g/ml, 60 g/ml, and 40 g/ml), it was shown to be effective against the yeast *C. Albicans*, with a zone of growth suppression that had a diameter ranging from 11 mm to 18 mm. This extract can be used to control the development of yeast and Gram-positive bacteria. Ketoconazole showed a zone of inhibition of 28 mm, whereas the test antibiotic ciprofloxacin had a zone of inhibition ranging from 29 to 34 mm. Hence methanolic extract exhibited good activity against yeast and Gram-positive bacteria [22].

#### Commercial Utilization

**Tree:** As a shade tree, it has been widely grown on tea and coffee estates. Crop plant growth is enhanced by shade, which also increases annual yield. In numerous ways, it raises the production of tea and coffee.





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**Root:** The robust root system of the plant uses the subsoil moisture and nutrients that tea and coffee plants are unable to get, reducing erosion. Rhizophore of understory plants receives nutrients in the soil and organic material from leaf litter. Tree canopies prevent weed development, lessen soil desiccation, and downpours [23].

**Fodder:** The leaves of the plant provide good bovine fodder, and monkeys consume the plant's pods for food[24].

**Fuel:** Dead and damaged branches from shade trees, such as *Albizia odoratissima*, are a significant source of fuel.

**Timber:** Mature trees have rich dark brown heartwood. The high-quality wood is appropriate for furniture and paneling. Carts, wheels, farm equipment, and construction timbers are also made from it.

**Gum:** Insoluble gum from the tree is produced; it is combined with other gums and used as an extender[17].

**Medicinal uses:** In Traditional Indian medicine bark is used to treat cough, ulcers, and leprosy[22]

## CONCLUSION

Plants have gradually increased in importance as a source of biologically active compounds in recent years. The Fabaceae family includes the species *Albizia*. One of these is *Albizia odoratissima*. Phytosterols, tannins, lipids, glycosides, phenols, fixed oils, flavonoids, alkaloids, triterpenoids, and saponins are all components of it. The overview of the phytochemistry, traditional usage, and pharmacological properties of extracts from *Albizia odoratissima* is the main emphasis of this paper. From there, we concluded that there is still scope to discover potential medicinal uses.

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**Table 1: Summary of known Pharmacological activities of *Albizia odoratissima***

Plant part	Extract/formulation	Pharmacological activity	Method	Effect and mechanism	References
Bark	Methanolic extract	Hepatoprotective	Paracetamol-induced hepatotoxicity in rats	In contrast to the normal group, it is evident that there are higher levels of biochemical parameters, lower levels of blood albumin, and antioxidants, and the absence of high-density lipoproteins.	[12]
Leaves	Methanol and ethyl acetate extract	Antimicrobial  Antioxidant	Broth dilution method  Invitro assays	The MICs and MBCs of methanol and ethyl acetate extracts against <i>S. aureus</i> , <i>E. coli</i> , <i>K. pneumonia</i> , <i>P. vulgaris</i> , and <i>P. aeruginosa</i> were 136 to 546 g/ml and respectively 273 to 1093 g/ml. Due to their high flavonoid and phenolic content, leaves have strong antioxidant and free radical scavenging properties	[21]
Bark	Methanolic extract	Anti-diabetic	Alloxan-induced diabetes assay in mice	In a 28days study at doses of 250 and 500 mg/kg, the blood sugar levels were decreased by 49.4% and 51.89%, respectively.	[8]
Bark	Methanolic extract	Antimicrobial	Agar well diffusion method	The bark of <i>A. odoratissima</i> exhibits significant antibacterial activity against yeast ( <i>Candida albicans</i> ) and Gram-positive bacteria ( <i>Staphylococcus aureus</i> ,	[22]







				Staphylococcus mutants), but not against Gram-negative bacteria.	
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<p><b>Figure:1 Illustration of scientific classification of <i>Albizia odoratissima (L.f.) Benth</i></b></p>	<p><b>Figure :2 <i>Albizia odoratissima (L.f.) Benth</i></b></p>





## Overview and Comparative Studies on Cosmetic Regulatory Requirement in India and GCC Countries

Saurabh Vijay Nirmal<sup>1\*</sup>, Prakash Goudanvar<sup>2</sup>, Aashutosh Vishwakarma<sup>1</sup>, Mohammed Saleem JM<sup>1</sup> and Vedamurthy Joshi<sup>3\*</sup>

<sup>1</sup>M.Pharm Student, Department of Pharmaceutics and Regulatory Affairs, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B.G. Nagara-571448, Karnataka, India

<sup>2</sup>Professor and Head, Department of Pharmaceutics and Regulatory Affairs, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B.G. Nagara-571448, Karnataka, India

<sup>3</sup>Associate Professor, Department of Pharmaceutics and Regulatory Affairs, CORMIL and CMPAT, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B.G. Nagara-571448, Karnataka, India

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### \*Address for Correspondence

#### Vedamurthy Joshi

Associate Professor,

Department of Pharmaceutics and Regulatory Affairs,

CORMIL and CMPAT, Sri Adichunchanagiri College of Pharmacy,

Adichunchanagiri University,

B.G. Nagara-571448, Karnataka, India.

E.Mail: vedamurthyjoshi@gmail.com



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### ABSTRACT

Cosmetics are any substances that are meant to be rubbed, poured, sprinkled, sprayed, inserted into, or otherwise applied to the human body or any part of it for cleaning, beautifying, promoting attractiveness, or changing the appearance. There are many different types of cosmetics, including creams, lotions, skin-cleansing solutions, and decorative cosmetics. The import, manufacture, pre-market approval, labelling, and safety of cosmetic products are all subject to control by several regulatory organisations operating on a worldwide scale. India and the Gulf Cooperation Countries have strict laws and regulations in place to guarantee the safe usage of cosmetics. An attempt has been made to present a comparison the regulatory requirements and scenario of cosmetic products in India and Gulf Cooperation Countries.

**Keywords:** Cosmetics, Gulf Cooperation Countries, Labelling.





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## INTRODUCTION

Since ancient times, cosmetics have been used to improve the appearance of the person. Cosmetics used for beauty which can drastically alter someone's appearance, since they hide flaws and enhance their greatest traits. The Greek term "kosmtikos," which meaning to be able to organise and have a skill for decorating, is where the word "cosmetic" originated [1]. Cosmetics come in a wide variety of forms, including cream, lotions, perfumes, skin-cleansing products, and ornamental cosmetics. Early cosmetics had ties to warfare, religion, and superstitious beliefs; subsequently, they had ties to medicine [2]. The creation of newer cosmetics with a variety of features comes from the cosmetics business and the usage of cutting-edge new technology. Worldwide, a large number of regulatory agencies oversee the production and marketing of cosmetics [3]. Cosmetics are made up of mixes of chemical substances that come from either natural or manufactured sources [4]. Cosmetics are chemicals used on the human body to enhance, protect, or cover up its odour or look. Along with deodorants, they also provide baby products, bath salts, bath oils, bubble baths, finger- and toe-nail polish, lipsticks, eye and face cosmetics, permanent waves, hair colours, and hair sprays. They are frequently used, particularly by ladies in Western nations. Makeup is a term used to describe a subset of cosmetics; primarily colourful items used to change a person's appearance.

### Herbal Cosmetics

In general, natural cosmetics and herbal cosmetics are synonyms. Herbal cosmetics are created by combining one or more herbal substances with other cosmetic ingredients to create a basis that can be used to treat a variety of skin conditions. New medicinal compounds for cosmetic and pharmaceutical uses are frequently developed by using plants [5]. Products containing herbs in their raw or extracted form are known as herbal cosmetics [6].

### Example for Herbal Cosmetics

Skincare: Coconut oil, Sunflower oil, Olive oil etc.

Antiaging: Carrot, Gingko, Neem etc.

Skin Protection: Green tea, Calendula, Turmeric etc.

Dandruff treatment: Henna and Shikakai.

Hair care: Amla, Eucalyptus oil etc [7].

### Merits of Natural Cosmetics against Synthetic Cosmetics

The most recent fashion and beauty trend is herbal cosmetics. Most women nowadays choose natural products over chemicals for their personal care to enhance their attractiveness since they nourish the body, promote health, and give happiness because they are free from synthetic chemicals and have comparably less adverse effects than synthetic cosmetics. The Following are a few benefits of utilising natural cosmetics that make them preferable to synthetic ones:

Natural products: - These products replace traditional synthetic ingredients like aloe vera gel and coconut oil with a variety of plant components and plant extracts. They also include natural nutrients like Vitamin E, which keeps the skin glowing and healthy.

Safe to use: - Natural cosmetics are safe to use when compared to conventional beauty products.

Appropriate for all skin types.

Affordable.

No animal testing was done.

No negative consequences [7].

### Types of cosmetics

- i) Skin care products
- ii) Hair styling products
- iii) Tooth care products





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**Regulatory Requirements of Cosmetics in India & GCC Countries**

Cosmetics manufacturing and sales are governed by various governmental entities all over the world. Despite the fact that there are several regulatory agencies, one for each nation, their common goal is to guarantee that cosmetics have accurate labels and are safe for use [8].

To understand the view point of the regulatory requirements in various nations, we need to comprehend how these nations define cosmetics in accordance with their legal systems [9].

**Definition of Cosmetics**

**India** Cosmetics comprise any items intended to be rubbed, poured, sprinkled, sprayed, introduced into, or otherwise applied to the human body or any portion thereof for washing, beautifying, encouraging attractiveness, or modifying the look, as defined by the D and C Act 1940 and Rules 1945 [9].

**GCC** Cosmetic goods are defined as: "Any substance or mixture intended to be placed in contact with the external parts of the human body [epidermis, hair system, nails, lips and external genital organs] or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odours" [10].

**Cosmetic Regulatory Scenario in India**

The manufacture of cosmetics is governed by a system of inspection and licensing by the State Licensing Authorities designated by the respective State Governments, in accordance with the requirements of the Drugs and Cosmetics Act, 1940 and Rules established there under. In accordance with the terms of the 1940 Drugs and Cosmetics Act, the Drugs Controller General [India] serves as the Central Licensing Authority, granting the Import Registration Certificate and controlling the import of cosmetics into India. Before being imported into the country, each item that meets the criteria of a cosmetic must be registered, together with information on its pack size, variants, and manufacturing location [11].

**Among CDSCO's Primary Responsibilities for Cosmetic Regulation Are Include**

1. amending the registration of imported cosmetic products under the New Cosmetics Rules 2020 and the Drugs and Cosmetics Rules of 1945.
2. Examining applications for registration of cosmetics in accordance with the regulations issued under the New Cosmetics Rules 2020 and the 1940 Drugs and Cosmetics Act and 1945 Rules.
3. Analysing a large number of requests for NOCs and explanations relating to the import of cosmetic items.
4. Reacting as necessary to BIS and government correspondence.
5. Providing information and assistance to the public with regards to enquiries or hearings involving the importation of cosmetics.
6. Address concerns regarding cosmetic standards raised by members of the public, NGOs, consumer forums, and industry organisations.
7. The applicant's registration of cosmetic import requests is pre-screened.
8. The pre-screening checklist and standard operating procedures for evaluating cosmetic import and registration applications have been amended to suit the current working practises.

One of the most crucial tasks of the Department of State Drug Control, which licences both cosmetic manufacturing and sales facilities, is to make sure that the state's residents have access to high-quality medications at reasonable prices in accordance with GOI regulations [NPPA][12].

**Cosmetics Manufacturing Needs For Factory Premises**

Schedule M requirements should be followed in manufacturing facilities.

Factory buildings can be situated in hygienic settings, and sanitary facilities must be kept up there. The manufacturing environment needs to be clean and well-ventilated.

To conduct the operations, the walls of the manufacturing room must be up to a height of 6 feet from the ground. It must have a smooth surface, be impervious to water, and be hygienic.





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The manufacturer should use drinking water while using water for manufacturing. A suitable plan must be in place for wastewater disposal.

A communicable or contagious disease must not be present in any of the personnel. Where necessary, clean gloves, masks, and uniforms must be provided for them [2].

### Manufacturing License for Cosmetics

The New Cosmetics Rules 2020 and associated regulations, as well as the 1940 Drugs and Cosmetics Act, govern cosmetics. Manufacturers of cosmetics must submit to inspections and get licences from the state drug control departments.

The following documentation is necessary for states to issue cosmetic manufacturing licences.

### List of Documents Needed to Get an India Cosmetics Import Registration Certificate.

- A covering letter outlining the application's goal
- The manufacturer's permission [Authorisation]
- Filled in Part-I of Second Schedule D
- An ingredient list with percentages of the ingredients listed
- Proposed product labels
- Test procedures and specifications
- Pack inserts
- Manufacturing Licenses/undertaking for no issuance of a manufacturing license in the nation.
- Free Sale Certificate
- Non-Animal Testing Statement
- Statement on the presence of heavy metals and hexachlorophene.
- Other documents [If any].
- Application in Form COS-1
- Original Bharatkosh e-receipt for the fee that was paid [12][11].

### Process of Cosmetic Registration in India

Step 1: - The licencing authorities must be notified of the importation and sale of any cosmetic items in India.

Step 2: - Regulation in India for overseas manufacturers have an Authorized Representatives from India.

Step 3: - To begin the registration procedure, a dossier must be produced with the necessary list of papers [see 4.3].

Step 4: - labelling Requirements such as bearing the brand's registration certificate number, the registration certificate holder's name and address, the name of the country where the product was manufactured, the importer's name and address, the import licence number, etc. are necessary before a product can be released onto the market.

Step 5: - confirmation from the producer that the product has not been subjected to animal testing, which is provided at the port office.

Step 6: - When you submit a document to CDSCO, they will send you a letter of inquiry. When they get your response, they will either give you another letter of inquiry or award you a licence in form 43.

Step 7: - Only when the registration certificate and licence have been issued may a product join the Indian market. [13].

### BIS for Cosmetic Ingredients

Additionally, the Bureau of Indian Standards has released lists of prohibited and permitted components used in cosmetics as well as particular requirements for cosmetics..

Based on the detrimental effects of fake cosmetics and the lack of effective standards or regulations for cosmetic substances, the "Classification" splits these compounds into two groups:

- Generally accepted as secure
- Generally, not accepted as secure
- Bureau of Indian standards offers a list of dyes, colours, and pigments [IS: 4707 Part 1] that are suitable for use in cosmetics.





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Similarly, a list of primary components that are not taken into account while formulating cosmetics [IS: 4707 Part 2] is offered by BIS as GNRAS[14].

### Labelling Requirement

The following are some of the labelling specifications outlined by the 1945 Drugs and Cosmetics Rules:

- The name of the product and the place of manufacture must appear on both the inner and exterior labels. If the container is tiny, the primary production site and the pin code are sufficient.
- The exterior label for the product should clearly disclose the net contents of the substances used to manufacture it.
- The "directions for use" and any necessary cautions or warnings should be written on the inside label. Additionally, it must list the names and amounts of any dangerous components.
- The label must have both a different batch number [preceded by the letter "B"] and the manufacturing licence number [preceded by the letter "M"].
- In the case of the aforementioned product categories, must adhere to the Indian standards established and periodically revised by the Bureau of Indian Standards[14].

### Recent Amendment

- In accordance with the requirements of the Drugs and Cosmetics Act 1940, India published and put into effect the "Cosmetic Rules 2020" in December 2020. It establishes regulations for the production, labelling, packaging, testing, sale, and distribution of cosmetics. There are 24 appendices, 13 schedules, and 72 regulations in the rules.
- The most recent rule defines "new cosmetics" as those that contain innovative or new ingredients that have never before been used in the world.
- The Cosmetic Rules 2020 have streamlined the application process to cut down on redundant regulatory procedures.
- Cosmetics Rules 2020, Goods made outside of India they must be registered through the e-Governance portal. If manufacturing, selling, or distributing a product in its nation of origin is prohibited, it cannot be imported into India. [14].

### Cosmetic Regulatory Scenario in GCC

The Gulf Cooperation Council is a political and economic alliance made up of Saudi Arabia, Kuwait, the United Arab Emirates, Qatar, Bahrain, and Oman. One of the states in this partnership with the power to issue global standards is the GCC Standardization Organization [GSO]. Then, each country has a distinct local competent authority that is in charge of carrying out the same criteria.

GSO 1943/2016 Cosmetics and Personal Care Products Safety Requirements

Cosmetic products - Product claims for cosmetics and personal care items are technically regulated. [GSO 2528/2016]

GMP: Good Manufacturing Practices [GMP] - Practices [GSO ISO 22716] Recommendations for Good Manufacturing[10].

### Requirements

The EU Cosmetics Regulation 1223/2009 is closely mirrored in the Gulf Cooperation Council's cosmetics laws. However, it has some unique standards for procedures, components, labelling, and claims. Products must adhere to a number of criteria, including the following: they must be totally free of pork, safe for human consumption, stable, and their attributes influencing safety, effectiveness, and quality must not vary throughout the course of their shelf life. The artwork, photos, and text on the labels must be in keeping with Islamic customs and ethical standards. The label's statements also need to be accurate, and some of it has to be translated into Arabic. Despite the fact that all GCC members share the same core laws, each nation has its own product notice requirements [Bahrain does not have any], and each country may have different requirements for the customs clearance procedure [15].





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## **GCC Technical Regulation for Cosmetic Products**

### **Safety Requirements**

The product shall be completely free from pork and all its derivatives.

It shall be safe for human health when used under normal or reasonably foreseeable conditions of use.

It shall be homogenous, stable and the properties shall not change during its shelf life when stored and used as per the instructions

It shall be free from any filthy or decomposed substance.

**Labelling Requirements** The following information must appear on all personal care and cosmetic goods in permanent, clearly visible type.

- The brand name and product name.
- The manufacturer or distributor's name and address.
- Product's country of origin.
- The item's nominal composition.
- The warning statement, the condition of use, and the safety advice.
- Batch no.
- Arabic or English are options.
- Storage instruction for safe use.

### **Packaging**

Packaging for cosmetics and personal care items must be designed to avoid harm and deterioration and not negatively impact the product under storage, handling, and transportation conditions specified by the manufacturer. Metal aerosol dispensers used to package personal care and cosmetic items must adhere to GSO 917 "Metal Aerosol Dispensers."

### **Product Claims**

The definition of cosmetic and personal care items as well as the range of cosmetic products must be followed when making claims about such products.

The following criteria must be satisfied by cosmetic product claims:

- Adherence to the law
- Genuineness
- Concrete evidence
- Adequacy
- Making wise decisions

### **Safety Requirements for Distribution and Sale of Cosmetics in GCC**

The product must be totally devoid of all traces of pork and all of its by-products.

When kept and used in accordance with the instructions, it must be homogeneous, stable, and its qualities must not change during the course of its shelf life.

It must not contain any dirty or decayed material, and it must not include any pictures, images, or statements that are at odds with Islamic customs and the social norms of the GCC. Products for cosmetic and personal care cannot contain any of the compounds mentioned in the annexes with restrictions.

If the presence of residues of the compounds mentioned in annex 2 is technically impossible to avoid in good manufacturing practice, it is permitted.

The manufacture of cosmetic products shall comply with good manufacturing practices. the manufacture is in accordance with the relevant harmonized standards such as GSO ISO 22716[16].

### **Regulatory Authority of GCC Countries**

SAUDI ARABIA: Saudi Food and Drug authority.





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UAE: Ministry of Health and Prevention.

KUWAIT: Drug and Food registration and control administration.

OMAN: The Directorate General of Pharmaceutical affairs and Drug Control OMAN.

BAHARAIN: National Health Regulatory authority.

QATAR: Ministry of Public Health.

### Regulatory Requirements of Cosmetics in Saudi Arabia

There are six important requirements for clearing shipments of cosmetics products from custom ports in Saudi Arabia are as follows:



**Purchase Invoice** The distributors or agents of the manufacturing firm must provide the purchase invoice, and a document verifying that the distributors are permitted to conduct business in the nation where the goods is acquired must be attached.

**Certificate of Conformity** A certificate of conformity is evidence that imported goods with a known batch number and bill number have complied with GSO1943 safety standards before being imported into Saudi Arabia by conformity organizations approved by the SFDA.

**Certificate of Origin** The chamber of commerce of the nation of export or the nation of origin must certify the authenticity of the certificate of origin.

**A copy of the Shipping Bill** Once the package has arrived at the customs port, a copy of the shipping bill is added to the commercial clearance requirements

**Customs Statement** Customs statement should be submitted in original copy.

**Notifying in eCosma** The cosmetic product notification system must receive notice of the cosmetic items. [eCosma]

### Document that must be Submitted for Clearance Request

- Information on the importation of chemicals, their intended use, and the warehouse.
- Data sheet for safety.
- A certified purchase invoice in its original form with the invoice's number and date.
- An original copy of the invoices' date and number from the verified certificate of origin.
- A replica of the Saudi Food and Drug Authority's licence for the producer, filling and packaging facility, or warehouse.
- A replica of the freight bill.
- The authentic customs declaration copy [17].

### Regulatory Requirement of Cosmetics in UAE

The Federal Law No. 28 of 2001 established and gave the Emirates Standardization and Meteorological Authority [ESMA] the authority to oversee and regulate the nation's personal care industry. All locally produced and imported cosmetic and fragrance goods are certified by the Emirates Conformity Assessment Scheme [ECAS], a product certification programme run by ESMA. The ECAS seeks to guarantee that these items comply to the pertinent





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technical requirements before to importation into the UAE, at the port of entry, or before being sold on the UAE market.

**Safety Requirement**

- It should be stable and homogenous in nature and shall be stored according to the instruction.
- Safe for human health.
- Safety complies with Standard GSO 1943/2016.
- The product must not include any illegal drugs.

**Packaging Requirements**

Products must be packaged in suitable, Cosmetic items should not react with clean containers, and vice versa. Additionally, the containers' sharp edges and poor closures must be examined.

**Labelling Requirements**

The labels of goods sold to UAE consumers must adhere to the general specifications outlined in Emirati Standard No. UAE.S GSO 1943. Labelling must be applied in a way that makes it difficult to remove, and it must be in a clear typeface. All of the information on the labels needs to be correct, laboratory- or scientifically confirmed, and truthful. With the exception of the following information, which must be in both English and Arabic, everything should be in either English or Arabic. Information about precautions to take and warnings directions for safe usage in storage[18].

**Regulatory Requirement of Cosmetics to Import and Sell in Kuwait**

- A genuine letter of appointment from the producer or distributor designating them as the sole agents for goods that have been authorized by the Arab Chamber of Commerce and the Kuwaiti Embassy in the nation of origin.
- FSC: Free Sale Certificate
- Issued and properly legalized by the appropriate governmental health authority for cosmetics or organisation in charge of the sale of cosmetic products in the country of origin, as well as the Kuwait Embassy in the country of origin, certifying that the products are sold legally as cosmetics in the country of origin and including the names of the products, the name and address of the manufacturer/distributor, and the rules to be followed.
- A certified copy of the manufacturing license, the GMP certificate, the ISO certificate, and any other certificates that have been legalised by the health authorities, the chamber of commerce & industry, or the Kuwait Embassy in the country of origin
- A safety certificate from the manufacturer stating that the products are safe for human use under typical use conditions and do not contain any cortisone, hormones, or harmful substances
- Every shipment of products must include the batch numbers, dates of manufacture, and expiration dates.
- The manufacturer's name and the nation of origin should be printed in Arabic or English on the product packaging.
- The department must receive the aforementioned paperwork, samples with complete study and registration information, and a cover letter on letterhead from the agent in Kuwait.
- A list of the countries and the dates where the products are sold.
- The following information must be included on the invoice submitted for release:
  - a. Name and address of the Kuwaiti agent, along with the location of the warehouse.
  - b. Name, location, and country of origin of the manufacturer [19].

**Regulatory Requirement of Cosmetics to Import and Sell in Oman**

The following are necessary for the clearance of imported goods, according to the website of the Royal Oman Police Customs Directorate [ROP Customs]

- A certified copy of the business registration, an activity form, or, in the absence of one, import authorization.
- A true copy of the Oman Chamber of Industry and Commerce affiliation certificate
- A current manufacturer's certificate.
- A list of credible quotes.





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- Lists for packing[20].

#### **Regulatory Requirement of Cosmetics in BAHRAIN**

- Required Documents which are submitted to Ministry of Health:
- Good Manufacturing Practice certificate [GMP]
- Free Selling Certificate [FSC]
- Ingredients certificate
- Certificate of chemical analysis
- Other certificates according to the product type
- Samples of each preparation[taking a sample of products with multiple colors or flavors]

#### **Cosmetic Products Import License Request in Kingdom of Bahrain Markets**

Original appointment letter for Bahrain's only agency stamped and signed by the maker or distributor. The manufacturer's name, the nation of origin, and the names of the products to be imported are listed on the license request form for imported cosmetics. Governmental health authority that gave and corrected the Good Manufacturing Practice Certificate. Free Sale Certificate, which includes the name, address, and name of the products to be imported, was issued and corrected by the government health authority and the Bahrain Embassy in the place of origin. COA of the products from an accredited laboratory, Certificate proves that the product is free from Bovine spongiform encephalopathy and Halal Certificate [21].

#### **Regulatory Requirement of Cosmetics to Import in QATAR**

The legislation mandates that all importers possess import licences. Only Import permits may only be obtained by Qatari nationals or the Qatari partner of a limited liability company, and they must be registered with the Ministry of Economy and Commerce. Entities operating in Qatar with 100 percent foreign ownership are likewise subject to this legislation. Importers Products must be cleared from customs zones at ports or land borders in Qatar by submitting a number of papers, such as a detailed customs declaration, bill of lading, certificate of origin, pro forma invoice, and import licence. If you want details on particular criteria, you should get in touch with the Customs and Ports General Authority. The products are often inspected in the customs station or elsewhere as directed by the Director General with the owner or his agent present. The official invoices and COO must have the commodity's HS [Harmonized System] CODE; if not, the shipment won't be allowed for clearing. For every item, for supplies, and on boxes, fields for "COUNTRY OF ORIGIN" or "MADE IN" are required[22].

## **CONCLUSION**

Cosmetic regulation varies a lot between India and GCC countries, in accordance to Indian regulation the manufacturing of cosmetics should obey the schedule M for achieving the good quality of cosmetic products and also required Pre-market approval for entering in to market for sale but according to GCC countries for manufacturing of cosmetics should follow the GSO ISO 22716. For safety requirements and technical requirements should comply with GSO 1943/2016 and 2528/2016 respectively and labelling should be in Arabic and English language. However, the aim is same to protect the consumer by ensuring safe and good quality of finished products. This article's primary goal is to demonstrate how cosmetic regulations varies between India and GCC countries and the need for regulatory convergence on matters of manufacturing, sale, import, labelling, stability, and safety.

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**Table 1: A Comparison of Cosmetic Regulation between India and GCC Countries.**

Country	INDIA	GCC countries
Authority	CDSCO	<b>Saudi Arabia:</b> - SFDA. <b>United Arab Emirates:</b> - Ministry of Health and Prevention. <b>Kuwait:</b> - Drug and Food registration and control administration. <b>Oman:</b> - The Directorate General of Pharmaceutical affairs and Drug Control <b>Bahrain:</b> - National Health Regulatory authority. <b>Qatar:</b> - Ministry of Public Health
Rules & Regulations	Dugs and Cosmetic Act	GCC Standardization Organization & <b>EU Cosmetics Regulation 1223/2009.</b>
Pre-market Approval	Required under state Government licensing	Required Under GSO
Halal certification	Halal India is a Halal certification Bodies	Required as Halal cosmetics and Personal care product [Toyyiban or shariah law]
BAN on Animal Testing	India banned cosmetic testing on animals in 2014.	N/A
Manufacturing regulation	Schedule M	Comply with <b>GSO ISO 22716</b>
Labelling language	English	Arabic and English
Certificate of conformity	ISI- mark	G- mark
Safety Certificate	yes	yes
Certificate of origin	yes	yes
Free sale Certificate	yes	yes
Notification of cosmetics	Gazette Notification G.S.R 426[E]	<b>Each nation needs its own product notice, for instance: - Different countries may have different criteria for the customs clearing procedure and eCOSMA [Bahrain does not require any notice].</b>





## On Pageant Electronic (E) Tabulator System, a Trace for Functionality and usability System Characteristics

Renz M. Buctuan\*

ICT Head, Surigao Del Norte State University, Philippines.

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### \*Address for Correspondence

**Renz M. Buctuan**

ICT Head,

Surigao Del Norte State University,

Philippines.

E. Mail: rbuctuan@ssct.edu.ph



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### ABSTRACT

The Pageant E Tabular was dynamic and capable of being modified in response to the changing needs of the user. The study generally aimed to use the ISO/IEC 9126 criteria to trace the system's characteristics in functionality and usability. During system analysis, design, and implementation, it observed development design and followed the Rapid Application Development (RAD) approach. The study used a descriptive research design with descriptive statistics. A group of pageant judges from two different events were asked to answer, with the event organizers for the two different events. Questionnaires were employed in the study, which were supplemented with unstructured interviews to provide further insights into functionality and usability. The E-Tabulator System was found to have widely observed functionality and usability system qualities. It performed well according to the users' functional needs to find the most popular women in the pageant. It can also be used in events such as pageants and other similar activities. To fully utilize its potential, it is advised that it be extended to similar events in the nearby cities hosting the pageant. Likewise, there should be complete measures of quality characteristics in future studies to substantiate the present results.

**Keywords:** Functionality, Usability, System characteristics, RAD methodology, Pageant

### INTRODUCTION

The E-Tabulator system was a dynamic system that was used during pageant actual sittings. The system design was dynamic and capable of being modified in response to user suggestions, recommendations, or feedback, if any, particularly in the categories that comprised the entire pageant, the change of the chosen judges and contestants, and the judging criteria per category. Pageants happen anywhere. It is one of the most beautiful portrayals of the beauty and performance of women across culture. Each country all over the world has their own criteria for selecting the most beautiful women to represent their country in international pageants. This pageant may have different

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functionality and usability. It depends on how it is defined, designed, and perceived during requirement gathering. Each team organizing the event has their own criteria or components in the declaration of the winner. The common categories are: sports attire, cultural costume, swimsuit attire, best gown, photogenic, best in interviews, and the like. However, each component has its own defined declaration. Whatever the criteria or components, the pageant declares the winner of each category.

According to Reppert, *et al* (2014), the "Beauty Pageant Effect" on Campus: Consequences and Clinical Implications, emphasized that women are very familiar with the experience of being evaluated by their physical attractiveness. This socialization intersects across all stages of a woman's development, beginning in early childhood. Too often, college women's beliefs about their own attractiveness influence their self-worth. As emphasized by Farrales (2018), "The Colonial Geographies of Filipina Pageants in Canada" considered how notions of beauty and performances at pageants transform as they move across different colonial times and spaces. It examined how gender, racial, and sexual subjectivities take shape among cisgender Filipina women who participate in and organize community-based pageants in the traditional and ancestral territories of the Musqueam, Skwxw7mesh, and Tsleil-Waututh peoples. In the study of Weiser (1999), it was stated that the advice given by the director of a pageant director for a regional California pageant in the Miss America pageant system was "This pageant is your chance to impress the judges." In the interview and the talent section, you get to show them how smart you are, how poised you are, how confident you are—these are the most important parts of any pageant.

It is said that the designed system was initiated in response to the observation of its need for different pageants to happen in different forms. It is designed in accordance with the functions and usage as defined by the clients. However, there is a need to determine how it functions and is used. In particular, this has been initiated to respond to the call of the government officials in their annual pageant activity in the locality. Thus, the system design is appropriate these days and its system characteristics need to be traced, particularly its functionality and usability, for better performance, high satisfaction of the user, and system improvement if deemed necessary.

**Objectives of the Study**

The study generally aimed to use the ISO/IEC 9126 criteria to trace the Pageant E Tabulator system's characteristics with emphasis on functionality and usability in reference to their sub characteristics.

**MATERIALS AND METHODS**

This part presents the materials and methods used in the study. The study observed descriptive design to trace the system's characteristics on functionality and usability.

**Analysis, Design and Implementation**

During system design, the proponents used the use case tool to analyze the data (Figure 1). According to Kalinga (2017), use cases are versatile and valuable techniques for describing user requirements. On this particular claim, the proponents, were able to anchor their design during analysis. In the design phase, the proponents observed the different phases of the System Development Life Cycle (SDLC), particularly the four phases of Rapid Application Methodology (RAD). Amplified by Eric, *et al* (2016), Rapid Application Development (RAD), (Figure 2), the goal is to quickly meet the business needs of the system; technical concerns are secondary. The customer is heavily involved in the process. The RAD has four phases: the requirement planning phase, user design phase, construction phase, and the cut-over phase. Accordingly, each phase has its own share in the development of the present study. In the study by Tejas, *et al* (2016), they said that many errors can originate or propagate from the requirements phase, caused by poorly written, ambiguous, unclear, or missed requirements. They said further that failure to specify the requirements correctly can lead to major delays and cost overruns. Thus, there is a need to specify the requirements correctly to avoid delays and cost overruns. During system implementation, the system was installed during



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two different pageant events in two different towns. The Local Area Network (LAN) facilities were prepared with the five personal computer units and XAMPP software with the E-Tabulator system installed

**Research Design**

The study used descriptive research design to purposively trace the functionality and usability of the system characteristics.

**Respondents of the Study**

The system was evaluated in two different geographical locations where it was installed and used. There was a group of pageant judges from two different events who were asked to answer, as well as the event organizers for the two different events. They were chosen because they were believed to be the group who could give concrete data on the systems developments since they know how the event is run and organized. There were 20 respondents who were able to use the system and answer it correctly using the questionnaires provided.

**Instruments**

The study used questionnaires and supplemented them with unstructured interviews to yield complementary insights regarding usability and efficiency. The questionnaires were defined in conformity with the ISO 9126 standard particularly in the sub characteristics of the functionality and usability. The questionnaires were validated by IT experts, researchers, and system developers. They were chosen to ensure the validity of the questionnaires. There was an actual demonstration of the system before the distribution of the questionnaire to the identified respondents so as to gather the right data according to their observation of the system's functionality and usability. The questionnaire was classified into the two quality systems' characteristics in reference to its sub characteristics.

**Data Analysis**

The researcher utilized descriptive statistics to derive the mean and the weighted mean for the evaluation of the functionality and usability of the system's characteristics. Given a five-point Likert scale with responses ranging from 5 points-Highly Effective; 4 points-Effective; 3 points-moderately Effective; 2 points-Ineffective and 1 point-Highly Ineffective. The numerical rating scale used in the system study to give interpretations of the evaluation of acceptability results is: 4.50–5.00 is Highly Effective (HE)/Strongly Agree (SA); 3.50–4.49 is Effective (E)/Agree (A); 2.50–3.49 is Moderately Effective (ME)/Moderately Agree (MA); 1.50–2.49 is Ineffective (I)/Disagree (D); and 1.00–1.49 is Very Ineffective (VI)/Strongly Disagree (D).

**Evaluation**

To ensure the veracity of its system's quality, the system's characteristics has to be evaluated with ISO/IEC 9126 criteria. Kilidar, *et al* (2005), said that *ISO/IEC 9126 is intended to support evaluation of intermediate software products*. According to the study by Padayachee, *et al* (2010), ISO/IEC 9126 defines quality as "the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs." The ISO/IEC 9126-1 defines a quality model with six characteristics, namely, functionality, reliability, usability, efficiency, maintainability, and portability. In the present study, of the six characteristics only functionality and usability were considered. These are believed important features to determine the user's perspectives in the quality of the software. As specified by Stefani, *et al* (2007), the model's structure relies on the set of quality characteristics and sub-characteristics that are directly related to quality as perceived by the end-users (referred to hereafter as "external measures"). In the study of Fahmy, *et al*. (2012), functionality is 'the capability of the software to provide functions which meet the stated and implied needs of users under the specified conditions of usage'. They said further that functionality is divided into 5 sub-characteristics: Suitability, Accuracy, Interoperability, Security, and Functional Compliance. In their study, they also specified that usability is 'the capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions'. Usability is divided into 5 sub characteristics: Understandability, Learn-Ability, Operability, Attractiveness and Usability. According to Losavio, *et al*. (2003), the usability of a system is the capability of the software product to be easily understood, learned, and used under specified conditions. In the study, it referred to



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the ease of usage and learning; users learned with minimal effort, with an appealing and user-friendly interface and organized usable modules. In the present study functionality defined as correct system functions on registration, contestant and judge data entries; reliable judge score entries per component in all categories; correct print outs and the summary of all categories for the top ranking winners. In like manner, referred to the ease of usage and learning; users learned with minimal effort, with an appealing and user-friendly interface and organized usable modules.

**RESULTS AND DISCUSSIONS**

This section presents results according to its defined objectives to trace the design aspects of the system's functionality and usability system's characteristics in Tables 1-2. Table 1, as shown, contains the system evaluation ratings on functionality. The table shows the functionality Weighted Mean (WM) of 5.00 as a *Highly Effective* rating. It connotes that the system functions as expected, as evidenced by all items' *Highly Effective* ratings. It means that the system functioned correctly on registration, contestant, and judge data entries; functioned reliably on judges' score entries per component in all categories; produced correct print-outs of all winners in all categories; produced correct print-outs of all winners in all categories; generated a summary of all top five ranking contestants in all categories; and generated correct print-outs of the top five ranking contestants with all judges. According to Raja and Barry in 2005, as cited in the study of Farooq, *et al* (2011), functionality is the capability of the software product to provide functions that meet stated and implied needs when the software is used under specified conditions. It means that the system as a whole is capable of providing the functions necessary for the events once installed.

As shown in Table 2, the results of the evaluation on the usability system design characteristics as perceived by the users are shown. The system garnered a WM of 4.79, deemed *Highly Effective rating*. The weighted mean rating implies that the system is easy to use; its functions are easily learned; they are learned with minimal effort; it has an appealing and user-friendly interface; and it provides four different usable modules. The result implies further that the system provided visible and organized four different usable modules with the highest mean rating ( $M = 5.00$ ), deemed *Highly Effective*. It means a visible and organized module upon opening, allowing the users to choose directly what particular modules they would choose. It is definitely true because the system provides visible and organized main modules and their sub modules. They are presented in the left portion successively with corresponding icons and labels. As said, usability needs to be addressed in the early development stage. The result was affirmed in the study of Golden (2010). According to her, addressing usability early in the software development process is a non-trivial problem. In order for usability to be a first-class citizen among software quality attributes, usability design must be made cost-effective for development organizations. This is confirmed in the study by Aziz, *et al.* (2013) that usability is one of the important characteristics in making products such as websites or software usable and quality. Preece, Rogers, & Sharp (2015), as cited in the study of Alshehri, *et al.* (2019), usability is a quality attribute of users' experiences when interacting with interactive technologies that assesses the easiness of the user interface. On the other hand, it is noted that the system functions that are easily learned got the lowest mean ratings ( $M = 4.60$ ), deemed *highly Effective*. The lowest result is not alarming because it is still a *highly effective rating*. Golden (2010) further said that usability needs to be addressed early in the design process in ways that enable it to be successfully incorporated into software architecture designs and software engineering implementations.

**CONCLUSION**

It is concluded that the E-Tabulator System generally observed functionality and usability system design characteristics. It functioned highly effective according to the functional requirements of the users to derive the most preferred women in the pageant. Likewise, it is highly usable for use in events like the pageant and similar activities. It is highly usable because the system provides visible and organized main modules and submodules with corresponding icons and levels that can be learned and used easily.





**Renz M. Buctuan****Recommendations**

To fully utilize its potential, it is recommended that it be extended to similar events in the nearby cities hosting the pageant. There is a need to create an alternative mobile-based E-Tabular system, as suggested by the user, so that judges can choose which design is most comfortable for them to use during the pageant. Likewise, there should be complete measures of quality characteristics in future studies to substantiate the present results.

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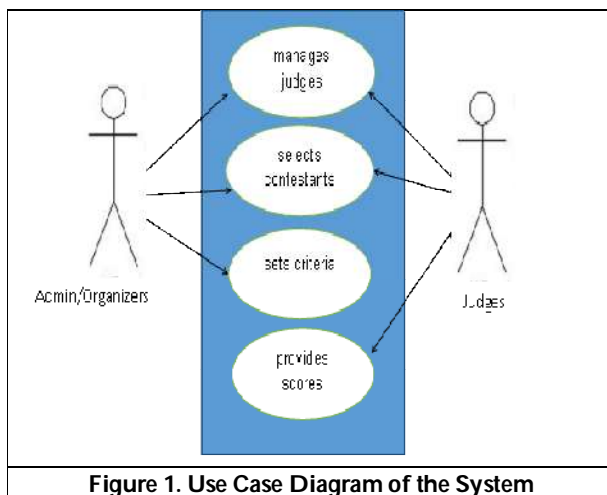




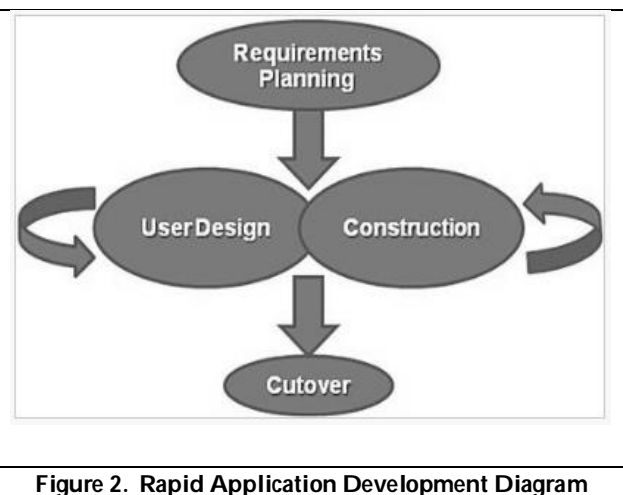
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<b>Table 1. Functionality System Design Characteristics</b>	
<b>Functionality:</b> The evaluators perceived that the system:	Mean
1. functioned correctly on registration, contestants and judges data entries;	5.00
2. functioned reliably on judges score entries per component in all categories;	5.00
3. produced correct print-outs of all winners in all categories;	5.00
4. generated summary of all top five ranking contestants in all categories; and	5.00
5. generated correct print-outs of the top five ranking contestants for all judges.	5.00
<b>Weighted Mean(WM):</b>	<b>5.00</b>

<b>Table 2. Usability System Design Characteristics</b>	
<b>Usability:</b> The user perceived that the system:	Mean
1. was easy to use;	4.70
2. functioned are easily learned;	4.60
3. users learned the system with minimal effort;	4.80
4. offered the user with an appealing and user friendly interface;	4.85
5. provided visible and organized four different usable modules;	5.00
<b>Weighted Mean (WM):</b>	<b>4.79</b>



**Figure 1. Use Case Diagram of the System**



**Figure 2. Rapid Application Development Diagram**





## Applications of Bacterial Pigments in Food Colour Market: A Review

Moitrayee Devi<sup>1\*</sup>, Deep Prakash Parasar<sup>2</sup>, Satyabrat Sarma<sup>3</sup>

<sup>1</sup>Assistant Professor, Faculty of Paramedical Sciences, Assam down town University, Panikhaiti, Assam, India

<sup>2</sup>Assistant Professor, Faculty of Sciences (Biotechnology), Assam down town University, Panikhaiti, Assam, India.

<sup>3</sup>Assistant Professor, Faculty of Pharmaceutical Science, Assam down town University, Panikhaiti, Assam, India.

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### \*Address for Correspondence

#### Moitrayee Devi

Assistant Professor,  
Faculty of Paramedical Sciences,  
Assam down town University,  
Panikhaiti, Assam, India.  
E. Mail: moitrayeedevi@gmail.com



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### ABSTRACT

Colors are added to food substances to make it more attractive. As a result the food colorant agents have high demands in the food industry. A wide range of synthetic coloring agents that have been approved as food additives are available and are used in various types of food prepared or manufactured around the world. However, there is growing concern that the use of synthetic colours may have a long-term negative impact on human health as well as in the environment. Therefore as an alternative source the natural pigments have successful marketing which are derived from microorganisms, animals and plants. The using of these natural pigments as food colorants and nutritional supplements reflects the existence and importance of global markets where consumers are willing to pay a premium for "natural healthy ingredients." Among all the natural pigments sources microorganisms have many advantages because of their no seasonal impact on pigment quality and quantity, ease of handling and large-scale production with little or no impact on biodiversity, and so on. Microorganisms such as bacteria, fungi and algae are basically used for pigment production. This review discuss about the types of bacterial pigments which have application in food industry.

**Keywords:** Colours, Microorganisms, Pigment, Natural, Food





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## INTRODUCTION

Colour is the integral part of human being. Without colour we cannot imagine the world and this is equally true for the food we consumed. Among the food materials such as fruits, vegetables etc have striking natural shades and hues and therefore, do not require any further coloration [1]. However, the addition of food colorants is an essential part of the recipe for many food items before final packaging or serving. Food colorants improve the visual appeal and give the food a distinct identity, making it appear more appealing and enjoyable to eat. Food color is frequently associated with flavor, safety, and nutritional value [1, 2]. Pigments have been used as colouring agents since prehistoric times. Color was first added to food in Egypt, when candy makers used natural extracts in their products. Similarly, the use of natural colourants in food was seen in Japan in shosin text of the Nara period (8th century), which contains references to colouring soybean and adzuki-bean cakes[3,4]. Previously, all colourants used were of natural origin, such as saffron, paprika, turmeric, various flowers, and so on[1,2,5]. Synthetic colours were first produced in the mid-nineteenth century, and due to their low production cost, high tinctorial strength, and chemical stability, they quickly became popular as food colourants [1,2]. However, several health concerns were raised in later years as a result of the use of many potentially hazardous synthetic chemicals as food colorants, leading to the prohibition of various such food colour additives, such as Quinoline Yellow, Yellow 2G, Ponceau SX, Brilliant Black B etc [1]. Because of synthetic colours have possible side effects like hyper-activity in children, allergenicity, toxicological, and carcinogenicity problems the natural pigments importance gaining day by day. Some of the research reported that natural food colour has become an important part in the food industry area, particularly the discovery of new natural colourants. The use of compounds as food colourants is strictly regulated, whether the colours are naturally derived or synthesized [6]. Organizations such as the US Food and Drug Administration (FDA), the European Food Standards Authority (EFSA), and the World Health Organization (WHO) have advocated for safe dosages of these colours in food, drugs, and cosmetics [6,7,8,9].

Plants, insects, and microbial sources are the main sources of natural colours. Microbial colourants are preferred due to their ease of scalability and potential lower production costs[5,6,9]. Lower production costs, higher yields, easier extraction, lower-cost raw materials, no seasonal variations, and strain improvement techniques to increase natural pigment production are all advantages of microbial fermentation for natural pigment production[6,10]. Pigments have different health benefit such as antioxidant, anticancer, antimalarial, antiproliferative, antimicrobial activity. Carotenoids, flavins, melanins, quinines, monascins, and violacein are some of the common pigments produced by microbes that can be used as food colours. They can also be used as food additives, antioxidants, colour enhancers, and functional ingredients[4,6,11]. This review discuss about the types of bacterial pigments which have application in food industry.

### Scenario of Natural Colours

The global dyes and pigments market was worth USD 36.4 billion in 2021, and it is predicted to increase at a CAGR of 5.2 percent from 2022 to 2030. Among all the markets area the international market for natural products is experiencing unprecedented growth. Among the cause, the boom in the market which is expected to exceed US\$ 4 billion in the United States alone in 2000, and the emergence of new categories of natural substances, which are rapidly and fundamentally changing the concept of health and disease [12,13].

Europe, North America, Asia-Pacific, and the rest of the world make up the global food colour market. Europe, North America, and Asia-Pacific account for 34%, 30%, and 22% of the total global food colour market, respectively (JAM) Consumer pressure, sociological changes, and technological advancements resulting in further advancements in the food processing industry have all contributed to an increase in the overall colour market. The most significant growth has been in naturally derived colours as a result of improved stability and the food industries' desire to meet the growing consumer perception that 'natural is best' [13]. The expansion of the food industry in China, India, and Japan would create an appealing market for food colour manufacturers in this region. It has been estimated that by 2024, the global food colour market may be projected to reach approximately US\$5.7 billion, with a 4.9% Compound



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Annual Growth Rate (CAGR) between 2019 and 2024 [14,15]. The food colour market in India is expected to grow at a CAGR of 5.3 percent between 2020 and 2025 [14,16]. India primarily produces synthetic colours that are approved by the Food Safety and Standard Authority of India (FSSAI). The FSSAI has approved the use of only eight synthetic colours in food products that do not exceed their Acceptable Daily Intake values.

**Types of Bacterial Pigment as a Food Colours**

Among all the microorganisms, fungi, bacteria and microalgae are the well known natural pigment producers. These naturally occurring pigments are reflections of secondary metabolites that have high commercial value in the food and dairy, cosmetics, pharmaceutical, textile, and dyeing industries [1,4]. According to the reports, microorganisms producing pigments such as carotenoids, canthaxanthin, astaxanthin, prodigiosin, phycocyanin, melanin and violacein having potential application as a food colour. The important natural food colour produced by bacteria and their benefits are discussed in this review.

**Astaxanthin** : Astaxanthin is an orange red colour, lipid soluble pigment. It is found in yeast, microalgae, some of the marine organisms, feathers of some birds. It has also been reported that various bacteria, including *Halobacterium salinarium*, *Agrobacterium aurantiacum*, and *Paracoccus carotinifaciens*, produce it [1,17,18,19,20]. It has anti-aging and memory-boosting properties and is used as a colouring agent in animal and fish foods [1,6,21].

**Canthaxanthin** : It is orange to dark pink colour, lipid soluble pigment and have potent antioxidant property. It has been reported that it is produced by Bacteriochlorophyll containing microbes such as *Bradyrhizobium* sp. and *Halobacterium* sp [1,22,23,24]. It is an approved food colourant which used in various food range as well as salmon and poultry feed [6,22,23,24].

**Lycopene** : Lycopene is a water insoluble pigment belonging to the carotenoid group. It is naturally found in tomato and red colour fruits and vegetables and can also be synthesised by chemically [6,25,26]. It is an approved meat colouring agent of several countries such as USA, Australia, New Zealand etc. Some of the research reported that lycopene has an ability to prevent breast and stomach cancer [1].

**Melanin** : Melanin are naturally producing pigments produced by variety of microorganisms as well as animal and plants. Some of the research reported that the bacteria such as *Actinoalloteichus* sp, *Bacillus safensis*, *Brevundimonas* sp, *Nocardiosis alba*, *Pseudomonas stutzeri*, *Streptomyces glaucescens* have an ability to produced melanin [27]. They are used in sunscreen cream, cosmetic items, food items, eye glasses, pharmaceutical product and food items [6,28,29,30,31,32,33].

**Phycocyanin** : Phycocyanin is a blue green, water soluble pigment produced by some species cyanobacteria. It has been also reported that *Pseudomonas* species can also have an ability to produced phycocyanin [6,34]. Phycocyanin is mostly used in making of sweets and ice cream and also used as a rich protein dietary supplements. According to the literature review, it has antioxidant, anti-alzheimeric, antimalarial activity [1,35].

**Prodigiosin** : It is a red colour water insoluble pigment produced by several groups of bacteria such as *Serratia marcescens*, *Vibrio psychoerythrus*, *Rugamonas rubra*, *Streptovorticillium rubrirculi*, and other eubacteria [1,36]. Prodigiosin shows antibacterial, anti-malarial, antifungal, anticancer, antineoplastic activity. It has been used as a colouring agent in yogurt, milk and carbonated drinks. [1,6,37]

**Violacein** : Violacein is the most common purple colored pigment with numerous biological activity. They have most common bioactivities such as antibacterial, antiviral, antileishmanial, anticancer, antiulcerogenic, enzyme modulation activity [6,38]. *Chromobacterium violaceum*, *Pseudoalteromonas*, *Collimonas*, *Janthinobacterium*, *Microbulbifer* are some of the common violacein producing bacteria [6,39]. It is widely used in cosmetics, food, medicine, and textiles [40].





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**Riboflavin** : It is a water soluble , yellow pigment producing bacteria. Riboflavin commonly known as vitamin B2. It is used as a dietary supplement and as a food additives in dairy items, baby foods , fruits and energy drinks. According to the report *Clostridium acetobutylicum* bacteria have an ability to produce this pigment[1,41].

## CONCLUSIONS

With growing public awareness and interest about the use of safe and hygienic food additives, the industrial demand for natural pigments is expected to rise significantly in the coming years. Microbial pigments are an appealing alternative to synthetic food colorants not only because they are natural, but also because they have several beneficial health activity. According to the literature review many microorganisms have been ability to produce food grade pigments in the laboratory. But large scale production and purification of these bioactive products from many of them remains a challenge. However, more studies is required to optimise pigment characteristics such as composition and yield by determining the most optimised growth parameters, the use of genetically modified organisms to boost production, lowering production cost and the presence of various elicitors for pigment production.

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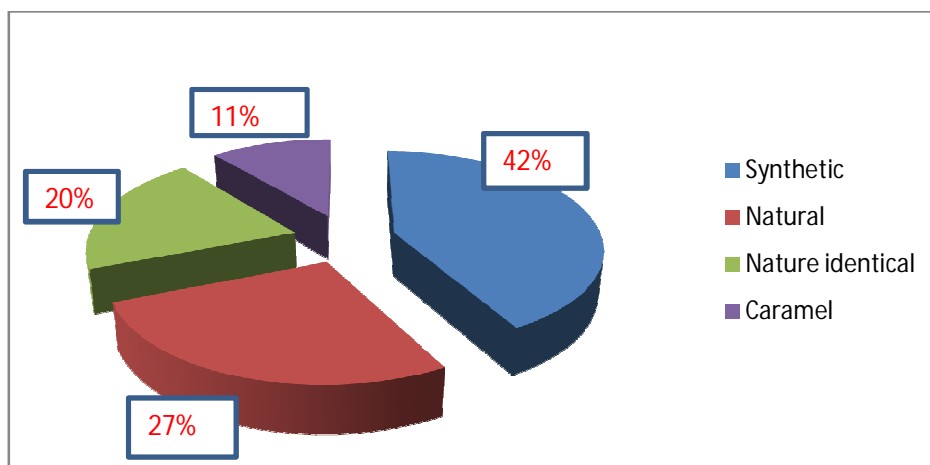


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**Table 1 : FSSAI Approved synthetic colours in food product**

Colour	Synthetic agent
Red	Ponceau 4R, Carmoisine, and Erythrosine
Yellow	Tartrazine and Sunset Yellow FCF
Blue	Indigo Carmine and Brilliant Blue FCF
Green	Fast Green FCF



**Fig 1: Percentage of Global Food colour market**







## Phytochemical Analysis of Two Different *Piper betle* Leaves Collected from Tamilnadu

Jegan.G.<sup>1\*</sup>, Bala Abi.R.<sup>2</sup>, Priyanka.K.<sup>2</sup> and Malu.H.<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Biotechnology, Apollo Arts and Science College, Poonamallee, Chennai, Tamil Nadu, India.

<sup>2</sup>Department of Biotechnology, Apollo Arts and Science College, Poonamallee, Chennai, Tamil Nadu, India.

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### \*Address for Correspondence

**Jegan G.**

Assistant Professor,  
Department of Biotechnology,  
Apollo Arts and Science College,  
Poonamallee, Chennai, Tamil Nadu, India.  
E. Mail: jeganbgl@gmail.com



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### ABSTRACT

The black and white *Piper betle* leaves were collected from Kumananchavadi, Guduvancheri and Poonamallee, Chennai, Tamil Nadu, India. The extractions of crude were made using the polar solvents such as ethanol, distilled water and hot distilled water. These different crude extracts were subjected to phytochemical analysis and the results of black *Piper betle* leaves were found that the ethanol extract contains Alkaloids, Saponins, Tanins, Cardiac glycosides, flavonoids, Phenols, steroids, Terpenoids, Quinones and Proteins. The Alkaloids were absence in the two solvents such as Distilled water and hot distilled water extraction. Moreover the Saponins were absence in hot distilled water extraction when compared to ethanol and distilled water. The results of phytochemicals from White *Piper betle* leaves was showed that the ethanol extract contains Alkaloids, Saponins, Tanins, Cardiac glycosides, flavonoids, Phenols, steroids, Terpenoids and Quinones. The Protein was absence in ethanolic extraction when compared to Distilled water and hot distilled water extraction. The compounds Alkaloids and Saponins were absent in distilled water and hot distilled water extraction when compared to ethanolic extraction. Finally in this study confirms the presence of various valuable phytochemicals in the black and white *Piper betle* leaves and these bioactive compounds can be use in pharmacological activities

**Keywords:** Black *Piper betle*, White *Piper betle*, Leaves, Phytochemicals





## INTRODUCTION

The Infectious diseases are disorders which are caused by many organisms such as bacteria, viruses, fungi, or parasites that are transferred through directly or indirectly from one person to another and sometimes infectious diseases are causes of death worldwide. The use of chemotherapeutants to treat organisms which result in drugs residues in the organisms which create eventually be harmful to human health (Hernandez-Serrano 2005). Scientists are searching of new alternative sources of antimicrobial drugs from natural resources due to different types of undesirable side effects using chemotherapeutants. Many scientific studies were reported that the natural plants products and their biologically activities were used for wide variety of purposes (Hammer *et al.*, 1999). One of the popular medicinal plants in Asia is *Piper betle* (L) commonly known as betel vine belongs to the family Piperaceae. The *Piper betle* plant consisting of roots, leaves, stems, stalks and fruits. The heart shaped dark green colored leaves of betle vine are popularly called as *Pann*, in India and vettrilai in Tamilnadu. The use of *Piper betle* plant leaf has many beneficial health effects. The betle leaves are chewing habit practices in many countries which are believed that it can avoiding bad breath, preserving the teeth, strengthening the gum and stimulating the digestive system (Fazal *et al.*, 2014; Kaypetch *et al.*, 2018). The leaf extracts of *Piper betle* contains various phytochemicals like phenol, steroids, tannins, flavonoids, alkaloids and saponins also contains diastases, sugar and essential oil. The purified compounds of *P. betle* leaf extracts have the efficiency of antioxidant, antibacterial, antiseptic, anti-cancer, anti-inflammatory, and immunomodulatory (Aara *et al.*, 2020). The leaf extract of *Piper betle* are also used for cough, fever, fatigue, asthma, to disinfect wounds externally (Rai *et al.*, 2011). The pharmacological action of *Piper betle* plants were demonstrated based on their presence phytochemical constituents (Pradhan *et al.*, 2013). However these phytochemicals has been reported to be varying because of its geographical factors (Dwivedi and Tripathi 2014). Therefore, in the present study black and white *P. betle* leaves were used for the analysis of Phytochemicals using different solvents.

## MATERIALS AND METHODS

### Plant Materials

The study deep green heart shaped and light green heart shaped *Piper betle* leaves were selected and the name is called in Tamil Nadu is the deep green as Karupu vettrilai (Black *Piper betle*) and the light green as Vellai vettrilai (White *Piper betle*). The black and white *Piper betle* leaves were collected from three places such as Kumananchavadi (Fig.1: A-B), Guduvancheri ((Fig.1: C) and Poonamallee (Fig.1: D), Chennai, Tamil Nadu, India. The collection was made in the month of December 2021. The collected black and white *Piper betle* plants were photographed separately (Fig. 1). The wet weights of the collected black and white *Piper betel* leaves were measured. The collected both plants leaves were stored in a sterilized polythene bag and transported to the laboratory for further experiment. The collected black and white *Piper betle* leaves were washed with tap water and distilled water to remove microbes and dust particles. The washed leaves were shade and air dried at room temperature for two weeks and stored in air tight containers. The dried leaves were pulverized by grinding using mortar and pestle and finally dry weight was measured

### Preparation of Extract

The experiments were made using three different solvent namely Ethanol, Distilled water and Hot distilled water for the extraction of phytochemicals from the black and white *Piper betel* leaf powder. In the extraction procedure 20 g of black and white *Piper betle* plants leaf powders were used with 250 mL of three different solvents such as Ethanol, Distilled water and Hot distilled water separately for 72 h (3 Days) at room temperature. After three days the extracts were collected, filtered through muslin cloth, Whatman filter paper and evaporated by rotary evaporator at 40°C and stored in air tight glass container for qualitative phytochemical analysis.



Jegan *et al.*,**Qualitative Phytochemical Analysis**

The ethanol, distilled water and hot distilled water solvents extractions were subjected to phytochemical analysis by the method given by Harborne J.B., 1973. The phytochemical analysis was made separately for both black and white *Piper betle*.

**Test for Alkaloids****Mayer's Test**

To the extract, 2 ml of mayer's reagent was added; formation of reddish brown precipitate indicates the presence of alkaloids.

**Test for Saponins**

To 1 ml of the extract, 5 ml of water was added and the tube was shaken vigorously. Copious lather formation indicates the presence of saponins.

**Test for Tannins**

To the extract, ferric chloride was added, formation of a dark blue or greenish black color showed the presence of tannins.

**Test for Cardiac Glycosides****Keller-Killani Test**

To 1ml of the extracts, 2 ml of glacial acetic acid containing a drop of FeCl<sub>3</sub>. Equal volume of conc. H<sub>2</sub>SO<sub>4</sub> was added from the sides of the tube. A brown colour ring indicates the presence of cardiac glycosides.

**Test for Flavonoids**

**Alkaline reagent test:** Extract was treated with 10% NaOH solution; formation of intense yellow color indicates presence of flavonoid.

**Test for Phenols**

**Lead acetate test:** The extract was taken; 3 ml of 10% lead acetate solution was added. A bulky white precipitate indicated the presence of phenolic compounds.

**Test for Steroids**

1 ml extract was dissolved in 10 ml of chloroform & equal volume of concentrated H<sub>2</sub>SO<sub>4</sub> was added from the side of test tube. The upper layer turns red and H<sub>2</sub>SO<sub>4</sub> layer showed yellow with green fluorescence. This indicates the presence of steroid.

**Test for Terpenoids****Salkowski Test**

5 ml of extract was mixed in 2 ml of chloroform, and concentrated sulphuric acid was carefully added to form a layer. A reddish brown colouration of the interface indicates the presence of terpenoids.

**Test for Quinones**

The extracts were treated separately with Alc. KOH solution. Appearance of colors ranging from red to blue indicates the presence of quinones.

**Test for Proteins****Ninhydrin Test**

The extract was taken and few drops of freshly prepared Ninhydrin reagent was added and heated. The appearance of pink or purple colour indicates that the presence of proteins, peptides or amino acids.





## RESULT AND DISCUSSION

The plant *Piper betle* are commonly known as betel leaf which is climbing shrub or small tree indigenous to tropical Asia, Australasia and the Pacific and which are mostly grown in India, Bangladesh, Malaysia, Bhutan and China (Ghani, 2003; Rahman, 2010; Yusuf *et al.*, 1994). In India which is mostly cultivated in Tamil Nadu, Andhra Pradesh, Karnataka, Kerala, Maharashtra, Odisha, Bihar, Uttar Pradesh and Madhya Pradesh (Sengupta *et al.*, 2011). This study black and white *Piper betle* leaves were used for the extraction of phytochemicals and these were collected from Kumananchavadi (Fig.1: A-B), Guduvancheri (Fig.1: C) and Poonamallee (Fig.1: D), Chennai, Tamil Nadu, India. The collected leaves were subjected to remove microbes and dust particles. Then the wet and dry weight of the collected white and black *Piper betle* leaves were measured and which the Black *Piper betle* showed 696g of wet leaves given 90g of dry leaf powder and White *Piper betle* showed 946g of wet leaves given 102g of dry leaf powder (Table 1 and Fig. 2).

### Extractions

The extraction of active target compounds is depends on the polarity of the diluents because the polar compounds can able to extract easily by using of polar solvents (Goli *et al.*, 2005). The extractions of crude were made using the Black and White *Piper betle* leaf powder by the polar solvents such as ethanol, distilled water and hot distilled water. These different crude extracts were subjected to phytochemical analysis and which confirmed the presence of bioactive compounds (Table 2&3 and Fig 3&4).

### Phytochemical screening

The previous report of *Piper betle* plant leaves extraction contains various bioactive compounds such as alkaloids, tannins, saponins, steroids and polyphenols (Koff *et al.*, 1971). The Phytochemical analysis of this study also proved that the presence of maximum bioactive compounds in Black and White *Piper betle* leaves. The results of phytochemicals in Black *Piper betle* leaves was showed that the ethanol extract contains Alkaloids, Saponins, Tanins, Cardiac glycosides, flavonoids, Phenols, steroids, Terpenoids, Quinones and Proteins. In distilled water extract contains Saponins, Tanins, Cardiac glycosides, flavonoids, Phenols, steroids, Terpenoids, Quinones and Proteins. The hot distilled water extract contains Tanins, Cardiac glycosides, flavonoids, Phenols, Steroids, Terpenoids, Quinones and Proteins. However, the Alkaloids were absence in the two solvents such as Distilled water and hot distilled water extraction. Moreover the Saponins were absence in hot distilled water extraction when compared to ethanol and distilled water (Table 2: and Fig 3).

The results of phytochemicals in White *Piper betle* leaves was showed that the ethanol extract contains Alkaloids, Saponins, Tanins, Cardiac glycosides, flavonoids, Phenols, steroids, Terpenoids and Quinones. In distilled water extract contains Tanins, Cardiac glycosides, flavonoids, Phenols, steroids, Terpenoids, Quinones and Proteins. The hot distilled water extract contains Tanins, Cardiac glycosides, flavonoids, Phenols, Steroids, Terpenoids, Quinones and Proteins. However, the Protein was absence in ethanolic extraction when compared to Distilled water and hot distilled water extraction. The Alkaloids and Saponins were absence in the two solvents such as Distilled water and hot distilled water extraction when compared to ethanolic extraction (Table 3 and Fig 4). Moreover the previous study of Periyanyagam *et al.*, 2021 reported that the collected betle leaf from Tamilnadu absence of alkaloids but in this study showed that the collected black and white *Piper betle* leaf from Tamilnadu contains alkaloids especially in ethanolic extractions. The *Piper betle* leaves are contains the essential oils which have the properties of anti-fungal, antibacterial and anti-protozoan activities (Joseph *et al.*, 2010) and some studies reported that the plant leaves contains also high Antioxidants activities(Dasgupta, 2004; Majumdar *et al.*, 2002). These all pharmacological actions are based on their presence phytochemical constituents (Pradhan *et al.*, 2013). In this investigation the major phytochemicals are found in the black and white *Piper betle* leaves and these bioactive compounds can be used for pharmacological actions present and future.





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## CONCLUSION

The leaves of *Piper betle* are naturally chewing habit practices in many countries especially in India. In this study the preliminary phytochemical screening of black and white *Piper betle* leaves were showed the presence of various major bioactive compounds in the ethanol, distilled water and hot distilled water extracts. These bioactive compounds can be used as therapeutic drugs for Antidiabetic, Antioxidant and Antibacterial activity. The *Piper betle* plant is easy to cultivate and these plant extractions and methods are simple, cost effective and eco-friendly when compare to synthetic drug.

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Table 1: Wet and Dry weight of the Black and White *Piper betle* leaves

Sample	Wet Weight (g)	Dry Weight (g)
Black <i>Piper betle</i>	696	90
White <i>Piper betle</i>	946	102

Table 2: Phytochemicals from Black *Piper betle* leaf Extraction

Samples	Alkaloids	Saponins	Tannins	Cardiac glycosides	Flavonoid <sub>s</sub>	Phenols	Steroids	Terpenoid <sub>s</sub>	Quinones	Proteins
Ehanolic Extract of black <i>Piper betle</i> leaf	+	+	+	+	+	+	+	+	+	+
Distilled water Extract of black <i>Piper betle</i> leaf	-	+	+	+	+	+	+	+	+	+
Hot distilled water Extract of black <i>Piper betle</i> leaf	-	-	+	+	+	+	+	+	+	+

+ Present; - Absent

Table 3: Phytochemicals from White *Piper betle* leaf extraction

SAMPLES	ALKALOIDS	SAPONINS	TANNINS	CARDIAC GLYCOSIDES	FLAVONOIDS	PHENOLS	STEROIDS	TERPENOIDS	QUINONES	PROTEINS
Ehanolic Extract of white <i>Piper betle</i> leaf	+	+	+	+	+	+	+	+	+	-
Distilled water Extract of white <i>Piper betle</i> leaf	-	-	+	+	+	+	+	+	+	+
Hot distilled water Extract of white <i>Piper betle</i> leaf	-	-	+	+	+	+	+	+	+	+

+ Present; - Absent





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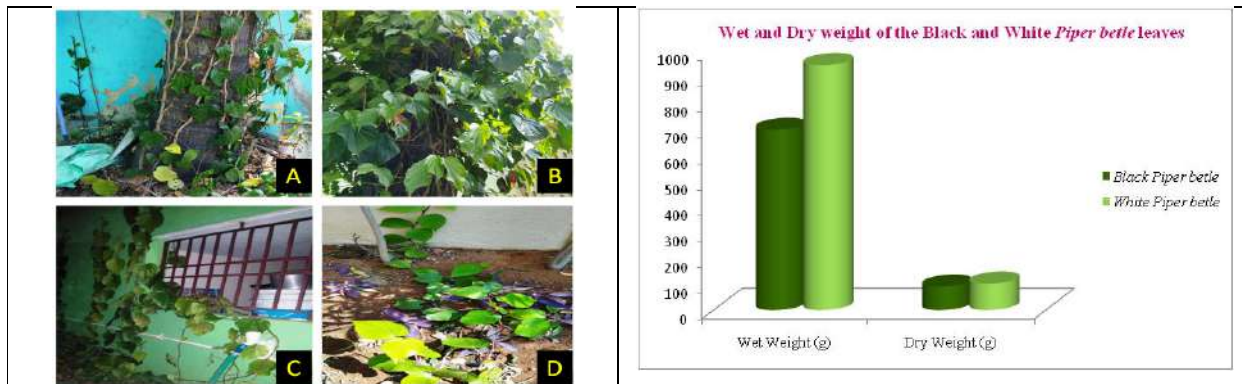


Fig 1: The collection of Black and White *Piper betle* leaves (A-B Kumananchavadi; C-Guduvancheri; D-Poonamallee)

Fig. 2: Wet and Dry weight of the Black and White *Piper betle* leaves

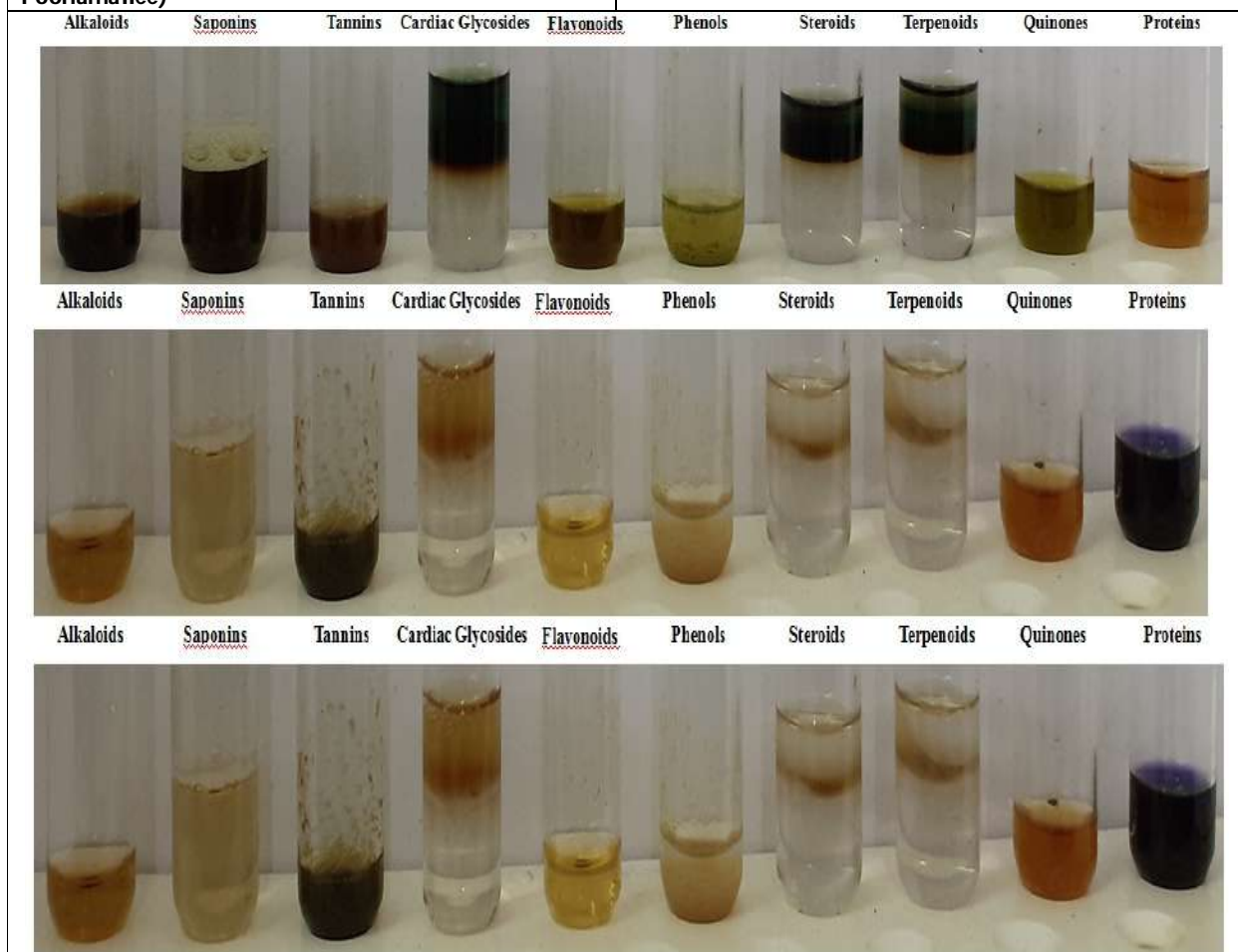


Fig 3: Phytochemicals from Ethanolic, Distilled water and Hot distilled water extract of Black *Piper betle* leaf





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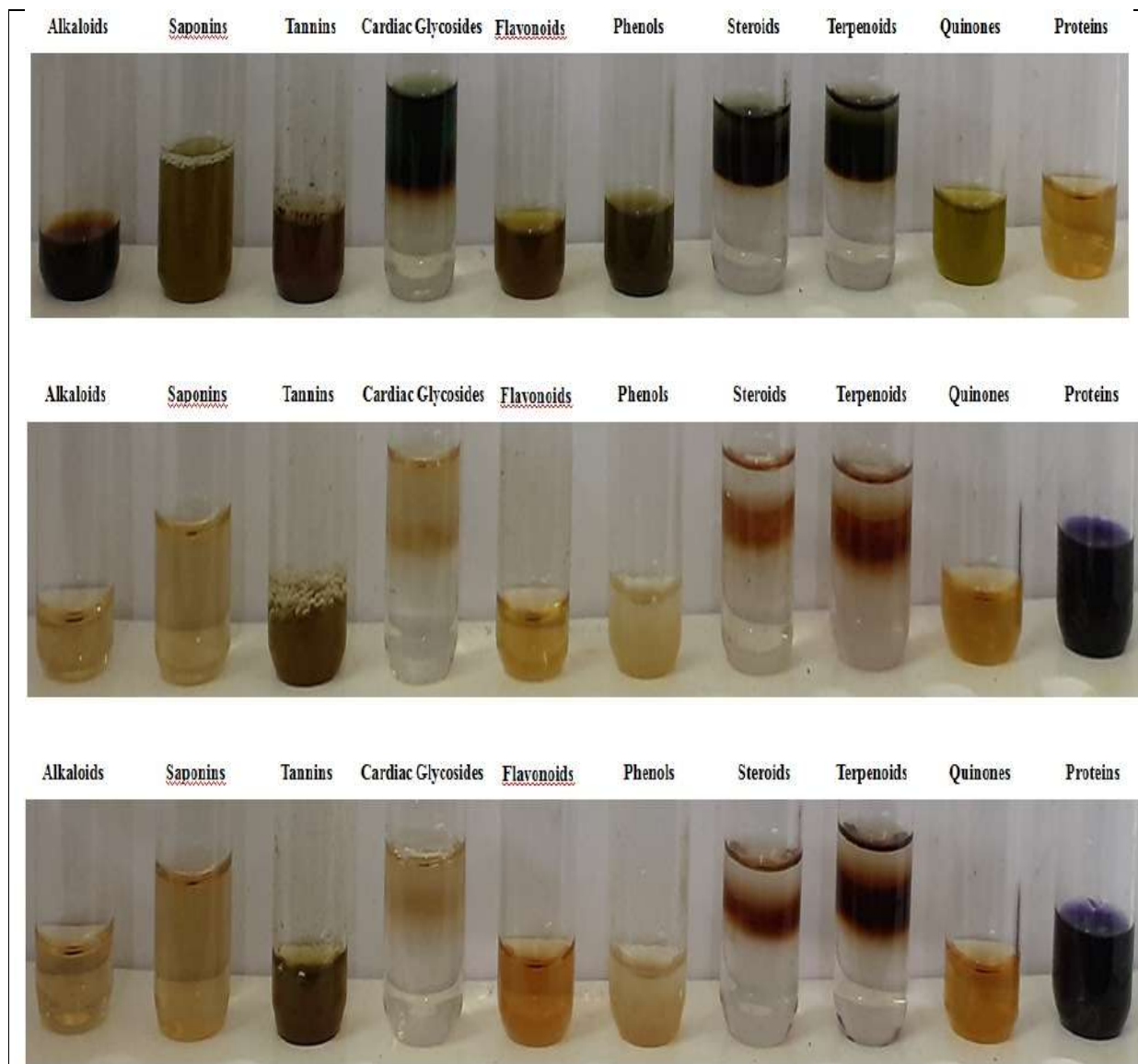


Fig 4: Phytochemicals from Ethanol, Distilled water and Hot distilled water extract of White Piper beetle leaf







## Effect of Shades on the Physiology of Tea Bushes

Dimonjyoti Bora\*

Research Scholar, Department of Life Sciences, Dibrugarh University, Dibrugarh, Assam, India

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### \*Address for Correspondence

#### Dimonjyoti Bora

Research Scholar,  
Department of Life Sciences,  
Dibrugarh University,  
Dibrugarh, Assam, India  
E.Mail: dimonjyotiborah@gmail.com



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### ABSTRACT

Globally tea (*Camellia sinensis* (L.) O. Kuntze) is widely accepted beverage which accommodates replete peculiar metabolites that are beneficial to human health. But the amount of epicuticular wax and chlorophyll and also the rate of photosynthesis of tea plant fluctuates due to the specific effect of shades on the plant. In terms of assimilate supply by way of photosynthesis, yield formation of tea is scrutinized. The present study deals with the effect of shade (i.e., heavy shade, moderate shade and no-shade condition) on physiological attributes of tea bushes. The main focus in this study is on how chlorophyll content, deposition of epicuticular wax on the surface of leaf and net photosynthesis of the plants are affected by contrasting shade conditions. Five different clones of tea plant (i.e., TV1, TV18, TV20, TV25, PANITOLA 126) is clutched from Tocklai tea gardens for the study. The study reveals that the chlorophyll content, mean wax accumulation and rate of photosynthesis is higher in moderate shade than heavy shade or no-shade condition. When yield potential and quality is considered, the tea bushes growing under medium shade shows the best performance. Distinct adaptation to shade is shown by the photosynthetic apparatus and other physiological process of tea.

**Keywords:** Photosynthesis, chlorophyll epicuticular wax, photosynthesis, shade conditions.

### INTRODUCTION

Globally tea (*Camellia sinensis*), which is considered as widely accepted beverage, is native to China. It is an evergreen shrub tilled in soils that are acidic in nature from tropical to temperature zones in Asia (Shuet *al.*, 2003). In well managed gardens, tea can endure fecund for a centenary as it is a durable commercial beverage crop. Due to their lengthy continuance, tea can resist the environmental provocations and adapt themselves physiologically to climate changes (Larson, 2015; Li *et al.*, 2017). C<sub>3</sub> mechanism of photosynthesis is revealed in tea plants (Roberts and Keys,





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1978). Although the stems play a part in CO<sub>2</sub> assimilation, the vital plant organ where photosynthesis transpire are the leaves of tea plants (Sivapalan, 1975). For photosynthesis, chlorophylls are considered as a crucial component and in all photosynthetic plant tissues, chlorophylls crop up in chloroplasts as green pigments. They are willingly draws out in organic solvents like acetone and others and are loosely bound to proteins (Dey, 2014). A physio-chemical blockade is furnished by epicuticular wax in tea plants in order to fortify against seizure by fungi and other baleful organism and also ameliorates hostility towards water lost. A large amount of simple chemical constituents such as hydrocarbons, aldehydes, wax ester, fatty acid etc have been secluded from waxes (Wollenweber, 1981). Tea is considered as a shade-loving plant which adapt themselves to the understorey of tropical rainforest in its vernacular habitat (Wang, 2012). Shade treatment can effectively fluctuate the physiological results in tea bushes as its physiology depends on the amount of sunlight received. This work clearly deals with the effect of shades on physiological attributes of tea bushes.

## MATERIALS AND METHODS

### Site Description

Tocklai Tea Research Institute is situated in the district Jorhat. It is located 26.7289° N latitude and 94.2281° E longitude. Various clones of tea plants are present in the institute's garden for various research purposes and other uses. Matured leaves of clones TV1, TV18, TV20, TV25 and PANITOLA 126 of Tocklai Tea Research Institute was taken for the calculation of chlorophyll content, leaf wax and photosynthesis of the tea bushes.

### Methods

#### For Estimation of Chlorophyll

Leaf discs of 5mm diameter were punched from matured leaves avoiding leaves veins. Leaf discs were then immediately weighted and immersed in 10 ml of 80% acetone in glass vials wrapped with aluminium foil kept in a refrigerator at 40°C for 72 hours. The supernatant was then decanted and the volume was made up to 10 ml with fresh acetone. The absorbance was recorded at 663 nm and 645 nm against 80% acetone as blank using spectrophotometer. Chlorophyll 'a' and chlorophyll 'b' were calculated adopting the equations suggested by Arnon (1949) based on the existing co- efficient for pigments. The equation adopted are given below-

$$\text{Chlorophyll 'a' (mg/g)} = [12.7(A_{663}) - 2.69(A_{645})]/1000 \times V/W.$$

$$\text{Chlorophyll 'b' (mg/g)} = [22.9(A_{645}) - 4.68(A_{663})]/1000 \times V/W.$$

Where V = Volume of the extract in millilitre.

W = Fresh weight of the sample in gram.

A<sub>663</sub> and A<sub>645</sub> are optical densities at respective wavelengths.

Chlorophyll concentration were expressed in milligram per gram of fresh weight of the sample.

#### For Estimation of Leaf Wax

Mature leaves were collected and their surface was cleaned with the help of wet cotton. Two sets of Petri plates were weighed for each variety and the initial weight of Petri plates was recorded. Leaf area of individual leaf was measured with the help of a leaf area meter and placed over the Petri plates. 10 ml of chloroform was poured on each Petri plates with leaf and allow to stand for 1 min. Then each leaf was properly rinsed in chloroform and then the leaves were discarded. The Petri plates along with the chloroform in it was left overnight. A tiny shining layer was observed on the surface of each Petri plates, which showed that the wax has been deposited. Finally, the weights of these Petri plates were taken. The amount of wax deposited was calculated by subtracting the initial weight from the final weight.

Wax present per unit area of the leaf = total wax present in the leaf/ leaf area.

#### For Photosynthesis Estimation

Gas exchange parameters like net photosynthesis are measured with the help of portable photosynthesis system CIRAS -2.





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## RESULTS AND DISCUSSION

### Results of Chlorophyll Estimation

Chlorophyll 'a' content in different clones ranged from 1.38-2.38 mg/g fr. wt. Chlorophyll 'a' content was highest in clone TV1 under moderate shade condition and lowest in the clone TV18 under no shade condition. Chlorophyll 'b' content in different clones ranged from 0.49-1.18 mg/g fr. wt. Chlorophyll 'b' content was highest in clone TV1 under moderate shade condition and was lowest in the clone TV1 & TV18 under no shade condition. Total chlorophyll content in different clones ranged from 1.87-3.13 mg/g fr. wt. It was observed that total chlorophyll content is higher in heavy shade condition compared to no shade and moderate shade condition in all the clones under investigation. Average data showed that chlorophyll content is comparatively higher in leaves growing under shaded condition than under non shaded condition. This may be due to increased photo-oxidation of chlorophyll under non shaded condition. Chlorophyll is constantly synthesized and destroyed (photo-oxidation) in the presence of light, but under very high light intensities the rate of decomposition is greater, with balance being established at a lower concentration (Kramer & Kozlowski, 1979). Shade leaves have higher concentration of chlorophyll than sun leaves (Boardman, 1977). Chlorophyll pigments harvest the solar energy and involve in light mediated reductive phosphorylation. They have direct correlation with photosynthetic carbon metabolism in higher plants. Due to the out-breeding nature of Camellia species, present day commercial plantations exhibit polymorphism, where each genotype shows significant colour differences. During processes such as fermentation, the chlorophyll-degradation chlorophyllase enzymes remain active, causing chlorophyll to degrade to pheophorbides and pheophytins. These compounds play a leading role in causing the resulting dark colour of fermented tea (Khamessan and Kermasha, 1995; Daood, 2003).

### Result of Leaf Wax Estimation

The wax content in the different clones ranged from 10.20- 151.07 ( $\mu\text{g}/\text{cm}^2$ ). Among the clones' highest leaf wax content was recorded in PANITOLA 126, which was maximum under moderate shade condition. Mean wax accumulation in our study was higher under moderate shaded condition compared to no shade and heavy shade condition. The above results indicates that moderate shade is suitable for high wax accumulation in tea plants, which impart them tolerance to biotic and abiotic stresses and has been implicated in defense mechanisms against excessive ultraviolet radiation, high temperature, bacterial and fungal pathogens, insects, high salinity, and low temperature (Domínguez *et al.*, 2011; Yeats and Rose, 2013). There are even distinctive cuticular waxes in different growth and developmental stages. Many environmental factors (e.g., light, temperature, and humidity) also influence wax composition considerably in the same species (Geyer and Schönherr, 1990; Kolattukudy, 1996).

### Result for Photosynthesis Estimation

Rate of photosynthesis under no shade condition ranged from 11.17 to 19.37  $\mu\text{mol}/\text{m}^2/\text{s}$ . Rate of photosynthesis under moderate shade condition ranged from 17.0 to 26.37  $\mu\text{mol}/\text{m}^2/\text{s}$ . Under heavy shade condition recorded rate of photosynthesis ranged from 5.63 to 11.13  $\mu\text{mol}/\text{m}^2/\text{s}$ . Highest rate of photosynthesis observed under moderate shade condition compared to heavy shade and no shade conditions in all the clones. The above results indicates that moderate shade, condition is most suitable condition for maximum photosynthesis in tea clones. Previous experimental findings have showed that shade trees interrupt the direct sun rays and provides adequate light i.e., 50-70% of the total sunlight, thereby rate of photosynthesis is increased by 24% compared to unshaded leaves. The yield of tea shoots under 35% light intensity was higher than that in plants grown with full sun (Barua, 1969). The net photosynthetic rate was significantly lower in unshaded tea compared to that of shaded tea (Mohotti and Lawlor, 2002; Karunaratne *et al.*, 2003). In our observations moderate shade condition was found to be more favourable condition for higher photosynthesis, that may be due to optimum light and optimum leaf temperature for maximum photosynthesis.

From the above study it is clear that the tea bushes growing under medium shade condition are found to be photosynthetically active because shade trees help in reducing the leaf temperature of the bushes and help in





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reflecting over 70% of harmful infra-red radiation from the solar spectrum. Epicuticular wax deposition is also found to be maximum in case of plants growing under medium shade while the chlorophyll a and chlorophyll b content has been found to be highest in case of bushes growing under heavy shade giving it a dark green colour whereas the bushes prevent in open condition (i.e., exposed to sunlight) are found to be light green in colour which is also correlated with the low chlorophyll content. It can be concluded that the tea bushes growing under medium shade are the best in performance when yield potential and quality is considered because there is a reduction in excessive heat and radiation. There is an increase in productivity as leaf area index and accumulation of dry weight in tea increases under medium shade condition. It has been also observed that there is a better partitioning of dry matter to actively growing shoots for higher harvest index in case of medium shade plants. At the same time, the leaf litters of shade trees add organic matter to the soil and also help in preventing soil moisture during dry winter months.

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**Table 1: Chlorophyll 'a' content in tea clones**

Clones	Chlorophyll a (mg/g fr. wt.)		
	NO SHADE	MODERATE SHADE	HEAVY SHADE
TV1	1.39	2.38	2.08
TV18	1.38	1.58	1.98
TV20	1.53	2.00	1.89
TV25	1.80	1.99	2.18
PANITOLA 126	1.46	1.67	1.74

**Table 2: Chlorophyll 'b' content in tea clones**

Clones	Chlorophyll b (mg/g fr. wt.)		
	NO SHADE	MODERATE SHADE	HEAVY SHADE
TV1	0.49	1.18	0.88
TV18	0.49	0.65	0.80
TV20	0.55	0.83	0.75
TV25	0.69	0.88	0.70
PANITOLA 126	0.54	0.62	0.72

**Table 3: Total chlorophyll content in tea clones**

Clones	Total Chlorophyll (mg/g fr. wt.)		
	NO SHADE	MODERATE SHADE	HEAVY SHADE
TV1	1.88	3.56	2.97
TV18	1.87	2.23	2.84
TV20	2.08	2.83	2.64
TV25	2.49	2.87	3.13
PANITOLA 126	2.00	2.29	2.47

**Table 4: Leaf wax content in tea clones**

Clones	Leaf Wax ( $\mu\text{g}/\text{cm}^2$ )		
	NO SHADE	MODERATE SHADE	HEAVY SHADE
TV1	68.30	100.52	75.62
TV18	74.89	52.50	40.67
TV20	38.03	38.99	10.20
TV25	31.72	59.71	92.24
PANITOLA 126	147.77	129.23	151.07
Mean	360.70	380.94	369.78



**Dimonjyoti Bora****Table 5: Photosynthesis estimation content in tea clones.**

Clones	Photosynthesis Estimation ( $\mu$ mol/m <sup>2</sup> /s)		
	No Shade	Moderate Shade	Heavy Shade
TV1	11.17	17	5.63
TV18	19.37	21.1	9.53
TV20	17.57	25.1	11.13
TV25	16.3	26.37	10.8
PANITOLA 126	13.13	19.87	8.7





## Checking the Adequacy of Signal Timings at an Isolated Signalized Intersection under Mixed Traffic Conditions: A Case study of ECIL Cross Roads Signalized Intersection in Hyderabad City, India

R.Prasanna Kumar<sup>1\*</sup>, Akella Naga Sai Baba<sup>2</sup>, A.Krishnaja<sup>3</sup>, CR.Jayshree<sup>3</sup>,A.Bhanu Prasad<sup>3</sup> and S.Manikanta<sup>3</sup>

<sup>1</sup>Professor of Civil Engineering and Registrar, Geethanjali College of Engineering and Technology (A),Cheeryal Village, Keesara Mandal, Hyderabad, Telangana, India

<sup>2</sup>Assistant Professor of Civil Engineering, Malla Reddy Engineering College (A), Hyderabad, Telangana, India.

<sup>3</sup>Under Graduate Student, Geethanjali College of Engineering and Technology (A), Cheeryal Village, Keesara Mandal, Hyderabad, Telangana, India.

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### \*Address for Correspondence

**R.Prasanna Kumar**

Professor of Civil Engineering and Registrar,  
Geethanjali College of Engineering and Technology (A),  
Cheeryal Village, Keesara Mandal,  
Hyderabad, Telangana, India.

E.Mail: prasannakumar.ce@gcet.edu.in



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### ABSTRACT

Many signalized intersections functioning in India are fixed time signals and most of the times the signal timings are decided based on the prevailing traffic volume conditions using some approximations. The signalized intersection located at ECIL cross roads attracts huge traffic from all the legs. In the present study traffic volume data was extracted from the video footage obtained from the city traffic wing. One unique feature of the present study was that, while extracting data from the video footage python programming code was used and hence the data was retrieved very quickly from the video footage. The other special features of the study include determination of saturation flow from the actual data collected using the saturation headway and PCU values recommended by Indo HCM 2017 for signalized intersections were used to convert the different vehicles of mixed traffic into equivalent PCU s. Using these inputs of traffic volume, saturation flow determined relatively more accurately, the optimum cycle time and signal timings were designed by Webster method. For Computing the signal timings, a C program was written and executed successfully. It was found from the analysis of results that at two approaches the existing green timings were not adequate and at the third approach, it was over estimated.

**Keywords:** HCM, PCU, Isolated, ECIL





## INTRODUCTION

Road traffic signals are the major bottlenecks in the smooth flow of traffic in general and more so in case of mixed traffic conditions, where in all the different types of vehicles with varying static and dynamic characteristics share the common space. Due to this reason the traffic flow at these locations is affected and results in increased delay to the vehicles. In order to reduce the delay and smoothen the flow of traffic, it is always desirable to check the adequacy of signal timings periodically at these locations. Periodicity may depend on several factors, but one of the major factor is increase in traffic volume and the resulting delay to the vehicles. In view of the above, in the present study, it is proposed to check the adequacy of signal timings at the ECIL signal, located in Hyderabad, India. Many times the road users expressed their dissatisfaction regarding the delay caused to the vehicles. As part of the study, it is proposed to collect the classified traffic volume data entering into the intersection from various approaches, and also to study the existing geometric condition of the intersection. It was observed from the geometry of the intersection that, there was a small rotary existing at the intersection, in addition to the traffic light signals. It is also proposed to use open CV software for retrieving the video recorded traffic data. Indo HCM 2017 proposed PCU values for signalized intersections were used to convert the different vehicle groups into PCUs. It is planned to determine the saturation flow, an important input parameter for signal timings from the average of several saturation headways and finally design the cycle length and signal timings, following Webster method and using a C program.

## REVIEW OF LITERATURE

Pranav Kumar Pal and Kamal Nabh Tripathi (2022) carried out research on signal timing design for a in Luck now city and used Webster method and IRC methods for design. Hima Bindu Maripini *et al* (2022) presented an optimal signal design using sample travel time information collected from mobile data and found that the proposed design is capable of handling traffic flow fluctuations without requiring the entire traffic stream data. They also demonstrated that sample data from four probe vehicles per phase is adequate for real-time optimal signal design. Jiangfan Yang *et al*(2021), optimized the signal timings using Webster method and from their results found that the average delay at the intersection is reduced by nearly 7 seconds, and the optimization effect is significant. Madhav Kumar *et al* (2020) redesigned the signal timings according to the present scenario of traffic. The design was according to the IRC and Webster method of signal design. The field traffic flow data was taken for an hour using a digital video camera. The study concluded that the IRC method is more suitable than Webster for the existing traffic conditions. To ensure the free flow of traffic and reduction in conflicts redesigning was done. Prasanna Kumar *et al* (2018) carried out a study for improving the safety of an uncontrolled road traffic junction at Maisammaguda, in Hyderabad and it is a T-junction and designed the traffic signals based on the Webster method.

### Objectives of the Present Study

In the present study the following objectives are defined.

- To collect the geometric details of the study intersection
- To collect the classified traffic volume data of the study intersection from the video footage using Open CV software
- To determine the saturation flow rate
- To design signal timings using Webster method with the help of C program

### Methodology and Data Collection

The methodology followed in the present study is given in the following steps.

1. Identification and description of study location
2. Geometric details of the intersection
3. Collecting the Video footage of traffic data pertaining to the location from traffic police wing and
4. Retrieval of the data from the Video footage using open CV software







5. Conversion of traffic volume into PCUs and determination of design hourly volume
6. Determination of saturation flow rate
7. Computation of optimum cycle time and signal timings using Webster's method
8. Presenting the signal timings in signal timing diagram
9. Comparison with existing timings

### Identification and Description of Study Location

The study location is the signalized intersection located near ECIL cross roads, in Hyderabad, Telangana state of India and is located at Latitude: 17.451749 and Longitude: 78.567116. It is an important intersection catering to the diverse categories of residential, commercial and school and college users. It also connects several important areas surrounding the location that include Moula Ali, AS Rao Nagar, Tarnaka, and Kushaiguda.

### Geometric Details of the Intersection

Geometric details of the intersection such as number of lanes, width of lanes etc. was collected by taking physical measurements at the location and the diagram showing all the geometric details is given in **Figure -2**. Classified traffic volume data was collected for the identified peak hour by extracting the video footage data obtained from the traffic wing of Hyderabad police.

### Collecting the Video footage of traffic data pertaining to the location from traffic police wing and Retrieval of the data from the Video footage using open CV software

For retrieving the video graphic data, an advanced vehicle detection and classification system with the aid of Open CV was used. YOLOv3 algorithm in conjunction with Open CV was used to detect and classify objects. YOLOv3 is trained on the COCO dataset, to read the files containing different categories of vehicles and store them in a list. The COCO dataset includes 80 distinct classes. In the present study it is only needed to detect cars, motorcycles, buses, and trucks, and hence the required class index contains the index of those classes from the COCO dataset. A random colour is generated for each class of vehicle in the dataset using the `np.random.randint()` function. These colours were used to draw the rectangles around the objects. The `random.seed()` function saves the state of a random function so that it can generate some random number on each execution. Frames from a video file were retrieved and then `Cap.read()` reads each frame from the capture object after reading the video file through the video capture object. The frame was cut in half by using `cv2.reshape()`. The crossing lines were then drawn in the frame using the `cv2.line()` function. Finally, the output image was displayed using the `cv2.imshow()` function. Snapshots of retrieval of video data is shown in **Figure -3**. Summary of traffic volume data obtained from the four legs of the study intersection is furnished in **Table -1** below.

### Conversion of traffic volume into PCUs and determination of design hourly volume

In the present study, the PCU values developed for signalized intersections and given in Indo HCM 2017 were used to convert the vehicles of different types and arrive at the design hourly volume. The PCU values used in the study are presented in **Table 2**.

### Determination of saturation flow rate

Saturation flow was computed from the average saturation headway of 25 cycles from each of the approaches for the straight going and right turning vehicles and then determined the number of vehicles going in the determined hourly saturation flow rate by dividing number of seconds in an hour (3600) with the average saturation headway. The obtained Saturation flow values are presented in **Table: 4** below.

### Computation of optimum cycle time and signal timings using Webster's method

Optimum Cycle Time by Webster's Method

Cycle length is the total period during which one complete sequence of signalization takes place around an intersection. A complete cycle comprises all the phases with their respective signal indications. The cycle length with minimum delay is often termed optimum cycle length, and it can be determined by Webster's equation:





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$$C_0 = 1.5L + 5 / 1 - Y_i$$

where  $C_0$  = optimum cycle length in seconds

and  $L$  = sum of the lost time (seconds) for all phases =  $l_1 + l_2 + l_3 \dots + l_i$  up to  $i$  number of phases.

Lost time per phase = Start up time (usually 1-2 sec) + Clearance lost time

Clearance lost time = A portion of the Amber interval (usually 1-2 sec) + All-Red interval  $Y_i = Y_i = \text{summation } (y_1 + y_2 + y_3 + y_4 + y_i)$

$Y_i$  = Flow ratio

Calculation of Green Time

Effective Green time ( $g_i$ ) for the respective  $i^{\text{th}}$  phase can be calculated from the following expression  $g_i = y_i / Y_i (C_0 - L_i)$

where  $g_i$  - effective green period of phase  $i$   $y_i$  = flow factor of phase  $i$ ;

$C$  = cycle length;

$L$  = total lost time

$Y$  = sum of  $y$  factors and

$C_0 - L_i$  = total effective green time

The C program written for signal timing design is presented as Annexure -1

The signal timings obtained are given in Table:5 below and the timing diagram is shown in figure 5 below.

## SUMMARY, CONCLUSION AND RECOMMENDATION

Signal timing design was carried out from the real time data collected from traffic police wing and extracted using open CV software and a C program was executed to compute the signal timings in Webster method. It was found that at North bound approach and west bound approaches the existing green timings were not adequate and at south bound approach the existing green time was over estimated. It is believed that these signal timings estimated in the present study based on actual traffic conditions, if implemented will reduce the delay to vehicles. It is also recommended that the rotary present inside the intersection area be removed so that the traffic flow can be improved and delay to vehicles also can be significantly reduced.

## ACKNOWLEDGEMENT

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### Annexure -1

#### 'C' Program for Signal timing design

```
#include <stdio.h>
#include <math.h> int main()
{
int n, r, l;
float qa, qb, sa, sb,sc,qc;
float ya, yb,yc, y, co, b, a, ga, gb,gc;
printf ("Enter the number of phases - n = ");
scanf ("%d", &n);
printf ("Enter the value of all red time - r = ");
scanf ("%d", &r);
l = 2 * n;
l = l + r;
printf ("\n The value of lost time is %d sec ", l);
printf ("\n Calculate the optimum cycle length ");
printf ("\n Enter the value of normal and saturation flow ");
scanf ("%f%f%f%f%f", &qa, &qb,&qc,&sa,&sb,&sc);
ya = floorf((qa / sa)*10)/10;
yb = floorf((qb / sb)*10)/10;
yc = floorf((qc / sc)*10)/10;
y = ya + yb+yc;
printf ("\n The value of ya is %.1f", ya);
printf ("\n The value of yb is %.1f", yb);
printf ("\n The value of yc is %.1f", yc);
printf ("\n the value of y is %.1f", y);
co=((1.5*l)+r)/(1-y);
printf ("\n The value of co is %.1f ", co);
a = co - l;
ga = (ya*a)/y;
printf ("\n The value of green time at phase A is %.1f ", ga);
gb = (yb*a)/y;
printf ("\n The value of green time at phase B is %.1f ", gb);
gc = (yc*a)/y;
printf("\n The value of green time at phase c is %.1f ",gc);
return 0;
}
```





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**Table: 1 Traffic Volume Data at the Intersection**

Name of the approach	No of Autos	No. of two Wheelers	No of Buses	No.of Cars	No.of LCVs	No. of HCV
North Bound (Straight and Right)	257	1738	37	207	88	28
South (Straight and Right)	162	854	36	270	21	04
West (Straight and Right)	311	1465	68	713	82	11

**Table: 2 PCU Values Used**

SNo	Vehicle Type	PCU
1.	Two Wheelers	0.4
2.	Autos	0.5
3.	Passenger Cars	1.0
4.	LCVS	1.1
5.	HCVS	1.6
6.	Bus	1.6

Source: Indo HCM 2017

**Table: 3 Design hourly Volume in PCU/h**

SNo	Name of the approach	Design hourly volume (PCU/h)
1.	North Bound	1232
2.	South Bound	780
3.	West Bound	1672

**Table: 4 Saturation Flow in PCU/h**

SNo	Name of the approach	Saturation Flow (PCU/h)
1.	North Bound	2073
2.	South Bound	3346
3.	West Bound	10004

**Table: 5 Comparison of Signal Timings**

SNo	Name of the approach	Green Time (Seconds)	
		Existing	Proposed
1.	North Bound	90	110
2.	South Bound	55	45
3.	West Bound	20	25





Figure 1: Ariel View of the Study Intersection

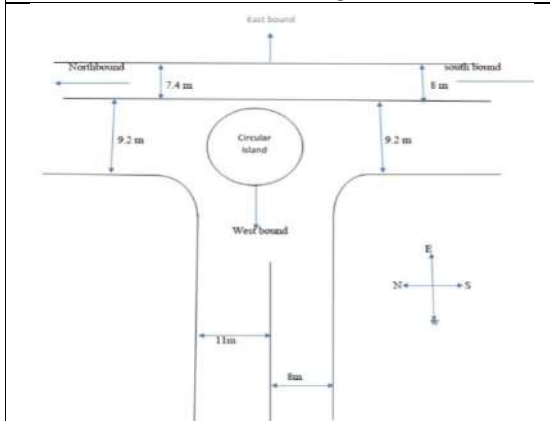


Figure 2: Geometric Details of Study Intersection



Figure 3: Snapshots of retrieval of video data

Direction	car	motorbike	bus	truck
Up	0	0	0	0
Down	0	0	0	0

Direction	car	motorbike	bus	truck
Up	0	0	0	0
Down	43	31	1	4

Figure 4: Excel Sheet before and after Execution





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Figure 5: Timing Diagram





## Evaluation of Antihyperlipidemic Activity of *Gossypium arboreum* Leaf Extract

Vijetha Pendyala<sup>1\*</sup>, Vidyadhara Suryadevara<sup>2</sup>, Saireshma Ramineni<sup>3</sup>, Sandeep Doppalapudi<sup>4</sup> and Lakshman Kumar Dogiparthi<sup>1</sup>

<sup>1</sup>Associate Professor, Department of Pharmacognosy and Phytochemistry, Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur, Andhra Pradesh, India.

<sup>2</sup>Professor and Principal, Department of Pharmaceutics, Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur, Andhra Pradesh, India.

<sup>3</sup>Lecturer, Department of Physiology and Pharmacology, Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur, Andhra Pradesh, India.

<sup>4</sup>Associate Professor, Department of Pharmacognosy and Phytochemistry, Chebrolu Hanumaiah Institute of Pharmaceutical Sciences, Guntur, Andhra Pradesh, India.

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### \*Address for Correspondence

#### Vijetha Pendyala

Associate Professor,

Department of Pharmacognosy and Phytochemistry,  
Chebrolu Hanumaiah Institute of Pharmaceutical Sciences,  
Guntur, Andhra Pradesh, India.

E. Mail: vijetha.85@gmail.com



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### ABSTRACT

Hyperlipidemia is a metabolic dysregulation associated with increased risk factors for the development of diabetes, premature development of cardiovascular diseases such as atherosclerosis, hypertension and coronary heart disease. *Gossypium arboreum* (Malvaceae) commonly known as cotton plant was used traditionally for the treatment of diarrhea and inflammatory conditions. It was reported to contain flavanoids like Gossypetin-O-glucoside, Quercetin-O-glucoside which play major role in anti-oxidant and anti-hyperlipidemic activity. So far, there is no scientific work reported on the anti-hyperlipidemic effect of this plant or its extracts. Keeping this in view, the present study was envisaged to investigate the possible antihyperlipidemic effect of *Gossypium arboreum* leaf extract in Triton-X induced hyperlipidemic rats. Antihyperlipidemic drug, Simvastatin (10mg/kg body wt.) was used as a positive control. Serum lipid parameters like total cholesterol, triglycerides, low density lipoprotein (LDL), very low density lipoprotein (VLDL) and high density lipoprotein (HDL) in hyperlipidemic rats and test groups are compared to normal control statistically. From the results, it was observed that, treatment with *G. arboreum* leaves extract (200 mg /kg and 400 mg/kg) significantly decreased the level of cholesterol,





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triglycerides, VLDL and LDL as compared to hyperlipidemic control. There was significant increase in the HDL as compared to hyperlipidemic control.

**Keywords:** Hypolipidemic activity, *Gossypium arboreum*, Flavanoids, Triton-X induced hyperlipidemia, Simvastatin, Phytochemical screening.

## INTRODUCTION

Lipids are the major components which serve as the major structural component of the body and also act as energy source. The plasma contains lipoproteins like high density lipoproteins (HDL), low density lipoproteins (LDL), very low-density lipoproteins (VLDL) and chylomicrons whose levels determine the human health. Hyperlipidemia is a condition in which an elevation in the blood lipid concentration was observed. It often results from delayed or defective clearance, or overproduction of VLDL by the liver, which subsequently transforms into LDL. Higher concentrations of LDL and low levels of high density lipoprotein (HDL) cholesterol in blood predict the cardiovascular risk in both men and women [1]. Life style habits like lack of exercise, smoking, age, excess alcohol intake causes hyperlipidemia. Other conditions like obesity, diabetes mellitus and pregnancy also have a part in causing hyperlipidemia[2]. Hyperlipidemia develops as a consequence of abnormal lipoprotein metabolism or reduction in the LDL receptor expression or activity and consequently diminishing the hepatic LDL clearance from the plasma. Various protein targets like HMG CoA reductase, bile acids and lipoprotein lipase have been selected in these pathways for the treatment of hyperlipidemia. Among all the hypolipidemics, HMG CoA reductase inhibitors, "statins" were effectively used. Statins mainly work by inhibiting the enzyme HMG CoA reductase, which is a key regulatory enzyme in the biosynthesis of cholesterol[3].

*Gossypium arboreum*(Tree Cotton) is a shrub attaining heights of one to two metres. Its branches are covered with pubescence and are purple in colour. Stipules are present at the leaf base and they are linear to lanceolate in shape and sometimes falcate. The leaves are glabrescent. The leaves exhibit a dentate margin though sometimes only very slightly so. They are cordate at the base and acute at the apex[4]. The flowers are set on short pedicels. An epicalyx is present, which is a series of subtending bracts that resemble sepals. True calyx is small, measuring only about 5 millimetres (0.20 in) long. The fruit is a three- or four-celled capsule measuring 1.5 to 2.5 centimetres (0.59 to 0.98 in) across. It is ovoid or oblong in shape and glabrous. The surface is pitted and a beak is present at the terminal end. The seeds within are globular and are covered in long white cotton[5].

Phytochemical review of this plant reported the presence of phenols, flavonoids and triterpenoids as major constituents. *Gossypium arboreum* is reported for its antidiabetic, antihypertensive, and antifungal activity. Infusion of the leaves of *Gossypium arboreum* is used to reduce respiratory complications like cough and cold[6, 7]. Analgesic and anti-inflammatory effect of the ethanolic leaf extract was established by using carrageenan-induced paw edema and tail flick model in rats. Leaf extract showed significant activity in tail flick model and a dose dependent inhibition of carrageenan-induced paw edema. Aqueous and acetone extract of *G.arboreum* exhibited potent  $\alpha$ -amylase and  $\alpha$ -glucosidase inhibitory activity at relatively low concentrations with IC<sub>50</sub> value of 10.10 mg/mL and 2.75 mg/mL respectively [8]. The extracts were also found to contain phytochemicals such as tannins and steroids which may be responsible for the inhibitory effect. Based on previous literature, we selected this plant for evaluating the antihyperlipidemic activity. Flavanoids are one of the important classes of phytochemical components from various plant sources. Research on flavanoids is increasing because of their versatile health benefits [9]. Flavanoids prevent coronary heart disease, scavenge free radicals and have hepatoprotective, anti-inflammatory, and anticancer activities, while some flavanoids exhibit potential antiviral activities[10].







## MATERIALS AND METHODS

### Plant Material

Leaves of *Gossypium arboreum* were collected in the medicinal garden of our institute and are authenticated by Dr.K.Ammani, Associate professor, Acharya Nagarjuna University. The collected leaves were dried and powdered to coarse consistency in cutter mill. The powder was passed through 40 # mesh particle size and stored in an airtight container at room temperature.

### Chemicals and Drugs

A suspension of triton -X (S D Fine chemicals) in 0.15 M NaCl was used for inducing hyperlipidemia in experimental rats. Simvastatin (Dr. Reddy's Laboratories, Hyderabad), Diagnostic kits for estimation were purchased from Merck Diagnostics India Ltd. Anesthetic ether (Ozone International, Mumbai), and all other chemicals were of analytical grade.

### Extraction

2.5 kg of the fresh air-dried, powdered leaves were extracted with alcohol and water (80:20) by simple maceration procedure at room temperature for 48 h in conical flask with occasional shaking and stirring. The extract was filtered and concentrated to dryness at room temperature to avoid the decomposition of the natural metabolites. The extract was preserved in a refrigerator till further use.

### Preliminary Phytochemical Screening of Plant Extract

Various qualitative tests were performed for the detection of phytochemical constituents present in the hydroalcoholic extract. Different tests were performed for the presence of carbohydrates, tannins, flavanoids, steroids, glycosides, alkaloids, saponins etc [11].

### Fractionation of Extract

The hydroalcoholic extract concentrate (130 mL) was partitioned repeatedly with petether, ethyl acetate (1:1 v/v) in a separating funnel to obtain the petether, ethyl acetate and residual hydro-alcoholic fractions. The solvents were evaporated under reduced pressure;

### Total Flavonoid Content

The total flavanoid content (TFC) content was determined according to the method of Zhishen et al., 1999. Each fraction of sample (0.2 ml) was added to 4 mL of double-distilled water and 0.3 mL of 5% NaNO<sub>2</sub> in a 10ml volumetric flask. The samples were maintained for 5 min, and 0.3 mL of 10% AlCl<sub>3</sub> was added. After 6 min, 2 mL NaOH was added and was made up to mark with double-distilled water. The absorbance was measured at 510 nm. TFC was calculated using a calibration curve of quercetin equivalents.

### Animal Studies

Adult albino rats of wistar strain (150-200 g) of either sex was procured and housed in the animal house. Standard pellets obtained from Gold mohar rat feed, Mumbai India, were used as a basal diet during the experimental period. The control and experimental animals were provided food and drinking water and libitum. All the animal studies were approved by Institutional Animal Ethical committee 1529/po/Re/S/11/CPCSEA/CHIPS/IAEC8/PRO-02/2020-21.

### Preparation of Test Sample

Hydroalcoholic extract of the plant and different fractions were formulated as suspension in distilled water using Tween-80 as suspending agent.

### Preparation of Standard

Simvastatin 10 mg/kg was used as the reference standard drug for evaluating the antihyperlipidemic activity which



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was made into suspension in distilled water using Tween-80 as a suspending agent.

**Triton-X Induced Hyperlipidemic Model [12].**

Animals kept for fasting for 24 h, were injected a saline solution of triton at the dose of 400 mg/kg intra-peritoneally. Plant extracts, at the dose of 200mg/kg, were administered orally through gastric intubation, the first dose being given immediately after triton injection and second dose 20 h later. After 4 h of second dose the animals were screened for various biochemical parameters. Blood was collected from orbital plexus of rat under ether anesthesia and centrifuged by using centrifuge at 2000 rpm for 30 minute to get serum.

**Experimental Design**

Animals were divided into five different groups with six animals in each group. Group I served as normal control and this group received regular standard pellet diet. Group II was hyperlipidemic control (Disease control) and this group did not receive any treatment except triton (400mg/kg/p.o). Group III was positive control which was given standard antihyperlipidemic drug simvastatin (10 mg/kg/day p.o.) along with Triton-X. Group IV and V received leaf extracts of *G. arboreum* (200 & 400 mg/kg/day, p.o.). Treatment period for all these groups was 48 hours.

**Method for *in-vivo* Anti-Hyperlipidemic Activity of Leaf Extract of GA**

Blood was collected by retro-orbital sinus puncture, under mild ether anesthesia. The collected samples were centrifuged for 10 minutes. The serum was assayed for total cholesterol, triglycerides, high-density lipoprotein (HDL), low density lipoprotein (LDL), and very low-density lipoprotein (VLDL) using standard protocol method. Serum total cholesterol, triglyceride was estimated by the method of CHOD-PAP and high-density lipoprotein by the method of GPO-PAP. Low density and very low-density cholesterol were calculated by using Friedwald formula and VLDL: TG/5 respectively. The results of the study were expressed as mean  $\pm$  S.E.M. Data was analyzed by using one way analysis of variance test (ANOVA) followed by Dunnett's t-test for multiple comparisons. Values with  $P < 0.05$  were considered significant.

**RESULTS AND DISCUSSION****Results of Phytochemical Analysis**

Phytochemical screening of all the extract of *G. arboreum* showed the presence of various phytochemical constituents like flavonoids, triterpenoids, carbohydrates, tannins, phytosterols and traces of alkaloids.

**Results of Anti Hyperlipidemic Activity**

The effect of the hydroalcoholic extract of leaves of *G. arboreum* was studied on serum lipids and lipoproteins level of triton (400 mg/kg) induced hyperlipidemic rats and results are expressed as change in serum lipid and lipoprotein levels. As expected, administration of triton X led to elevation of serum lipid and lipoprotein levels, which were maintained over a period of study in hyperlipidemic control group and these rats, were given treatment with the plant extract. The results were comparable with reference standard simvastatin. There was a significant elevation in serum lipids and lipoproteins in triton induced hyperlipidemic control rats when compared with normal control. At this time an increased level of HDL-Cholesterol was also observed. 400 mg/kg body weight *G. arboreum* leaf extract reduced serum lipids significantly ( $p < 0.001$ ) as compared to hyperlipidemic control statistically.

Treatment with *G. arboreum* leaves extract (400 mg/kg) significantly decreased the level of cholesterol, triglycerides, VLDL and LDL as compared to hyperlipidemic control. There was significant increase in the HDL as compared to control. This effect may be due to the increased activity of lecithin: cholesterol acetyl transferase which incorporates free cholesterol, free LDL into HDL and transferred back to VLDL and intermediate density lipoprotein. Decrease in the triglyceride level may be due to the increase in activity of the endothelium bound lipoprotein lipase which hydrolyses the triglyceride into fatty acid or due to inhibition of lipolysis so that fatty acids do not get converted to triglyceride.





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Hepatic cholesterol synthesis is accelerated by triton X. Moreover, triton physically alters very low-density lipoproteins rendering them refractive to the action of lipolytic enzymes of blood and tissues, preventing or delaying their removal from blood. Hence the hypolipidemic effect of extracts could be due to an increased catabolism of cholesterol into bile acids. The results obtained from the pharmacological screening have led to the conclusions that, hydroalcoholic extract of *G. arboreum* leaves have significant antihyperlipidemic activity. Hence it can be exploited as antihyperlipidemic therapeutic agent or adjuvant in existing therapy for the treatment of hyperlipidemia.

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**Table 1: Experimental Design for evaluation of Anti-hyperlipidemic activity**

Group	Experimental Groups	Treatment
I	Normal Control	Normal Saline
II	Hyperlipidemic or Disease Control	Triton-X in saline (400 mg/kg)
III	Standard	Simvastatin (10 mg/kg)
IV	Test-I	GA extract (200 mg/kg body weight)
V	Test-II	GA extract (400 mg/kg body weight)





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**Table-2: Results of phytochemical analysis**

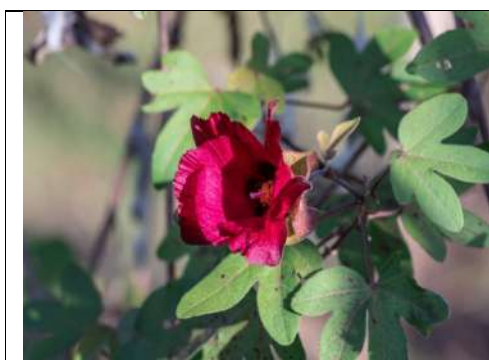
S. No	Plant Constituents	Test Performed	Result
1.	Carbohydrates	Molisch's test	+
2.	Proteins	Ninhydrin test	-
3.	Flavanoids	Shinoda's test	+
4.	Alkaloids	Mayer's test	+
5.	Steroids	Liebermann burchard's test	+
6.	Terpenoids	Salkowski test	+
7.	Saponins	Froth test	+
8.	Tannins	Ferric chloride test	+
9.	Glycosides	Keller- kiliani test	-
10.	Phenolic compounds	Ferric chloride test	+
11.	Fixed oils	Spot test	-

**Table 3: Total Flavanoid Content**

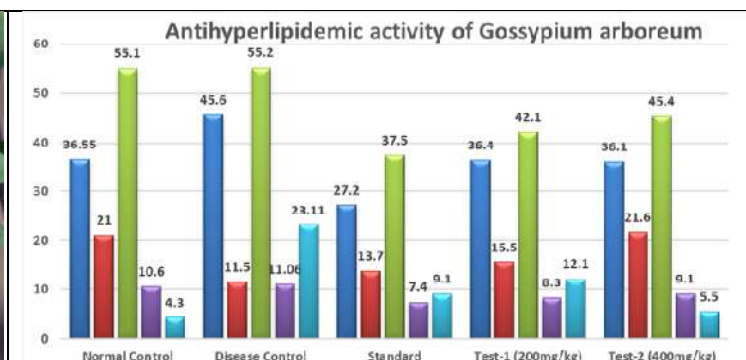
Total Flavanoid Content	Pet Ether Fraction	Ethyl acetate Fraction	Hydro Alcoholic Fraction
	0%	3%	9%

**Table 4: Results of Anti-Hyperlipidemic Activity**

Groups	Total Cholesterol	HDL	TG	VLDL	LDL
Normal Control	36.55±14.2	21±4.9	55.1±6.2	10.6±1.6	4.3±5.1
Disease Control	45.6±4.4	11.5±3.3	55.2±3.4	11.06±0.6	23.11±3.8
Standard	27.2±1.5**	13.7±4.2*	37.5±6.9**	7.4±1.4**	9.1±0.5**
Test-1 (200mg/kg)	36.4±3.5*	15.5±0.5**	42.1±3.3*	8.3±0.6*	12.1±3.7*
Test-2 (400mg/kg)	36.1±3.7*	21.6±2.1**	45.4±3.6*	9.1±0.7*	5.5±1.0**



**Figure 1: Image of *Gossypium arboreum***



**Figure 2: Graphical representation of results of Anti-Hyperlipidemic Activity**





## Sol-gel Assisted Nano Structured Spinel Ferrite $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$ and its Catalytic Application for the Reduction of P-Nitrophenol to P-Aminophenol

B.V. Jadhav<sup>1</sup>, R.P. Patil<sup>2</sup>, and A.D. Pinjarkar<sup>3\*</sup>

<sup>1</sup>Professor and Head, Department of Chemistry, Changu Kana Thakur Arts, Commerce and Science College New Panvel, (Autonomous) Mumbai, 410206, Maharashtra, India.

<sup>2</sup>Assistant Professor, Department of Chemistry, M.H. Shinde Mahavidyalaya, Tisangi, 416206, Maharashtra, India.

<sup>3</sup>Department of Chemistry, Changu Kana Thakur Arts, Commerce and Science College New Panvel, (Autonomous) Mumbai 410206, Maharashtra, India.

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### \*Address for Correspondence

**A.D.Pinjarkar**

Department of Chemistry,  
Changu Kana Thakur Arts Commerce and Science College,  
New Panvel, (Autonomous) Mumbai 410206,  
Maharashtra, India.  
E. Mail: amolpinjarkar111@gmail.com



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### ABSTRACT

The simple and affordable sol-gel approach was used to successfully preparation of nanostructured spinel ferrite ( $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$ ). X-ray diffraction (XRD) and high resolution transmission electron microscopy (HRTEM) were used to characterize the prepared nanomaterial. P-nitro phenol was converted to P-amino phenol through the catalytic reduction of spinel ferrite in the presence of sodium borohydride at room temperature. The UV-VIS and IR spectroscopy was used to study the reduction of p-nitro phenol to P- amino phenol. Using prepared spinel ferrite, complete reduction of p-nitro phenol was effectively accomplished.

**Keywords:** Nanostructured ferrite, XRD, Catalytic reduction, Room temperature.

### INTRODUCTION

Nowadays, as industrialization expands, the release of hazardous compounds into the environment has increased exponentially. Hazardous pollutants are frequently produced by industries like textile, paper and pulp, printing, iron and steel, petroleum, pesticides, paint, and pharmaceuticals. The wastewater from these sectors has high quantities of both organic and inorganic pollutants. Organic pollutants such benzene hydrocarbons, sulphonamides,

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polychlorinated biphenyls, dyes, phthalates, aromatic nitrates, etc. are a severe issue because they are hazardous and can cause cancer [1]. Aromatic nitro compounds, in particular nitrophenols, are the primary pollutants discovered in industrial and agricultural waste waters. This happens as a result of their stability and solubility in water. Due to its negative consequences, the US Environmental Protection Agency has designated nitrophenols as a priority contaminant [2]. Nitrophenols have been demonstrated to be a substantial toxicity for aquatic life in addition to causing odour problems in aquatic environments. Nitrophenols must therefore be eliminated from industrial effluents in order to protect the environment and human health [3]. Yet, it is difficult to eliminate nitrophenols naturally by microbial degradation since they are chemically and physiologically persistent compounds [4]. Therefore, the creation of clean, environmentally friendly techniques is necessary for the removal of these toxins from industrial wastewater. Several oxidation and reduction processes have been recorded for the removal of nitrophenol, including catalytic with air oxidation (CWAO), photo cathodic degradation, electrochemical methods, and hydrogenation reactions [5-12] etc. One of the most important steps in the process of eliminating nitrophenols from industrial water is reducing them to aminophenol. In reduction reactions, nitrophenols are transformed into amino phenols, which is an important step in the commercial production. Phenols are the main ingredients in many industrially made medicines. Moreover, several biologically active compounds are used in the commercial sector as photographic develops and as corrosion inhibitors in paints [13–14]. Nitrophenols can be transformed into amino phenols in a variety of ways, such as electrolytic reduction and metal/acid reduction. using reducing agents including hydrazine hydrate and hydrazine, among others, as well as homogeneous and heterogeneous catalytic hydrogenation and photo reduction [15–20]. The difficulties in recovering the catalyst, the problem of disposing of the metal oxide sludge, the mutagenic and carcinogenic properties of hydrazine, etc. are just a few of the disadvantages of this procedure.  $\text{NaBH}_4$  has shown to be a potential reducing agent because it is a gentler and more thermally stable chemical hydride than the others [21–22]. investigated the use of  $\text{CuFe}_2\text{O}_4$  magnetic nanoparticles in the reduction of nitrophenol. 95% conversion was reached in 40 seconds when 200 equivalent excesses of  $\text{NaBH}_4$  were employed to observe the reduction reaction. There aren't many publications out there right now that discuss using ferrites as a catalyst to reduce aromatic nitro compounds when using  $\text{NaBH}_4$  as a reducing agent. Ferrites are a fantastic option for use as catalysts because of their simplicity in synthesis, ability to be recycled, low cost, and tolerance to highly acidic and basic conditions. Determining the catalytic efficiency of ferrites made using the Sol-gel method in the reduction process of nitrophenols to aminophenols is the main goal of the current investigation.

## Experimental

### Synthesis spinel ferrite ( $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$ )

Simple and cost-effective sol-gel method was used to synthesize mixed metal ferrite sample ( $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$ ). AR grade ferric nitrate, cobalt nitrate, nickel nitrate, chromium nitrate and citric acid were used for synthesis of ferrite. The necessary stoichiometric ratios for the metal nitrate solutions were combined with the least amount of distilled water possible. At 353 K, the solution was stirred using a magnetic stirrer. Ammonia solution was added to the mixture to keep the pH between 9 and 9.5. To create a fluff-like mass, the solution combination was gradually heated to a temperature of 373 K while being stirred continuously. The reaction was seen to cause the solution to become viscous (converting to gel). Further heating produced colourful powder. The powder was first allowed to cool for a while before undergoing six ethanol washes. Following washing, the powder was dried in an oven for eight hours. To produce ferrite nanoparticles, the obtained powder was calcites at various temperatures for 8 hours.

## RESULTS AND DISCUSSION

### XRD and HRTEM Study

The XRD pattern of spinel ferrite  $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$  is shown in Fig. 1. The spinel pattern shows well, high, strong and acute peaks. The growth of smaller crystallites may have contributed to the broadening of the peaks. In XRD patterns there were diffraction peaks associated with Co, Ni, Fe and Cr species. This result indicates that no inferior phase of any impurity was identified. XRD result confirms purity of nano sample. Fig. 2 represents a high resolution transmission electron microscopy of  $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$  powder. The micrograph demonstrates how a homogeneous



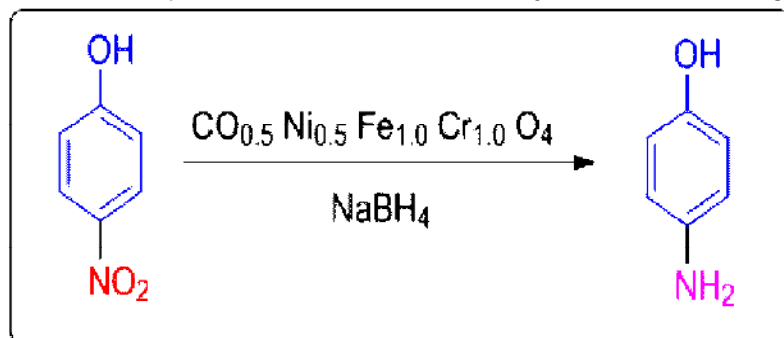


product with aggregated nanoparticles was created. Fig. 2 represents HRTEM images at 20 nm spinel ferrite nano material. It also exhibits nanorods with a hexagonal shape. The average length and diameter of the spinel ferrite material are 45-56 nm and 15-27 nm respectively. Therefore, the surface to volume ratio is higher than in other material, which is advantageous for catalytic applications.

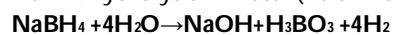
### The Catalytic Test

The yellow color of p-nitrophenol disappeared after 60 seconds when sodium borohydride was added to the reaction mixture comprising  $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$  during the conversion of p-nitrophenol to p-aminophenol. When  $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$  wasn't present, the decolorization took about five and a half hours. This might be because the milder reducing capacity of  $\text{NaBH}_4$  was markedly enhanced by the presence of spinel oxide. In the UV spectra, it was possible to see that the  $\text{NO}_2$  group's 400 nm absorption peak had disappeared. O-H stretch caused the  $3324\text{ cm}^{-1}$  strong sharp peak in the FTIR spectra was observed.

Anti-symmetric N-H stretching vibrations lead to  $3118.33\text{ cm}^{-1}$  peak. Aromatic C-H stretching frequency of about  $3084\text{ cm}^{-1}$  was discovered. In the areas  $1614.13\text{ cm}^{-1}$ ,  $1589.06\text{ cm}^{-1}$ , and  $1515.78\text{ cm}^{-1}$  as a result of skeletal vibration or aromatic C=C.  $1344.14\text{ cm}^{-1}$   $1324.86\text{ cm}^{-1}$  due to N-H bending,  $1215.9\text{ cm}^{-1}$  due to C-N stretching a vibration was noticed. The spectroscopic analysis proved that there were no contaminants as a result of the intentional synthesis of p-aminophenol and hydrogenation of the benzene ring. It has also been documented that Ni-nanoparticles can reduce p-nitrophenol when hydrazine hydrate is used as the reducing agent. In this case, the reaction was carried out at a high temperature ( $50\text{--}60\text{ }^\circ\text{C}$ ) and it was demonstrated that the reaction was finished after one and a half hours. In contrast, in the current work, p-nitrophenol was reduced by  $\text{NaBH}_4$  at room temperature without the need of a solvent, and the product was also obtained after only a short time of stirring. Reaction is given below.



This exemplifies how the spinel oxide catalyst directly affects the reaction activation energy. To evaluate the catalyst's ability to be employed again, five successive fresh batches of p-nitrophenol were repeatedly reduced. The UV-Vis absorption curves for five consecutive reductions are shown in Fig. 3. The release of hydrogen during the hydrolysis reaction between  $\text{NaBH}_4$  and water is hypothesized to be sped up by spinel oxide. According to a report,  $\text{NaBH}_4$  hydrolysis in water (Below reaction).



A negligible amount of hydrogen was theoretically created. There have been numerous efforts to hasten the process of creating additional hydrogen. Spontaneous hydrogen liberation was seen over spinel oxides with the general formula  $\text{CuM}_2\text{O}_4$  ( $\text{M}=\text{Al}, \text{Cr}, \text{Mn}, \text{Fe}, \text{Co}$ ). Hence, it makes sense that the presence of mixed metals spinel oxide would trigger the in-situ, spontaneous generation of hydrogen, which would swiftly cause p-nitrophenol to decline.

### Mechanism of Reduction

Ferrites have more interesting catalytic activity than single component metal oxides, as is widely documented from the literature. The composition of the catalyst is often what determines its catalytic activity. The catalytic activity of ferrites is influenced by a number of variables, including the particle size, redox characteristics of the metal ions, and the distribution of those ions among the tetrahedral (A) and octahedral (B) sites of the cubic spinel lattice. The metal





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ions in the octahedral positions of ferrites are essential for catalysis. This is as a result of the exposed octahedral sites on the surface. Moreover, metal ions at octahedral sites are positioned farther apart to allow unrestricted interaction with the reactant molecules. Nitrophenol and borohydride ions (generated by the ionisation of  $\text{NaBH}_4$  in aqueous medium) diffuse from the aqueous solution towards the nano ferrite surface when nano ferrite catalyst is added to the reaction mixture. The metal ions at the octahedral positions of the nano ferrite catalyst's cubic structure serve as a conduit for the transfer of electrons from  $\text{BH}_4$  to nitrophenol, which produces aminophenol. The  $\text{H}^+$  ions needed for reduction are present in the aqueous media.

## CONCLUSION

Nanostructured spinel ferrite ( $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$ ) prepared using simple sol-gel method. XRD and HRTEM techniques were used to confirmed the prepare nanosized material. Spinel oxide ( $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_{1.0}\text{Cr}_{1.0}\text{O}_4$ ) was proven to be a powerful catalyst for the reduction of p-nitrophenol at room temperature and without the need of a solvent. The reduction rate has significantly increased as compared to the reaction that was carried out without the catalyst. It is described and explored how P-Nitro Phenol (PNP) transforms into P-Amino Phenol (PAP). Spinel oxide accelerated the in-situ reaction's rate of hydrogen production from the aqueous  $\text{NaBH}_4$  solution, which could account for the catalyst's activity. Insights from our extensive research on the catalytic mechanism may help to enhance the functionality of spinel ferrite-based devices for pertinent applications.

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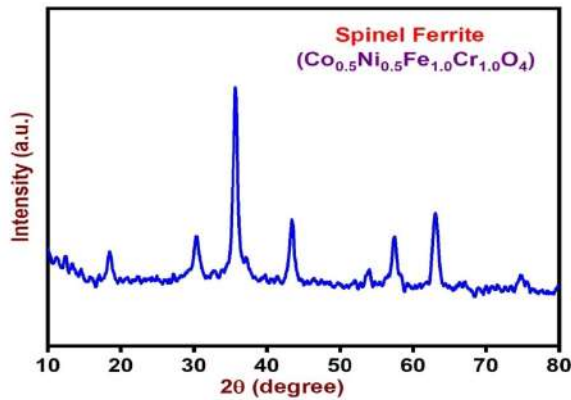


Fig. 1 X-ray diffraction pattern of Spinel Ferrite sample

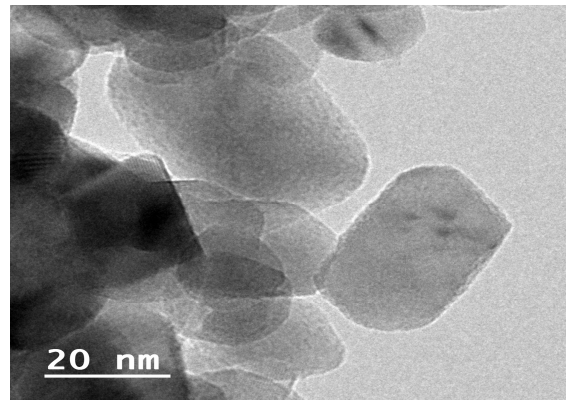


Fig. 2 HRTEM image of spinel ferrite sample

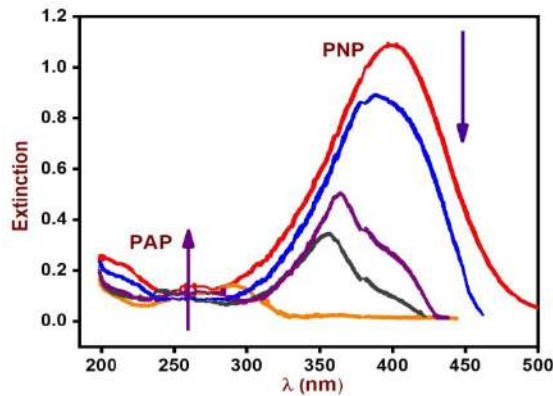


Fig. 3 UV-VIS spectrums of P-Nitro Phenol (PNP) to P-Amino Phenol (PAP)



Fig. 4 Mechanism of conversion of P-Nitro Phenol (PNP) to P-Amino Phenol (PAP)





## Study of Multi Story Building with Single and Multiple Shear Wall

J. Selwyn Babu<sup>1</sup> and MohdImranullah Khan<sup>2\*</sup>

<sup>1</sup>Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India.

<sup>2</sup>PG Scholar, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India.

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### \*Address for Correspondence

**MohdImranullah Khan**

PG Scholar,

Department of Civil Engineering,

Malla Reddy Engineering College,

Hyderabad, Telangana, India.

E. Mail: imran.mreca@gmail.com



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### ABSTRACT

Shear wall systems are often used by buildings as one of the lateral load-resisting systems that they include. Shear walls are the structural characteristics that are among the most efficient in preventing the passage of lateral forces through a building. When it comes to the construction of buildings that are meant to withstand seismic activity, reinforced concrete structural walls, which are often referred to as shear walls, play an important role as the primary earthquake-resistant components. Shear walls have extremely high in-plane stiffness and strength, which enables them to be utilized to simultaneously withstand huge horizontal loads and sustain gravity loads. This permits shear walls to be employed in a variety of applications. Due to the fact that shear walls are capable of performing both of these duties, they are highly useful in a range of applications that fall within the purview of structural engineering. When earthquake forces are applied to a structure, they are almost always included in order to prevent the building from collapsing entirely. These members are mostly flexural in nature. It is very necessary to carry out a precise assessment of seismic response of the walls since the characteristics of these shear walls have such a substantial impact on the response of the buildings. Within the parameters of this inquiry, a high-rise building of twenty stories is taken into consideration. There are three unique types of RCC structures that are used today, and each of these models may have a single shear wall, a double shear wall, or a triple shear wall. The findings of the study will be presented so that they can be contrasted with one another and analyzed in order to gain an understanding of the behavior of RCC-framed buildings with shear walls when they are subjected to seismic load in Zone V. Specifically, this will be done so that the results can be compared with one another.



**Selwyn Babu and Mohd Imranullah Khan**

**Keywords:** Shear wall, gravity loads, seismic forces, earthquake load, storey drift, lateral displacement, base shear, shear force, bending moment.

## INTRODUCTION

### General

Shear walls are a type of structural wall that is specifically designed to withstand horizontal forces that are generated in the plane of the wall as a result of wind, earthquakes, and other types of forces. These forces may be caused by a variety of natural and manmade events. The most typical kind of shear wall is one made of reinforced concrete (RC), which also happens to be the most durable material. These wall components are often used in the construction of structures. Because of their very high in-plane stiffness and strength, shear walls are able to withstand massive horizontal loads without being damaged. Shear walls are able to withstand large amounts of horizontal stress because of this feature, which also enables them to support gravity loads. Because of this, the use of shear walls in a variety of settings is now open to a broad variety of options. It is possible for the thickness of walls made of reinforced concrete to range anywhere from 140 millimeters to 500 millimeters, but this will be depend on various factors, including the age of the structure, the horizontal pressures that are caused by things like wind and earthquakes, and the thermal insulation requirements of the building. These walls, in the overwhelming majority of situations, continue to climb all the way up to the very pinnacle of the structure. These situations may be rather specific. The placement of the walls will, in almost all cases, be symmetrical in reference to at least one axis of symmetry that is included in the design. This will be the case in the vast majority of cases. Shear walls are able to resist lateral loads because they transmit the load that is created by external forces such as wind or earthquakes to the foundation. This allows the shear walls to withstand the external pressures. In addition to this, they are responsible for the lateral rigidity of the system and carry the weight of the gravity loads that are applied to it.

### Seismic Design Philosophy

The guiding principles of a certain document provide an indicator of the overall level of security that one may anticipate getting as a result of employing it. Documents pertaining to codes make it abundantly clear that the standards they establish are merely minimum criteria that are intended to ensure the protection of human life but do not guarantee against the loss of property. This is made clear by the fact that the standards they establish are only minimal criteria.

The fundamental ideas of earthquake-resistant architecture may be summed up as follows:

1. The design philosophy that was chosen for the code IS: 1893 (Part I)-2002 was to ensure that all structures have at least the needed degree of strength to withstand the potential hazards that may be encountered.
2. When compared to the real forces that are exerted on buildings when they are shaken by earthquakes, the design forces that are listed in the standards are much lower. The primary criteria that should be used when constructing earthquake-resistant structures should be based on the lateral strength of the structure.
3. It is expected that this will make it possible for the structure to endure just minor damage without falling entirely apart. When planning the construction of a building, it is essential to take into consideration the earthquake-generated vertical inertia forces, unless the magnitude of these forces is not considered to be significant.
4. The design pressures that must be applied to buildings that are supported by rock or soils that are compact and do not become liquefied or slide as a result of ground vibrations are outlined in detail in the building regulations.
5. These pressures must be applied to ensure that the buildings remain stable. When constructing a structure, it is essential to take into consideration the lateral design pressures that are outlined in the code IS: 1893 (Part I)-2002. These forces must be taken into account.



**Selwyn Babu and Mohd Imranullah Khan****Objectives**

The following are the main objectives of this project

1. To investigating the seismic conduct of multi story working by IS 1893:2002 utilization.
2. To contrast the multi story structures with single, double and triple shear wall condition.
3. To study the values of the Story Drift, Shear, Bending, Building, time period and frequency for different shear wall conditions
4. To examination the structures in ETABS Software.

**METHODOLOGY****General**

In this chapter, we will talk about the methodology that was used in the study that served as the foundation for present investigation. This study was carried out to investigate a variety of parameters, including storey drift and lateral displacement, with the goal of determining the optimal location for shear walls and braces inside the structure, in addition to the most effective configuration for those components.

**Equivalent Linear Static Analysis**

When planning against the effects of earthquakes, one must constantly keep in mind the dynamic nature of the load that they are trying to account for. On the other hand, analysis of easy regular structures may often be achieved by the use of equivalent linear static techniques. This is something that can be done according to the great majority of standards of practice to regular constructions that are low to medium in height. The approach to structural analysis of multi-story structures that is suggested in code considers the building as if it were a distinct system with concentrated masses at each floor levels. After computing, the value obtained from this calculation is then spread across the height of the structure.

After collecting the lateral forces in this way, they are subsequently allocated to the different components that are responsible for the lateral load resistance. The building in issue must be of a low height, and it must not spin an excessive amount when the surrounding area is shifted for this to be the case. The response of the structure is read from the response spectrum design once the natural frequency of the structure has been determined (either calculated or defined by the building code).

**Linear Dynamic Analysis**

In situations in which the impacts of higher modes are not thought to be substantial, it is advised to make use of static approaches. This is something that often occurs with buildings that have lengths that are relatively comparable to those of neighboring structures. As a result of this, buildings like towering skyscrapers, structures with torsion anomalies, and non-orthogonal systems need a dynamic process in order to work in the correct manner. The seismic input can be treated in a number of different ways. After that, a simulation of the seismic input is carried out using either of these two modeling methodologies. In comparison to linear static processes, these linear dynamic processes have the benefit of being able to take into consideration higher modes.

**Seismic Analysis by Response Spectra**

Response spectrum analysis is likely the method that is utilized most frequently in design when attempting to determine the greatest reaction that may be expected from a structure as a result of being subjected to seismic activity. This is because response spectrum analysis can be used to determine the maximum reaction that may be expected from a structure. This is an approximation method that makes use of linear algebra. It is possible to determine the maximum response for each mode by using the proper response spectrum in the calculation.





### SRSS (Square Root of Sum of Squares)

One of the methods of modal combination that is used the most often is known as SRSS, which is an acronym that stands for "square root of sum of squares." According to this rule, the maximum response in definitions of a given parameter (displacements, velocity profile, accelerations, or even internal forces) can be estimated by taking the square root of the total of the squares of the modal responses that contribute to the global response.

### Load Combinations

The following Load Combinations have been considered for the design:

1.  $1.5(DL \pm LL)$
2.  $1.5(DL \pm EQX)$
3.  $1.5(DL \pm EQY)$
4.  $1.2(DL + LL \pm EQX)$
5.  $1.2(DL + LL \pm EQY)$
6.  $(0.9DL \pm 1.5EQX)$
7.  $(0.9DL \pm 1.5EQY)$

Where:-

DL - Dead Load

LL - Live Load

EQX-Earthquake load in X direction

EQY-Earthquake load in Y direction

Out of these different load combinations  $1.5(DL + EQX)$  or  $1.5(DL + EQY)$  load is worst load combination and was giving worst effect on the structure in the present study.

### Design Considerations

In the present study, analysis of G+ 20 stories building in Zone IV and Zone V seismic zones is carried out in ETABS.

Basic parameters considered for the analysis are:

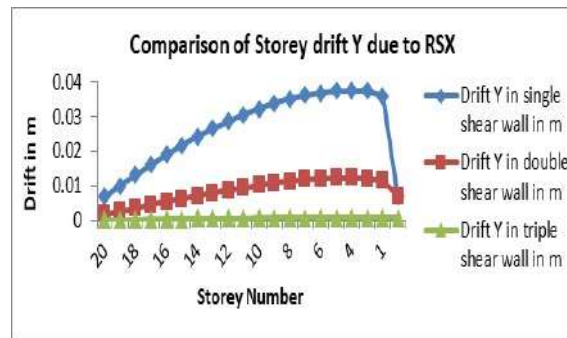
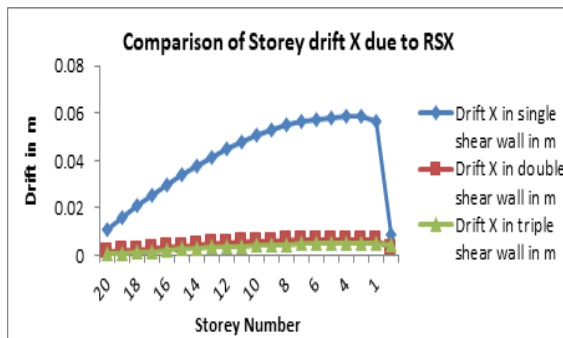
- |      |                               |                         |
|------|-------------------------------|-------------------------|
| [1]  | Concrete grade                | : M30                   |
| [2]  | Reinforcing steel grade       | : HYSD Fe500            |
| [3]  | Beam dimensions               | : 230mmX460mm           |
| [4]  | Column dimensions             | : 230mmX460mm           |
| [5]  | Slab thickness                | : 150mm                 |
| [6]  | Bottom story height           | : 4m                    |
| [7]  | Remaining story heights       | : 3m                    |
| [8]  | Live load                     | : 5 KN/m <sup>2</sup>   |
| [9]  | Dead load                     | : 2 KN/m <sup>2</sup>   |
| [10] | Density of concrete           | : 25 KN/m <sup>3</sup>  |
| [11] | Seismic Zones                 | : Zone 3                |
| [12] | Site type                     | : II                    |
| [13] | Importance factor             | : 1.5                   |
| [14] | Response reduction factor     | : 5                     |
| [15] | Damping Ratio                 | : 5%                    |
| [16] | Structure class               | : C                     |
| [17] | Basic wind speed              | : 44m/s                 |
| [18] | Risk coefficient (K1)         | : 1.08                  |
| [19] | Terrain size coefficient (K2) | : 1.15                  |
| [20] | Topography factor (K3)        | : 1.36                  |
| [21] | Wind design code              | : IS 875: 1987 (Part 3) |
| [22] | RCC design code               | : IS 456:2000           |
| [23] | Steel design code             | : IS 800: 2007          |



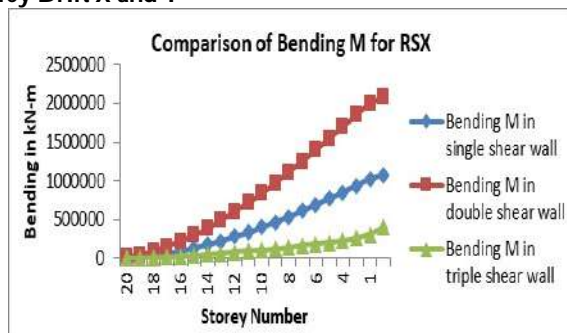
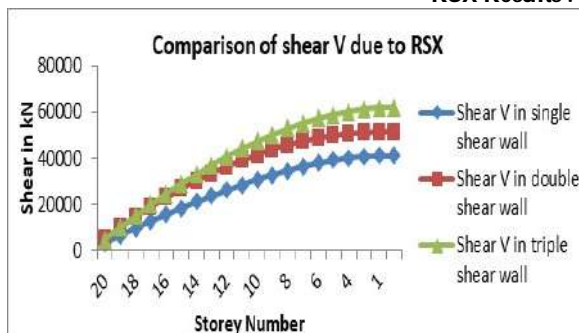


[24] Earth quake design code : IS 1893 : 2002 (Part 1)

## RESULTS AND ANALYSIS

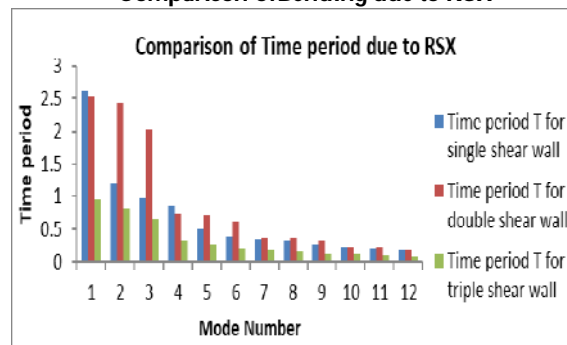
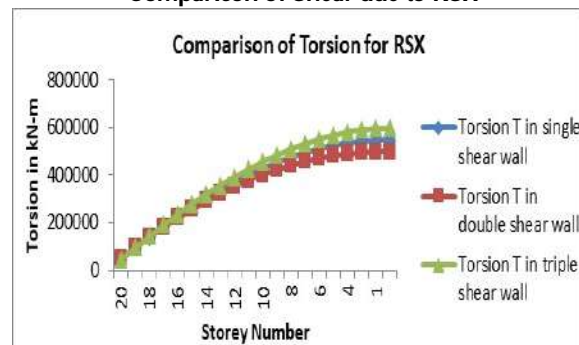


**RSX Results : Storey Drift X and Y**



**Comparison of Shear due to RSX**

**Comparison of Bending due to RSX**



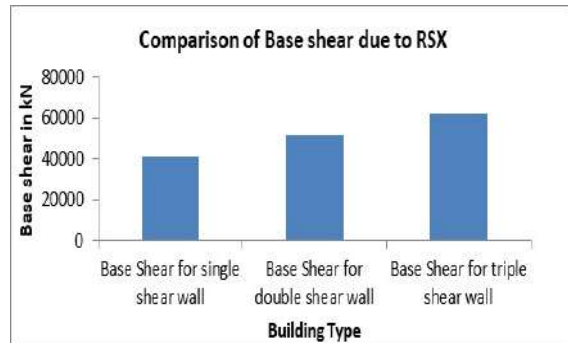
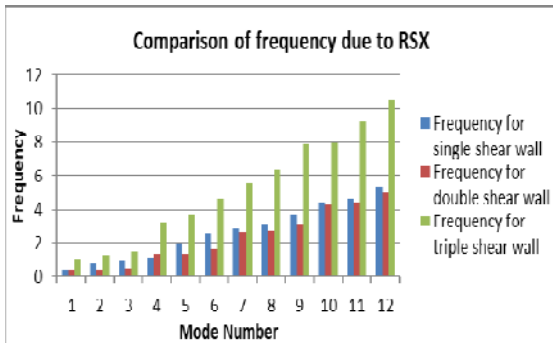
**Comparison of Torsion due to RSX**

**Comparison of Time Period due to RSX**



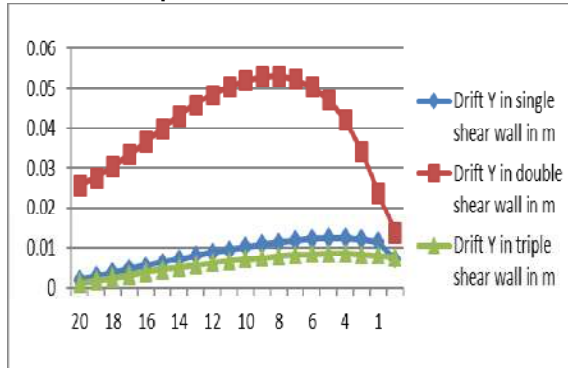
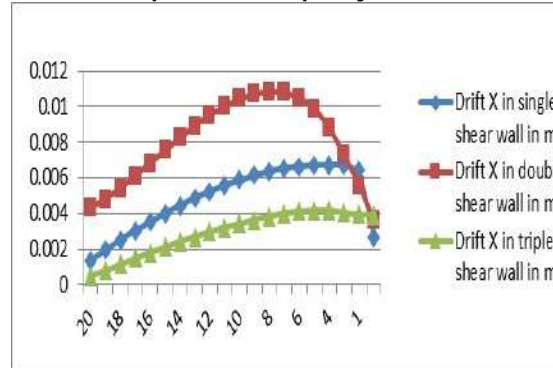


**Selwyn Babu and Mohd Imranullah Khan**



Comparison of Frequency due to RSX

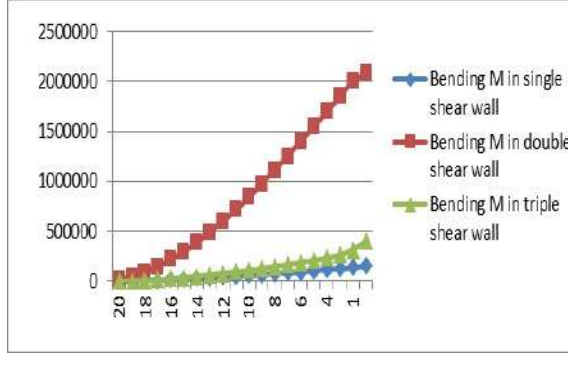
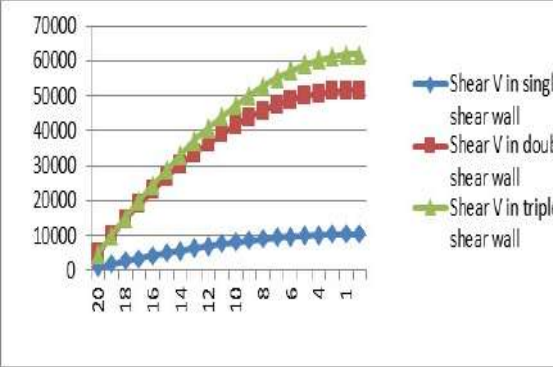
Comparison of Base shear due to RSX



Comparison of Frequency due to RSX

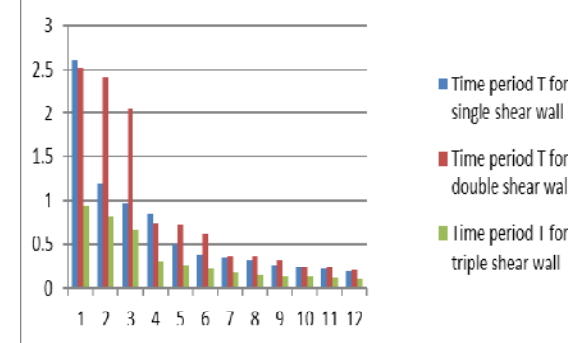
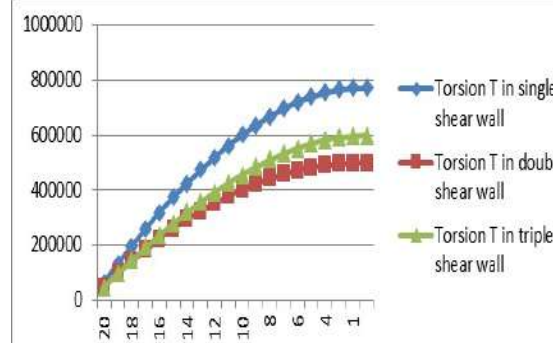
Comparison of Base shear due to RSX

**RSY Results : Storey Drift X and Y**



Comparison of Shear due to RSY

Comparison of Bending due to RSY



Comparison of Torsion due to RSY

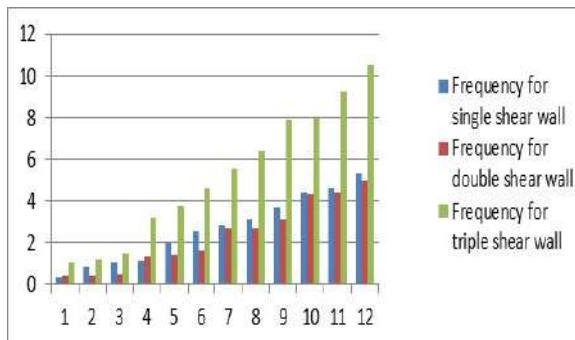
Comparison of Time Period due to RSY



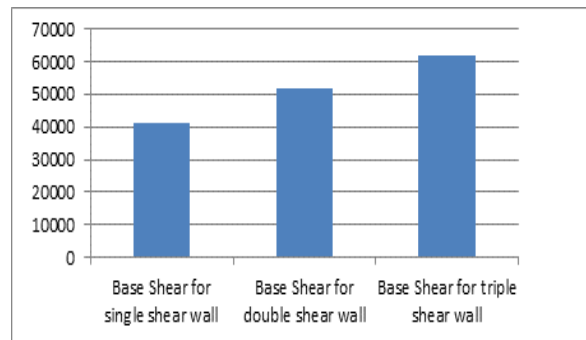




## Selwyn Babu and Mohd Imranullah Khan



Comparison of Frequency due to RSY



Comparison of Base Shear due to RSY

## CONCLUSION

The following conclusions were drawn from this investigation.

1. After supplying the shear wall from single to triple in both X and Y direction conditions, top deflection was decreased and attained within the permitted deflection.
2. Comparing different sites, it was discovered that the shear wall location was more efficient for shorter columns.
3. Cracked wall For regular shape building, symmetry in the outermost moment-resisting frames provides higher performance.
4. The value of drift is discovered to be smaller for buildings with triple shear walls than for those with double and single shear walls.
5. The value of drift is found to be lower value for building with triple shear wall shear wall than remaining cases like double shear wall and triple shear wall.
6. The values of Shear found lower value for building with single shear wall condition system and bending is lower for building with double shear wall.
7. When the opening position is changed from one position to another position, it has been seen for a specific opening in a wall.
8. This investigation led to the conclusion that as the percentage of shear walls increases, drift and deflection decrease but shear force and bending moment increase.

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## Edible Coating from Nontoxic Biomaterials for Extending Shelf Life of Fruits and Vegetables

P.Sathishkumar<sup>1\*</sup>, M.Meenambigai M<sup>2</sup>, K.Pavithra<sup>2</sup>, Neelamathi E<sup>1</sup>, R.Rakkimuthu<sup>3</sup>, A.M.Ananda kumar<sup>1</sup> and D.Sowmiya<sup>1</sup>

<sup>1</sup>Assistant Professor, Department of Botany, NallamuthuGounderMahalingam College, Pollachi, Coimbatore, Tamil Nadu, India.

<sup>2</sup>Research Scholar, Department of Botany, NallamuthuGounderMahalingam College, Pollachi, Coimbatore, Tamil Nadu, India.

<sup>3</sup>Assistant Professor and Head, Department of Botany, NallamuthuGounderMahalingam College, Pollachi, Coimbatore, Tamil Nadu, India.

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### \*Address for Correspondence

#### P. Sathishkumar

Assistant Professor,  
Department of Botany,  
NallamuthuGounderMahalingam College,  
Pollachi, Coimbatore, Tamil Nadu, India  
E. Mail :sathishkumarkutti@gmail.com



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### ABSTRACT

The present work has been designed to create ecofriendly edible coating from the isolated biomaterials. The biomaterials were extracted from the selected plants such as *Kappaphycusalvarezii* (Doty) Doty ex Silva (Solieriaceae), *Pancreatiumtriflorum*Roxb. (Amaryllidaceae), *Terminaliacatapa*L. (Combretaceae) and *Cyanodondactylon*(L.) Pers. (Poaceae). These plants were frequently available biomass and are edible. The extracted biomaterials were mixed together with different ratios to produce the edible coating solution A, B, C, D and E. The colour, odor, pH, bubble, heating resistance, water content and water resistance of the coating solutions were recorded. The coating solution of composition (E) gives the positive result. The produced edible coating solution is colourless and has good stability, quality and shelf life may better alternative to chemical and wax based edible coating solutions. The results of microbiological studies revealed that the edible coating solution has decreased the fungal as well as bacterial contamination and no toxicity. The successfully produced edible coating solutions were applied to selected fruits and vegetables. The following parameters such as shelf life, sensory evaluation, weight loss, pH, shrinkage percentage, shrivelling percentage and decay percentage were analysed at regular intervals and recorded.

**Keywords:** Biomaterials, biofilm, edible coating, shelf life.





Sathishkumaret al.,

## INTRODUCTION

Fruits and vegetables are essential in human's daily diet due to health and nutritional value associated with their intake. However, they are products with a relatively short postharvest life, as long as they are used for consumption, they are living tissues and may undergo physiological and biochemical changes that may have significant physical or pathological manifestations for economic loss [1, 2].

Postharvest treatments with conventional synthetic waxes or chemical fungicides have been used for many years to control postharvest decay and extend shelf life for fruits and vegetables. The continuous application of these treatments has caused health and environmental issues. Considering the growing interest in healthier, safer, more natural and environment-friendly natural coatings have been developed in recent years to avoid the use of synthetic waxes [3]. Hence the use of edible coatings has emerged as an effective and ecofriendly and also alternative to extend their shelf life and protect them from harmful environment [4].

In addition, coatings are able to act as a carrier of many functional ingredients such as antimicrobials, antioxidants, antibrowning agents, nutrients or flavouring and colouring compounds enhancing food stability, quality and safety [5]. The proposed study aims at the production of edible coating film from biomaterials from plants especially from non toxic sea weeds and plants with rich edibility particularly carrageenan, starch, mucilage, cellulose content, gelling agent and antimicrobial properties. Therefore, the present work is designed to create an ecofriendly edible coating from non toxic biomaterials isolated by plants to enhance the shelf life of fruits and vegetables. In order to separate biomaterials from plants the following species has been selected such as *Kappaphycusalvarezii*(Doty) Doty ex Silva (Solieriaceae), *Pancretriumtriflorum*Roxb. (Amaryllidaceae), *Terminaliacatappa*L. (Combretaceae) and *Cynodondactylon*(L.) Pers. (Poaceae).

## MATERIALS AND METHODS

### Collection of Plant Materials

The production of edible coating for fruits and vegetables, the following plant materials were selected for the present study such as *Kappaphycusalvarezii*(Doty) Doty ex Silva, *Pancretriumtriflorum*Roxb., *Terminaliacatappa* L. and *Cynodondactylon* (L.) Per. The selected study plant materials were obtained from various regions of Tamilnadu and Kerala. The seaweed *Kappaphycusalvarezii* were harvested from the coastal regions of Mandapam, Rameshwaram in Tamilnadu. The tubers of *Pancretriumtriflorum* were collected from Karimkulam, Kerala. The *Cynodondactylon* leaves were collected from N.G.M College campus, Pollachi. The essential oil (Clove oil) and badam resins were purchased from the local market. In laboratory, the collected species were washed and cleaned under running tap water to remove salt, sand, dust particles and other impurities. The process was repeated with distilled water. The cleaned plant materials were kept for further studies.

### Isolation of Biomaterials

#### Isolation of Carrageenan[6]

Dried sample of *Kappaphycusalvarezii* seaweeds were cut into small pieces ( $\pm 1$  cm) and then weighed 50 grams. Samples are soaked with distilled water for 30 minutes. Then, it was extracted using NaOH with the ratio of seaweed to the solvent 1: 20 (g/ml). The extraction was done using a hot plate at 90°C. It was filtered using a muslin cloth when it was still hot. The filtered solution was taken in a separate container and 5 % KCl was added to stand for 15 to 20 minutes at room temperature until the gel formation. After the gel formation, they were washed with distilled water to reach the pH of  $\pm 7$  and filtered using muslin cloth. The isolated carrageenan gel was dried in oven at 60°C for 24 hours. The dried powder of carrageenan was weighed and stored for further use.



**Sathishkumaret al.,****Identification of Carrageenan**

The carrageenan is determined by soluble in water at a temperature of 80° C, forming a viscous clear solution and insoluble in ethanol.

**Isolation of Starch [7]**

The fresh tubers of *Pancreatiumtriflorum* were cut into small pieces and the samples were ground with distilled water. The ground slurry was then sieved and filtered using a coarse sieve and muslin cloth. Filtrate was allowed to settle for 2 hours, the resulting starch was washed three times with distilled water and allowed to settle for 21 hours. After 21 hours, supernatant was decanted, the starch (wet) was dewatered and then oven dried at a temperature of 55° C for 4 hours. Finally the dried starch was collected in a container for further use.

**Identification of Starch**

The iodine test is used to analysis the presence of starch. Add 2 ml of iodine solution in the sample. The colour turned to blue to black confirmed the presence of starch.

**Isolation of Cellulose[8]**

Cellulose isolation was carried out using the pulping technique consisting of four steps: (1) mild acid hydrolysis with 0.4% H<sub>2</sub>SO<sub>4</sub> for one hour, and subsequent washing; (2) chlorination with 3.5% citric acid, stirring the solution in a water bath at 30° C to pH 9.2, washing with distilled water until neutral pH; (3) alkaline extraction with 20 % NaOH under stirring for 1 h, followed by a washing process; (4) bleaching with a solution of 0.5 % citric acid and continuous stirring for 1 hour, and a final wash to neutral pH. Then the material was manually shredded and placed in an oven for 24 hours at 60° C. The material was weighed to determine the total yield of the cellulose.

**Identification of Cellulose**

The cellulose was confirmed through iodinated zinc chloride solution. A small amount of sample was placed in a watch glass and dispersed with iodinated zinc chloride solution. The violet blue colour confirmed cellulose

**Isolation of Mucilage**

The shade dried plant materials were soaked with distilled water for 1 hour; fully soaked materials were boiled for 30 minutes and allowed to stand for 15 minutes. Then the material is centrifuged at 8000 rpm for 15 minutes to release mucilage. The supernatant is collected. The yield of isolated mucilage was weighed and stored for further use.

**Preparation of Coating Solution**

The coating solution was prepared from isolated biomaterials of study plants such as carrageenan, starch, cellulose, mucilage, resin and essential oil (Clove oil). The isolated biomaterials were combined together with different proportion to form a coating solution and to produce final transparent edible coating solution. A known quantity of isolated biomaterials such as carrageenan, mucilage, starch, cellulose, resin and essential oil were added in 100 ml distilled water. The mixture solution was stirred for one hour using magnetic stirrer at room temperature, followed by the solution was heated at 40° C for 10 minutes continuous stirring using glass rod. Then the solutions was autoclaved for 121° C at > psi for 15 minutes. The final volume of the solutions was kept under room temperature for 1 minute.

**Processing of Coating Solution**

The edible coating technology was tested for the following fruits and vegetables i.e. *Malusdomestica*Borkh (Apple), *Musa acuminata*Colla (Banana) *Capsicum annum* L. (Chilly) and *Solanumlycopersicum* L. (Tomato) respectively. The testing samples were selected accordingly uniform size, colour and absence of damage and fungal contamination. The uncoated testing samples (Fruits and vegetables) were used as a control. The testing samples (fruits & vegetables) were capsulated with edible coating solution by dipping process according to Prasad *et al.*, 2018 [9]. The testing samples were soaked in 50 % sodium chloride solution for two minutes to remove all contaminants. Further the



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samples were submerged in coating solution container for few second. Then the samples were taken out to allow excess coating by drain until the uniform coating formation. Finally the samples were dried under ambient conditions. After drying, samples were stored at room temperature. The observations were performed on both control and coated fruits and vegetables for regular intervals of storage period.

**Observations**

The following parameters were tested for the present study.

**Parameters for Edible Coating Solution****Sensory Evaluation [10]**

For sensory evaluation, visual inception of color, odor, bubble and pH were observed.

**Heat Resistance Analysis**

The heat resistance capacity of prepared coating solutions are identified at 10, 30, 50, 70 and 1000 C temperatures.

**Water Content Analysis [11]**

Determination of water content was performed by drying method, the following formulae was used as follows.

$$\text{Percentage of Water Content} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

**Water Resistance Analysis [12]**

1×1 cm of dried coating film was weighed and soaked for 10 seconds in distilled water. The final weight of the soaked film are weighed. Procedure of soaking and weighing were carried out back until final sample mass will constant.

$$\text{Water resistance (w)} = \frac{W - W_0}{W_0} \times 100$$

Where,  $W_0$  - Initial sample mass,  $W$  - Final sample mass.

**Microbial Analysis**

The antimicrobial activity of coating solution was studied by streak plate method. The microbial inhibition were tested by the following microorganisms such as *Escherichia coli* (MTCC 77), *Staphylococcus aureus* (MTCC 96), *Klebsiellapneumoniae* (MTCC 3384), *Pseudomonas aeruginosa* (MTCC 424) and fungi like *Aspergillusniger* (MTCC 282). The organisms were purchased from PSG Hospitals, Coimbatore, Tamilnadu state in India. 100 mm sterile I - petri plates (2-section) were taken and the first section filled with freshly prepared nutrient agar medium and potato dextrose agar medium separately, followed by the second section filled with coating solution. The microbial strains were streaked on the both side of the plate. The inoculated petri plates were kept in incubator at 28°C for 24 hours. The microbial growth was observed and recoded.

**Parameters for Treated Fruits and Vegetables****Shelf - Life Test**

The shelf life assessment of testing samples of coated and non-coated fruits and vegetables was assessed by visual inception on daily basis.

**Sensory Evaluation [13]**

During storage, the sensory evaluation of stored testing samples were performed by a panel of five members on hedonic scale ranging from 0 to 5, where 1 = very bad, 2 = bad, 3 = medium, 4 = good and 5 = excellent. Color, aroma, appearance and overall acceptability were recorded.

**Weight Loss [14]**

Weight loss of the testing samples was performed for weekly intervals until the end of experiment. The weight loss (WL) percent was determined by using following the formula.





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$$WL = \frac{(A - B)}{A} \times 100$$

Where, A - Initial weight. B - Final weight

#### **pH Measurement**

The samples were cut into small pieces and homogenized in a grinder. 10 g of grounded samples were suspended in 100 ml of distilled water and then filtered. The pH of the samples was assessed using a pH meter.

#### **Titrateable Acidity [15]**

The titrateable acidity of samples was calculated by titration method. 50 ml of juice samples were titrated with 0.1 N NaOH, few drops of phenolphthalein was used as indicator. The titration done triplate till the concrete reading has been achieved.

$$\text{Percentage of Acidity} = \frac{0.064 \times \text{Normality of NaOH} \times \text{Titre Value}}{\text{Volume of Sample (ml)}} \times 100$$

#### **Fruit Shrivelling Percentage [16]**

Fruit Shrivelling Percentage (FSH %) of testing samples was evaluated based on a 4-score scale as: 1- very shrivelling, 2- low shrivelling, 3- normal and 4- very smooth.

#### **Shrinkage Percentage [17]**

The length and breadth of fruits and vegetables were measured as an index for shrinkage. The samples were measured by using Verniercalliper weekly interval during the storage period.

$$\text{Shrinkage percentage in terms of length} = \frac{\text{Initial length} - \text{Final length}}{\text{Initial length}} \times 100$$

$$\text{Shrinkage percentage in terms of breadth} = \frac{\text{Initial breadth} - \text{Final breadth}}{\text{Initial breadth}} \times 100$$

#### **Decay Percentage [18]**

The testing samples of fruits and vegetables were examined for mold growth during periods of storage. The sample was considered infected when a visible lesion was observed. The decay incidence was expressed as percentage of samples infected for all samples were used for measurement.

$$\text{Decay percentage} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

#### **Statistical Analysis**

The collected data of results were analyzed statistically and carried out with the SPSS Software.

## **RESULTS AND DISCUSSION**

#### **Preparation of Edible Coating**

The present study for the preparation of edible coating for fruits and vegetables the following biomaterials were extracted *viz.* carrageenan from *Kappaphycusalvarezii* (Doty) Doty ex Silva (Solieriaceae), mucilage and starch from *Pancreatiumtriflorum*Roxb. (Amaryllidaceae)cellulose from *Cyanodondactylon*(L.) Pers. (Poaceae) and the resins were obtained from *Terminaliacatapa*L. (Combretaceae) Fig. 1. The current work to produce eco-friendly edible coating from these combinations of biomaterials has a completely new record; previously no work has been published on these formulations. Biomaterials were extracted using different methods. The extracted biomaterials were combined at different ratios to form formulations A, B, C, D, and E. The volume of the final coating solution obtained, colour, pH, odor, heating resistance, water content and water resistance were recorded and tabulated (Table 1, 2 & 3 and Figure 2 to 4). Based on coating ability and quality the formulation E shown positive results, whereas the formulation A, B, C and D are exhibited negative results. Finally the formulation E is selected for the coating process on fruits and



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vegetables. The edible coating produces has good strength and stability, Therefore the replacement of chemical and synthetic wax based coatings make the basis for sustainable and ecofriendly edible coatings. Likewise many authors have extensively studied ecofriendly edible coatings from plants such as *Aloe vera* gel, neem, lemon grass, rosemary, tulsi, and turmeric. Usually herbs have antimicrobial properties including vitamins, antioxidants and essential minerals [19, 20, and 21]. Ginger, essential oil, clove bud oil; turmeric neem extract, mint oil, other essential oil and extracts are also used in edible coating of fruits and vegetables. Herbs are natural source of vitamins, minerals, antioxidants, beneficial for health act as a nutraceutical and medicines [23, 24].

**Evaluation of physical and chemical parameters for edible coated fruits and vegetables during storage period**

The prepared coating solutions were applied by dipping method on some selected fresh fruits and vegetables like apple, banana, chilly and tomato respectively. After the coating process it is observed the encapsulated coating looks transparent appearance. During storage period the following physical and chemical parameters were tested.

**Sensory Evaluation**

The sensory evaluation (color, aroma, appearance and overall acceptability) of the control and coated samples were examined at intervals of three days during the storage period. The edible coating enhances the sensory quality and extends the shelf life of coated samples rather than control samples. Some control samples are deteriorating and completely unacceptable but coated samples remain intact. Thus, the sensory evaluation revealed that the edible coating treated samples score high in hedonic scale than the control samples. At the end of the storage period, panellist members gave high score to edible coated treated samples (Table 4). The coated samples have no significant difference at the end of the storage period. It could be concluded that the maximum score can be related to the minimum water loss from the fruit surface and maintenance of better balance between sugars and acids of fruit juice [25] This study similar to Seehanamet al. [26] which said that the coated tangerine fruits showed higher gloss and better visual appearance results as compared with the non - coated fruit.

**Weight Loss**

The weight losses of coated samples are compared to the control samples during the storage period for all tested fruits and vegetables. Water transfer is restricted by coatings that act as barriers and protect fruit skin, thus delaying dehydration [27]. Thus, the control sample causes changes in morphology as well as fungal and bacterial contamination, while the coated sample has no changes in morphology and the absence of contamination (Table 6). Respiration and transpiration are a major cause of weight loss of fruits and vegetables. Hence the edible coating decreased the respiration and transpiration rate by acting as a semi permeable membrane on the surface of the fruits and vegetables. According to Perez-Gago, Serra and delRio [28], coatings of edible material applied as a thin layer can offer a possibility to extend the shelf life of fresh-cut vegetables by providing a semi permeable barrier for gases and water vapor, reducing, therefore, respiration and water loss and thus avoiding dryness and weight loss.

**pH**

The pH value of both control and coated test samples were increased gradually during the storage period. The pH value of coated samples was lesser when compared to control samples (Table 6). As the storage time passes, the senescence occurs in fruits during which there will be increase in the pH value [29]. It is also due to a decrease in acidity and an increase in TSS value as the fruits ripen at the storage time [30]. Coating reduces respiratory and metabolic rates, and thereby the lesser utilization of organic acids, reported by Baraiyaet al. [31]. The results showed that the coatings show better control on pH during the entire storage period compared to control samples.

**Titrateable Acidity**

The titrateable acidity of uncoated and coated samples was analyzed regularly during the storage period. The titrateable acidity level of both control and coated samples were gradually decreased over the storage period. Titrateable acidity was higher in coated samples compared with uncoated samples. The reason for fall in acidity level





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is the utilization of organic acid in the respiration and metabolic process[32] also suggested that the decrease in acidity has been attributed towards the conversion of organic acids into sugars and their further utilization in the metabolic process of the fruit (Table 7).

#### **Shrivelling Percentage**

The shrivelling percentage of the control and coated samples were examined at intervals of three days during the storage period based on a 4 - score scale. The control samples showed lowest score compared to coated samples (Table 8).

#### **Shrinkage and Decay percentage**

The shrinkage percentage of control and coated fruits and vegetables in terms of length and breadth were observed on weekly intervals. The maximum shrinkage percentage (length) for Banana and Tomato observed in control ranges from 88.56 at 0 day to 84.36 at 14<sup>th</sup> day of storage and 65.95 at 0 day to 62.17 at 21<sup>st</sup> day of storage respectively. The shrinkage percentage (length) of coated samples resulted minimum when compared to control; similarly other tested samples also reflected better result for coated samples (Table 9). The shrinkage percentage (breadth) of fruits and vegetables also reflected the minimum value in coated samples than the control (Table 10). It is clearly indicates that the coating biomaterials retard the activity of enzymes responsible for ripening, cell degradation was prevented and help to reduce moisture loss and lesser respiratory gas exchange, hence delay in senescence and lower the shrinkage percentage. Similarly the decay percentage of the coated samples also resulted better than the uncoated control (Table 11).

#### **Microbiological Analysis**

Microbiological analyses of edible coating solution were carried out on streak plate method. Two section petri plates were used to fill nutrient agar medium and edible coating solution respectively. After incubation period the streak plates were observed and the microbial growth was noted. Interestingly the result indicates that the first half of nutrient agar medium shows higher microbial population; meanwhile the second half of edible coating solution shows no growth for selected bacterial and fungal strains. It is indicates that the stronger antimicrobial ability of edible coating solution. It may due to the presence of natural antimicrobial compounds in edible coating solution. This edible coating solution has been suggested to as alternatives to synthetic coating ones for preserving fruits and vegetables quality, owing to their effectiveness against spoilage and food borne pathogens. Recently the use of edible coatings as polymeric matrices for the entrapment of natural antimicrobial agents has been investigated as a promising alternative to overcome these limitations by lowering the diffusion of active compounds onto food surfaces and hence maintaining their concentrations at a critical level for microbial growth inhibition over long periods of storage [33]. Moreover, edible coatings may act as a semi permeable barrier providing an additional protection for foods against moisture loss, solute migration, gas exchange, respiration, and oxidative reactions [34]. This in agreement with Natalia *et al.* [35] prepared edible antimicrobial coating using plant extracts showed that the extracts of clove, garlic and cinnamon are incorporated in coating to reduce the growth of *Pseudomonas fluorescens* and showed stronger antibacterial activities.

## **CONCLUSION**

In this study, the coated fruits exhibited more shelf life period when compared with the control. The results showed that the edible fruits coating is an eco friendly approach and showed the less microbial growth in room temperature. The present study concluded for edible coating solution used for various fruits and vegetables but the problem is the materials do not resist to over moisture level.





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**Table 1. Biomaterials isolation from non-toxic plant raw materials**

S.No	Plant name	Biomaterial name	Initial weight (grams)	Final weight (grams)	Percentage of yield (%)	Colour	Texture
1	<i>Kappaphycusalvarezii</i>	Carrageenan	5	3.5	70%	White	Powder
2	<i>Pancreatiumtriflorum</i>	Mucilage	50	20	60%	White	Colloid
3	<i>Pancreatiumtriflorum</i>	Starch	5	3.5	70%	White	Powder
4	<i>Cyanodondactylon</i>	Cellulose	10	0.762	7.62%	White	Powder

**Table 2. Formulations of edible coating solutions**

S.No	Biomaterials name	Solution A (-)	Solution B (-)	Solution C (-)	Solution D (-)	Solution E (+)
1	Carrageenan	1.5	1.5	1.5	1.0	1.5
2	Mucilage	3.0	3.0	3.0	3.0	3.0
3	Starch	2.0	1.5	0.1	0.5	0.01
4	Cellulose	1.5	1.0	0.5	0.01	0.01
5	Resin	0.2	0.02	0.2	0.02	0.01
6	Essential oil (Clove oil)	0.005	0.005	0.005	0.005	0.01
7	Distilled water (ml)	100	100	100	100	100

+ Positive result, - Negative result

**Table 3. Physical properties of edible coating solutions**

Properties	Solution A	Solution B	Solution C	Solution D	Solution E
Colour	White	White	White	Colorless	Colorless
Odor	No specific	No specific	No specific	No specific	No specific
Ph	7.3	7.7	7.2	7.9	7.0
Bubble	High	High	Medium	Low	Low
Heating resistance	60	60	60	60	60
Water content	50	35	20	35	15
Water resistance	12.67	17.64	17.64	19.14	20.93

**Table 4. Effect of edible coatings on sensory evaluation of fruits and vegetables during storage period**

Sample	Treatments	Storage periods (days)							
		0	3	6	9	12	15	18	21
Apple	Control	5	5	4	4	4	3	2	2
	Coated	5	5	5	4	4	4	4	4
Banana	Control	5	3	3	2	1	-	-	-
	Coated	5	5	4	4	4	3	-	-
Chilly	Control	5	5	4	3	3	3	-	-
	Coated	5	5	5	4	4	4	3	3
Tomato	Control	5	5	4	4	4	3	3	2
	Coated	5	5	5	5	5	4	4	4

Hedonic scale ranging from 0 to 5, where 1 = very bad, 2 = bad, 3 = medium, 4 = good and 5 = excellent





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**Table 5. Effect of edible coatings on weight loss of fruits and vegetables during storage period**

Sample	Treatments	Storage period (Weight in grams)			
		0	7	14	21
Apple	Control	140.64±0.27	139.21±0.44	136.2±0.72	120.55±0.54
	Coated	143.52±0.75	140.75±0.58	129.76±0.91	128.19±0.62
Banana	Control	88.56±0.88	87.68±0.91	84.36±1.66	-
	Coated	84.11±0.92	83.7±1.47	81.55±0.97	-
Chilly	Control	12.15±1.27	8.38±0.75	8.12±0.43	-
	Coated	12.54±0.98	12.11±0.95	10.92±0.57	9.2±0.41
Tomato	Control	65.95±0.21	64.14±1.42	65.95±0.62	62.17±0.24
	Coated	60.02±0.34	59.11±0.97	57.56±0.71	56.43±0.39

Mean ± SD

**Table 6. Effect of edible coatings on pH of fruits and vegetables during storage period**

Sample	Treatments	Storage periods							
		0	3	6	9	12	15	18	21
Apple	Control	4.68±0.14	4.99±0.41	5.00±0.74	5.00±0.92	5.10±0.16	5.14±0.27	5.21±0.44	5.25±1.29
	Coated	4.68±0.25	4.68±0.38	4.97±0.65	5.08±1.21	5.06±0.29	5.11±0.11	5.17±0.75	5.21±0.94
Banana	Control	4.48±0.73	4.48±0.17	4.58±0.52	5.08±0.74	5.26±0.64	-	-	-
	Coated	4.48±0.61	4.50±0.26	4.52±0.47	5.09±0.83	5.29±0.42	-	-	-
Chilly	Control	5.64±0.09	5.50±0.44	5.54±0.66	5.68±0.07	5.71±0.77	5.86±0.45	-	-
	Coated	5.64±0.17	5.39±0.52	5.39±0.72	5.57±0.14	5.69±0.65	5.81±0.71	-	-
Tomato	Control	4.56±0.16	4.36±0.18	4.69±0.61	5.12±0.47	5.07±0.49	5.11±0.94	5.11±0.71	5.26±0.19
	Coated	4.82±0.11	4.90±0.24	5.05±0.58	5.07±0.63	5.11±0.44	5.18±1.28	5.19±0.82	5.20±0.27

Mean ± SD

**Table 7. Effect of edible coatings on titratable acidity of fruits and vegetables during storage period**

Sample	Treatments	Storage periods							
		0	3	6	9	12	15	18	21
Apple	Control	0.20±0.74	0.18±0.91	0.17±0.46	0.14±0.85	0.13±1.12	0.10±0.41	0.08±0.07	0.07±0.73
	Coated	0.21±0.78	0.21±0.27	0.20±0.24	0.18±0.74	0.16±0.36	0.12±0.41	0.12±0.85	0.10±0.76
Banana	Control	0.23±0.46	0.19±0.09	0.16±0.37	0.11±0.42	0.08±0.78	-	-	-
	Coated	0.22±0.23	0.21±0.17	0.17±0.29	0.14±0.47	0.13±0.11	0.12±0.78	-	-
Chilly	Control	0.27±0.14	0.23±0.84	0.20±0.45	0.18±0.94	0.15±0.65	0.09±0.45	-	-
	Coated	0.27±0.57	0.26±0.42	0.23±0.70	0.19±0.52	0.18±0.23	0.15±0.41	0.13±0.90	0.11±0.54
Tomato	Control	0.31±0.85	0.29±0.46	0.26±0.27	0.21±0.54	0.19±0.76	0.17±0.85	0.13±0.19	0.11±0.57
	Coated	0.32±0.54	0.31±0.86	0.28±0.91	0.26±0.67	0.25±0.74	0.24±0.82	0.23±0.63	0.21±0.98

Titratable acidity in percentage % Mean ± SD

**Table 8. Effect of edible coatings on shrivelling percentage of fruits and vegetables during storage period**

Sample	Treatments	Storage periods							
		0	3	6	9	12	15	18	21
Apple	Control	4	4	4	3	3	3	2	2
	Coated	4	4	4	4	4	3	3	3





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Banana	Control	4	4	4	3	3	-	-	-
	Coated	4	4	4	4	3	2	-	-
Chilly	Control	4	4	4	4	3	2	-	-
	Coated	4	4	4	4	4	3	3	3
Tomato	Control	4	4	4	4	3	3	2	2
	Coated	4	4	4	4	4	4	3	3

4-score scale as: 1-very shrivelling, 2- low shrivelling, 3- normal and 4- very smooth

Table 9. Effect of edible coatings on shrinkage percentage (length) of fruits and vegetables during storage period

Sample	Treatments	Storage period			
		0	7	14	21
Apple	Control	98.64±0.47	96.21±0.85	94.2±0.92	92.55±0.42
	Coated	98.52±0.76	97.75±1.07	96.76±0.73	96.19±0.84
Banana	Control	88.56±0.99	87.68±0.92	84.36±1.06	-
	Coated	84.11±0.57	83.7±1.22	81.55±0.75	-
Chilly	Control	12.15±1.46	8.38±0.76	8.12±0.48	-
	Coated	12.54±0.31	12.11±0.19	10.92±0.73	9.2±0.42
Tomato	Control	65.95±0.49	64.14±0.45	65.95±0.94	62.17±0.56
	Coated	60.02±0.97	59.11±0.73	57.56±0.57	56.43±0.79

Shrinkage percentage %, Mean ± SD

Table 10. Effect of edible coatings on shrinkage percentage (breadth) of fruits and vegetables during storage period

Sample	Treatments	Storage period			
		0	7	14	21
Apple	Control	0	0.93±0.43	2.79±0.1.43	4.65±0.94
	Coated	0	0.47±0.31	1.90±0.82	2.85±1.55
Banana	Control	0	2.54±1.29	5.93±0.46	-
	Coated	0	1.69±1.46	4.23±0.37	-
Chilly	Control	0	4.41±0.93	13.23±0.51	-
	Coated	0	2.77±0.95	4.16±0.97	5.55±0.91
Tomato	Control	0	1.17±0.48	2.94±1.25	5.29±0.42
	Coated	0	0.62±0.29	1.87±0.96	3.75±0.35

Shrinkage percentage %, Mean ± SD

Table 11. Effect of edible coatings on decay percentage of fruits and vegetables during storage period

Sample	Treatments	Initial weight	Final weight	Decay percentage %
Apple	Control	140.64±0.94	120.55±0.88	14.28±0.61
	Coated	143.52±0.41	128.19±1.37	10.68±0.43
Banana	Control	88.56±0.34	84.36±0.48	4.74±0.97
	Coated	84.11±0.49	81.55±0.89	3.04±0.38
Chilly	Control	12.15±0.93	8.12±0.97	33.16±0.46
	Coated	12.54±0.53	9.2±1.14	27.48±0.93
Tomato	Control	65.95±0.83	62.17±0.92	5.73±1.27
	Coated	59.11±0.31	56.43±0.53	4.53±0.91

Decay percentage %, Mean ± SD





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a. *Kappaphycus alvarezii* (Doty) Doty ex Silva



b. *Pancreatium triflorum* Roxb.



c. *Cynodon dactylon* (L.) Per.



d. *Terminalia catapa* L.

Figure 1. Photographs of study plant species



a. Carrageenan



b. Mucilage



c. Starch



d. Cellulose

Figure 2. Biomaterials isolation process





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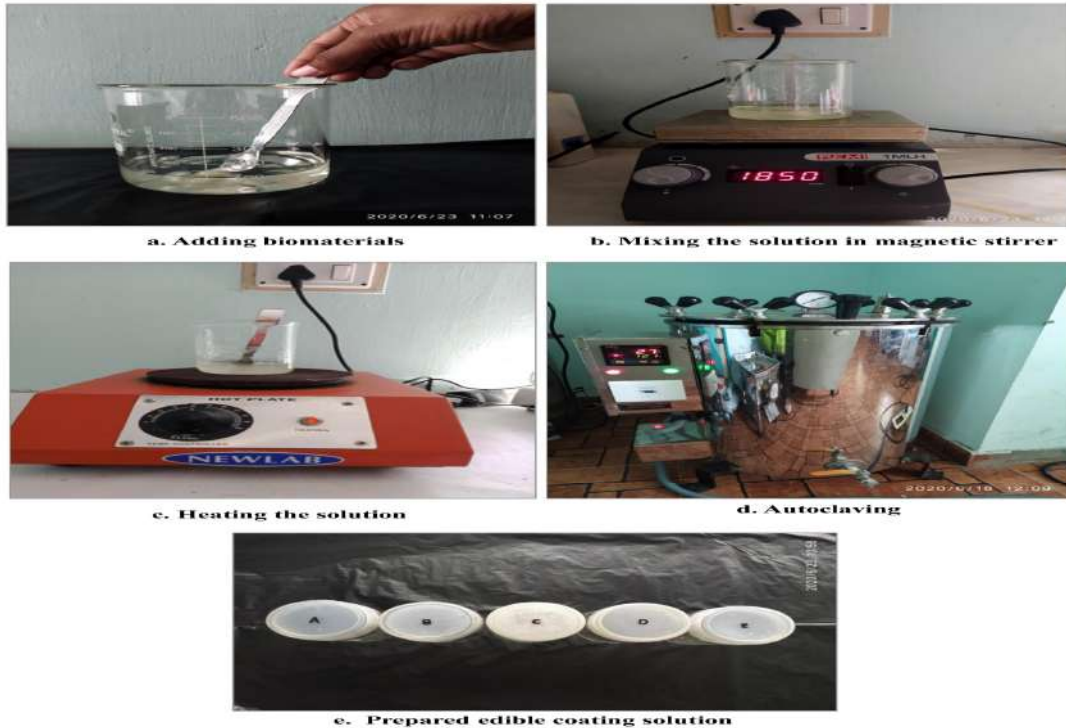
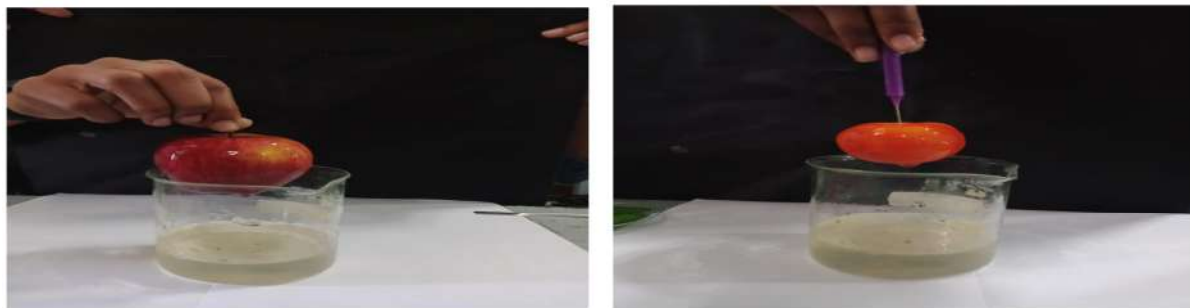


Figure 3. Showing the steps in coating solution preparation



Processing of edible coating



Coated fruits and vegetables

Figure 4. Processing of edible coating on fruits and vegetables







## Effect of Synbiotics on Saliva in Completely Edentulous Patients- a Prospective Study

Umesh Palekar<sup>1</sup>, Ashwini Komalan<sup>2\*</sup>, Deepak Vikhe<sup>3</sup>, Minal Awinashe<sup>4</sup>, Shubham Parmar<sup>5</sup> and Amruta Tambare<sup>6</sup>

<sup>1</sup>Professor and Head, Department of Prosthodontics, Rural Dental College, PIMS, Loni, Ahmednagar-413736, Maharashtra, India

<sup>2</sup>Final Year Post Graduate, Department of Prosthodontics, Rural Dental College, PIMS, Loni, Ahmednagar-413736, Maharashtra, India

<sup>3</sup>Associate Professor, Department of Prosthodontics, Rural Dental College, PIMS, Loni, Ahmednagar -413736, Maharashtra, India

<sup>4</sup>Associate Professor, Department of Oral Surgery and Diagnostic Science, College of Dentistry, Qassim University, Buraydah, Qassim Province, Saudi Arabia-52571

<sup>5</sup>Second Year Post Graduate, Department of Prosthodontics, Rural Dental College, PIMS, Loni, Ahmednagar-413736, Maharashtra, India

<sup>6</sup>First Year Post Graduate, Department of Prosthodontics, Rural Dental College, PIMS, Loni, Ahmednagar, Maharashtra, India

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### \*Address for Correspondence

#### Ashwini Komalan

Final Year Post Graduate,  
Department of Prosthodontics,  
Rural Dental College, PIMS,  
Loni, Ahmednagar-413736,  
Maharashtra, India.

E.Mail: dr.ashwinikomalan4@gmail.com



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### ABSTRACT

Xerostomia in older individuals is one of the cause of failure of complete dentures due to lack of retention and stability of dentures. The treatment of choice for such patients is the use of salivary stimulants, topical agents, saliva substitutes, synbiotics and systemic sialogogues and prosthodontically by means of a salivary reservoir incorporated denture. To assess the effect of synbiotics on quantity and pH of saliva in completely edentulous individuals. The study prospectively reviewed pH and quantity of saliva from samples taken from completely edentulous individuals at baseline and after intervention in Control (Group 1) and Study group (Group 2) respectively. Synbiotics did show an increase in quantity of saliva, however, change in quantity and pH of saliva was not statistically significant ( $P>0.05$ ) The





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effect of synbiotics on quantity and pH of saliva in completely edentulous individuals was not statistically significant.

**Keywords:** Prebiotics, Probiotics, Xerostomia, Synbiotics, Modulation Of Saliva

## INTRODUCTION

Combination of electrolytes, glycoproteins and enzymes forms saliva which lubricates and keeps the oral mucosa hygienic. In addition, it protects the mucosa from distress, aids in digestion and also helps with the process of taste sensation. In complete dentures, saliva helps with retention of the prosthesis [1]. Saliva also plays a profound role in decreasing the chances of stomatitis and candidiasis by maintaining the pH of oral cavity. In patients with xerostomia, the oral mucosa becomes dry, tends to crack and ulcerate which makes wearing removable prostheses uncomfortable as it may lead to frequent ulcerations, poor retention, difficulty in speaking and swallowing. Xerostomia is seen in Sjogren Syndrome (SS), after radiotherapy, autoimmune diseases or as side effect of medications [2]. It can be managed by the use of salivary stimulants, topical agents, saliva substitutes and by means of denture with salivary reservoir.

World Health Organization (WHO) defined Probiotics as 'live microorganisms which when administered in adequate amounts confer a health benefit on the host.' A number of probiotic induced benefits on the general health has been proposed, such as decrease in susceptibility to infections, allergies as well as lowered blood pressure and serum cholesterol values [3]. It has also shown to alter the composition of saliva and also efficiently lessen the risk of xerostomia [1]. Prebiotics are defined as "substrates that are selectively utilized by host microorganisms conferring a health benefit [4] which have the capacity of altering the intestinal microflora. Some of the commonly known prebiotics are lactose, inulin, fructo-oligosaccharides, galacto-oligosaccharides and xylo-oligosaccharides [5].

Gibson and Roberfroid introduced the concept of "Synbiotics"- "a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract, by selectively stimulating the growth and/or by activating the metabolism of one or a limited number of health-promoting bacteria, and thus improving host welfare" [6]. One such commercially available formulation of synbiotics is Vibact-DS (Mumbai, India) capsules with strains of 4 beneficial bacteria namely *Streptococcus faecalis*, *Clostridium butyricum*, *Bacillus mesenteric* and *Lactobacillus sporogenes*, which was used in this study and will be henceforth named synbiotics. Effect of synbiotics on quantity and pH of saliva in completely edentulous patients was assessed in this study.

## MATERIALS AND METHODOLOGY

Simple random sampling of 40 patients were done with 20 in control Group (Group 1) and 20 in study group (Group 2) according to the inclusion criteria (Table 1) after taking consent from the patients. In the first visit, the participants were asked to rinse their mouth with water and wait for 10 minutes prior to collection of saliva. Participants were allowed 10 minutes between collection of unstimulated and stimulated saliva. Samples were collected between the time frame of 9am to 12pm and quantity and pH of both stimulated and unstimulated saliva were assessed. Resting saliva was collected followed by acid stimulated saliva.

### Whole Unstimulated Saliva

Patients were asked to sit quietly with their head slightly lowered without talking or chewing and to spit any saliva that accumulates in the floor of the mouth. Saliva within the first minute of collection was discarded to eliminate food debris and unwanted substances, after which the saliva that was pooled in the floor of the mouth for 5 minutes and then collected into a graduated beaker and the quantity was measured.





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### Whole Stimulated Saliva

The patient was asked to swish 0.25% citric acid solution twice for 15 seconds and then spit out. Followed by collection of saliva for next 5 minutes, by spitting into a pre-weighed beaker after discarding first minute of saliva collection.

### pH of Saliva

pH of saliva was tested using pH-O-Meter for both unstimulated and stimulated sample of saliva. Participants of study group were provided with synbiotics and participants in control group were given empty gelatin capsules, which were taken once daily for a period of 14 days. All assessment variables under study were compared by applying Student's Paired 't' test from before to after intervention in both the groups under study at 5% ( $p, 0.05$ ) and 1% ( $p, 0.01$ ) level of significance. Statistical analysis software namely SYSTAT version 12 (made by Crane's software, Bangalore) a licensed copy was used to analyse the data.

## RESULTS

Salivary parameters of quantity (stimulated and unstimulated) and pH of saliva before and after intervention with empty gelatin capsules and synbiotics are shown in (Table 2) and (Table 3) respectively. In control group and study group, quantity and pH of saliva did not show statistically significant changes after intervention [ $p>0.05$ ]. On comparing the mean values of quantity of saliva after intervention in control and study group there was an increase in salivary secretion after intervention in study group, compared to control group as shown in table (Table 4) while pH was not affected. By applying Student's Unpaired 't' test there is no statistically significant difference [ $p>0.05$ ] in the mean values of parameters of saliva after intervention when control group was compared with study group as shown in (Table 5)

## DISCUSSION

Quality of life and nutrition are encumbered in older completely edentulous individuals due to decrease in salivary flow [6], leading to poor retention of the prosthesis and digestion of food which further affects nutrient absorption capacity. Prolonged indigestion may lead to altered flora and acute or chronic inflammation of the intestines. Suggested protocol for such cases are prebiotics, probiotics or synbiotics [7]. If salivary pH is acidic in nature then the denture wearers are more prone to oral candidiasis [8]. Studies have shown that effect of prebiotics [9], probiotics [1,3] and synbiotics [10-12] increases and influences the composition of saliva, such as the concentrations of mucins and salivary immunoglobulins and also maintains pH. Growth and activity of beneficial organisms is enhanced and simultaneously activity of potentially deleterious bacteria is suppressed, thus modifying the balance of microflora in that region. [11] Exact mechanism of how synbiotics is still unclear but proposed mechanisms include [10]:

- a) Enhancement of colonization of hard and soft tissues in the oral cavity,
- b) Modulation of the immune response and
- c) Antagonism of pathogens either by the production of antimicrobial compounds or through competition for mucosal or binding sites.

Combining the effects of fermentable substrates and live microorganisms are known as synbiotics. They may be complementary or synergistic. If the prebiotics and probiotics have their own independent action that may confer health benefits then they are called complementary and if they are dependent on each other to elicit a health benefit then they are called synergistic [13]. Synbiotics in the study falls under synergistic combination of pre and probiotics with genetically modified *Bacillus mesenteric* as probiotic and, *Streptococcus faecalis*, *Clostridium butyricum* and *Lactobacillus sporogenes* as probiotic, which helps in restoring the flora of intestine. Spitting method of salivary collection and pH of both stimulated and unstimulated saliva was checked [14,15].





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Effect of synbiotics on quantity and pH of saliva in completely edentulous individuals was assessed. Synergistic effect of synbiotic did show an increase the quantity of saliva in the study group, however it was not statistically significant. There was no effect on pH of saliva in both stimulated and unstimulated conditions. A comparison of results of this study could not be made as this study is first of its kind. Although this study did show an increase in the quantity of saliva, exact mechanism of this effect could still not be identified.

## CONCLUSION

Synbiotics are now viewed as a prime tool that helps in reducing and preventing risks related to diseases. Most research on synbiotics has been done in humans, but research is increasingly focused on animals. Improved numbers of beneficial bacteria and reduced potential pathogen load after administration of synbiotics to livestock, has been proven. This study concludes that consumption of synbiotics did not lead to statistically significant effect on quantity and pH of saliva in completely edentulous patients. Nevertheless, further studies must be conducted in this direction so as to elucidate the exact mechanism of functioning of synbiotics.

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**Table:1: List of inclusion and Exclusion Criteria**

Inclusion criteria	Exclusion criteria
Subjects above 55 years of age who are completely edentulous.	Those who are on any other pro/prebiotic or synbiotics supplements during the course of the study
Omnigender	Subjects who use salivary stimulants, topical agents, saliva substitutes and systemic sialogogues
Healthy, non-smokers without any systemic disease	Subjects with a history of salivary gland disorder
Subjects willing for the study and has signed informed consent	Subjects not willing for the study

**Table 2: Comparison of mean and SD values of all parameters of saliva before and after intervention in the Control group**

	Control group (n=20)			'p' value and significance
	Before intervention Mean ± SD	After intervention Mean ± SD	Student's Paired 't' test value	
Quantity of Saliva (MI) Unstimulated	0.88±0.25	0.85±0.26	0.5297	p=0.5763 not significant
Quantity of Saliva (MI) Stimulated	2.20±1.00	2.19±1.04	0.1765	p=0.8638 not significant
pH of Saliva Unstimulated	7.19±0.10	7.19±0.10	0.4497	p=0.6636 not significant
pH of Saliva Stimulated	7.65±0.13	7.62±0.13	.1068	p=0.2967 not significant





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**Table 3: Comparison of mean and SD values of parameters of saliva before and after intervention in the Study group**

	Study group (n=20)		Student's Paired 't' test value	'p' value and significance
	Before intervention	After intervention		
	Mean ± SD	Mean ± SD		
<b>Quantity of Saliva (MI)</b> <b>Unstimulated</b>	1.17±0.75	1.21±0.68	0.7682	p=0.4620 not significant
<b>Quantity of Saliva (MI)</b> <b>Stimulated</b>	3.23±2.13	3.29±2.21	1.000	p=0.3434 not significant
<b>pH of Saliva</b> <b>Unstimulated</b>	7.21±0.12	7.24±0.11	1.846	p=0.0980 not significant
<b>pH of Saliva</b> <b>Stimulated</b>	7.68±0.11	7.68±0.12	0.1606	p=0.8760 not significant

**Table 4. Comparison of mean and SD values of parameters of saliva before and after intervention in the Control and Study group**

	Control group (n=20)		Study group (n=20)	
	Before intervention	After intervention	Before intervention	After intervention
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
<b>Quantity of Saliva (MI)</b>				
<b>Unstimulated</b>	0.88±0.25	0.85±0.26	1.17±0.75	1.21±0.68
<b>Stimulated</b>	2.20±1.00	2.19±1.04	3.23±2.13	3.29±2.21
<b>pH of Saliva</b>				
<b>Unstimulated</b>	7.19±0.10	7.19±0.10	7.21±0.12	7.24±0.11
<b>Stimulated</b>	7.65±0.13	7.62±0.13	7.68±0.11	7.68±0.12





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**Table. 5. Comparison of mean and SD values of parameters of saliva at after intervention in the Control and Study group**

	<b>Control group (n=20)</b>	<b>Study group (n=20)</b>	<b>Student's Unpaired 't' test value</b>	<b>'p' value and significance</b>
	<b>After intervention</b>	<b>After intervention</b>		
	<b>Mean ± SD</b>	<b>Mean ± SD</b>		
<b>Quantity of Saliva (MI) Unstimulated</b>	0.85±0.26	1.21±0.68	1.5500	p=0.1385, not significant
<b>Quantity of Saliva (MI) Stimulated</b>	2.19±1.04	3.29±2.21	1.424	p=0.1715, not significant
<b>pH of Saliva Unstimulated</b>	7.19±0.10	7.24±0.11	1.059	p=0.3035, not significant
<b>pH of Saliva Stimulated</b>	7.62±0.13	7.68±0.12	1.033	p=0.3152, not significant





## Pharmacological Properties of North Indian Herbs *Cleome viscosa*-A Review

Sam David E<sup>1</sup>, Devi R<sup>2\*</sup>, R Srinivasan<sup>3</sup>, Sree Sivasakthi A<sup>1</sup> and R.Jothi Lakshmi<sup>2</sup>

<sup>1</sup>B.Pharm Student, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

<sup>2</sup>Associate Professor, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

<sup>3</sup>Dean and Professor, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

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### \*Address for Correspondence

#### Devi R

Associate Professor,  
Faculty of Pharmacy,  
Bharath Institute of Higher Education and Research,  
Chennai, Tamil Nadu, India.



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### ABSTRACT

Plants that have medicinal properties have been used from the traditional system of medicine to the modern medical system and used in the treatment of various diseases and disorders. *Cleome viscosa* is commonly known as "wild mustard or Dog mustard," an annual sticky herb widely used in traditional medicine and developing in modern medicine. It belongs to the Family Capparaceae, and it is a weed that is widely distributed in the regions of Pakistan, India, China, Ceylon, Africa, USA, Nigeria, etc. *Cleome viscosa* is a common remedy in the Ayurvedic and Unani systems of medicine, as documented in the ethnobotanical surveys. In the traditional method of treatment, the leaves, seeds, and roots of the plant are widely used as an anthelmintic, antiscorbutic, antiseptic, cardiac stimulant, carminative, febrifuge and sudorific, anticonvulsant, anti-diarrhoeal. They are also used to treat skin diseases. The plant contains various pharmacological activities such as anthelmintic, antimicrobial, analgesic, anti-inflammatory, Immuno Modulatory, antipyretic, Psycho Pharmacological, anti-diarrheal, and Hepato Protective. The plant also contains various Phyto constituents used as novel medicinal agents and in the specific herbal formulation. This review intends to explain the pharmacological properties of *Cleome viscosa* along with its Phyto chemistry and ethnobotanical features.

**Keywords:** *Cleome viscosa*, Ayurvedic, Phyto chemistry, medicine







## INTRODUCTION

Viscosa belongs to the genus cleome, which includes 12 genera and 250 species worldwide, and belongs to the family Capparaceae. It is commonly known as the Asian spider flower, tickweed, dog mustard, wild mustard, and yellow mesambay [1]. It is an annual herb showing erectile growth and bears sticky leaves; rural people cultivate this plant as a substitute for cumin seeds[2]. *Cleome viscosa* is a bisexual plant bearing both reproductive characteristics, enabling self-pollination. It is found in Asia, North America, and South America, also distributed locally on the coast of the Andaman & Nicobar Islands, Andhra Pradesh, and Tamil Nadu. This plant is consumed as a food supplement due to its medicinal value. The leaves and seeds are used in the medicinal preparation of many systems, especially in Unani, Siddha, folk medicine, and Ayurveda [3].

### Botany

**Botanical Name:** *Cleome viscosa* Linn.

**Class:** Dicotyledonae.

**Genus:** Cleome.

**Family:** Capparaceae.

**Synonym(s):** *Arivela viscosa* (L.) Rafin.

*Polanisia viscosa* (L.) DC. [3]

**Common Name:** Asian spiderflower, dog mustard, wild mustard, yellow mesambay, ground dove feed, caia, Tickweed. Yellow cleome, etc. [1].

### Description

Viscosa, an annual herb, has a branched stem, leaves simple or spiral, and 3-13 foliate. Flowers are bisexual, with both stamen and pistil, and have a nectar gland at the base, which attracts insects for self-pollination. The plant bears up to 40 seeds, and they are orbicular or reniform. The flowers are brightly coloured with four sepals and petals freely attached to the plant.[3]

### Distribution

*Cleome viscosa* originates in Asia and is distributed throughout the continents for its medicinal value. It is cultivated locally in Kerala, Karnataka, Uttar Pradesh, West Bengal, and the coastal region of Andaman and Nicobar. Recently it was found in North America, Australia, Africa, etc.

### Cultivation

Viscosa grows on sandy soil and rocky soil. It needs a perfect humid temperature and an altitude of 1000 meters above sea level. In some rural places, it is considered a weed in the fields of paddy and sugarcane.[1]. Animals or insects do not harm the plant due to its sticky nature on the stem and strong odour[2]. It can withstand a temperature of about 12 degrees to 26 degrees Celsius. The harvesting period lies between the end of August and October. It grows during the Kharif season along with the other agricultural crops.[4]

### Ethnopharmacology

The cleome plant plays a vital role in food and medicinal fields. Every plant part has therapeutic value and is cultivated to extract the desired crude drug. Cleome species treat certain bacterial and fungal infections [5]. The leaves, stems, flowers, seeds, and roots of the plant contain different chemical constituents, which have Anti-cancer, Analgesic, Anti-inflammatory, Antimicrobial, and Antidiarrheal properties. The leaves of the plant were known to have an antimalarial property and larvicidal activity [6]. When introduced to the rats, the methanol extract of the entire plant showed antidiarrheal potential and decreased gastrointestinal motion [7]. The anti-inflammatory property exhibited by the *Cleome viscosa* was found to have significant activity compared to a standard anti-inflammatory agent [8]. The decoction made out of crushed leaves is used to treat dysentery, and chewing the fresh leaves for a week is said to increase the probability of women becoming pregnant [9]. The decoction from seeds





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treats diarrhea and rheumatism; excess can cause stomach discomfort. Leaf decoction is mixed with clarified butter to treat ear inflammation [4]. The roots are reported to cure skin diseases like rashes and diabetes [10].

### Phytochemistry

Cleome was reported with a wide range of phytochemical components present in different plant parts. The seeds of *Cleome viscosa* are rich in essential fatty acids and vitamins. Cleome seeds contain 18% oil, five fatty acids, seven amino acids, and sucrose. It contains Palmitic acid, stearic acid, linolenic acid, and oleic acid but is mainly rich in linoleic acid [10].

### Seeds

Upon various phytochemical studies, the seeds are reported to have certain chemical constituents such as dihydrokaempferide-3- glucuronide and docosanoic acid. The ethanol isolation of seeds is said to have a derivative called cleosandrin [11].

### Roots

The root is one of the crucial parts of the cleome plant as it contains enormous chemical components such as naringenin-4-galactoside and dihydrokaempferol-4'- xyloside [12].

### Whole Plant

A new glycoside was isolated from the entire plant and designated eriodictyol-5-rhamnoside [13]. The glycoside was glycoflavanone, 3',4'-dihydroxy-5-methoxyflavanone-7-O-  $\alpha$ -L- rhamnopyranoside.

### Pharmacological Properties

#### Edibility

Cleome seeds are a cheap and alternative source for mustard seeds. It is found abundant in rural places and hilly regions. It has an oil content that comprises essential oils, fatty acids, and vitamins. The leaves of the cleome plant were found to cure boils and other skin problems. The studies and isolation of essential elements from *Cleome viscosa* prove the edibility.

#### Antipyretic Activity

A study showed that the *Cleome viscosa* has an antipyretic activity. The methanol extract obtained from cleome was introduced to a person having normal body temperature and yeast-induced pyrexia in rats. The extract was given to both at successive doses of 200, 300, and 400 mg/kg. The extract decreased the body temperature and the action extended up to 5 hours. This confirms the antipyretic activity of *Cleome viscosa* Linn [7].

#### Analgesic Activity

The seeds of *Cleome viscosa* contain oils, and it is used as analgesic agents for arthritis, joint pain, etc. The poultices obtained from seeds are used as a counter-irritant in joint pain. The methanol extract of *Cleome viscosa* shows significant activity as compared to the standard analgesic agent [14].

#### Antidiarrheal Activity

Not only the seeds, but the entire plant of *Cleome viscosa* also has an antidiarrheal property. A common laxative 'castor oil' was given to rats to induce diarrhea. Then the methanol extract from the entire plant was given to the rats. After extract introduction, the rats exhibited reduced gastrointestinal motility. These studies prove the antidiarrheal property of cleome viscosa [7].

#### Antimalarial Activity

The leaves of cleome seeds have a natural mosquito repellent formula that keeps away the mosquitoes. The leaves are burned and the smoke is used to keep the mosquitoes away as possible. It also has a larvicidal property that kills the 2<sup>nd</sup> and 4<sup>th</sup> stage larvae of female anopheles [15].





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## SUMMARY

*Cleome viscosa* has been used as a food additive in many rural areas, and the knowledge about its uses has not been spread among people very well. Despite having many medicinal values cleome is not used as a cash crop and is still considered a weed among many. It is easy to cultivate and harvest, even on a large scale as it does not require any special irrigation techniques or skilled labour. The cleome species serves a crucial role in novel medicine agents; showing antidiarrheal, antimalarial, anticancer, antimicrobial, and many more. In spite of chemical components found on the *Cleome viscosa* further studies on the species can help us to improve the modern and traditional medicines and enables us to cure different diseases. The data given above emphasize the potential of the traditional medicine cleome viscosa.

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Figure 1: *Cleome viscosa* Plant

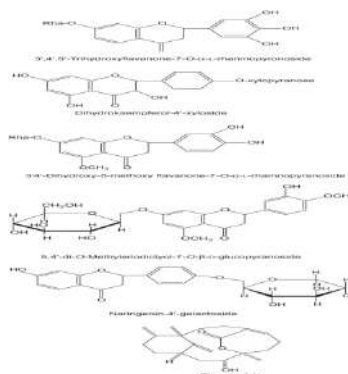


Figure 2. Phytoconstituents of *Cleome viscosa* Linn.

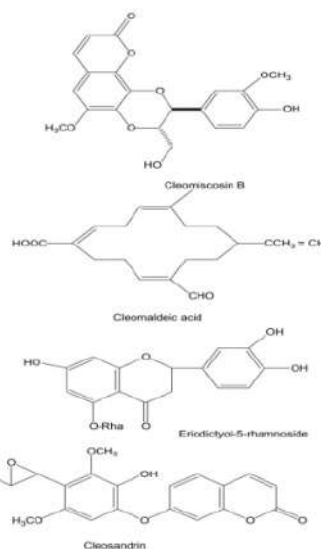
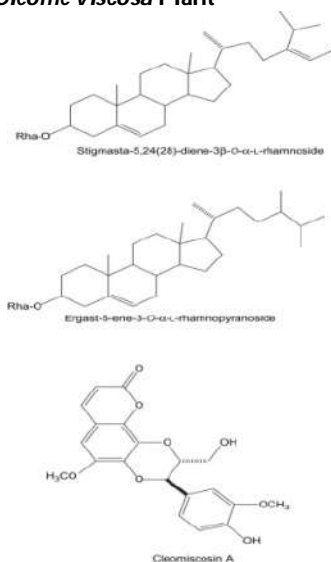


Figure 3. Phytoconstituents of *Cleome viscosa* Linn.





## An Overview on Pharmacological Effects of *Aegle marmelos* L.

V. Jhansi Lakshmi<sup>1\*</sup>, M.Nagabharathi<sup>2</sup> and K.Manasa<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Pharmacology, Vignan Institute of Pharmaceutical Technology, Duvvada, Andhra Pradesh, India

<sup>2</sup>Associate Professor, Department of Pharmacology, Vignan Institute of Pharmaceutical Technology, Duvvada, Andhra Pradesh, India

<sup>3</sup>M.Pharm, Student, Department of Pharmacology, Vignan Institute of Pharmaceutical Technology, Duvvada, Andhra Pradesh, India

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### \*Address for Correspondence

#### V. Jhansi Lakshmi

Assistant Professor,

Department of Pharmacology,

Vignan Institute of Pharmaceutical Technology,

Duvvada, Andhra Pradesh, India

E. Mail : jhanu.18@gmail.com



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### ABSTRACT

The pharmacological effects of *Aegle marmelos* are reviewed in this article. It's a member of the Rutaceae family. Other names for the *Aegle marmelos* include Bael, Bilwa, and wooden apple plant. It has a variety of biologically active substances with great medicinal value that are found in the leaves, flowers, fruits, wood, roots, and bark. Coumarins (Marmelosin, marmesin, imperatorin), alkaloids (Aeglin, aegelenine), tannins (skimmianine), carotenoids, seed oils, and other unspecified phytochemicals are among the components recovered from *Aegle marmelos*. This plant's phytochemicals have demonstrated a range of pharmacological and biological efficacy against a number of chronic illnesses, including cancer, cardiovascular disease, immunosuppressive illness, and gastrointestinal dysfunction. This plant extract's various components have pharmacological properties including anticonvulsant, antioxidant, anti-inflammatory, anti-diabetic, anti-diarrheal, antihyperglycemic, anxiolytic, antidepressant, antihistaminic, antimicrobial, hepato protective, analgesic, immuno modulatory, cardio protective, and antithyroid activities. The knowledge on the botany, ethnopharmacology, phytochemistry, biological activities, and insecticidal qualities of the *A. marmelos* plant is summarised in the current review.

**Keywords:** Coumarins, tannins, pharmacological properties, *Aegle marmelos*, botanical description, phytochemical, and ethnopharmacology.





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## INTRODUCTION

Since ancient times, people have employed plants as a natural supply of therapeutic chemicals. A moderately sized, slender, aromatic tree, Bael (*Aegle marmelos* (Linn), family Rutaceae, is also known as the bale fruit tree. It grows in the western Himalayas between 6.0 and 7.5 metres in height and between 90 and 120 cm in width, reaching an altitude of 1200 metres [1]. The *A. marmelos* plant and its plant-derived medicines are used to treat and alleviate physical and mental disorders. Traditional Chinese, Ayurvedic, Siddha, Unani, and Tibetan remedies all use these herbs. Many ancient texts a number of ancient texts, including as the Rigveda, Yajurveda, Atharvaveda, Charak Samhita, and Sushrut Samhita, mention the use of plants as treatments for various illnesses.. [2]. Additionally, these plants are used to treat various medical conditions due to their a number of ancient texts, including as the Rigveda, Yajurveda, Atharvaveda, Charak Samhita, and Sushrut Samhita, mention the use of plants as treatments for various illnesses.. They are also used to treat diarrhoea and dysentery. *A. marmelos* leaves were once used to induce infertility or abortion in females [3].

### Origin and Distribution [5,6]

The Eastern Ghats and Central India are where the bael tree first appeared. India is where *A. marmelos* originally lived. *A. marmelos* is a plant that grows in some Egyptian gardens in Surinam and Trinidad, as well as along the foothills of the Himalayas, in Bihar, Uttarpradesh, Jharkand, and Madhya Pradesh. *Aegle marmelos* are found in practically all of the states of India as well as in China, Nepal, Sri Lanka, Pakistan, Bangladesh, Indonesia, Malaysia, Tibet, and the Philippines.

### Botanical Description [7]

*Aegle marmelos* is a slow-growing, medium sized tree, up to 25 -30 feet in height with short trunk, thick, soft, flaking bark, and has few spiny branches. The full botanical description of *A. marmelos* is given in Table 2

### Utilization of *A. marmelos*

Every part of *A. marmelos* plant is utilized for general purpose and also medicinal purpose.

### General uses

The Eastern Ghats and Central India are where the bael tree first appeared. India is where *A. marmelos* originally lived. *A. marmelos* is a plant that grows in some Egyptian gardens in Surinam and Trinidad, as well as along the foothills of the Himalayas, in Bihar, Uttarpradesh, Jharkand, and Madhya Pradesh. *Aegle marmelos* are found in practically all of the states of India as well as in China, Nepal, Sri Lanka, Pakistan, Bangladesh, Indonesia, Malaysia, Tibet, and the Philippines.

### Ethanomedicinal uses

#### Phytochemical Composition

There are many different types of compounds present in plants, including alkaloids, cardiac glycosides, saponins, steroids, coumarins, terpenoids, phenylpropanoids, tannins, polysaccharides, and flavonoids.

### Alkaloids [12]

The alkaloids are the largest single class of secondary plant chemicals. A number of different alkaloids exist, such as aeglin, aegelenine, dictamine, fragrine (C<sub>13</sub>H<sub>11</sub>O<sub>3</sub>N), O-methylhalfordinine, isopentenylhalfordinol (15), N-2- [4-(3', 3'-dimethylallyloxy) phenyl] ethyl cinnamide



**Jhansi Lakshmi et al.,****Terpenoids [13,14]**

The leaves of *A. marmelos* were extensively investigated for their essential oil. It was discovered that alpha-phellandrene was a vital component found in the leaves, twigs, and fruits. Leaf oil provided alpha phellandrene (56%) and p-cymene (17%). Later, P-Menth-1-en-3,5-diol was extracted from *A. marmelos* leaves and characterised. Aegle's primary ingredient is

**Coumarins [15]**

There are marmelide, marmellosin, marmesin, imperatorin, marmin, and allomperatorin, as well as methyl ether, xanthotoxin, scopoletin, scoparone, umbelliferone, and umbelliferone

**Phenylpropanoids [16]**

These phenolic compounds are organic compounds that have 3C sidechains linked to an aromatic ring. The phenylpropanoids include lignans, hydroxycoumarins, and phenylpropenes. From leaves, heartwood, and root, a novel chemical called marmesin was create

**Flavonoids [17]**

Rutin, flavone, flavan-3-ols, and flavone glycosides are all present.

**Polysaccharides [18,19]**

**On hydrolysis, galactose, arabinose, uronic acid, and L-rhamnose are produced.**

**Seed oil [20]**

Seed oil is bitter and it consists palmitic, stearic, oleic, linoleic and linolenic acid.

**Tannins [18]**

The fruit of *A. marmelos* had the highest amount of tannin when tested in January. The pulp of wild apples contains 9% less tannin than farmed ones. Skimmianine, another name for tannin, which is also known as 4, 7, and 8-trimethoxyfuroquinoline, is also contained in leaves.

**Carotenoids**

The therapeutically useful elements of *Aegle marmelos* are the carotenoids Marmellosin, skimmianine, and umbelliferone. There are other insignificant components such ascorbic acid, sitosterol, crude fibres, tannins, -amyrin, carotenoids, and crude proteins. Psoralen, the xanthotoxin scopoletin, and tembamine are all present in roots. *A. marmelos* 12 has also been shown to contain substances including praealtin D, trans-cinnamic acid, 4-methoxy benzoic acid, betulunic acid, and montanin. Several of the many bioactive chemicals that have been discovered in this plant's numerous parts are listed in Table 4 [21].

**Nutritional Value [10]**

The bael plant has a high nutritional value and is a good source of vitamins, minerals, carbs, and proteins. The Bael plant provides minerals including calcium, iron, and phosphorus as well as vitamins like carotene, thiamin, riboflavin, and niacin. The inclusion of macro- and micronutrients like vitamins, organic compounds like tannins, alkaloids, polyphenols, and terpenes, fibre, protein, and oil allows plants to exhibit a variety of health advantages. Bael pulp contains a lot of vitamin C. (ascorbic acid). A dehydrated powder made from the fruit pulp and 30% sugar is used to make a soft squash or a cold beverage. The pulp of the bael fruit is combined with sugar, glucose, skim milk powder, and hydrogenated fat to make toffee. Worms are destroyed by the bael fruit in the intestine. Additionally, it is suggested as a treatment for persistent dysentery. Fresh leaf or flower juice reduces appetite, however a floral infusion made with sugar and milk is used as a cooling beverage. Fruit juice is made more palatable by adding milk and sugar. The Bael fruit's pulp is employed in the production of candy, squash, nectar, jellies, and marmalades. Unripe Bael fruit seeds' mucilage is utilised as glue and adhesive. Feronia gum is made from a thick,



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gum-like substance that is extracted from the Bael tree's trunk and branches. For the treatment of burns, Bael dry powder is diluted with mustard oil (1:2) and administered topically. This is frequently used to treat dysentery and diarrhoea. Bael fruit is frequently prescribed to treat peptic ulcers or piles, digestive issues, and to combat heat exhaustion. Blood purification and toxin removal from the liver and kidneys are two common uses for bael fruit juice. Additionally, it modulates the immune system and serves as a toxin defense. An excellent source of the liver-health enhancing nutrients beta-carotene, thiamine, and riboflavin is *A. marmelos*. Additionally, bael fruit serves as a component of cardiac tonics.

**REPORTED ACTIVITIES OF AEGLE MARMELOS:**

One of the most popularly utilised medicinal plants in the Rutaceae family is *A. marmelos*. This herb has reportedly been used for numerous therapeutic purposes recently.

**Antioxidant Activity**

Antioxidants are substances that have the ability to scavenge free radicals and are also utilised to protect cells from oxidative stress caused by free radicals. The antioxidant molecules come from organic materials like plants. The presence of flavones, isoflavones, flavonoids, anthocyanin, coumarin lignans, catechins, and isocatechins in these plants is what gives them their antioxidant action. *A. marmelos* is crucial for both cytoprotection and defence against membrane damage brought on by pro-oxidants. Male albino rats were used to test the antioxidant effects. Glucose, Estimates of urea and glutathione-S-transferase concentrations in plasma, glutathione (GSH) and malondialdehyde (MDA) concentrations in erythrocytes, and DT-diaphorase, superoxide dismutase, and catalase concentrations in the lung were made for each animal group at the end of the four-week period. Drug-catabolic body fluids underwent these changes. After 4 weeks, blood glucose levels and MDA levels in the *A. marmelos* group are lower than those in the diabetic rats, and erythrocyte GSH levels are then raised. Leaf extract protects the antioxidant defence system and corrects pancreatic beta-cell histological changes in STZ-induced diabetic rats [24]. Comparing the antioxidant and free radical-scavenging properties of ripe and unripe *Aegle marmelos* When ripe fruit extract was compared to unripe fruit extract, the results of enzymatic antioxidants showed an increase (except glutathione peroxidase). Unripe fruit has a higher percentage of free radical inhibition than ripe fruit does [25]. Screening for antioxidant activity using the DPPH radical scavenging method, reducing power assay, nitric oxide scavenging test, and superoxide radical assay on the fruit pulp of *A. marmelos* has H<sub>2</sub>O<sub>2</sub> radical scavenging assay, ABTS radical scavenging assay, and others. Alcoholic and aqueous extract both have strong antioxidant properties [26].

**Antimicrobial Activity**

*A. marmelos* has long been used to reduce a wide range of dangerous microorganisms as well as treat a variety of infectious diseases brought on by bacteria, fungi, and viruses. The antibacterial activity of *A. marmelos*'s leaves was found utilising the agar well diffusion technique. The aqueous, petroleum ether, and ethanol extracts of the leaves of *Aegle marmelos* efficiently suppress the multiresistant strains of *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Streptococcus pneumoniae*, *Salmonella typhi*, *Klebsiella pneumoniae*, and *Proteus vulgaris*. The ethanolic extract showed activity against *Penicillium chrysogenum*, whereas the petroleum ether and aqueous extracts showed action against *Fusarium oxysporum* [27]. The bacteria that the methanol kills include *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Escherichia coli*, *Salmonella paratyphi A*, and *Salmonella paratyphi B*. Hexane, cold methanol, hot methanol, and ciprofloxacin extracts all demonstrated significant antibacterial action against *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Micrococcus luteus*, *Enterococcus faecalis*, and *Streptococcus faecalis*. Antimicrobial activity testing revealed that gram-negative bacteria were more active than gram-positive ones [28]. Cuminaldehyde and eugenol, two chemical components found in eagle leaves, both exhibit potent antibacterial properties [29].





**Jhansi Lakshmi et al.,****Antibacterial Activity**

The leaves, roots, and fruits of *A. marmelos* contain a number of extracts that have been shown to be efficient against a wide range of bacterial species. Bacteria, the most adaptable unicellular pathogens, often spread through soil, water, air, and food to infect humans and other animals with disease. Similar diseases can be treated with natural treatments like aegle marmelos. Several Aegle extracts demonstrated antibacterial activity against *Pseudomonas denitrificans*, *Staphylococcus aureus*, *Bacillus stearothermophilus*, *Micrococcus luteus*, *Streptococcus faecalis*, *Micrococcus glutamicus*, and *Streptococcus faecalis*. Various extracts' antibacterial potency was assessed using the agar well diffusion method. ... *Klebsiella pneumoniae*, *Escherichia coli*, *Proteus vulgaris*, *Micrococcus luteus*, *Enterococcus faecalis*, and *Streptococcus faecalis* are just a few of the organisms that a variety of extracts, such as hexane, cold methanol, hot methanol, and ciprofloxacin extracts, exhibit high antibacterial activity against [30]. Leaf extracts have demonstrated anti-*Escherichia coli* action. *Aeromonas* sp., *Escherichia coli*, *Pseudomonas salanacearum*, and *Xanthomonas vesicatoria* were all susceptible to the essential oil made from the leaves. the ethanolic scavenging assay, the ABTS radical assay, and the H<sub>2</sub>O<sub>2</sub> radical assay. Alcoholic and aqueous extract both have strong antioxidant properties [26].

**Antimicrobial Activity**

*A. marmelos* has long been used to reduce a wide range of dangerous microorganisms as well as treat a variety of infectious diseases brought on by bacteria, fungi, and viruses. The antibacterial activity of *A. marmelos*'s leaves was found utilising the agar well diffusion technique. The aqueous, petroleum ether, and ethanol extracts of the leaves of *Aegle marmelos* efficiently suppress the multiresistant strains of *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Streptococcus pneumoniae*, *Salmonella typhi*, *Klebsiella pneumoniae*, and *Proteus vulgaris*. The ethanolic extract showed activity against *Penicillium chrysogenum*, whereas the petroleum ether and aqueous extracts showed action against *Fusarium oxysporum* [27]. *Salmonella paratyphi* A, B, *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Proteus mirabilis*, and *Staphylococcus aureus* are a few of the microorganisms that the methanol extract of bilwa demonstrates potent antibacterial effect against. Hexane, cold methanol, hot methanol, and ciprofloxacin extracts have extremely strong antibacterial activity against *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Micrococcus luteus*, *Enterococcus faecalis*, and *Streptococcus faecalis*. Antimicrobial activity assays revealed that gram-negative bacteria had higher levels of microbial activity than gram-positive strains [28]. Cuminaldehyde and eugenol, two chemical components found in aegle leaves, both exhibit potent antibacterial properties

**Antibacterial Activity**

Various extracts of *A. marmelos* leaves, roots and fruits have been reported to be active against many bacterial strains. Bacteria are the most versatile unicellular pathogens, which are normally transmitted through soil, water, air and food and cause diseases in human beings and animals. Such types of diseases could be treated with various natural products like *Aegle marmelos*. Different extracts of *Aegle* showed antibacterial activity against *Micrococcus glutamicus*, *Streptococcus faecalis*, *Staphylococcus aureus*, *S. pyogenes*, *Bacillus stearothermophilus*, *Micrococcus luteus*, *E. coli* and *Pseudomonas denitrificans*. The antibacterial activity of the different extracts was evaluated by agar well diffusion method. Various extracts like hexane, cold methanol, hot methanol and ciprofloxacin extracts shows high antibacterial activity against different organisms that are *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Micrococcus luteus*, *Enterococcus faecalis* and *Streptococcus faecalis* [30]. Leaf extracts have showed an activity against *Escherichia coli*. The essential oil obtained from the leaves exhibited activity against *Aeromonas* sp. The anti-fungal effects of ethanol, including those against *Trichophyton rubrum*, *T. terrestre*, *Epidermophyton floccosum*, *Aspergillus fumigatus*, *A. niger*, and *A. flavus*. The root's ethanolic extract has revealed action against *Trichophyton mentagrophytes* and *Aspergillus fumigatus*. The presence of Ca<sup>2+</sup> - dipicolonate and/or free Ca<sup>2+</sup> ions in the media and within the cytoplasm of microorganisms is related to the germination of any spore (bacterial or fungal). One of the crucial elements that determines whether a spore will germinate or remain dormant is the uptake and usage of the Ca<sup>2+</sup> ion by the spore. The Ca<sup>2+</sup> - dipicolonic acid metabolic pathway may be disrupted by the essential oil from aegle leaves, thereby inhibiting spore germination. This is one potential mechanism for the anti-fungal effects of aegle leaf oil..., *Escherichia coli*, *Pseudomonas salanacearum* and *Xanthomonas vesicatoria*.





#### Antiviral Activity [31]

A virus is seen as both a living and non-living entity, depending on where it is located in the host body. It causes seasonal outbreaks and doesn't react well to the majority of synthetic medications. The tiniest pathogen, a virus has two forms: a live organism inside the host body, and a non-living organism outside the host body. The effectiveness of several bael tree sections' in vitro antiviral activity against human coxsackie viruses B1–B6 has been assessed. As a typical antiviral drug, ribavirin has an IC50 of 100- 1000, 500- 1000, 250- 500, and 62.5 g/ml for leaves, stem and stem bark, fruit, root and root bark, and pure compound marmelide, respectively. The most effective virucidal agent is marmelide, which disrupts the beginning stages of the replicative cycle. In contrast to contemporary virucidal chemotherapeutic drugs (such as ribavirin), which operate in the later stages of viral replication and also have significant side effects, it appears that *Aegle* possesses antiviral actions in the early stages of viral reproduction with minimal host damage. To gauge its level of potential as an antiviral drug, the impact of several *Aegle* extracts on late protein synthesis was investigated. Fruit extracts at a concentration of 50% ethanol have demonstrated antiviral efficacy against Ranikhet sickness. The fruit extract hasn't shown any activity against the vaccinia virus, but it has shown interferon-like activity against the same virus. to improve the viricidal action of the *Aegle*.

#### Antidiarrheal Activity

One of *A. marmelos*' most significant therapeutic traits is its antidiarrheal action, which is widely used to treat chronic diarrhoea and dysentery. *A. marmelos*' antidiarrheal activity has recently been confirmed by a number of in vitro and in vivo experiments. The antidiarrheal activity of *A. marmelos*' dried fruit pulps was tested in vitro. The MIC technique was used to perform antidiarrheal activity against the organisms that cause diarrhoea [37]. *Aegle* root and leaf extracts exhibit gastroprotective and antidiarrheal properties against diarrhoea brought on by oil in animal prototypes. Unripe fruit slows down the flushing process and limits the sensation of faeces, blood, and mucus. Subacute, chronic, and amoebic dysentery are treated specifically with the dry powdered leaves and fruit pulp.. Additionally, the unripe fruit is baked with brown sugar or jaggery. To treat acute dysentery, green fruit pulp juice is employed. When consumed with cold water, fine fruit powder slows down blood clotting and causes stools to become more feculent and solid. Additionally, the mucous disappears following continued Belgiri use. It is one of the most crucial treatments for chronic dysenteric disorders characterised by intermittent constipation and diarrhoea. Mice exposed to castor oil-induced diarrhoea were found to be responsive to methanolic extract of *A. marmelos* 10. The ethanolic extract has moderate activity against *Shigella dysenteriae* and good activity against *Shigella boydii*, *S. sonnei*, and *S. flexneri*. Unripe *A. marmelos* fruit crude aqueous extract was isolated for diarrhea-causing compounds. The extract was found to have antibacterial, anti-Giardia, and anti-rotavirus properties, as well as an inhibitory effect against *Giardia* and rotavirus [38]. However, none of the six examined bacterial strains had their viability changed

#### Antihistaminic Activity [39]

*A. marmelos*' roots are the source of the quinoline alkaloid complex known as skimmianine. The effects of skimmianine on the release of histamine from rat mast cells are investigated in this study. Rat basophilic leukaemia (RBL- 2H3) cell line and rat peritoneal mast cells were the two cell types used in the investigation (RPMCs). Histamine release from rat mast cells was induced with DNP24-BSA, thapsigargin, and Ionomycin mixes 48/80. Skimmianine acts on the histamine H1 receptor in RBL-2H3 cells that have been stimulated to release histamine by DNP24-BSA, thapsigargin, and ionomycin.

#### Hepatoprotective Activity [40]

*A. marmelos* leaf has a hepatoprotective effect against liver damage brought on by alcohol consumption in albino rats. The intraperitoneal method is used to provide bacterial suspension to rats at a concentration of 5x10<sup>6</sup> CFU/0.1 ml. Then, for 15 days, the animals were given an alcoholic extract of *Aegle marmelos* diluted in functional saline at a concentration of 100 mg/kg body weight. The animals were starved for 12 hours after 15 days, and then they were lightly sedated with chloroform before being scarified. Animal blood is drawn to separate the serum, and the organs are removed and homogenised in ice-cold saline solution. The levels of protein, SGOT, SGPT, alkaline phosphate,



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total bilirubin, and other biochemical markers were examined. DTNB was used to estimate blood glutathione levels. *Aegle marmelos* leaves were used as a control group in certain trials that involved administering 30% ethyl alcohol to four groups of animals for 40 days. The rats that were induced given for 21 days with *A. marmelos* leaves. According to the findings of this study, *Aegle marmelos* leaves exhibit outstanding hepatoprotective properties.

#### **Cardioprotective Activity [40,41]**

In albino-wistar rats, isoprenaline-induced myocardial infarction is prevented by aegle leaf extract. It demonstrates a large increase in the enzyme levels of lactate dehydrogenase and creatine kinase as well as a significant decrease in the heart of isoprenaline-treated rats. *Aegle marmelos* is a heart depressant that has also been reported to cause palpitations [40]. For cardiostimulatory activity, fresh *Aegle* fruit juice is taken in various dilutions. The current research supports the claim that *Aegle* has superior cardiostimulatory action to Digoxin [41]

#### **Anticancer Activity**

In both industrialised and developing nations, cancer ranks as the second leading cause of mortality for both men and women. *Aegle* fruit extract is utilised to strengthen the immune system, which raises a body's anticancer activity. Preclinical research shows that *A. marmelos* leaf extracts were effective in preventing the development of organisms such as leukemic K562, T-lymphoid Jurkat, B-lymphoid Raji, erythroleukemic HEL, melanoma Colo38, and breast cancer cell lines MCF7 and MDAMB-231. Numerous studies have demonstrated the anticancer benefits of phytochemicals found in *A. marmelos*, including lupeol, eugenol, citral, cineole, and d-limonene [42]. The Ehrlich ascites carcinoma animal model has demonstrated an anticancer effect of the hydroalcoholic extract of *Aegle* leaves. The strongest anticancer impact was seen when the extract (400 mg/kg) was administered. In tests using sea urchin eggs, brine shrimp, and methyl thiazolyl tetrazolium (MTT), the plant extract displays cytotoxicity against tumour cell lines. Additionally, the extract has anti-proliferative effects on the breast cancer cell lines MCF7 and MDA-MB231. The presence of skimmianine in the leaf extract, which kills the tumour cells [31], causes the start of apoptosis.

#### **Wound Healing Activity [43]**

*Aegle marmelos* leaves are mostly used for the treatment of wound. The methanolic extract of *Aegle marmelos* was administered on topical as well as intraperitoneal administration was studied under two types of wound models that are excision and incision wound model in rats. Both the injection and ointment produces same response in excision as well as incision wound type was tested. In the excision model the extract which is used in treated wounds were found to epithelialize faster and also the rate of wound contraction was higher when compared to control wounds. The extract also facilitates the healing process by increasing the tensile strength in incision wound type. Then the results were also compared with the standard drug nitrofurazone

#### **Antifertility Effect [44]**

Male Albino rats were used to test the antifertility effects of *Aegle marmelos* leaf aqueous extracts. *Aegle marmelos* leaf aqueous extracts (250 mg/kg body weight) were given to the rats for 45 days, after which the treatment was determined by the decrease in testis, epididymis, and seminal vesicle weights. Additionally, testicular sperm count, epididymal sperm count, motility, and aberrant sperm count are all decreased by the extract

#### **Antidiabetic Activity [10]**

*A. marmelos* leaf extract is a crucial medication for the management of diabetes. Additionally, it improves the body's capacity to utilise the external glucose load by stimulating glucose uptake similarly to insulin. In experimental diabetic animals, aegle leaf extract significantly lowers blood urea and cholesterol levels as well as oxidative stress, as shown by a significant decrease in lipid peroxidation, conjugated diene and hydroperoxide levels and an increase in several enzymes such as superoxide dismutase, catalase, glutathione peroxidase, and glutathione levels in serum as well as liver. The anti-diabetic and anti-hyperlipidemic effects of the allopolyherbal formulation are demonstrated in oral glucose tolerance test and STZ-induced diabetic rat model using leaf extract from *A. marmelos*. It has



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considerable hepatoprotective, antioxidant, and pancreas-protective properties in addition to improving glycemic management greatly. It has an ingredient called umbelliferon-D-glucopyranosyl-(2(l) 1 (ll))-D-glucopyranoside, which lowers the excess glucose level in STZ-induced diabetic rats. Additionally, *A. marmelos* exhibits ameliorative benefits in rat models of early-stage diabetic nephropathy and cardiomyopathy caused by alloxan. Additionally, *A. marmelos* extract inhibits the enzyme aldose reductase and demonstrates its preventive function in diabetic cataract. Additionally, it inhibits both pancreatic and intestine -glucosidase *in vitro*. The presence of limonene, a strong anti-glycating agent, in the leaf extract helps to reduce secondary problems in STZ-induced diabetic mice. In STZ-induced diabetic rats, bark extract exhibits hypoglycemic and beta-cell regeneration properties. The antioxidant defence system of tissue and histological integrity are improved by *A. marmelos* leaf extract. Additionally, it improves haemostatic performance in STZ-diabetic rats and functions as a hypoglycemic and dyslipidemic inhibitor. The preparation of herbal medications for the treatment of ischemic heart disease in diabetic people uses both the extracts and chemical components of aegle. The green leafy porridge plants are utilised to regulate hypo- and hyperglycemic reactions. Additionally, Aegle leaf extract lowers the expression of the muscarinic M1 receptor gene in the cerebral cortex of STZ-induced diabetic rats. In experimental rats with STZ-induced diabetes, leaf extract exhibits antihyperlipidemic and anti-diabetogenic characteristics and reduces the diabetic consequences. The chloroform extract of *A. marmelos* developed anti-diabetic, anti-glycating, and antioxidant activities, successfully reducing cataract development and kidney damage. As a result, the plant is employed in the treatment of Type 2 diabetes.

**Miscellaneous Properties [12]**

Leaves of *Aegle marmelos* are used for the treatment of jaundice, leucorrhoea, conjunctivitis, and also wounds and thyroid related disorders. *Aegle marmelos* acts as an astringent and carminative and also acts as cardiac stimulant. It is also used in treatment of irritable bowel syndrome, snake bite, acute shigellosis, and in gonorrhoea.

**Toxicity Studies**

*Aegle marmelos* are both used as a food source of nourishment and have a number of therapeutic benefits. The leaves of *A. marmelos* are not administered to pregnant or nursing women, nevertheless, as they have historically been used to sterilise and induce abortion in females. *A. marmelos* leaves have recently been investigated for their acute and subacute toxicities. The acute and subacute LD50 values of the various extracts of *A. marmelos* leaves were examined in Wistar albino rats. The results showed that the LD50 values of the various extracts were given to several groups of animals at doses ranging from 1300 mg to 1700 mg/kg body weight. The histopathology examinations following 50 mg/kg body weight (daily, for 14 days) 45 showed no alterations. *A. marmelos*' dried fruit pulp was examined for its topological characteristics. Swiss albino mice were subjected to acute oral toxicity tests with ethanol extracts of the dried fruit pulp from *A. marmelos* at doses of 550 and 1250 mg/kg body weight. Test extract did not exhibit any toxicity at this doses. Throughout the 14-day experiment, mice's behaviour and physiological activity remained unchanged. The results showed that the test extract's LD50 values were greater than 1250 mg/kg body weight [37].

**CONCLUSION**

*Aegle marmelos* is a significant medicinal herb and is widely utilised in Ayurveda, Siddha, and other medical systems, according to this review. This plant's various parts, including the leaf, fruit, seed, bark, and root, are used to treat a wide range of illnesses. The *A. marmelos* has anti-inflammatory, wound-healing, anti-cancer, anti-fertility, anti-bacterial, anti-fungal, anti-diarrheal, anti-antidiabetic, cytoprotective, hepatoprotective, anti-viral, anti-cancer, and anti-fungal effects. Numerous physiologically active substances have been extracted from different *A. marmelos* sections. Alkaloids, Terpenoids, Vitamins, Coumarins, Tannins, Carbohydrates, Flavonoids, Fatty Acids, Essential Oils, and other diverse molecules are among the isolated substances. This review mainly concentrated on a number of reported pharmacological research and phytochemical analyses of *A. marmelos*.





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**Table 1 : Taxonomic Classification of *A. marmelos* L.**

<b>Taxonomy of <i>Aegle marmelos</i></b>	<b>Vernacular names of <i>Aegle marmelos</i></b>
Kingdom: <u>Plantae</u>	English: Wood/Stone apple, Bengal Quince, Indian Quince
Subkingdom: <u>Tracheobionta</u>	Bengali: <u>Bel</u> , <u>Shreefal</u>
Super division: <u>Spermatophyta</u>	Hindi: <u>Sir Phal</u>
Division: <u>Magnoliophyta</u>	French: <u>Oranger du Malabar</u>
Class: <u>Magnoliophyta</u>	Indonesian: <u>Mojo tree</u>
Subclass: <u>Rosidae</u>	Javanese: <u>Modjo</u>
Order: <u>Sapindales</u>	Khmer: <u>Banu</u>
Family: <u>Rutaceae</u>	Latin: <u>Aegle marmelos</u>
Genus: <u>Aegle</u>	Malay: <u>Pokok Maja Batu</u>
Species: <u>Aegle marmelos</u>	Marathi: <u>Kaveeth</u>
	Nepali: <u>Bel</u> , <u>Gudu</u>
	Sanskrit: <u>Shreephal</u> , <u>Bilva</u> , <u>Bilwa</u>
	Tamil: <u>Vilva Maram</u> , <u>vilva Pazham</u>
	Telugu: <u>Maredu</u>
	Thai: <u>Mapin</u> , <u>Matum</u> , <u>Tum</u>
	Urdu: <u>Bel</u>
	Vietnamese: <u>Mbau Nau</u> , <u>Trai Mam</u>

**Table 2: Botanical Description of *A. marmelos* L.**

<b>Plant part</b>	<b>Morphological characters</b>
Seed	The seeds are individually enveloped in an adhesive sac and are tiny, hard, flattened-oblong shapes with woolly hairs.
Bark	The bark has a number of long, straight spines and is brownish or grey in colour.
Leaf	These trifoliate leaves have a pointy apex and a round base. Young leaves have a light green colour, while mature leaves have a dark green hue
Flower	These trifoliate leaves have a pointy apex and a round base. Young leaves have a light green colour, while mature leaves have a dark green hue
Fruit	The Bael fruit is green when it is unripe and turns yellowish brown when it is ripe. Inside the apple is about 15 orange pulp.

**Table 3: Botanical Description of *A. marmelos* L.**

<b>Plant part</b>	<b>Morphological characters</b>
Bark	The bark is brownish or grey in colour and it contains a no. of straight long spines.
Leaf	These leaves are trifoliate and having round base and pointed tip. Young leaves are light green & Matured leaves are dark green in color.
Flower	The flowers are greenish or yellowish in color and bisexual in nature.
Fruit	The Bael fruit is green in unripe stage and it changes to yellowish brown when ripen. It contains 15-20 orange pulp inside of the fruit.
Seed	The seeds are small, hard, flattened-oblong, bearing wooly hairs and each enclosed in adhesive sac.



**Jhansi Lakshmi et al.,****Table 4: Phytochemical Constituents of *Aegle marmelos* L.**

Parts of plant	Chemical constituents	Therapeutic effects
Leaf	Skimmiamine, Aegelin, Lupeol, Cineol, Citral, Citronellal, Cuminaldehyde, Eugenol, Marmesin	Anti-cancer, cardio active, Anti-inflammatory, Anti-septic, Antiallergic etc.
Bark	Immature- Marmin, Skimmiamine, Mature-Fagarine	Abortifacient, Anti-ulcer, Antidiarrheal,
Unripe fruit	Tann	Astringent
Fruit	Marmelosin, Luvangetin, Aurapten, psoralen, Marmelide	Cardio-protective, anti-ulcer Antispasmodic, Anti-diarrheal

**Figure 1: Leaves of *Aegle marmelos***





## A Study on Review of Status, Influencing Factors, And Economic Implications of Financial Literacy among Women

Sushma V<sup>1\*</sup> and Vinay Joshi C<sup>2</sup>

<sup>1</sup>Research Scholar, Presidency University, Bengaluru, Karnataka, India.

<sup>2</sup>Associate Dean and Research Guide, Presidency University, Bengaluru, Karnataka, India.

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### \*Address for Correspondence

#### Sushma V

Research Scholar,

Presidency University,

Bengaluru, Karnataka, India.

E. Mail: sushma.v@presidencyuniversity.in



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### ABSTRACT

For effective money management, financially education is a necessary ability. The condition of financial literacy in women is investigated in this literature review, along with the variables that affect women's level of financial literacy and the economic repercussions of inadequate financial literacy. It concludes that despite advancements, there remains a sizable disparity across men and women when it comes to their financial literacy, having women more likely than men to report insufficient knowledge and lack of confidence in their capacity to make sound financial decisions. As contributing factors, factors including age, marital status, education, money, and culture are also included. Early financial education, greater salaries, and marital status all increase the likelihood that women will advance professionally and academically. Economic repercussions of inadequate financial education among women include a decreased amount of savings for retirement, greater amounts of debt, and lower levels of economic mobility. Strategies like expanding access to financial information and tools, removing social and cultural barriers, and focusing interventions on specific groups are suggested as ways to increase women's financial literacy levels. Even if achievement has been made, more needs to be undertaken to close the gender pay gap and advance women's economic security.

**Keywords:** Financial Literacy, women, Education, Behaviour, Factors.

### INTRODUCTION

For people to make wise financial decisions, they need to have financial literacy, which is a crucial skill. It requires having the capacity to comprehend, evaluate, and efficiently manage one's own financial. Given the increasing proof of substantial disparities between genders in this area, financial literacy is especially important for women. Even

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after taking into account variations in background, income, and marital status, a number of studies have demonstrated that women aren't as financially savvy than men. This lack of understanding of finances can result in decreased savings rates, greater debt levels, and lower income during retirement for women, all of which have substantial economic repercussions. Therefore, it is crucial to pinpoint the causes of this gender disparity in financial literacy along with to create solutions, prosperity and financial stability. Studies have revealed that women frequently have lower levels of financial literacy than males, despite the fact that financial literacy is a vital aspect of economic well-being (Lusardi & Mitchell, 2014). The present status of study on the subject of financial literacy in women is examined in this literature review, with an emphasis on the economic ramifications of poor financial literacy and methods for raising those levels. Despite recent gains in promoting financial awareness among women, more needs to be done to guarantee that every one of women have the skills and knowledge required for both economical security and prosperity. The significance of financial literacy & its possible effects on people as well as society have been emphasised by numerous academics and policymakers. The idea of financial literacy, however, has only recently drawn considerable attention. Financial literacy was formerly frequently seen as a personal obligation rather than a communal issue. However, recent studies have demonstrated that having poor financial literacy can result in serious economic repercussions for both individuals and society as a whole. This has prompted greater attempts to raise financial literacy & to create practical plans for enhancing financial literacy, particularly among women. Several factors, such as variations in earnings, educational attainment, and cultural norms, bring to the gender disparity in knowledge of finances. Recent study, however, indicates that the threat of stereotypes could have a substantial role in the reported gender discrepancy. Stereotype danger is a phenomena in which people are concerned about confirming unfavourable preconceptions about their peer group. In regard to financial literacy, biases may cause women to be less confidence in their financial ability, influencing their decisions regarding finances. As a result, tackling the risk of stereotypes is a critical component of initiatives to promote women's financial literacy.

**REVIEW OF LITERATURE****Women Have Lower Levels of Financial Knowledge than Males**

Women continuously exhibit lower levels of financial literacy than males, according to studies (Lusardi & Mitchell, 2014; OECD, 2014). According to a research conducted by Lusardi and Mitchell (2014), women performed lower than men on the financial literacy examination in every country studied, with the gender gap being worst in poorer nations. Another research conducted by the Financial Industries Regulatory Authority (FINRA, 2019) discovered that women had poorer levels of financial literacy in areas such as investment, risk management, and credit.

**Financial Literacy Is Influenced By Socioeconomic Circumstances.**

According to research, socioeconomic variables such as earnings, schooling, and age might impact women's financial literacy levels. For example, Hung, Parker, and Yoong (2009) discovered that women with greater levels of education had higher levels of financial literacy. Similarly, according to a research conducted by the National Bureau of Economic Research (NBER, 2015), financial literacy is positively associated to income and wealth.

**Economic Results Are Connected To Financial Literacy**

Financial literacy is consistently associated with a variety of economic outcomes, including greater savings rates, more effective investment choices, and superior planning for retirement (Lusardi & Mitchell, 2014; NBER, 2015). Low levels in financial literacy, on the other hand, can contribute to financial instability, debt, and poor (Lusardi & Mitchell, 2014). A National Endowment for Financial Education (NEFE) research, for example, discovered that women who participated in financial education programmes reported lower levels of financial stress and more confidence in their abilities to handle money.



**Sushma and Vinay Joshi****Interventions In Financial Literacy Can Be Successful.**

Financial literacy programmes have been proven in studies to increase women's understanding of finances, attitudes, and behaviours (Hung et al., 2009; NEFE, 2019). These types of measures can take many different forms, such as financial literacy lessons, workshops, and coaching. For example, a World Bank (2017) research discovered that financial education programmes targeted to the individual desires and requirements of women significantly more efficient than generic programmes.

**Cultural Variables Might Have An Impact On Financial Literacy.**

Gender norms and money attitudes, for example, can have an impact on women's financial literacy (Hung et al., 2009). Some cultures, for example, may regard financial issues as the preserve of men, and this can result in a lower degree of financial understanding among women. Furthermore, social norms regarding savings and spending can influence financial behaviour (OECD, 2014). Overall, the evidence demonstrates that increasing women's financial literacy is vital for achieving economic stability and empowerment. Interventions that take socioeconomic and cultural issues into consideration may be the most successful in reaching this aim.

**Research Questions**

1. What is the present state of financial literacy amongst women versus men?
2. What factors contribute to the gender disparity in financial literacy levels?
3. What effect does stereotype threat have on women's financial literacy?
4. Which strategies have been successful in lowering stereotype threat and increasing financial knowledge among women?

**Objectives**

1. Determine and compare the present state of financial literacy amongst women and men.
2. Determine the elements that lead to the gender disparity in financial literacy level.

**RESEARCH METHODOLOGY**

The first stage in conducting a literature review research on financial awareness and literacy among women is to perform an extensive review of relevant literature. After that, I searched academic databases, internet library resources, and search engines for pertinent information. Data from chosen studies should be collected and analysed, and findings would be synthesised to create a clear and succinct description of the procedure for reviewing literature

**Findings of the Study**

Women often have a lesser amount of financial knowledge than males: Women routinely have a lower degree of knowledge about finances than males, according to studies. This might be attributable to a variety of variables, including disparities in educational possibilities, social conventions about gender roles, and life events. Women's financial literacy levels can be influenced by social and economic variables such as income, schooling, and age: People with greater amounts of earnings, schooling, and work experience are more likely to be financially literate. When it pertains to financial literacy, women whom come from lower-income homes, have less schooling, or are young might fall at a disadvantage.

Women often have a lower level of financial knowledge than males: Financial literacy is associated with a variety of favourable economic outcomes, including improved savings rates, more favourable investment selections, and better retirement planning. According to studies, persons with greater levels of financial literacy make greater financial choices as a whole, including accumulating more money, saving more efficiently, and preparing for retirement more successfully. Financial literacy initiatives can help women improve their economic knowledge, attitudes, and behaviours: Various educational actions, such as seminars, distance learning courses, and coaching programmes, have been shown to improve women's financial literacy.



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Gender conventions and money attitudes, for example, can all have an impact on women's financial literacy: Cultural beliefs and expectations around gender roles, as well as beliefs about money and financial management, can also play a role in shaping financial literacy levels among women.

**CONCLUSION OF THE STUDY**

Improving women's financial literacy is critical for ensuring economic stability and empowerment: Raising financial literacy within women is critical because it may lead to improved overall economic results as well as more economic empowerment & security for women. Interventions that take socioeconomic and cultural aspects into consideration may be the most successful in boosting financial literacy for women: Financial education initiatives that are tailored to the individual socioeconomic and cultural characteristics that impact financial literacy in women may be more successful than generic treatments that do not account for these aspects. Women's financial education programmes that are targeted to their unique needs and preferences outperform generic programmes: Financial education initiatives customised to women's individual needs, interests, and circumstances might prove more effective to generic programmes that do not account for these characteristics. Financial literacy initiatives can reduce financial stress and increase women's confidence in money management: Financial education interventions have been shown in studies to reduce financial stress and boost confidence in money management among women, which can have a good influence on their general health and quality of life.

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## Health and Safety Measures in Chettinad Cement Corporation Limited Puliyyur

Kanimozhi M<sup>1\*</sup> and C.Suganya<sup>2</sup>

<sup>1</sup>MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of MBA, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

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### \*Address for Correspondence

**Kanimozhi M**

MBA Student,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E. Mail:kanimurugan7321@gmail.com



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### ABSTRACT

Construction and engineering depend heavily on the cement industry. The purpose of this research was to get insight into the perspectives and awareness of workers at Chettinad Cement Corporation Limited, Puliyyur with regards to health and safety policies and practises. The employer's brightly coloured welfare measures will have an instantaneous effect on the work environment's artificial safety and productivity. There were 108 participants in the study. Probability and Chi-square tests, as well as a correlation analysis, are employed in this investigation. Workers at Chettinad Cement Corporation Limited tend to be between the ages of 26 and 35, and this research found that the workers' perceptions of health and safety measures were significantly influenced by their level of experience. According to the research, Chettinad Cement Corporation Limited has a number of potential problems that may be mitigated if the association increased worker compensation and took other appropriate measures.

**Keywords:** Cement Industry, Employee Health, Working Condition, Safety, Labour Welfare

### INTRODUCTION

Each organisation must prioritise the wellbeing of its employees above all else. One of the major contributors to accidents that result in plant injuries and work-related illnesses is a worker's own poor state of physical and mental health. If health and safety aren't properly handled, it can have disastrous results. Employers are legally required to ensure their employees' well-being. There is a moral need for employers to ensure the well-being of their employees. The groups must take responsibility for the safety of its members in the workplace. Social welfare includes worker protections and benefits. It entails conforming one's work life, social life, and family life to the norms of the society in

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which one resides. Depending on factors including a nation's value system, social institutions, level of industrialization, and the state of the country's social and economic development, the concept of "weal" will always be shifting. The content may also vary from area to region within a single country. Weal is a condition of complete contentment and material security, according to Chambers' Dictionary. The term "welfare" is used to describe a situation in which a person or group enjoys a satisfying level of ecological, economic, and social success. The welfare measures instituted by the union boost the union's standing in the eyes of the working population, guarantee a more harmonious workplace and cut down on employee waste, all of which lead to higher productivity and a better standard of living for everyone.

#### Objectives of the Study

- To study the effectiveness of health and safety measures espoused by chettinad cement corporation limited, karur.
- To know the workers perception regarding the safety programs and practices.
- To find out the impact of artificial safety and work terrain on productivity.

#### Need for the Study

- It keeps workers healthy and protects their well being.
- A safe and healthy plant protects workers from injury.

#### Scope of the Study

- To promoting and maintaining overall well-being of workers in all occupation.
- To easily fete and understand health problems in any artificial atmosphere that may be generated from any source.

#### Limitations

- The data has been collected only from 108 workers in the association due to the deficit of time.
- My study is compare to your association only.
- The data has been collected during the busy hour of the workers.

## REVIEW OF LITERATURE

The purpose of this study, as stated in Johannson B; Rask K; Stenberg M (2010), was to conduct a comprehensive literature review on the topic of piece rate earnings and their effects on health and safety. Seventy-five scholarly publications were reviewed, and 31 of them were deemed to be of adequate quality and applicability for this investigation. The survey compiles and analyses the results of these articles. Health, musculoskeletal injuries, physical workload, aches, and occupational injuries have attracted a lot of attention in recent years. Although the fact that 27 of the 31 research reviewed indicated negative impacts of piece rates on various health and safety aspects does not prove causality, it does provide extremely strong support for the idea that piece rates typically have adverse consequences on health and safety.

We analysed the literature on occupational health and safety interventions by Tompa, Emile PhD; Dolinschi, Roman MA; de Oliveira (2009) to draw conclusions on the economic value of these programmes. Journal databases, current systematic reviews, and research recommended by subject matter experts were all part of the search for relevant literature. We found substantial evidence that the financial benefits of implementing ergonomic and other musculoskeletal injury prevention interventions in the manufacturing and warehousing sectors outweigh the costs. There is room for more research into the monetary worth of interventions. The assessment also offered suggestions for enhancing the methodological quality of economic evaluations in this body of work.



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Peter A. Cripton; Meghan Winters; Conor C. O'Reilly; M. Anne Harris (2009), It's possible that riding a bike could help you get in shape. Improving public health requires an understanding of how to make bicycling safer. We looked at research on how better bicycle infrastructure may make streets safer for cyclists. Injuries, severity of injuries, and collisions were included as outcomes studied in order to evaluate safety. So far, it appears that the presence of bicycle facilities (such as on-road bike routes, on-road marked bike lanes, and off-road bike paths) is associated with the lowest risk, while the presence of sidewalks and multi-use trails is associated with the highest risk, major roads are more hazardous than minor roads, and major roads are more hazardous than minor roads. Additional characteristics that appear to promote cyclist safety are street illumination, paved surfaces, and low-angled hills. The purpose of the research conducted by Artazcoz, Cortes, Escriba-aguir, and Cascant (2009) was to determine the personal and professional factors that contribute to extended workweeks. Salary workers aged 16-64 were included in the sample from the Catalonian Health Survey of 2006 (3950 males and 3153 women). There was a gender gap in the causes of lengthy work hours. A lack of sleep, smoking, job discontent, and hypertension were all linked to working 51-60 hours per week among men. For females, the only correlations were with smoking and sleep deprivation. Male breadwinner status may account for the disparate effects of overtime on men's and women's health.

Edington, Dee W., and Schultz, Alyssa B. (2008), The purpose of this literature review was to show the data linking health risks to the economic indicators of lost time at work, decreased productivity, increased medical expenses, and higher prescription drug prices in the workplace. PubMed was searched, and then high-quality studies were chosen and added to those already known to the authors. There is a substantial amount of research connecting worker health concerns to health care and pharmaceutical expenses. Health concerns are linked to productivity indicators, according to a growing body of literature. The study demonstrates the significance of success metrics in the evolving field of workplace health management. Cantor, David E. (2008), The goal of this paper was to examine existing literature on supply chain workplace safety and to advocate for more study of the human, operational, and regulatory factors that affect worker protection. This report proposes a number of avenues for future study that could help raise consciousness about the need to better an organization's approach to workplace safety. This study cites 108 sources that discuss the development of logistics and transportation safety. The study identifies 14 potential avenues for further research in the field of supply chain safety, all of which would benefit practitioners dealing with safety challenges in the workplace.

Lorena Cascant, Imma Cortes, VincentaEscriba-aguir, and Lucia Artazcoz (2007), The purpose of this paper is to create a framework for epidemiological research on work and health by bringing together traditional occupational epidemiology with a structural view that centres on gender inequalities in health and the workplace. Classic occupational epidemiology is critiqued for its omissions and shortcomings when viewed through a feminist lens. Women's health issues have received less attention than men's in traditional occupational epidemiology. Few studies of health disparities between men and women in the workplace have taken into account socioeconomic status or the effect of family responsibilities on men's well-being. It is important to consider the interplay between gender, family responsibilities, job, and socioeconomic status when analysing the relationship between work and health from a gender viewpoint.

## RESEARCH METHODOLOGY

### Research Design

This study employs a descriptive research strategy based on a comprehensive and methodical questionnaire.

### Method Of Collection

Primary and secondary data are used in the data collection process.



**Kanimozhi and Suganya****Sampling Size**

The sampling size of the study is 108

**Sampling Unit**

The sampling unit of the study is employees of Chettinad Cement Corporation Limited.

**Sampling Method**

The sampling method used in the study is simple random sampling method.

**Tools for Data Analysis**

- Descriptive Statistics
- Chi-Square Test
- Correlation

**Data Analysis****Descriptive Statistics**

Number of responders to a questionnaire expressed as a percentage of the overall population selected for the study; this is the focus of percentage analysis, a straightforward statistical tool. It's one of the simplest types of analysis that can provide significant findings to a researcher. From the above table it was found that major of the respondents are Male (85.2%) & they are under the age group of between 26-35 (37%) & they recompleted Post graduate (78.7%) & the persons have 1-2 years of experience (47.2%) and their Salary is between Rs.15000-25000 per month (38.9%).

**Chi-Square Test**

**Table 1:** Gender and Effectiveness

**H0** – There is no significance relation between using Gender and Effectiveness.

**H1** – There is significance relation between using Gender and Effectiveness.

**Inference**

The determined cumulative value of 0.000 from the table above is below the threshold of 5%. Therefore, H1 is a valid and accepted hypothesis.

**Table 2:** Age and Effectiveness

**H0**– There is no significance relation between using Age and Effectiveness.

**H1** – There is significance relation between using Gender and Effectiveness.

**Inference**

The preceding table shows that the estimated cumulative value was below the level of 0.05 percent, coming in at 0.000. Therefore, H1 is a valid and accepted hypothesis.

**Correlation**

**Table 1:** Gender and Perception

**H0**– There is significance relation between using Gender and Perception

**H1** – There is no significance relation between using Gender and Perception

**Inference**

The preceding table shows that the estimated cumulative value is 0.051, which is lower than the threshold of 0.05 percent. Therefore, H0 is a well-fitting and valid hypothesis.

**Table 2:** Experience and Perception

**H0**– There is significance relation between using Experience and Perception

**H1** – There is no significance relation between using Experience and Perception





**Kanimozhi and Suganya****Inference**

From the above table the calculated table the calculated sum value is 1.35 which was above the level of 0.05%. Hence the Hypothesis of H1 is truly fit and it is acceptable.

**FINDINGS, SUGGESTIONS AND CONCLUSION****Findings**

From the above table it was found that major of the respondents are Male (85.2%) & they are under the age group of between 26-35 (37%) & they are Completed Post graduate (78.7%) & the persons have 1-2 years of experience (47.2%) and their Salary is between Rs.15000-25000 per month (38.9%).

**Suggestions**

The following are some recommendations for the company to consider in order to enhance worker safety. The researchers recommend that the employer raise the worker's salary. Also, to reduce air pollution, trees will be planted around the factory and in any surrounding towns. In addition, the report recommends that the organization prioritise the reduction of risks and the enhancement of safety rules and procedures in the workplace.

**CONCLUSION**

The goal of the research was to learn about the health and safety policies in place at the chettinad cement corporation limited, puliyur. A total of 108 people were selected for the study using a stratified simple random selection strategy. According to the data, most workers are between the ages of 26 and 35. According to the data, the vast majority of workers hold post-secondary education degrees. The research also indicates that there should be separate policies in place to protect workers engaged in high-risk business processes. The company's obligation to its workers extends to the provision of personal protective equipment like gloves and face masks.

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**Table 1. Demographic variables**

Demographic variables		Frequency	Percent
Gender	Male	92	85.2
	Female	15	13.9
	Not prefer to say	1	.9
	<b>Total</b>	108	100
Age	18-25	28	25.9
	26-35	40	37.0
	36-45	30	27.8
	Above 45	10	9.3
	<b>Total</b>	108	100
Education	Under graduate	12	11.1
	Post graduate	85	78.7
	Diploma	9	8.3
	Others	2	1.9
	<b>Total</b>	108	100
Experience	Less than 1 year	4	3.7
	1-2 years	51	47.2
	2-3 years	28	25.9
	Above 3 years	25	23.1
	<b>Total</b>	108	100
Salary	Below 15000	6	5.6
	15000-25000	42	38.9
	25000-35000	35	32.4
	Above 35000	25	23.1
	<b>Total</b>	120	100.0

**Table 2: Gender and Effectiveness**

	Chi-square	df	Asymp. Sig.
Gender	5.62	1	.000
To what extent do you feel that safety measures are adequately implemented in your workplace?	42.00	3	.000
How effective are safety training programs in minimizing workplace hazards and risks?	28.43	2	.000
How often do you witness unsafe behaviors or actions in your workplace?	54.24	3	.000
To what extent do safety policies and procedures improve your personal safety and well-being?	25.21	3	.000
How confident are you in using safety equipment and tools provided by the company?	78.25	3	.000

**Table 3: Age and Effectiveness**

	Chi-square	df	Asymp. Sig.
Age	49.45	2	.000
To what extent do you feel that safety	42.00	3	.000





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measures are adequately implemented in your workplace?			
How effective are safety training programs in minimizing workplace hazards and risks?	28.43	2	.000
How often do you witness unsafe behaviors or actions in your workplace?	54.24	3	.000
To what extent do safety policies and procedures improve your personal safety and well-being?	25.21	3	.000
How confident are you in using safety equipment and tools provided by the company?	78.25	3	.000

**Table 4: Gender and Perception**

		Gender	The safety training program is informative and helpful.	The safety equipment provided is sufficient and effective.	The safety rules and regulations are clearly communicated and understood.	The safety incidents are reported and addressed promptly.	The safety culture in the workplace promotes accountability and responsibility.
<b>Gender</b>	Pearson Correlation	1.000	-.168	.057	-.028	-.129	-.150
	Sig. (2-tailed)		.083	.555	.776	.182	.121
	N	108	108	108	108	108	108
<b>The safety training program is informative and helpful.</b>	Pearson Correlation	-.168	1.000	.417	.319	.410	.454
	Sig. (2-tailed)	.083		.000	.001	.000	.000
	N	108	108	108	108	108	108
<b>The safety equipment provided is sufficient and effective.</b>	Pearson Correlation	.057	.417	1.000	.222	.200	.222
	Sig. (2-tailed)	.555	.000		.021	.038	.021
	N	108	108	108	108	108	108
<b>The safety rules and regulations are clearly communicated and understood.</b>	Pearson Correlation	-.028	.319	.222	1.000	.267	.029
	Sig. (2-tailed)	.776	.001	.021		.005	.767
	N	108	108	108	108	108	108
<b>The safety incidents are</b>	Pearson Correlation	-.129	.410	.200	.267	1.000	.244
	Sig. (2-tailed)	.182	.000	.038	.005		.011





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<b>reported and addressed promptly.</b>	N	108	108	108	108	108	108
<b>The safety culture in the workplace promotes accountability and responsibility.</b>	Pearson Correlation	-.150	.454	.222	.029	.244	1.000
	Sig. (2-tailed)	.121	.000	.021	.767	.011	
	N	108	108	108	108	108	108

**Table 5: Experience and Perception**

		<b>Experience</b>	<b>The safety training program is informative and helpful.</b>	<b>The safety equipment provided is sufficient and effective.</b>	<b>The safety rules and regulations are clearly communicated and understood.</b>	<b>The safety incidents are reported and addressed promptly.</b>	<b>The safety culture in the workplace promotes accountability and responsibility.</b>
<b>Experience</b>	Pearson Correlation	1.000	-.287	-.077	-.048	-.011	.036
	Sig. (2-tailed)		.003	.427	.619	.913	.709
	N	108	108	108	108	108	108
<b>The safety training program is informative and helpful.</b>	Pearson Correlation	-.287	1.000	.417	.319	.410	.454
	Sig. (2-tailed)	.003		.000	.001	.000	.000
	N	108	108	108	108	108	108
<b>The safety equipment provided is sufficient and effective.</b>	Pearson Correlation	-.077	.417	1.000	.222	.200	.222
	Sig. (2-tailed)	.427	.000		.021	.038	.021
	N	108	108	108	108	108	108
<b>The safety rules and regulations are clearly communicated and understood.</b>	Pearson Correlation	-.048	.319	.222	1.000	.267	.029
	Sig. (2-tailed)	.619	.001	.021		.005	.767
	N	108	108	108	108	108	108
<b>The safety incidents are reported and addressed promptly.</b>	Pearson Correlation	-.011	.410	.200	.267	1.000	.244
	Sig. (2-tailed)	.913	.000	.038	.005		.011
	N	108	108	108	108	108	108





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<b>The safety culture in the workplace promotes accountability and responsibility.</b>	Pearson Correlation	.036	.454	.222	.029	.244	1.000
	Sig. (2-tailed)	.709	.000	.021	.767	.011	
	N	108	108	108	108	108	108





## Indigenous Knowledge of Plants Used as Medicine by Rengma Naga of Karbi Anglong, Assam

Temsutola<sup>1\*</sup>, T. Lirola Sangtam<sup>2</sup> and Nidheesh KS<sup>3</sup>

<sup>1</sup>Research Scholar, Department of Botany, St. Joseph University, Chumoukedima, Nagaland-797115, India.

<sup>2</sup>Assistant Professor, Department of Botany, St. Joseph University, Chumoukedima, Nagaland-797115, India.

<sup>3</sup>Adjunct Faculty, National Institute of Plant Science Technology, Mahatma Gandhi University, Kerala-686560, India.

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### \*Address for Correspondence

#### Temsutola

Research Scholar,  
Department of Botany,  
St. Joseph University, Chumoukedima,  
Nagaland-797115, India.  
E. Mail: temsutolawalling@gmail.com



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### ABSTRACT

The main goal of the current study is to provide evidence of how the Rengma Naga people of Karbi Anglong, Assam, used plants to treat a variety of illnesses. An intensive Field study was conducted from January 2021 to June 2022. Questionnaires, personal interviews, and group discussions were conducted. Informants were selected randomly belonging to different age groups and gender. The data collected were all from primary sources as there is no written record or documentation on medicinal plants. For the treatment of various ailments and diseases, 40 medicinal plants belonging to 38 genera and 29 families were identified. The families Asteraceae and Zingiberaceae were found to have a maximum number of species used in traditional medicine.

**Keywords:** Ethno medicine, Indigenous knowledge, Rengma Naga, health care.

## INTRODUCTION

Ethnomedicine is the branch of Ethnobotany that focuses on the investigation of plants used by the tribal or indigenous populations to treat different ailments and health disorders. By definition, Indigenous knowledge (IK) of Ethnomedicine implies the long-historical use of plants for medicinal purposes by different communities. It is believed to have evolved over the years through trial and error methods and symbolizes the relationship between

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humans and nature. Traditional healthcare practices are common among ethnic groups and are still used as a source of medication for a variety of illnesses. North East India is well recognized for its variant culture, diverse ethnicity, abundant biodiversity, and beautiful hilly terrains. It is home to more than 200 ethnic tribal groups [1]. Each ethnic group has a distinct culture and customs. The region has a vast geographical area rich in flora and fauna. Most of the tribals depend on the surrounding environment for their daily needs and especially depend on plants for medicinal purposes. Among the different ethnic groups settled in the north-eastern part of India, the Rengma Naga is found to inhabit the fertile land of East Karbi Anglong (then Mikir hills), Assam since 1800 [2]. Karbi Anglong district is situated in the state of Assam, India. The district administrative headquarter is Diphu. It covers a total area of 10,434 sq. km and is located between 25°33' to 26°35' N Latitude and from 92°10' to 93°50' E Longitude [3]. Besides Rengma Naga, Karbi, Dimas, Kuki, Garo, Tiwa, Pnars, Boro and a few plain tribes inhabited the region [4]. The main occupation of the Rengma Naga is agriculture and rice comprises the staple food. Ngada is the main festival of the Rengma as which is celebrated every year in the last week of November.

The literature review shows several ethnobotanical studies that have been conducted and documented the valuable plant species with their usage. In North East India, the significance of ethnobotanical studies starts in the late 1970s [5]. One of the ground-breaking works was done by Borthakur, [6] who identified 46 medicinal plant species while researching the lesser-known therapeutic use of plants among the tribes of Karbi Anglong (Mikir Hills), Assam. From Kamrup district of Assam, Kotoky & Das, [7] documented the utilization of 24 plant species for the treatment of liver disorders. 31 medicinal plants were identified by Sajem & Gosia, [8] as being used by the Lushai tribe in North Cachar Hills of North East India. Much such work on the documentation of Ethnomedicinal plants of Assam was conducted. Some of the listings were the Chorei tribes of Assam employed 53 distinct medicinal plants according to the research done by Choudhury *et al.*, [9], antitode against toxins among the karbis of Assam [10], medicinal plants for treating various gynaecological problems [11], according to Basumatary, *et al.*, [12] the Bodo Kachari tribe of Karbi Anglong, Assam uses 44 medicinal plant species for treating diseases like cough, fever, dysentery, bone fracture, etc., plants used for treating skin conditions by the major ethnic groups of Assam were studied by Tamuli and Ghosal, [13], 201 medicinal plants used by Karbis, Pnar and Tiwa [4], used of anthelmintic plants by the tribal populations of Udalguri, Assam [14], In lower Assam, 41 medicinal plants from 31 families were documented as the potential antidiabetic plants [15], documented anti-jaundice plants utilized by tea tribes of Morigaon [16], Baidya *et al.*, [17] recorded 38 Ethnomedicinal plants used by the Karbisthat belonged to 36 genera and 27 families and Terangpi and Yashmin, [18] gave an account on the practise of medicinal plants for inducing abortion among the karbis of Assam. The studies in various literature highlight the inadequate documentation on the Rengma Nagas of Karbi Anglong Assam. Therefore the current research work was conducted with a primary focus on the documentation of plants use by the Rengma Naga for medicinal purposes.

**MATERIAL AND METHOD**

The study area includes 6 villages under Nilip Block, East Karbi Anglong, Assam. The villages are Akhoiphuta Enrghuga, Jonpha, Chokihola, Khirang gaon (Lolashongnyu), Chosenlari - I, and Jamerhe Borlangso Rengma Gaon. An intensive field study was conducted from January 2021 to June 2022. Prior Informed Consent was signed by the village head (Gaon Burah) and also by the informant before conducting the interview. All the informants were given the necessary explanation about the main objective of the study before obtaining the PIC. The selection of the informant was done randomly. A total of 122 informants were interviewed for gathering the information. Indigenous information on the use of medicinal plants was collected through questionnaires, group discussions, field surveys, personal interviews, and observation. The questionnaires contain questions about the detailed information of the informant, followed by the vernacular name of the medicinal plants, part use, uses, method of consumption, distribution, and sources of collection. The field survey was done with the help of a field guide and informants for the collection of medicinal plants. All the plant specimens were photographed and collected for making Herbarium. With the aid of published works [19, 20, 21, 22, 23, 24, 25, 26, 27], the plant species were identified. Some of the



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herbarium specimen was identified and authenticated at BSI, Shillong, Meghalaya. All the plant species were photographed with DSLR Camera EOS 1500D and a Samsung galaxy A30 mobile phone.

## RESULTS

In the present study, 40 medicinal plant species from 38 genera and 29 families have been identified. These plants are used for treating various diseases and ailments like skin infections, stomach-ache, diarrhoea, dysentery, constipation, blood clotting, joint pain, jaundice, toothache, and other diseases. The family Asteraceae and Zingiberaceae were found to have a maximum number of species followed by the family Acanthaceae, Apocynaceae, Fabaceae, Lamiaceae, and Piperaceae. One species each were represented by the other remaining 22 families (Figure 2). The leaf was the most commonly utilized plant part, followed by the rhizome, bark, fruit, root, whole plant, pulp, petiole, and stem (Figure 1). Herbs made up the majority of plant species with 37%, followed by shrubs (25%), trees (20%), a climber (12%), palms (3%), and succulents (3%) (Figure 3). Method of preparation falls under different categories such as paste, external application, and oral consumption. The study also reveals the use of many medicinal plants reported as vegetables and fruit by the community. Table 1 includes the scientific name, common name, vernacular name, family, habit, part used and uses. A few of the medicinal plants are depicted in Plate 1 below.

## DISCUSSION

The Rengmas are found to depend on plants mostly grown in wild for treating various ailments. They collect the plants while visiting the field and also many villagers grow wild medicinal plants in their home gardens which is indirectly conserving the plant species. The predominance of Asteraceae and Zingiberaceae family shows that the plant species are prevalent in natural surroundings and are familiar to the villagers for their medicinal purpose. This is proven by the use of *Curcuma aeruginosa* Roxb. and *Zingiber zerumbet* (L.) Roscoe ex Sm for treating diarrhoea instead of modern medicine. Additionally, both Arya, et.al. [28] and Kala, [29] reported on the dominance of Asteraceae family utilized for medicinal purposes. The result of the present study depicts a similarity in the traditional uses of some plants with other indigenous tribes of the region. Basumatary, et.al. [12] documented the use of *Aloe vera* (L.), *Azadirachta indica* A. Juss and *Andrographis paniculata* (Burm.f.) Nees. for treating cuts and burn, skin infections and malaria respectively. Baidya, et.al. [17] (2020) also reported the similar medicinal uses of *Ageratum conyzoides* L. and *Acmella oleracea* (L.) R.K.Jansen in their findings. In agreement with our result, Arya, et.al. [28] have reported the use of *Centella asiatica* (L.) Urban as a blood purifier, *Ageratum conyzoides* L. for cuts and wounds, and *Paederia foetida* L. for stomach disorder. Baruah, et.al. [30] reported the similar medicinal usage of *Azadirachta indica* A. Juss., *Ricinus communis* L., *Paederia foetida* L., and *Carica papaya* L. The use of *Calotropis gigantea* L. Dryand, *Piper nigrum* L. & *Saccharum officinarum* L. has been mentioned by Alom, [31]. The similarity in the practise of therapeutic plants among the different indigenous communities suggest the wide utilization of these plant species and there is a possibility of cross-cultural sharing of traditional knowledge among the people of different ethnic groups or neighbouring regions.

## CONCLUSION

The study concluded that the Rengma Nagas are well connected with nature for food and medicinal purposes. The poor road connectivity and limited healthcare facility make the villager more dependent on wild plants available in their vicinity for medicinal usage. Among the Rengma people, the practice of traditional medicine is still widely used. However, the very existence of valuable indigenous knowledge is severely challenge by the younger generation's lack of interest, which has grown over time. On the other hand, environmental degradation due to anthropogenic activities has also posed a threat to the diversity of wild plants. The conservation of plant species is essential as they are culturally, socially, and economically linked with the villagers. Therefore extensive research and documentation of the existing aboriginal information of medicinal plants utilized by the Rengmas are indispensable.





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Furthermore, phytochemical and pharmacological analysis for bioactive compounds would yield important details of therapeutic action. There is a greater scope to do more ethnomedicobotanical research as the region is very much neglected in this field.

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**Table 1: Listed below are the reported medicinal plants arranged according to the family:**

Sl. No.	Scientific Name	Common name	Vernacular name	Family	The habit/ Part used	Uses
1	<i>Andrographis paniculata</i> (Burm. f.) Nees	Creast/ green chiretta	Malaria ben	Acanthaceae	Herb Whole plant	The entire plant is boiled in water and consumed to treat malaria.
2	<i>Thunbergia grandiflora</i> alba Roxb.	Bengal trumpet	Tenghedu ranyu	Acanthaceae	Climber Leaf	The leaf paste is applied on cuts by stone/rock to control bleeding.
3	<i>Acorus Calamus</i> L.	Sweet flag	Lamba	Acoraceae	Herb Rhizome	The fresh rhizome is taken raw or boil for constipation and is also used to get rid of a bad spirit.





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4	<i>Centella asiatica</i> L. Urban	Indian pennywort	Thüjeng Rungho	Apiaceae	Creeping Herb Whole plant	The whole plant is boiled and eaten to purify the blood.
5	<i>Calotropis gigantea</i> (L.) Dryand.	Crown flower	Jangnyipvu	Apocynaceae	Shrub Leaf	The leaf with mustard oil is warm near the fire and applied externally to cure joint pain and swelling.
6	<i>Catharanthus roseus</i> (L.) G.Don	Cape periwinkle	-	Apocynaceae	Herb Leaf	The leaf is taken after being boiled in water to lower high pressure. Raw leaf extract is applied externally on cat and dog scratches.
7	<i>Lasia spinosa</i> (L.) Thwaites	Spiny taro	Sethetpvu	Araceae	Herb Leaf/petiole	The young leaf and petiole are boiled and eaten for intestinal deworming.
8	<i>Caryota urens</i> L.	Fishtail palm	Nshen ben	Areaceae	Palm Pulp	The extract of the pulp sap is taken for jaundice.
9	<i>Aloe vera</i> (L.) Burm.f.	Aloe vera	Aloe vera	Asphodelaceae	Succulent Leaf	The gel mixed with honey is eaten raw to cure gastric, and applied externally on cut and burn.
10	<i>Ageratum conyzoides</i> L.	Billy goat weed/ chickweed	Kengkhüpvu	Asteraceae	Herb Leaf	To control bleeding from cuts and wounds, the leaf paste is topically applied.
11	<i>Acmella oleracea</i> (L.) R.K.Jansen	Toothache plant	Hüthüpu	Asteraceae	Herb Leaf	The leaf paste is applied to cure toothache.
12	<i>Inula cappa</i> (Buch-Ham. Ex D.Don) DC.	Sheep's ear	Jangnyet	Asteraceae	Herb Leaf	To treat dizziness/vertigo, the leaf is crushed and smells/ apply topically. Additionally it is employed to get rid of evil/bad spirits.





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13	<i>Mikania micrantha</i> Kunt h	Bitter vine	RangnyuKeshi ngü	Asteraceae	Vine/climber Leaf	External application of leaf paste on cuts and sores to stop bleeding.
14	<i>Oroxylum indicum</i> (L.) Benth. ex Kurz	Trumpet flower	Nchupo	Bignoniaceae	Tree Bark	The bark is boiled and taken for jaundice and pneumonia.
15	<i>Carica papaya</i> L.	Papaya	Thengsha	Caricaceae	Tree Fruit, young leaf	Raw juice from the young leaf is taken to cure Dengue, ripe fruit is eaten for treating the digestive disorder.
16	<i>Chloranthus officinalis</i> Blume	Tall Chloranthus	Nyenchen	Chloranthaceae	Shrub Root	The root is crushed, boil, and taken to cure joint pain/anti-spasmodic.
17	<i>Garcinia pedunculata</i> Roxb. ex Buch. Ham.	Garcinia/Borthekera	Rencha sha	Clusiaceae	Tree Fruit	Fresh fruit is eaten to cure diarrhoea.
18	<i>Terminalia chebula</i> Retz.	Black/Chebulicmyobalam	Khüsen Sha	Combretaceae	Tree Bark /fruit	The bark of the tree is boiled and taken for curing measles and dried and fresh fruit is taken to lower high pressure.
19	<i>Kalanchoe pinnata</i> (Lam.) Pers.	Air plant/ Clapper bush	Ma keronyen	Crassulaceae	Herb Leaf	The leaf extract is taken for gastric and kidney stones.
20	<i>Ricinus communis</i> L.	Castor bean	Yongtu	Euphorbiaceae	Shrub Leaf	The young leaf is warm near the fire and applies to swelling and joint pain.
21	<i>Cajanus cajan</i> (L.) Millsp.	Pigeon pea	Roho dal	Fabaceae	Shrub Leaf	Liver problems and jaundice are treated by ingesting the leaf boiled in water.
22	<i>Mimosa pudica</i> L.	Touch me not	Ketjetpvu/kejonyen	Fabaceae	Herb Root	The root with holy basil leaf is grind





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						and the juice is taken to cure headaches.
23	<i>Clerodendrum colebrookianum</i> Walp.	East Indian glory bower	Hingcheren	Lamiaceae	Shrub Leaf	The fresh leaf is boiled and eaten to lower high blood pressure.
24	<i>Ocimum sanctum</i> L.	Holy basil	Tulokhi	Lamiaceae	Herb Leaf	The leaf is crushed and applied to cure mouth ulcers and blisters. The leaf of holy basil and betel leaf is crushed and the paste is used to control bleeding.
25	<i>Punica granatum</i> L.	Pomegranate	Kharatü ben	Lythraceae	Shrub Leaf /bark	To treat typhoid, malaria, and dysentery, the young leaf is boiled and consumed.
26	<i>Azadirachta indica</i> A.Juss.	Neem	Neem ben	Meliaceae	Tree Leaf/bark	The leaves and bark are boiled and either eaten or applied topically to treat skin ailment.
27	<i>Morus nigra</i> L.	Black mulberry	Khemosha	Moraceae	Tree Leaf	For jaundice, the leaf extract is used.
28	<i>Musa paradisiaca</i> L.	Vegetable banana	Thayabi	Musaceae	Shrub Rhizome	External application of rhizome paste provides immediate toothache alleviation.
29	<i>Psidiumguajava</i> L.	Guava	Mitheri ben	Myrtaceae	Tree Young leaf	For diarrhoea, the leaf extract is administered orally.
30	<i>Bougainvillea spectabilis</i> Willd.	Great bougainvillea	Kagos nyen	Nyctaginaceae	Shrub Leaf	For diarrhoea, a leaf decoction is used.
31	<i>Piper betle</i> L.	Betel leaf	Pennyi	Piperaceae	Climber/vine Leaf	Betel leaf with the leaf of Holy basil is crushed and





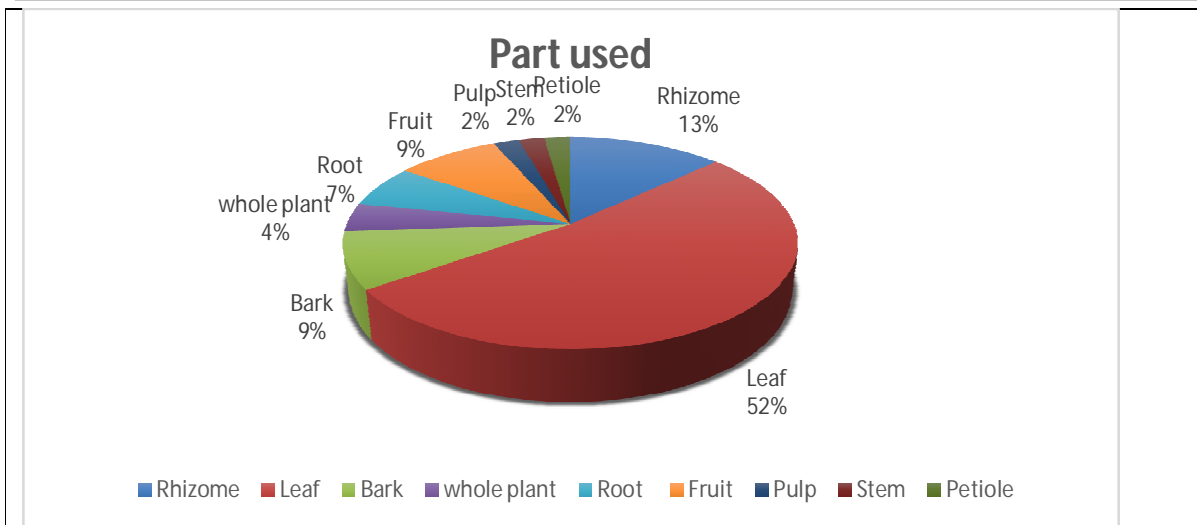
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						applied to control bleeding from the cut.
32	<i>Piper nigrum</i> L.	Black pepper	Gulmoris	Piperaceae	Vine/climber fruit	The dried fruit and leaf of <i>Ocimum sanctum</i> L. are crushed and taken for pneumonia and cough
33	<i>Saccharum officinarum</i> L.	Sugar cane	Kwed	Poaceae	Shrub Stem	The juice is taken for jaundice.
34	<i>Paederia foetida</i> L.	Stink vine	Thabyi-e	Rubiaceae	Climber/vine Leaf, root	The young leaf and root are boiled and taken for indigestion and stomach ache.
35	<i>Murraya koenigii</i> (L.) Sprengel	Curry leaf tree	Curry ben	Rutaceae	Tree Leaf	To treat food poisoning, gas and stomach-aches, the leaf decoction is taken.
36	<i>Laportea crenulata</i> (Roxb.) Gaud.	Stinging tree	Jambo kadagi	Urticaceae	Shrub Leaf	The leaf is boiled and consumed to relieve physical pain and increase appetite.
37	<i>Curcuma amada</i> Roxb.	Mango ginger	Gü	Zingiberaceae	Herb Rhizome	The crushed rhizome is combine with water and taken orally to treat stomach-ache.
38	<i>Curcuma aeruginosa</i> Roxb.	Pink and blue ginger	Gülomogi	Zingiberaceae	Herb Rhizome	The rhizome extract mixed with water is used for dysentery and diarrhoea.
39	<i>Zingiber officinale</i> var. <i>rubrum</i>	Red ginger	Gachen	Zingiberaceae	Herb Rhizome	To treat cough and vomiting, the rhizome is consumed.
40	<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Wild ginger	Melinyu gü	Zingiberaceae	Herb Rhizome	The extract of crushed rhizome mixed with warm water and a pinch of salt is taken for diarrhoea.

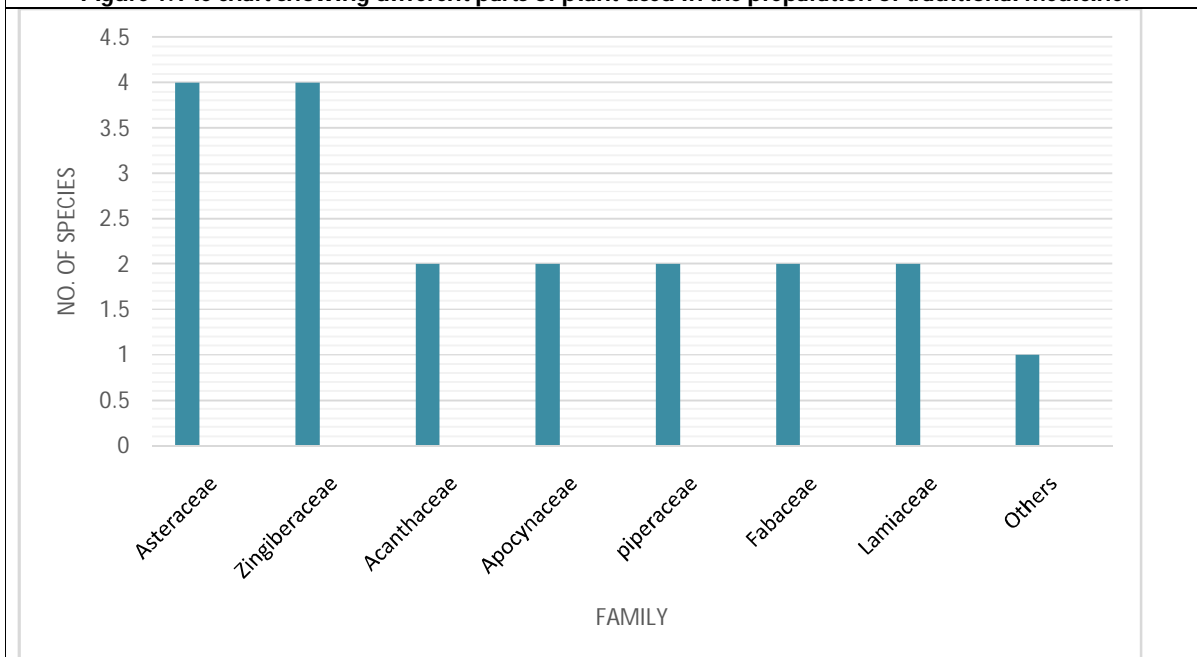




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**Figure 1: Pie chart showing different parts of plant used in the preparation of traditional medicine.**



**Figure 2: Representation of the medicinal plants reported from the study area according to family units(Others represent a family with one species: Acoraceae, Apiaceae, Arecaceae, Araceae, Asphodelaceae, Bignoniaceae, Caricaceae, Chloranthaceae, Combretaceae Clusiaceae, Crassulaceae, Euphorbiaceae, Lythraceae, Rubiaceae, Rutaceae, Meliaceae, Moraceae, Musaceae, Myrtaceae, Nyctaginaceae, Poaceae, and Utricaceae )**





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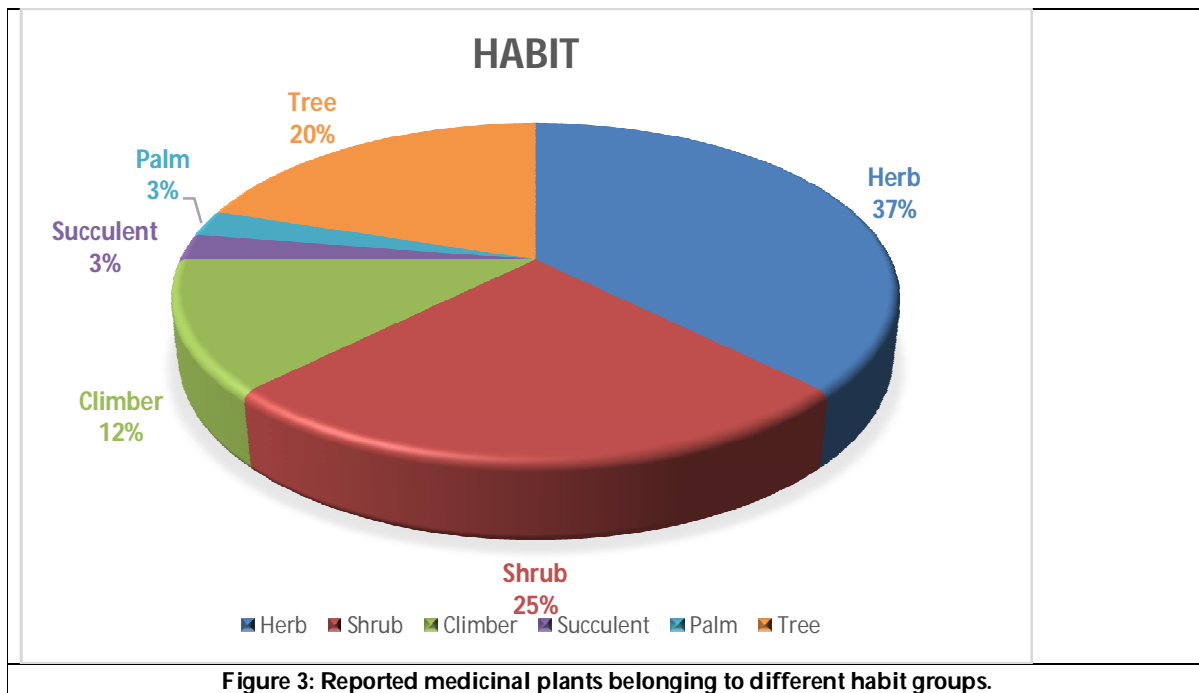
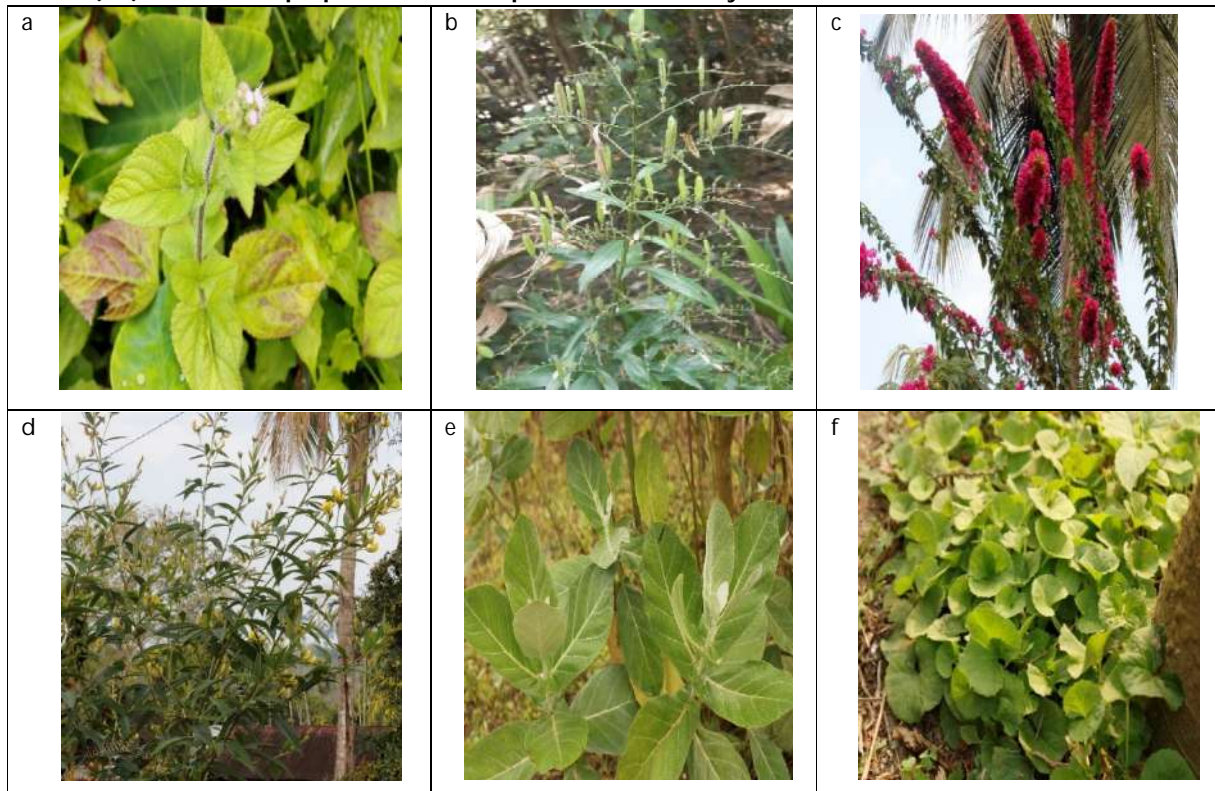


Plate 1(a- f): Some of the purported medicinal plants from the study area.







Temsutola et al.,

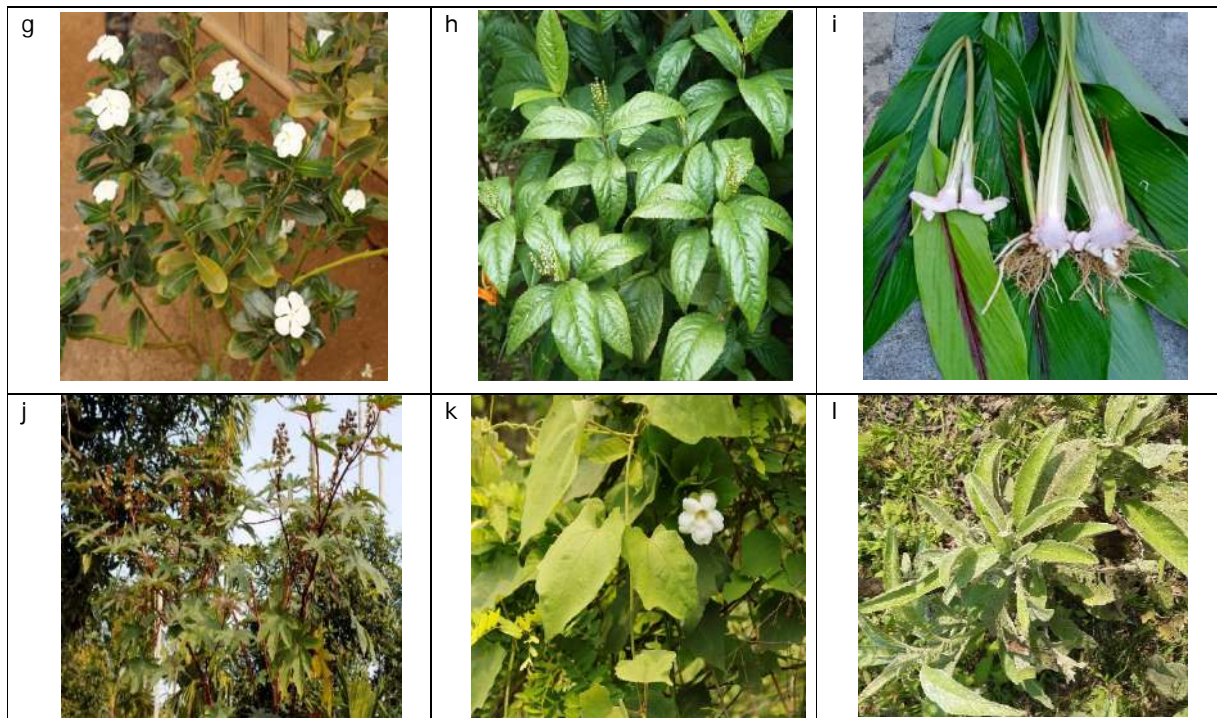


Plate 1 (a-l): a. *Ageratum conyzoides* L., b. *Andrographis paniculata* (Burm.f.) Nees. c. *Bougainvillea spectabilis* Willd. d. *Cajanus cajan*(L.) Millsp. e. *Calotropis gigantea* (L.) Dryand. f. *Centella asiatica* (L.) Urban g. *Catharanthus roseus* (L.) h. *Chloranthus officinalis* Blume. i. *Curcuma aeruginosa* Roxb. j. *Ricinus communis* L. k. *Thunbergia grandiflora alba* Roxb l. *Inula cappa* (Buch-Ham. Ex D.Don) DC.





## A Study on Stress Management among Employees Working in Auro

Karishma S<sup>1\*</sup> and C.Suganya<sup>2</sup>

<sup>1</sup>MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of MBA, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

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### \*Address for Correspondence

**Karishma S**

MBA Student,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India

E. Mail: karishma119001@gmail.com



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### ABSTRACT

A study on stress management in the workplace is the topic of this research. The primary purpose of this research is to determine what aspects of life are most affected by stress, what makes stress less of an issue for people at work, and what kinds of procedures can be used to alleviate stress in the workplace. This is a descriptive study meant to gauge the stress experienced by workers there. The questionnaires were collected via an interview schedule approach. A total of 120 questionnaires were given out to workers in this descriptive study, although only 104 were usable in the end. The resulting percentage is 82%. Primary and secondary sources were used to fill out the questionnaire, and we used a basic random sample technique. In this analysis, we employed Descriptive Statistics, Chi-Square Testing, and Analysis of Variance (ANOVA). Finally, a number of recommendations are made to further encourage the knowledge-sharing and creative actions of AURO's staff.

**Keywords:** Stressors, Effects of stress, Stress copying, Mechanism

### INTRODUCTION

Employees' physical and mental health can suffer from the stress that is inescapable in the workplace. The purpose of this research was to examine existing research on how to help workers cope with stress on the job. The research will look into what causes stress in the workplace, how that stress manifests itself in the workplace, and what kinds of stress management strategies have been implemented there in the past. More and more workers report feeling overwhelmed by pressures at the office. They may be adjusting to an unusually heavy workload, unusually long hours, or unusually rapid shifts in innovation and deadlines in order to keep up with changing demands. The emphasis on getting things done has replaced the possibility of having a job for life as the driving force behind



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company success. Now more than ever, stress is recognised as a genuine threat to employee health and safety on the job. Both the individual and the ecosystem can benefit from better management of stress. It's useful for lowering stress levels in people's lives and in the workplace as a whole.

**Objectives of the Study**

The objectives of the study are

- To know the importance of stress management
- To analyse the effects of stress on individual life
- To study the various factors causing stress among the employees
- To identify the different methods and techniques of reducing the stress
- To study the effects of stress on the health of employees

**Need of the Study**

- It helps the various factors causing stress among the employees.
- It helps to coping up techniques as how they overcome stress.
- To give constructive suggestion to the management as how to minimize stress.

**Scope of the Study**

- To study aims to find out the work stress management restricted within the organisation and
- To know the factors which are contributing for stress
- To analyze managing the work stress of employees
- The scope of the study is extended only to the employees working in AURO, Coimbatore, it does not cover employees working in other branches of AURO to fulfil the objectives of this research, this study is conducted to analyze the stress management among the employees of AURO

**Limitations**

- The study restricts only with the employees of Auro,Coimbatore
- The study only assumes that information was given by the employees without any bias
- The time duration was three months and it is limited. This will be a limitation to complete the study

**REVIEW OF LITERATURE**

Kavitha's study, "Role of stress among women employees forming the majority workforce at IT industry in Chennai and Coimbatore," (2012), focuses on the impact of workplace stress on IT workers. From her findings, she deduced that married women, in particular, experience significantly more stress than single women in the workplace. According to research by P.S. Swaminathan and Rajkumar S., "Stress Levels in Organizations and Its Effect on Employee Behavior" (2013). (2013). An investigation was conducted to determine the correlation between stress and demographic factors such as age, employment, work schedule, and workplace setting. An employee's stress is unique to them. The results show that there is a sweet spot where everyone is productive to their fullest potential, and they pinpoint three causes of occupational stress: 1) Role overload; 2) Job insecurity; and 3) Performance expectations. 2) Distancing oneself from one's roles #3 Stability in the role.

"Emotional Intelligence as Predictor of Occupational Stress among Working Professionals" by Satija S. and Khan W. (2013). (2013). Occupational stress, which they equate with job stress, is said to have a similarly negative effect on workers' attitudes and behaviour if not managed well. The correlation between EQ and stress at work is the focus of this investigation. The results of this study suggest that emotional intelligence is a strong indicator of job stress. 7 Researchers Amir Shani and Abraham Pizam (2009) examined the prevalence of job-related depression among Central Florida hotel workers. By analysing the connection between job stress and characteristics of the hospitality industry, they found that incidence of depression was higher than expected.





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The relationship between "occupational stress, bad health, and organisational commitment" has been studied by Viljoen and Rothmann (2009). (2009). They saw a strong correlation between workplace stress and health problems and poor levels of employee dedication. Physical and mental illness were both exacerbated by worries about one's job security. Five stressors, including Work-life balance, Overload, Control, and Job characteristics, were found to be predictive with low person commitment to the business. Occupational stress among nursing workers in surgical settings, by Schmidt, Denise Rodrigues Costa, *et al.* (2019). The researchers set out to assess the extent to which nursing professionals in surgical settings experience occupational stress, as well as the relationships between stress and various aspects of their jobs. A study titled "Occupational Stress and Teaching Strategies among Chinese Academics" was conducted by Li-fang Zhang (2009). (2009). According to the study's authors, when participants' self-evaluations are taken into account, it becomes clear that both positive and negative conceptual changes in teaching strategy are predicted by participants' role inadequacies.

According to research by Kayoko Urakawa and Kazuhito Yokoyama titled "Sense of Coherence (SOC) may Reduce the Effects of Occupational Stress on Mental Health Status among Japanese Factory Workers," published in 2009, male managers' mental health status was negatively impacted by job demand and stress, while female coworkers' mental health status was positively impacted by SOC. They concluded that SOC is a major factor in determining how well people of both sexes deal with stress at work. According to J.E. Agolla's study "Police Officers: The Case of the Botswana Police Service" (2009), the force in Botswana has 12 officers (2009). He conducted research among police officers in Botswana to learn more about the prevalence of stress at work and how officers there deal with it. The results of this study show that the use of force is a major source of stress for police officers. Exercising, going out with friends, eating a good diet, planning a career, and training personnel were all named as coping techniques.

## RESEARCH METHODOLOGY

### Research Design

Descriptive research using a well-structured questionnaire was used for this study's design.

**Table 1. Method of Collection**

Demographic variables		Frequency	Percent
Gender	Male	47	45.2%
	Female	47	45.2%
	Not prefer to say	10	9.6%
	<b>Total</b>	<b>104</b>	<b>100%</b>
Age	18-25	28	26.9%
	26-35	40	38.5%
	36-45	27	26.0%
	Above 45	9	8.7%
	<b>Total</b>	<b>104</b>	<b>100%</b>
MaritalStatus	Married	48	46.3%
	Unmarried	48	46.2%
	others	8	7.5%
	<b>Total</b>	<b>104</b>	<b>100.0%</b>
Job Experience	Less than1 years	23	22.1%
	1-3years	40	38.5%
	3-5years	27	26.0%
	Above 5 years	14	13.5%
	<b>Total</b>	<b>104</b>	<b>100.0%</b>
	Below 20000	20	19.2%





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<b>salary</b>	20000-30000	34	32.7%
	30000-40000	24	23.1%
	40000-50000	12	11.5%
	Above50000	13	12.5%
	<b>Total</b>	<b>104</b>	<b>100%</b>

Primary and secondary data are used in the data collection process.

#### Sampling Size

The sampling size of the study is 104

#### Sampling Unit

The sampling unit of the study is employees of Auro.

#### Sampling Method

The sampling method used in the study is simple random sampling method.

#### Tools for Data Analysis

- Descriptive Statistics
- Chi-Square Test
- ANOVA

#### Data Analysis

##### Descriptive Statistics

Percentage analysis is a straightforward statistical tool that measures the proportion of a sample population that answers a questionnaire. It's one of the simplest types of analysis, and it's useful for seeing how a study turns out. It can be seen from the table that the majority of respondents are both male and female (45.2 percent), are between the ages of 26 and 35 (38.5 percent), are married (46.3%), have between one and three years of work experience (38.5 percent), and make between twenty thousand and thirty thousand rupees (\$3,500 and ten thousand dollars) per month (32.7 percent).

##### Chi-Square Test

**Table 1:** Gender and Employee Empowerment

**H0** – There is no significance relation between using Gender and Employee Empowerment.

**H1** – There is significance relation between using Gender and Employee Empowerment.

##### Inference

The preceding table shows that the estimated cumulative value is below the level of 0.05 percent, coming in at.000. As a result, H1 can be accepted as a valid hypothesis.

**Table 2:** Age and Employee Empowerment.

**H0**– There is no significance relation between using Age and Employee Empowerment.

**H1** – There is significance relation between using gender and Employee Empowerment.

##### Inference

The aforementioned tabular analysis revealed a total value of.000, well below the threshold of 5%. Therefore, H1 is a valid and accepted hypothesis.

#### ANOVA

##### Hypothesis Statement

**Table 1:** Age and Environment change

**H0:** There is no significance relationship between age and Environment change.



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**H<sub>1</sub>:** There is a significance relationship between age and Environment change.

**Inference**

The determined significance value from the preceding table is.000, which is less than the threshold value of.05 (5 percent level of significance). As a result, we cannot accept H<sub>0</sub>. You can go with H<sub>1</sub>. Thus, it follows that the passage of time correlates significantly with shifts in the surrounding environment.

**Table 2:** Age and Leadership

**H<sub>0</sub>:** There is no significance relationship between Age and Leadership.

**H<sub>1</sub>:** There is a significance relationship between Age and Leadership.

**Inference**

The determined significance value from the preceding table is.000, which is less than the threshold value of.05 (5 percent level of significance). As a result, we cannot accept H<sub>0</sub>. You can go with H<sub>1</sub>. It follows that there must be a strong connection between seniority and leadership ability.\

**FINDINGS, SUGGESTIONS AND CONCLUSION****Findings**

Based on the data presented above, we can infer that 45.2% of respondents were female, 38.5% were between the ages of 26 and 35, 46.3% of employees were married, the average length of an employee's tenure at their current job was 1-3 years, their monthly income ranged from 20,000 to 30,000 rupees, and they took pride in their work and were inspired to share what they had learned.

**Suggestions**

Stress is a common experience among employees in various organizations . Therefore, conducting a study on stress management among employees would be beneficial. The study could investigate the reasons for stress among employees, as well as interventions that could be used to manage stress. Additionally, the study could explore organizational interventions, such as improving management styles and ensuring adequate time for planning work tasks, as well as personal interventions outside of work, such as physical exercise and taking breaks .By targeting both individuals and organizations, the study could promote effective interventions that improve management practices and promote personal interventions outside of work, ultimately reducing the negative effects of work stress on physical and mental health.

**CONCLUSION**

Therefore, from this study , it is found a study on stress management among employees in an organization could be highly beneficial. The study could investigate the reasons for stress and interventions that could be used to manage it, including personal and organizational interventions. Organizational interventions, such as implementing a system of checks and balances when delegating work and assigning tasks, were perceived as effective. Personal interventions outside of work, such as physical exercise and taking breaks, were also important. By targeting both individuals and organizations, the study could promote effective interventions that improve management practices and reduce the negative effects of work stress on physical and mental health. Ultimately, this could lead to improved employee health, better performance, and a healthier workplace culture

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**Table 1: Gender and Employee Empowerment**

	Chi-square	df	Asymp. Sig.
Gender	38.38	3	.000
I feel empowered to make decisions related to my work	44.32	3	.000
I have the necessary resources to effectively perform	30.22	1	.000
I feel supported by my colleagues and supervisors in my work	79.90	4	.000

**Table 2: Age and Employee Empowerment.**

	Chi-square	df	A symp. Sig.
Age	8.46	3	0.00
I feel empowered to make decisions related to my work	44.32	3	.000
I have the necessary resources to effectively perform	30.22	1	.000
I feel supported by my colleagues and supervisors in my work	79.90	4	.000

**Table 3: Age and Environment change**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	68.02	3	34.01	16.74	.000
Within Groups	237.77	117	2.03		
<b>Total</b>	<b>305.79</b>	<b>120</b>			

**Table 2: Age and Leadership**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	94.09	3	47.05	42.65	.000
Within Groups	129.07	117	1.10		
<b>Total</b>	<b>223.17</b>	<b>120</b>			





## Impact of Social Media Advertising on Online Purchase Intention

Manasa N<sup>1\*</sup> and G. Alex Rajesh<sup>2</sup>

<sup>1</sup>Research Scholar, CMS Institute of Management Studies, Bharathiar University, Coimbatore, Tamil Nadu, India.

<sup>2</sup>Professor and Principal, Sri Venkateswara Institute of IT and Management, Coimbatore, Tamil Nadu, India.

Received: 25 Mar 2023

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### \*Address for Correspondence

#### Manasa N

Research Scholar,  
CMS Institute of Management Studies,  
Bharathiar University,  
Coimbatore, Tamil Nadu, India.

E. Mail: manasangowdaphd@gmail.com



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### ABSTRACT

Social media is now widely used in our daily lives. In particular, this applies to the millennial generation. Social media is still the most practical and straightforward method of connecting with people today. As a result, companies may utilize it as a tool to reach their target consumers through a variety of means, including advertising. The aim of the study is to conduct a survey regarding the impact of social media advertising on the online purchase intention of cosmetics among female consumers and In addition to that knowing cosmetics purchase and social media behavior. This research is carried out considering female consumers in Bangalore who are purchasing cosmetics through an online mode. For this study non-probability technique is been adopted, convenience sampling technique is used. Data was collected through the structured questionnaire from 385 respondents. A total of 21 questionnaire were collected from respondents. Once the data was collected, SPSS program is used by the researcher to carry out analysis. Cronbach's Alpha test is conducted to test the data reliability, finding the link between social media advertising and online purchase intent is the major goal of the study. The social media advertising had three items i.e. Credibility, Entertainment and Informativeness. There is an hypotheses proposed in the study, The association between the effectiveness of social media advertising and online purchase intent for cosmetics was examined using a Pearson Correlation test. It has been discovered that social media advertising significantly influences female customers' online cosmetics purchasing intentions.

**Keywords:** Social media advertising, online purchase intention, consumer behavior





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## INTRODUCTION

The World Wide Web has seen a significant increase of user-driven web technologies during the past ten years, known as social media, which has resulted in the development of online communities, improved discussions, and opinion-sharing, as well as user-generated content. The huge popularity of social networking sites like Facebook, Instagram and Twitter was brought on by this development. In the year 2022 the average time spent in a Social Media by people of India in a day is 2 hours 33 minutes (GWI, 2022). Social media plays a significant role in contemporary lives. Numerous data elements and user-related information may also be found on social media platforms. They let marketers to exploit publicly available information. Social media allows marketers the ability to develop customized advertising based on the interests, behaviors, demographics, and even email addresses of their audience. Social media is now widely used in our daily lives. In particular, this applies to the millennial generation. Social media is still the most practical and straightforward method of connecting with people today. As a result, organizations may utilize it as a tool to reach their target consumers through methods other than advertising. The possibility of creating value via social networks influences customers' intention to purchase. (Goldwin, Prabhu, & Ahmed, 2021) Consumers' heightened awareness of hygiene and beauty in recent years has been largely attributed due to technological advancements, globalization, and rising purchasing power. This is the primary driver behind the cosmetics industry's explosive growth. (Shaji, 2020)

With 530 million members as of February 2021, messaging app Whatsapp had the most social media users in India. Facebook was ranked third at the time, with YouTube coming in second. The nation's government updated its IT legislation earlier that year in an effort to encourage social media sites to self-regulate by putting a heavier emphasis on the standards. More over 50% of Indians had access to social networks in 2020. It was predicted that 67 percent of the population will be using social networks by the year 2025. This was due in part to the burgeoning telecom sector, which offered inexpensive mobile data and saw Reliance Jio pave the way for affordable digital communication for the common Indian.

### Online Advertising

With the development of the internet, advertisement adds the digital tool to the traditional media (TV, print and radio). Through webbased publicizing, "Marketers, communicate with, and convince users of online to position a brand, which permits an organization to advance both customer awareness and preference in redid and customized way, and decline the time expected to settle on a purchasing choice (Hanafizadeh & Behboudi, 2012). By the by, it merits seeing that online advertisement has not supplanted traditional advertising, as the two strategies are corresponding. In any case, online advertisement has constrained the traditional advertisement idea to adjust to the difficulties of the new innovation and rethink the length of its extension and techniques, as has occurred over the years at whatever point an innovative headway influenced the promoting scene. In other words, the Internet has meaningfully had an impact on the manner in which the customers and promoters see what's more, experience advertisement, as in it has set out a special freedom for tweaked and customized association between the two parties (Barreto, 2013)

### Purchase Intention

With the steady purchasing choices consistently and various choices on the lookout, buyers need to adapt to overload information. Purchase intention is characterized as the chance of buyer in buying item or service soon (Laksamana, 2018).

### India Beauty and Personal care Industry in India

Evolving ways of life, and developing awareness added to a huge improvement in India's cosmetics industry. In 2021 India is positioned fourth worldwide for generating the most noteworthy revenue in the market of beauty and personal care. The beauty care products market overall is constrained by a modest bunch of combinations like Procter and Gamble L'Oréal and Unilever. Though these were enormously effective in India. The India excellence



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and individual to consideration market is supposed to show a CAGR of 6.5% during 2022-2027 Beauty and Personal Care Market in India is assessed to be USD 24.53 Bn in 2022 and is supposed to arrive at USD 33.33 Bn by 2027, developing at a CAGR of 6.32%. (Research and Markets , 2022).

**Research Problem**

These days, because of the prominence of the Internet and its Social media networks, social advertisement is viewed as important to the progress of organizations today (Gaber, Wright, & Kooli, 2019) the market however is loaded up with many organizations that convey to a similar Targetmarket. In the magnificence and wellbeing cosmetics industry, there are numerous competitors that sell comparative items. Thus, organizations should know about how to grasp buyers' consideration regarding their communication (El-zoghby, El-Samadicy, & Negm, 2021). This study investigated the impact of social media advertising on online purchase intention among female consumers.

**Need for the Study**

The aim of the study is to conduct a survey regarding the impact of social media advertising on the online purchase intention to buy the cosmetics and In addition to that knowing cosmetics purchase and social media behavior.

**Research Objectives**

- To study the impact of cosmetic brands' social media advertising on online purchase intention towards cosmetics among female consumers
- To understand the cosmetics purchase and social media behavior.

**RESEARCH METHODOLOGY**

In this study the technique of research adopted is descriptive research. It's a study which is done by identifying various variables. It has considered the following methods

- Formulation of a research problem
- A clear research design about the data collection
- Data was collected with a structured questionnaire
- Helps in defining the relationship between variables

**Scope of Research**

This research is carried out considering female consumers in Bangalore who are purchasing cosmetics through an online mode.

**Methods of Data Collection**

In this study the primary mode of data collection was through a structured questionnaire, in the present study journals from published source were reviewed for better understating of the subject and the conceptual model. A part from journal, collected statistical data from various trusted online sites.

**Sampling**

For this study non-probability technique is been adopted, convenience sampling technique is used. Data is collected from 385 respondents.

**LITERATURE REVIEW****Social Media**

(Ahmad, Salman, & Ashiq, 2015) The study aimed to understand the impact of Social Media on Fashion Industry, primary data was collected through a questionnaire from 130 respondents, and study has found that social media



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and fashion industry are highly interdependent on each other. (Mazeed & Kodumagulla, 2019)The study was conducted to understand the impact of social media on purchase intention, data was collected from 100 customers through a questionnaire to know the impact of social media on purchase media in comparison with print media. They concluded that social media had a great impact on purchase intention in comparison with print media. (Harun & Husin, 2019)This study attempted to understand influence of social media marketing on online purchasing behavior of low involvement products, the sample size for the study was 384, the sampling unit was Millennials, and they looked into four dimensions in social media marketing i.e. "Entertainment", "Interaction", "Perceived Trust" and "Online Communities". The study concluded that "Perceived Trust" and "Entertainment" had a favorable effect on Millennials' shopping habits.' (Gupta, 2013)The purpose of the study was to evaluate how customers' buying intentions were affected by social media, the variables under the study were "Product involvement level", "Peer communication" and "Perceived product informativeness", the data was collected through the questionnaire, and inference was drawn using statistical tool i.e. Anova, Regression and Correlation. They concluded that Perceived product informativeness have a high impact on purchase intention of consumers.

(Laksamana, 2018)With just the banking sector and 286 participants, the study was undertaken to evaluate the influence of social media marketing on online purchase intention. Its findings showed that social media had a significant influence on both brand loyalty and buy intention. (Poturak & Softic, 2019)The main aim of the study was to know the impact of social media communication in creating e-WOM and its effect on brand equity and purchase intention, 300 responses were taken into consideration to draw an inference. Study found that social media communication which is created by user and firm will influence brand equity and it creates a mediation effect between e-WOM and purchasing behavior of consumers. (Yogesh & Yesha, 2014)Social media has completely changed how people communicate and share interests and information. Marketing professionals now have a new way to reach clients thanks to the social media and social networking industry's explosive expansion, particularly in emerging nations like India. The study has found that social media is highly used by people as an information source.

The primary and dominant market outlet for goods is now social media (He, Wang, Chen, & Zha, 2017) (Oktriyanto, Budiarto, Siahaan, & Sanny, 2021)Social Media Marketing enables companies to engage with customers more quickly and more easily. From a business standpoint, social media use has the same beneficial consequences as conventional advertising. (Mikalaf, Giannakos, & Pateli, 2013)The study found that the convenience factor in product browsing in social media and ease of product selection in company social media sites is having an impact on consumer purchase intention. (Gupta, Banga, & Kumar, 2021) The goal of the study was to look at how people use different social media platforms and how that usage effects on their purchases. Descriptive research methodology was used. According to the survey, respondents utilized social networking sites to obtain information, make informed purchases, and were swayed by their close friends when choosing a product.

**Theoretical Background of The Study**

The model of "consumer decision making" (Schiffman & Kanuk, 2004) which explains the "consumer decision making process" through "Input", "Process" and "output". The insert stage impacts the consumer's product need identification; it holds 2 considerable origins of information: Company's marketing attempt viz. "product", "price", "place", "promotion" and the outer most sociocultural factors buyers ("friends", "family", "non-commercial sources", other "informal sources" and "neighbors", "social-class", and "cultural" and "subcultural" factors. The model stresses on how consumers will make the purchase decision. The emotional factors intrinsic in every discrete ("perception", "motivation", "attitude", "personality", and "learning") effects how the exterior inputs affects the consumer's recall of a requirement, pre-purchase explore for data, assessment of various alternatives. The consumer decision includes 3 stages: 1."need recognition", 2."pre-purchase search", and 3."evaluation of alternatives". The output stage of the "consumer decision making model" contains of 2 post-decision activities: "purchase behavior" and "post-purchase evaluation".





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**The Stimulus Response Model**

“The stimulus response model” of consumer behavior is essential to know the individual consumers buying behavior. The model briefly advances that customers are uncovered to different marketing stimuli that is “Product”, “Price”, “Place” and “Promotion” and they are also exposed to various external environmental factors such as “Political”, “Economic”, “Technological” and “Cultural”. There are internal factors such as psychological, perception, attitude, learning, personal (Age, Economic situation, Occupation, Personality, Lifestyle and self-concept) and motives that will influence on consumers buying decision. All these factors will have an impact on buying decision making of a customer which contain “product choice”, “brand choice”, “dealer choice”, “purchase quantity”, and “purchase timing”.

Figure given below portrays the stimulus-response model.

Source: Source: Kotler & Armstrong (2009, p. 159).

Kotler’s model helps the study in understanding the impact of cosmetics brands’ social media marketing stimuli on consumer buying behavior. This is extended to the research to analyze how the stimuli influence the decision-making process and respond to the need and purchase of cosmetics.

**Conceptual Framework**

The exchange of knowledge and interests has been revolutionized by social media. Marketing professionals now have a new channel with the rapid expansion of social media and social networking sites, particularly in emerging nations like India.(Yogesh & Yesha, 2014) The primary and dominant market outlet for goods is now social media (He, Wang, Chen, & Zha, 2017)Companies are able to engage with customers more quickly and simply through social media marketing. From a business standpoint, social media use has the same beneficial consequences as conventional advertising.(Oktriyanto, Budiarto, Siahaan, & Sanny, 2021). (Gupta, 2013) Perceived informativeness plays a vital role in consumer purchase intention. Perceived trust ad Entertainment factor will have an effect on consumer buying decision (Harun & Husin, 2019).

The proposed hypothesis for this study is based from the above discussion.

**Hypothesis 1: There is a significant relationship between Social Media Advertising Value and Online Purchase Intention towards cosmetics.**

**Data Reliability**

**Cronbach’s Alpha**

Case Processing Summary			
		N	%
Cases	Valid	385	100.0
	Excluded	0	.0
	Total	385	100.0
a. Listwise deletion based on all variables in the procedure.			

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.917	.906	17

Item Statistics			
	Mean	Std. Deviation	N
Cosmetics_Usage_Frequency	2.15	.767	385
Social_media_platform_used_more_ofTENly	1.64	1.057	385
Money_spent_on_cosmeticspurchase	1.45	.745	385
Number_of_cosmetics_purchased_in_online	1.62	.542	385





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SOCIAL_MEDIA_ADVERTISING	2.74	.873	385
SOCIAL_MEDIA_ADVERTISING	2.55	1.192	385
SOCIAL_MEDIA_ADVERTISING	2.49	1.125	385
SOCIAL_MEDIA_ADVERTISING	2.68	.898	385
SOCIAL_MEDIA_ADVERTISING	2.76	1.064	385
SOCIAL_MEDIA_ADVERTISING	2.81	.969	385
SOCIAL_MEDIA_ADVERTISING	2.62	1.081	385
SOCIAL_MEDIA_ADVERTISING	2.79	.871	385
SOCIAL_MEDIA_ADVERTISING	2.99	.986	385
SOCIAL_MEDIA_ADVERTISING	2.91	1.052	385
PURCHASEINTENTION	2.86	1.032	385
PURCHASEINTENTION	2.73	1.087	385
PURCHASEINTENTION	2.80	1.061	385

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Cosmetics_Usage_Frequency	40.42	114.875	.219	.305	.921
Social_media_platform_used_more_oftenly	40.93	116.364	.070	.384	.928
Money_spent_on_cosmetics_purchase	41.12	118.495	.001	.468	.925
Number_of_cosmetics_purchased_in_online	40.95	121.063	-.192	.621	.926
SOCIAL_MEDIA_ADVERTISING	39.83	101.609	.949	.997	.904
SOCIAL_MEDIA_ADVERTISING	40.02	98.611	.804	.931	.906
SOCIAL_MEDIA_ADVERTISING	40.08	98.593	.860	.957	.904
SOCIAL_MEDIA_ADVERTISING	39.89	104.894	.727	.898	.910
SOCIAL_MEDIA_ADVERTISING	39.81	101.504	.766	.883	.908
SOCIAL_MEDIA_ADVERTISING	39.76	103.061	.766	.907	.908
SOCIAL_MEDIA_ADVERTISING	39.95	99.781	.839	.898	.905
SOCIAL_MEDIA_ADVERTISING	39.78	103.416	.841	.886	.907
SOCIAL_MEDIA_ADVERTISING	39.58	102.517	.781	.956	.908
SOCIAL_MEDIA_ADVERTISING	39.66	100.876	.809	.915	.906
PURCHASEINTENTION	39.71	105.733	.578	.802	.913
PURCHASEINTENTION	39.84	106.176	.523	.942	.915
PURCHASEINTENTION	39.77	104.747	.608	.932	.913





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A survey was conducted among 385 female consumers, a two part questionnaire was sent to 385 female consumers. The social media advertising consisted of 10 items and the purchase intention consisted 3 items. The data reliability analysis was done using SPSS software, the result of Cronbach's Alpha was  $\alpha .917$ , which indicates great internal consistency and the data is acceptable and it is excellent.

**RESULTS AND DISCUSSION**

Data was collected through the structured questionnaire from 385 respondents. Once the data was collected, SPSS program was used by the researcher to carry out analysis. This study's respondents came from a variety of sociodemographic backgrounds. Below table shows the respondents' socio-demographic profile. The second part of the questionnaire relates to the cosmetics purchase and social media behavior. The following tables illustrates the same. Majority of the respondents use cosmetics during special occasion, Majority of the respondents use Instagram application more often and the majority of the respondents spend less than Rs.500 per month for cosmetics purchase

Cosmetics Usage Frequency	Frequency	Percent
Daily	89	23.1
Special occasion	151	39.2
Rarely	145	37.7
Total	385	100.0

Social Media Platform Used More Often	Frequency	Percent
Instagram	254	66.0
Facebook	58	15.1
You Tube	47	12.2
Snapchat	11	2.9
Pinterest	15	3.9
Total	385	100.0

Money Spent on Cosmetics online purchase in a Month	Frequency	Percent
Less than 500	260	67.5
501-1500	88	22.9
1501-3000	26	6.8
Above 3000	11	2.9
Total	385	100.0

**Hypothesis Testing**

Null Hypothesis: There is no significant relationship between Social Media Advertising Value and Online Purchase Intention towards cosmetics. Alternative Hypothesis: There is a significant relationship between Social Media Advertising Value and Online Purchase Intention towards cosmetics.

Correlations			
		Social_Media_Advertising_Value	Purchase_Intention
Social_Media_Advertising_Value	Pearson Correlation	1	.722**
	Sig. (2-tailed)		.000
	N	385	385





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Purchase_Intention	Pearson Correlation	.722**	1
	Sig. (2-tailed)	.000	
	N	385	385
**. Correlation is significant at the 0.01 level (2-tailed).			

The above Pearson Correlation test was conducted to check the relationship between social media advertising value and online purchase intention towards cosmetics, In the Pearson Correlation test, the correlation coefficient value between social media advertising value and online purchase intention is 0.722 and with significance level 0.000, This shows a high positive correlation between social media advertising value and online purchase intention towards cosmetics. Hence the alternative hypothesis is supported by the statement by that there is “a significant relationship between Social Media Advertising Value and Online Purchase Intention towards cosmetics”.

### Findings

The purpose of the study was to understand the cosmetics purchase and social media behavior among female consumers. Greater part of the respondents use beauty care products during special occasion, Majority of the respondents use Instagram application on a more regular basis and most of the respondents spend under Rs.500 each month for beauty care products. The main purpose of the research was to identify the relationship between social media advertising and online purchase intention. A total of 21 questionnaire were collected from respondents. The social media advertising had three items i.e. Credibility, Entertainment and Informativeness. There was a hypothesis proposed in the study and it was found that Social media advertising and online purchase intent are significantly correlated towards cosmetics among female consumers.

Hypothesis	Decision
<b>H1: There is a significant relationship between Social Media Advertising Value and Online Purchase Intention towards cosmetics.</b>	<b>Supported</b>

## CONCLUSION AND PRACTICAL IMPLICATION

The findings of this study will be a remarkable contribution for marketers and researchers. This study explored in understanding relationship between Social Media Advertising Value and Online Purchase Intention towards cosmetics. Respondents stated that the information provided in social media is credible, it is a valuable source, it also makes them to keep up to date about the cosmetics available in the market place and the information shared in social media is entertaining and interesting, these findings in the study helps in knowing the significance of social media advertisement. This will help marketers perceive that social media advertising, can assist them with expanding deals of cosmetics and possibly advance brand loyalty from buyers. The cosmetics marketers can make strategies in digital marketing to reach their target market and to pursue them to buy cosmetics.

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Education	Frequency	Percent
School Education	74	19.2
Graduate	134	34.8
Post Graduate	109	28.3
PhD/ Professional course	68	17.7
Total	385	100.0

Age	Frequency	Percent
<20	36	9.4
20-29	194	50.4
30-39	115	29.9
>40	40	10.4
Total	385	100.0

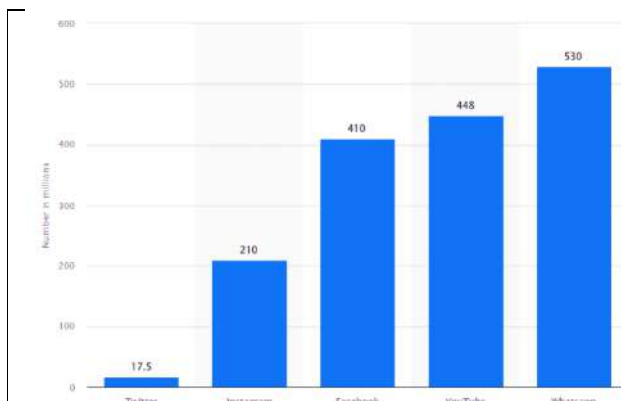




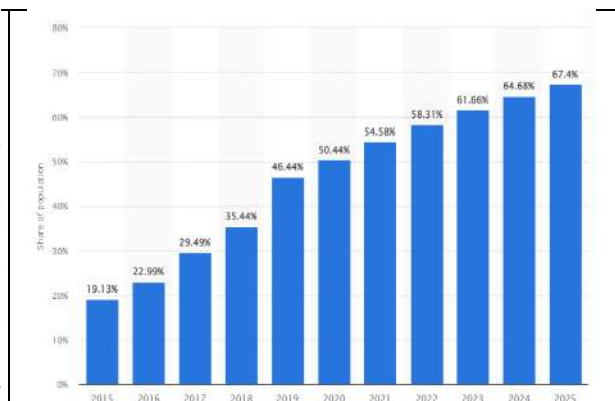


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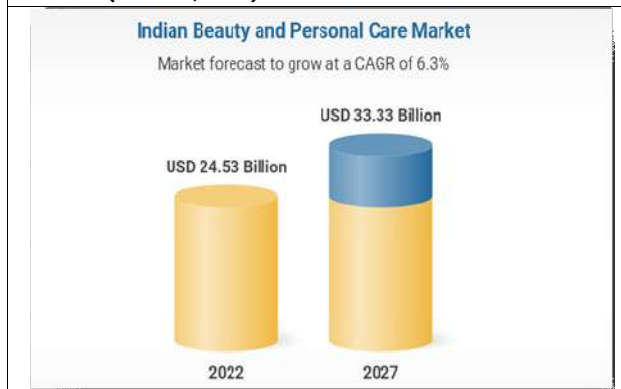
Occupation	Frequency	Percent
Student	71	18.4
Business owner	28	7.3
Employee	191	49.6
Home maker	95	24.7
Total	385	100.0



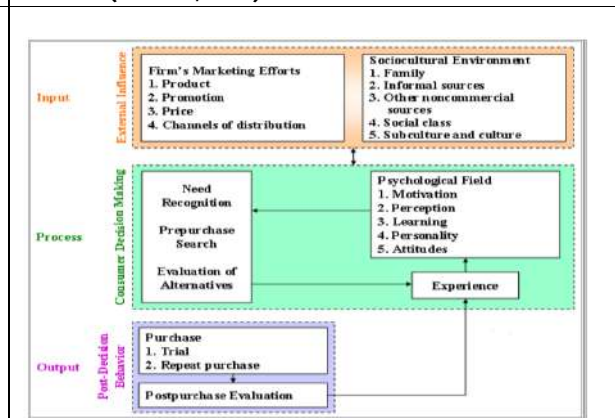
**Figure 1. India's total number of social media users as of February 2021, broken down per platform (in millions)**  
Source: (Statista, 2022)



**Figure 2. "Social network user penetration in India from 2015 to 2020, with estimates until 2025"**  
Source: (Statista, 2022)



**Figure 3. Indian Beauty and Personal Care Market (Market forecast to grow at a CAGR of 6.3%)**  
Source: (Research and Markets, 2022).

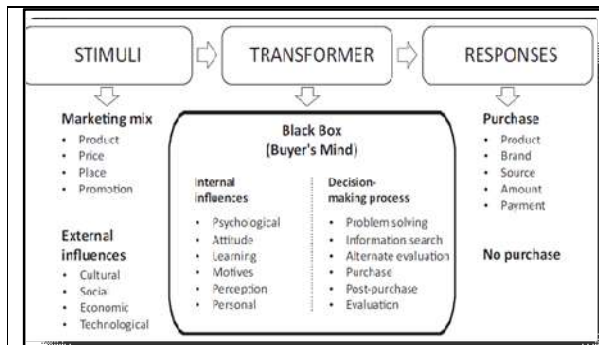


**Figure 4. A Simple Model of Consumer Decision Making**

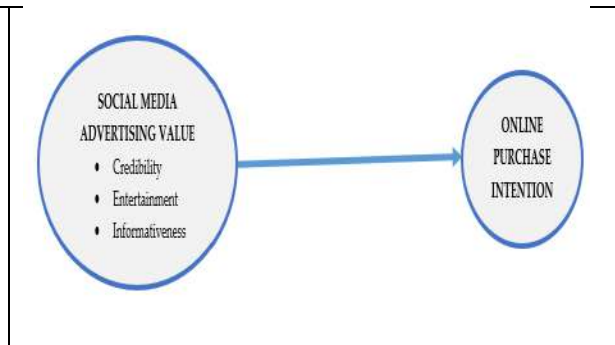




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**Figure 5. 3.9.2: Kotler's Black Box Model: Stimulus-Response Model**



**Figure 6. Conceptual Framework: Influence of Social Media Advertising on Online Purchase Intention**





## A Study on Significance of Motivational Techniques on Overall Employee's Work Performance and Productivity with Reference to URC Construction Pvt. Ltd, Erode

Navitha B<sup>1\*</sup> and C.Suganya<sup>2</sup>

<sup>1</sup>MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of MBA, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

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### \*Address for Correspondence

#### Navitha B

MBA Student,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E Mail: navitha2614@gmail.com



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### ABSTRACT

The labour force, or human resource, is widely recognised as the most crucial factor of production in today's advanced economies. Why? Because it's tough to do business in any economy without a strong human resource base. Using a wide range of motivational strategies is crucial for any business that wants to get the most out of its personnel. That's why companies of all stripes are putting a premium on finding effective ways to inspire their staff members to go above and beyond in their work. No of the state of the economy, finding strategies to motivate your staff is currently regarded as the top priority for any manager. All firms, for-profit and non-profit alike, need to prioritise employee incentive strategies in today's cutthroat business climate. The purpose of this research is to investigate the impact of various motivational strategies on workers' efficiency and output.

**Keywords:** Motivation, Types, Techniques, Significance, Performance, Productivity

## INTRODUCTION

Employees need to feel motivated to give their all in order to help the business achieve its objectives. Human needs, desires, causes, wants, purpose, or urges are the origin of the word 'motive,' from which we get the word 'motivation. Motivation can be defined as the process of inducing or encouraging people to take action in order to achieve specific corporate goals. It's how enthusiastically and imaginatively staff members approach their work for the company. In other words, it's the method of getting others to do what you want them to do by reading their body language and responding appropriately. It's a crucial part of being a manager in any type of business.



**Navitha and Suganya****Objectives of the study**

- To study about the motivational techniques provided by organization.
- To analyse the techniques of motivation to increase performance.
- To understand the impact of motivational techniques on employees performance.

**Need for the Study**

- This research is important for businesses who want to learn about the effects of staff incentive strategies on output.
- The study is necessary since it helps to discover the training needs and solutions to motivate people inside an organisation.
- Employees will benefit from this research since it will provide them a chance to learn new things, hone their abilities, and feel encouraged to contribute to the company's success as a whole.

**Scope of the Study**

The purpose of this research is to examine the positive effects of the offered motivational tactics on employees and to determine what kinds of motivational training are needed to improve the business as a whole.

**Limitations**

- Due to time constraints, we were only able to collect data from 107 of our staff members.
- My research is limited to your company.
- The information was gathered during the busiest time of day for the staff.

**REVIEW OF LITERATURE**

In his study, Vinaya Chaitanya Ganta (2014) discussed the theories and methodologies of motivation in depth, as well as the necessity of motivation in the workplace to improve employee performance and productivity. The research ultimately indicates that intrinsic employee motivation is crucial for any business hoping to boost staff performance and overall output. Managers play a crucial part in keeping workers engaged and inspired on the job. The manager is responsible for coming up with novel approaches to continuously inspire their staff. In his recent article, Professor Amit Singh (2017) spoke about the importance of inspiration in the contemporary workplace. The paper reaches the conclusion that employee motivation is a highly nuanced and complex topic. To achieve organisational success, managers must cope with a number of challenges. Managers must understand the importance of employee motivation, its underlying principles, and the variety of employee demands. Managers need to keep up with the shifting priorities of different employee incentive elements throughout time.

Dr. Chandrakant Varma (2017) wrote an article in which he analysed the impact of intrinsic motivation on worker engagement and productivity. The research found that when workers are inspired to do better, they actually do better. Human resources departments at companies can encourage staff to stay by cultivating friendly and productive workplaces. The most significant conclusion, according to Niranjana and Pattanayak (2016), is that most workers agree that rewards motivate and affect performance. In conclusion, acknowledgment can be an effective method for boosting morale in the workplace. Employees want it, and having it makes them far more productive. Social benefits like acknowledgment have been hypothesised to have a similar impact on productivity as monetary compensation.

Research conducted by Sajuyibe (2013) on a small sample of manufacturers in Ibadan, Oyo state, Nigeria, using both descriptive and qualitative methods, found that pay, recognition, and pay jointly predict the performance of employees. This study used a sample size of 100 workers to draw its conclusions. Employee motivation and performance shows that whenever a task is valuable, the employees act with a high level of dedication, but just like there were no illustrations of data, although the research desired, was identified by Vinay (2014) as the driving force



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in the workplace, which used motivational tools to achieve high performance from employee through the deductive reasoning of methodology.

The commercial Bank of Sri Lanka Plc in the Jaffna District had its reward system and its effect on employee motivation evaluated by Pratheepkanth (2011). His research set out to determine if and how much monetary and nonmonetary incentives affect workers' motivation. Positive and significant effects of rewards and recognition on employee motivation were found in the study overall. The findings also showed a disparity in the degrees of incentive and motivation experienced by staff and employees of non-white racial origins. Internal and external incentives were studied by Kuvaas et al. (2017), who found that each type of motivation has a unique impact on workers' productivity on the job. The study's results demonstrated a favourable relationship between intrinsic motivation and job performance, as well as a negative relationship between intrinsic motivation and both job turnover intent and burnout. However, there is a negative association between extrinsic motivation and job performance and a positive relationship with intentions to leave and feelings of burnout.

**RESEARCH METHODOLOGY****Research Design**

Descriptive research using a standardized questionnaire was the method of choice for this investigation.

**Method Of Collection**

Primary data and secondary data are collected.

**Sampling Size**

The study has a sample size of 107.

**Sampling Unit**

Workers at URC Construction Pvt. Ltd. serve as the study's sampling unit.

**Sampling Method**

The researchers utilised a random sample technique for their investigation.

**Tools For Data Analysis**

- Descriptive Statistics
- Chi-Square Test
- Correlation

**Data Analysis****Descriptive Statistics**

Number of responders to a questionnaire expressed as a percentage of the overall population selected for the study; this is the focus of percentage analysis, a straightforward statistical tool. It's one of the simplest types of analysis that can provide important findings to a researcher. According to the data shown above, 53.9% of respondents are female, 43.9% are between the ages of 31 and 35, 43.9% have postgraduate degrees, 44.9% have six to ten years of work experience, and 44.9% are senior engineers (40.2 percent).

**Chi- Square Test**

If you want to know if the distributions of two or more independent samples differ on a single variable, you can apply the Chi-square test of homogeneity. This test is frequently used to evaluate differences between three or more groups or conditions based on a binary outcome. Independence and homogeneity tests are used in the formulation of the omnibus test statistic.



**Navitha and Suganya****Table 2. Gender of the Respondents and Quality of work life**

**H0** – There is no significance relation between using Gender of the Respondents and Quality of work life.

**H1** – There is significance relation between using Gender of the Respondents and Quality of work life.

**Inference**

The aforementioned tabular analysis revealed a total value of .000, well below the threshold of 5%. As a result, H1 can be considered a valid hypothesis.

**Table 3. Age of the Respondents and Job satisfaction**

**H0** – There is no significance relation between using Age of the Respondents and Job satisfaction.

**H1** – There is significance relation between using Age of the Respondents and Job satisfaction.

**Inference:**

The aforementioned tabular analysis revealed a total value of .000, well below the threshold of 5%. As a result, H1 can be considered a valid hypothesis.

**Correlation**

The degree to which two or more variables move in tandem is measured statistically by their correlation. If the two variables both go up or down at the same rate, the correlation will be positive; if one goes up while the other goes down, the correlation will be negative. As an illustration, there is a correlation between height and weight; often, those who are taller will also be heavier.

**Table 4: Age and Quality of work life**

**H0**– There is significance relation between using Age and Quality of work life

**H1** – There is no significance relation between using Age and Quality of work life

**Inference**

The preceding table shows that the estimated cumulative value is -.051, which is lower than the threshold of 0.05 percent. Therefore, H0 is a well-fitting and valid hypothesis.

**Table 5: Experience and Job Satisfaction**

**H0**–There is significance relation between using Experience and Job Satisfaction

**H1** –There is no significance relation between using Experience and Job Satisfaction

**Inference**

The estimated aggregate value of 1.35 was greater than the threshold of 0.05 percent, as shown in the table below. As a result, H1 can be considered a valid hypothesis.

**FINDINGS, SUGGESTIONS AND CONCLUSION****Findings**

From the above table it was found that major of the respondents are female (55.1%) & they are under the age group of 31 – 35 years (43.9%)& they are qualified with PG (43%)& the persons have 6 – 10 years of job experience (44.9%) and their designation is Senior Engineer (40.2%).

**Suggestions**

- If you want better results from the employee, reward them more.
- There are a few caveats to this research report. Money, non-money, work environment, quality of life, training and development, job happiness, and job security were some of the few motivational elements addressed in this study.
- Second, in order to learn about the most crucial factors on a more macro scale, the study's sample size should be raised.
- Thirdly, the sample population is carefully selected. The future of the discussion of motivation should include illuminating additional factors, such as recognition and organisational dedication.





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## CONCLUSION

The ability to motivate yourself is an asset throughout every stage of life. The same is true of corporate structures. Management tasks place a premium on inspiring employees. It plays a crucial role in the management procedure. A highly motivated workforce is a company's greatest asset, one that yields substantial returns in the form of sustained, bolstered operations. Management can benefit from using motivation as a technique to excite their staff. Workers are more effective, productive, and enthusiastic when they feel motivated. When employees aren't inspired to do their best work, they become dissatisfied with their jobs and their work environment, which in turn has a negative impact on the company's bottom line. The study demonstrates the generally utilised tactics in boosting employee motivations, the distinct types of motivation, and the general impact of employee motivating elements on organisational performance through the examination of many quantitative and qualitative studies.

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**Table 1. Demographic variables**

Demographic variables		Frequency	Percent
Gender	Male	48	44.9%
	Female	59	55.1%
	<b>Total</b>	<b>107</b>	<b>100%</b>
Age	Below30	22	20.6%
	31-35	47	43.9%
	36-45	34	31.8%
	Above45	4	3.7%
	<b>Total</b>	<b>107</b>	<b>100%</b>
Educational Qualification	Degree	23	21.5%
	PG	46	43.0%
	Professional degree	30	28.0%
	Ph.D	8	7.5%
	<b>Total</b>	<b>107</b>	<b>100%</b>
Experience	Below 5 years	19	17.8%
	6 - 10 years	48	44.9%
	11 – 15 years	28	26.2%
	Above 15 years	12	11.2%
	<b>Total</b>	<b>107</b>	<b>100%</b>





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<b>Designation</b>	Asst. Engineer	21	19.6%
	Senior Engineer	43	40.2%
	Civil site Engineer	25	23.4%
	Asst. Civil Engineer	18	16.8%
	<b>Total</b>	<b>107</b>	<b>100%</b>

**Table 2. Gender of the Respondents and Quality of work life**

	<b>Chi-square</b>	<b>df</b>	<b>Asymp. Sig.</b>
Gender of the Respondents	48.20	3	.000
Opportunities are provided for greater growth and development of the individual	53.13	3	.000
Leaves provided by the superiors when family members got sick	60.87	3	.000
Mutual trust in the organization motivates me to perform effectively	24.67	3	.000
The relationship between the employees and work environment is healthy	35.00	2	.000
Human dignity and growth are promoted in the organization	45.52	2	.000

**Table 3. Age of the Respondents and Job satisfaction**

	<b>Chi-square</b>	<b>df</b>	<b>Asymp. Sig.</b>
Age of the Respondents	35.20	3	.000
Doing the work that is well suited to my abilities and skills motivates to work hard	55.53	3	.000
Chance to develop new ways to do the job	24.20	3	.000
Promotional policy in the organization motivates me to improve my skills	42.20	2	.000
I feel satisfied after completion of the work assigned by the organization	22.45	2	.000

**Table 4. Age and Quality of work life**

		<b>Age</b>	Opportunities are provided for greater growth and development of the individual	Leaves provided by the superiors when family members got sick	Mutual trust in the organization motivates me to perform effectively	The relationship between the employees and work environment is healthy	Human dignity and growth are promoted in the organization
<b>Age</b>	Pearson Correlation	1.000	-.051	-.162	.044	-.202	-.084
	Sig. (2-tailed)		.582	.078	.637	.027	.361
	N	107	107	107	107	107	107
Opportunities are provided for greater growth and development of the	Pearson Correlation	-.051	1.000	.409	.329	.465	.173
	Sig. (2-tailed)	.582	.000	.000	.000	.000	.000
	N	107	107	107	107	107	107







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individual							
Leaves provided by the superiors when family members got sick	Pearson Correlation	-.162	.409	1.000	.244	.411	.435
	Sig. (2-tailed)	.078	.000		.000	.000	.000
	N	107	107	107	107	107	107
Mutual trust in the organization motivates me to perform effectively	Pearson Correlation	.044	.329	.244	1.000	.606	.328
	Sig. (2-tailed)	.637	.000	.000		.000	.000
	N	107	107	107	107	107	107
The relationship between the employees and work environment is healthy	Pearson Correlation	-.202	.465	.411	.606	1.000	.337
	Sig. (2-tailed)	.027	.000	.000	.000	.000	.000
	N	107	107	107	107	107	107
Human dignity and growth are promoted in the organization	Pearson Correlation	-.084	.173	.435	.328	.337	1.000
	Sig. (2-tailed)	.361	.000	.000	.000	.000	
	N	107	107	107	107	107	107

**Table 5. Experience and Job Satisfaction**

		<b>Experience</b>	Doing the work that is well suited to my abilities and skills motivates to work hard	Chance to develop new ways to do the job	Promotional policy in the organization motivates me to improve my skills	I feel satisfied after completion of the work assigned by the organization
<b>Experince</b>	Pearson Correlation	1.000	.254	.267	.176	.288
	Sig. (2-tailed)		.005	.003	.054	.001
	N	107	107	107	107	107
Doing the work that is well suited to my abilities and skills motivates to work hard	Pearson Correlation	.254	1.000	.409	.329	.465
	Sig. (2-tailed)	.005		.000	.000	.000
	N	107	107	107	107	107
Chance to develop new ways to do the job	Pearson Correlation	.267	.409	1.000	.244	.606
	Sig. (2-tailed)	.003	.000		.007	.000
	N	107	107	107	107	107
Promotional	Pearson	.176	.329	.244	1.000	.411





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policy in the organization motivates me to improve my skills	Correlation					
	Sig. (2-tailed)	.054	.000	.007		.000
	N	107	107	107	107	107
I feel satisfied after completion of the work assigned by the organization	Pearson Correlation	.135	.173	.435	.328	.337
	Sig. (2-tailed)	.142	.059	.000	.000	.000
	N	107	107	107	107	107





## A Study on the Effect of Compensation on Employee Productivity in Bescal Steel Industries Pvt. Ltd

Saran R<sup>1\*</sup> and C.Suganya<sup>2</sup>

<sup>1</sup>MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of MBA, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

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### \*Address for Correspondence

**Saran R**

MBA Student,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E. Mail: saranmani159@gmail.com



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### ABSTRACT

Staff morale and output are strongly correlated with pay levels. That's why they're crucial to the company as a whole. This study aims to analyse the relationship between pay and productivity at bescal steel industries pvt ltd. This study combined a descriptive approach with an explanatory one. Data was gathered through the use of a questionnaire, an interview, and a review of relevant documents. The information was compiled with the help of bescal steel industries pvt ltd. All 180 workers of bescal steel industries pvt ltd make up the study's population, from which a subset of 117 was drawn using a basic stratified random sampling technique. The data was analysed using descriptive statistics, a correlation analysis, and a chi-square test. Descriptive research concludes that all elements of pay packages impact productivity in some way. Correlation study shows a positive and statistically significant link between monetary pay and productivity, but non-monetary incentives have no effect on output. Statistical investigation confirms that monetary compensation has a positive and significant influence on productivity, while non-monetary compensation has a negative and insignificant effect on output.

**Keywords:** Compensation, Administration, Employee productivity, Organization

### INTRODUCTION

The main aim of any organization is to increase its productivity by improving its performance. Performance of the organization is wholly dependent on the performance of its employees, since employees performance directly influences organizational productivity, organization need to ensure that their employees are constantly motivated to perform better. Compensation is the driving force which keeps the employees happy and satisfied employees can



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give better output. Production and productivity depend on the effectiveness and efficiency of the employees which in turn, depends on the compensation and reward they get.

**Objectives of the Study****General Objective**

- The purpose of this research is to examine compensation packaging at Bescal Steel Industries to draw conclusions about its impact on employee productivity.

**Specific Objectives**

- The purpose of this study is to determine what factors influence packaging salaries at Bescal Steel Industries.
- The goal of this survey is to ascertain the extent to which Bescal Steel Industries' employees are happy with their pay and willing to work more.

**Need of the Study**

- This research has implications for the administration of the Bescal steel sector.
- The management of the targeted businesses can close the pay equity gap and improve future compensation decisions by understanding the link between the compensation system and employee productivity.

**Scope of the Study**

- Compensation and output at Bescal Steel Industries are the focus of this research.
- In order to learn how employees feel about and think about the company.
- Examining the company's strategic direction is a top priority.
- The study's focus area was crucial for determining the extent to which employee satisfaction contributes to organisational success.

**Limitations**

The study's primary weakness is that it focuses solely on the Bescal steel industry in Mannady. Furthermore, it does not take into account other aspects that may influence worker output. Despite these caveats, the study's findings can help managers boost the output of their subordinates.

**REVIEW OF LITERATURE**

Mr. Owen Harvey-Beavis (February 2003) looks at the research and policy papers written about pay for performance programmes in elementary and secondary education. This document serves as a working draught for OECD's project entitled "Attracting, Developing, and Retaining Effective Teachers" (OECD) Zubin R. Mulla 'Human resource management (HRM) is the study of how management decisions affect workers' motivation, outlooks, and output (Noe, et al. 2006). One of the most vital functions of human resource management is compensation administration. There are three reasons why the topic of Compensation is relevant to you as working managers. First, if you're not currently doing so, you might want to gain experience in human resources before going into a more general managing position. You will thereafter have primary responsibility for developing and overseeing an efficient pay structure. As a manager in charge of a team, you will have to recruit, evaluate, and inspire your subordinates regardless of whether or not you pursue a human resources career path. When it comes to hiring new employees, conducting performance reviews, and trying to inspire existing workers to give their all, pay is typically a big talking point for managers at all levels.

Jonathan Trevor (January 2008) looked into that Besides being the largest single expense for most businesses, compensation has also been praised as a way to boost productivity and maintain a competitive edge by several analysts in recent years. The focus of modern methods of employee remuneration is on encouraging actions that contribute to the company's overall goals. Organizations increasingly rely on what is known as strategic





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compensation to structure employee pay. It is important to differentiate between reward and recognition systems, despite the fact that these two concepts are commonly employed interchangeably. Companies often implement employee compensation systems to incentivize workers both individually and collectively for their efforts and the success of the business as a whole. They are not part of regular pay and may have a monetary or nonmonetary cost to the business. Although they were once only used by giant corporations, small firms are increasingly turning to them to improve productivity and attract talented workers in today's tight labour market.

Dubin( 2002 )acknowledged and widely studied in the field of human resources since the 1930s (Lee-Ross, 2002). Motivation is the process of satisfying one's own wants by means of one's own activities and behaviours. It has to do with the interplay between an individual's internal motivations and those imposed on them by their external surroundings (Lee-Ross, 2002, 55). Motivation, as defined by psychologist Robert L. Dubin, is "a force that motivates the person to act and pushes him or her to continue in the course of action that has already been undertaken" (cited in Kumar & Sharma, 2001). Compensation Administration Having a pay system where higher performers are compensated more than ordinary workers is implied by the term "performance-based pay" (Hewitt, 2009). This fosters healthy competition among employees and motivates those already performing well to raise their game even further.

## RESEARCH METHODOLOGY

### Research Design

This study employs a descriptive research strategy based on a comprehensive and methodical questionnaire.

### Method of Collection

Primary and secondary data are used in the data collection process.

### Sampling Size

The sampling size of the study is 117

### Sampling Unit

The sampling unit of the study is employees of Bescal steel industry pvt ltd.

### Sampling Method

The sampling method used in the study is simple random sampling method.

### Tools for Data Analysis

- Descriptive Statistics
- Chi-Square Test
- Correlation

### Data Analysis

#### Descriptive Statistics

Percentage analysis is a straightforward statistical tool that measures the proportion of a sample population that answers a questionnaire. It's one of the simplest types of analysis, and it's useful for seeing how a study turns out. The majority of respondents are men (74.4%), as shown in the table above; they also fall into the age range of 36-45 (41%); they are single (71.8%); they have between one and three years of work experience (42.7%); and they make between 2,000 and 30,000 rupees per month (average) (41.0 percent ).



**Saran and Suganya****Chi-Square Test****Table 1: Gender and Employee's compensation**

**H0** – There is no significance relation between using Gender and Employee's compensation.

**H1** – There is significance relation between using Gender and Employee's compensation.

**Test Statistics****Inference**

The preceding table shows that the estimated cumulative value is below the level of 0.05 percent, coming in at.000. Therefore, H1 is a valid and accepted hypothesis.

**Table 2: Age and Employee's compensation**

**H0**– There is no significance relation between using Age and Employee's compensation

**H1** – There is significance relation between using Age and Employee's compensation

**Inference**

The preceding table shows that the calculated cumulative value is.000, which is below than the threshold of 5%. As a result, H1 can be considered a valid hypothesis.

**Correlation****Table 1: Age and Compensation on employee productivity**

**H0**– There is significance relation between using Age and Compensation on employee productivity

**H1** – There is no significance relation between using Age and Compensation on employee productivity

**Inference**

Based on the data shown above, we can conclude that the computed sum value is -564, which is less than 5%. Therefore, H0 is a well-fitting and valid hypothesis.

**Table 2: Experience and Compensation on employee productivity**

**H0**–There is significance relation between using Experience and Compensation on employee productivity

**H1** –There is no significance relation between using Experience and Compensation on employee productivity

**Inference**

The preceding table shows that the estimated cumulative value was -.443, which was lower than the threshold of 0.05 percent. Therefore, H0 is a well-fitting and valid hypothesis.

**Findings, Suggestions & Conclusion****Findings**

Employees are personally satisfied by their work and get motivated towards compensation based on employee productivity; the average age of respondents is 36; 74.4 percent of them are male; the percentage of single employees is 71.8 percent; the average length of employment is 1-3 years; and the average salary is between Rs.20001 and Rs.30000 per month.

**Suggestions**

- Employee output often responds to compensation levels.
- Workers who believe they are receiving adequate pay for their efforts are more likely to put out maximum effort on the job.
- Workers are more likely to put in their best effort and care about their jobs if they know and understand how they will be compensated.





## CONCLUSION

Employees might be encouraged to give their all by providing they are part of a system that is both financially and otherwise rewarding for their efforts. But if workers believe they are being underpaid or undervalued, it can have a negative impact on their motivation and output. Employers should design a compensation plan that is fair to workers and takes into account their working conditions and the people they employ. They can boost productivity and provide workers with a more satisfying environment if they do so.

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**Table 1. Demographic variables**

Demographic variables	Frequency	Percent	
<b>Gender</b>	Male	87	74.4%
	Female	30	25.6%
	<b>Total</b>	117	100%
<b>Age</b>	25-35years	11	9.4%
	36-45years	48	41.0%
	46-55years	45	38.5%
	above55years	13	11.1%
	<b>Total</b>	117	100%
<b>Marital Status</b>	Single	84	71.8%
	Married	33	28.2%
	<b>Total</b>	117	100%
<b>Job Experience</b>	Lessthanone year	5	4.3%
	1year-3year	50	42.7%
	3year-5year	43	36.8%
	Morethan5years	19	16.2%
	<b>Total</b>	117	100%
<b>Income</b>	Rs.10000 - Rs.20000	11	9.4%
	Rs.20001- Rs.30000	48	41.0%
	Rs.30001- Rs.40000	45	38.5%
	Rs.Above40000	13	11.1%
	<b>Total</b>	117	100%





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**Table 2. Gender and Employee’s compensation**

	<b>Chi-square</b>	<b>df</b>	<b>Asymp. Sig.</b>
Gender	27.77	1	.000
Employee compensation costs forms a significant portion of your company’s costs	27.40	4	.000
Employee compensation plan at BSI is well formulated	42.79	4	.000
The pay structure at BSI ensures there is a good balance of pays between the employees in the company	87.57	4	.000

**Table 3. Age and Employee’s compensation**

	<b>Chi-square</b>	<b>df</b>	<b>Asymp. Sig.</b>
Age	40.91	3	.000
Employee compensation costs forms a significant portion of your company’s costs	27.40	4	.000
Employee compensation plan at BSI is well formulated	42.79	4	.000
The pay structure at BSI ensures there is a good balance of pays between the employees in the company	87.57	4	.000

**Table 4. Age and Compensation on employee productivity**

		<b>Age of there spondents</b>	<b>My Basic pay is reviewed periodically</b>	<b>I am aware of what the Conditions of Service Manual Contains</b>	<b>I am satisfied with the non-financial compensation I receive</b>	<b>Compensation have a direct impact on employee Productivity</b>	<b>The compensation what I receive from BSI have a direct impact on my productivity</b>
Age of the respondents	Pearson Correlation	1.000	.116	-.564	-.006	-.416	-.323
	Sig. (2-tailed)		.212	.000	.953	.000	.000
	N	117	117	117	117	117	117
My Basic pay is reviewed periodically	Pearson Correlation	.116	1.000	.370	-.001	-.150	.298
	Sig. (2-tailed)	.212		.000	.995	.107	.001
	N	117	117	117	117	117	117
I am aware of what the Conditions of Service Manual Contains	Pearson Correlation	-.564	.370	1.000	.002	.383	.260
	Sig. (2-tailed)	.000	.000		.980	.000	.005
	N	117	117	117	117	117	117
I am satisfied with the non-financial compensation I receive	Pearson Correlation	-.006	-.001	.002	1.000	-.170	-.178
	Sig. (2-tailed)	.953	.995	.980		.066	.055
	N	117	117	117	117	117	117
Compensation	Pearson	-.416	-.150	.383	-.170	1.000	-.218







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have a direct impact on employee Productivity	Correlation						
	Sig. (2-tailed)	.000	.107	.000	.066		.018
	N	117	117	117	117	117	117
The compensation what I receive from BSI have a direct impact on my productivity	Pearson Correlation	-.323	.298	.260	-.178	-.218	1.000
	Sig. (2-tailed)	.000	.001	.005	.055	.018	
	N	117	117	117	117	117	117

**Table 5. Experience and Compensation on employee productivity**

		Total years of experience of there spondents	My Basic pay is reviewed periodically	I am aware of what the Conditions of Service Manual Contains	I am satisfied with the non-financial compensation I receive	Compensation have a direct impact on employee Productivity	The compensation what I receive from BSI have a direct impacton my productivity
Total years of experience of there spondents	Pearson Correlation	1.000	.098	-.443	.324	-.439	.192
	Sig. (2-tailed)		.292	.000	.000	.000	.038
	N	117	117	117	117	117	117
My Basic pay is reviewed periodically	Pearson Correlation	.098	1.000	.370	-.001	-.150	.298
	Sig. (2-tailed)	.292		.000	.995	.107	.001
	N	117	117	117	117	117	117
I am aware of what the Conditions of Service Manual Contains	Pearson Correlation	-.443	.370	1.000	.002	.383	.260
	Sig. (2-tailed)	.000	.000		.980	.000	.005
	N	117	117	117	117	117	117
I am satisfied with the non-financial compensation I receive	Pearson Correlation	.324	-.001	.002	1.000	-.170	-.178
	Sig. (2-tailed)	.000	.995	.980		.066	.055
	N	117	117	117	117	117	117
Compensation have a direct impact on employee Productivity	Pearson Correlation	-.439	-.150	.383	-.170	1.000	-.218
	Sig. (2-tailed)	.000	.107	.000	.066		.018
	N	117	117	117	117	117	117
The compensation what I receive from BSI have a direct impact on my productivity	Pearson Correlation	.192	.298	.260	-.178	-.218	1.000
	Sig. (2-tailed)	.038	.001	.005	.055	.018	
	N	117	117	117	117	117	117





## A Comparative Study of Service Quality among Commuters of South Zone Metro Rail – India

Sushmitha V<sup>1\*</sup> and K. Nagendra Babu<sup>2</sup>

<sup>1</sup>Research Scholar, DOS in Commerce, Manasagangotri, University of Mysore, Karnataka, India.

<sup>2</sup>Professor, DOS in Commerce, Manasagangotri, University of Mysore, Karnataka, India.

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### \*Address for Correspondence

#### Sushmitha V

Research Scholar,  
DOS in Commerce,  
Manasagangotri, University of Mysore,  
Karnataka, India.  
E. Mail: sushmithanaidu9319@gmail.com



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### ABSTRACT

Services are people centric, humanistic and subjective and the outcome of service mainly depends on its quality. Service quality is the comparison of perceived expectation of a service with perceived performance. This empirical study attempts to understand the dimensions of service quality in the context of Metro Systems in BMRC, HMRL and CMRL. Metro is a rapid transit system serving various cities in India. To ensure reliability and safety in train operations, it is equipped with most modern communication technology and train control system. It offers number of benefits to commuters such as long-distance travel, safe travel, high speed and hassle-free travel. The present study is conducted using SERVQUAL model to find and analyze commuter's perception on three service quality dimensions – Tangibility, Reliability and Responsiveness, and to identify the relationship between service quality dimensions and its interactions among the demographic factors in Bengaluru, Hyderabad and Chennai. The study is carried out by using structured questionnaire. Convenience sampling with 814 respondents were taken for data collection.

**Keywords:** Commuter's perception, Service Quality, BMRC, HMRL, CMRL, SERVQUAL

## INTRODUCTION

Intra-city mobility affects the well-being of city dwellers and quality of urban life. A highly sophisticated and sustainable mass transit system is key to facilitate such mobility. A major concern in public transit is to keep improving level of service quality and make it more appealing to commuters. Therefore, commuter's expectations need to be met by public transit providers which can be achieved with the framework that allows managers to

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monitor the perceptions about the service. SERVQUAL developed by Parasuraman is one such framework that helps to measure the dimensions of service quality and capture customer's perceptions.

Namma Metro also known as Bengaluru Metro is a rapid transit system serving the city of Bangalore. It is the fourth longest metro in India. It also contains first underground metro line in South India. The metro network consists of two colour-coded lines, with a total length of 42.3 kilometers serving 40 stations. The system has mix of underground, street level and elevated stations using standard-gauge tracks. The metro has an average daily ridership of 400,000 passengers. By 2023, the system is expected to complete its phase 2 network and provide connectivity to the city's important tech hubs of Electronic city and Whitefield.

The BMRC Limited, a joint venture of Government of India and Government of Karnataka, built and operates the Namma Metro. Services operate daily between 5.00 a.m to 23.00 p.m with a headway varying between 4-20 minutes. The trains are composed of three to six cars. The power output is supplied by 750-volt direct current through third rail. Namma Metro was the second rail transport in India to use 750 V DC third rail traction, the first being the Kolkata Metro.

The Hyderabad Metro is a rapid transit system, serving the city of Hyderabad, Telangana, India. It is the third longest operational metro network in India after Delhi Metro and Namma Metro (Bengaluru) and the lines are arranged in a secant model. It is funded by a public-private partnership (PPP), with the state government holding a minority equity stake. Hyderabad Metro is the world's largest elevated Metro Rail system based on DBFOT basis (Design, Built, Finance, Operate and Transfer).<sup>1</sup> A special purpose vehicle company, L&T Metro Rail Hyderabad Ltd (L&TMRHL), was established by the construction company L&T to develop the Hyderabad metro rail project. The Chennai Metro Rail Limited is a joint venture between Government of India and Government of Tamil Nadu. The system has underground and elevated stations and uses standard gauge. It is the fourth largest metro system in India covering a length of 54 kilometers.

Transport plays a very important role in the economic development of the country by creating employment opportunities and sustaining economic activities. Transport is the channel of social and economic interaction involving the physical movement of people and goods. The quest for service quality has been an essential strategic component for service firms like BMRC attempting to succeed and survive in today's competitive world. The SERVQUAL Model focuses on the difficulty in ensuring high quality of service for all customers in all situations. SERVQUAL methodology is an analytical approach for evaluating the differences between customer's expectation and quality of service.

**Objective of the Study**

- To identify the demography of commuters who prefer metro in South Zone of India with reference to Bengaluru, Hyderabad and Chennai.
- To analyse the relationship between service quality dimensions using SERVQUAL model and its interactions among the demographic factors of the respondents.

**RESEARCH METHODOLOGY**

For the purpose of study both primary data and secondary data were considered. The primary data was collected from different routes of Bengaluru, Hyderabad and Chennai Metro with the help of well-structured questionnaire. A sample of 814 respondents were taken from existing Bengaluru, Hyderabad and Chennai Metro stations. Further the questionnaire was bifurcated into demographic dimensions like education qualification, income level etc. and Service quality dimensions like Reliability, Tangibility and Responsiveness. Secondary data includes BMRC, HMRL and CMRL websites and search engine.



**Sushmitha and Nagendra Babu****Sample Frame**

In order to collect the information convenience sampling was used due to easy accessibility, affordability and time constraints.

**REVIEW OF LITERATURE**

(Pradeep Chaitanya Dasti, 2019) Opines that inter-city transportation affects well-being and quality of life of city dwellers. The study reveals that Mumbai's metro network is outperforming to a satisfactory level in service and quality-oriented sectors such as metro system network, system capacity and comfort. Though the social aspect of sustainability dimension is performing at satisfactory level, the rest of the aspects such as environment, economic and financial dimensions need significant improvement. The government has huge responsibility of utilizing multilateral and bilateral funding agencies for developing a network with minimal customization to anticipate, track and compare the performance of various metro rail systems in India.

(Rajasekhara Mouly Potluri, 2018) collected opinions from both costumers and transport providers on the problems faced in transport sector in India and the study reveals that the traffic congestion is the major problem faced by them. This results in slower speed and increased travel time. The other problems include illegal parking, high fuel prices, cleanliness, security and operational costs. The success or failure of any service organization depends on how frontline staff delivers the required services based on customization to meet customer's requirements by clearly understanding the expectations of the diverse customers.

(Srivastava, 2017) opines that Customer orientation is one of the most important determinants of success of a service organization as customers form their perceptions about service quality-based interactions with service personnel. It requires human touch, adaptability and prompt action to make service experience upbeat and enduring for the customers. The study reveals that reliability has most significant impact over customer satisfaction and customers value empathy shown by employees while addressing their problem.

(Dr. Kuldeep Sharma, September 2018) have examined the platform service quality offered for railway passengers in Mumbai Metro Corridor. They have evaluated the demographic factors like age, income, gender and its relationship on level of passenger's satisfaction. There was no significant relationship between these two parameters. However, the research discovered that there was relationship between marital status and level of passengers' satisfaction with Mumbai Metro Corridor in relation to services offered there. Most of the respondents were satisfied with the services and suggested to improve the number of ticket counters, parking facilities and facility for disabled person to enhance the services to its passengers.

(Chih-Hsing Sam Liu, 2016) developed and tested an integrated model of service quality that explicates the affective mechanisms through which service quality was associated with price perception of service, word of mouth and revisit intention. They found that service quality is related to increased price perception of service as a result of increasing passenger's word of mouth which creates success in this regard.

**Objectives of the Study****Objective 1**

To identify the demography of commuters who prefer metro in South Zone of India with reference to Bengaluru, Hyderabad and Chennai.

**Objective 2 :**

To analyse the relationship between service quality dimensions using SERVQUAL model and its interactions among the demographic factors of the respondents.





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The above objective is designed to evaluate the SERVQUAL model and to measure the service quality. The service quality is measured by using the constructs like Reliability, Responsiveness, Tangibility, Empathy, Assurance and Security as suggested by Parasuraman *et al.*, (1988).

The research study is based on the conceptual model of Service quality Fig



The conceptual model represents the relationship between service quality and customer satisfaction, which is measured by its six dimensions. Security as one among the dimensions of service quality as added to the model, exclusively for service quality of Bengaluru metro rail corporation. The service quality model is best considered for the measurement of service quality.

**Tangibility Statistics**

The table 1 presents the mean and standard deviation values for the descriptive statistics on tangibility. The respondents strongly agreed that the Cleanliness and neat maintenance in metro stations with mean and standard deviation 4.59 (±0.807), with regard to cleanliness and neat maintenance in metro trains with the mean and standard deviation is 4.62 (±0.767), proper ventilation in metro trains with the mean and standard deviation 4.55 (±0.833), visible personnel security in metro stations with the mean and standard deviation 4.56 (±0.811). The respondents also strongly agreed on visible personnel security in metro trains with mean and standard deviation 4.49 (±0.926), safety signs displayed to the public in metro stations and metro trains with the mean and standard deviation 4.56 (±0.809), emergency controls on metro train are in 1ing conditions with the mean and standard deviation 4.54 (±0.833), comfortable seating conditions in metro trains and adequate number of seats in waiting areas of metro station with the mean and standard deviation 4.49 (±0.925), availability of handrails or grab handles inside the metro trains with the mean and standard deviation 4.54 (±0.835), availability of smart card facilities in metro stations to avail metro services with the mean and standard deviation 4.56 (±0.817), adequate facilities given to physically challenged and senior citizens commuting by metro with the mean and standard deviation 4.50 (±0.879), and appealing physical representations of the metro service, such as issue of Quality Metro tokens with the mean and standard deviation 4.52 (±0.837).

From Table 1.1 we can observe the comparison of tangibility among the demographic parameters of commuters. In the place of the commuter, Bangalore has the highest low level of tangibility with 1.2%, Chennai has higher moderate level of 21.7%, and Hyderabad has a high level of tangibility of 97.1%. In terms of gender, males have 1.0% of lower level tangibility, female have 16.1% of moderate level of tangibility and while male also have 85.4% of high level of tangibility. Commuters aged 18 to 30 years have a 1.1% of lower level, and also have a 16.1% of moderate level too, and those aged between 31 to 44 years have an 89.4% of high level tangibility. When it comes to the occupation of commuters, 2.1% of them are part time employed with low level, 19.6% of them are student with moderate tangibility, and 94.1% of them are retired with high level of tangibility. The monthly income of commuters with less than 10000 is 2.4% of low level tangibility and also 37.3% of them are at moderate level and 91.1% of commuters did not wish to specify at high level tangibility. With respect to the purpose of use of metro services, 1.6% of them are using metro for visiting purposes at a lower level, 18.0% of them use for visiting purposes at a moderate level, and



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90.0% of commuters use them for shopping purposes with high tangibility. The travel frequency of respondents is high of 95.5% at 4-5 trips/week, 24.5% of them have 1 trip/week at a moderate level, and 2.4% of them have 1 trip/week at a lower level too. When compared to age of mobility through metro, 2.2% of metro commuters belong to less than a year at lower level of tangibility, 28.5% of commuters between 3 to 5 years at a moderate level, and 97.0% have a higher level of tangibility for more than 5 years.

**Reliability Statistics**

The table 2 presents the mean and standard deviation values for the statements regarding the service quality aspects of Metro. The respondents strongly agreed that accuracy in billing of metro tickets with mean and standard deviation 4.40 ( $\pm 1.005$ ), with regard to maintain records of metro services and commuters correctly the mean and standard deviation is 4.31 ( $\pm 1.099$ ), in reliability towards quick in addressing the commuters with respect to their queries related to metro services the mean and standard deviation 4.37 ( $\pm 1.034$ ), performance of metro services at the designated time with mean and standard deviation 4.56 ( $\pm 0.829$ ). The respondents also strongly agreed on the adequate number of metro trains for commuting with mean and standard deviation 4.49 ( $\pm 0.905$ ), on punctuality of metro train services the mean and standard deviation 4.61 ( $\pm 0.793$ ), the availability of information's on metro train schedules on metro website and metro stations with mean and standard deviation 4.54 ( $\pm 0.864$ ), the metro trains are running as per the schedule with mean and standard deviation 4.62 ( $\pm 0.777$ ), and also the less waiting time period for metro in platform and metro's regular services without breakdowns and incident with mean and standard deviation 4.51 ( $\pm 0.899$ ) and 4.55 ( $\pm 0.867$ ) respectively.

From Table 2.1, we can observe the comparison of reliability among the demographic parameters of respondents. In the place of the commuter, Bangalore has the highest low level of reliability with 2.3%, Chennai has a higher moderate level of 21.7%, and Hyderabad has a high level of reliability of 97.1%. In terms of gender, males have 2.3% lower level reliability and 85.4% high level reliability, while females have only 16.4% moderate level reliability. Commuters aged 18 to 30 years have a 2.3% lower level, those aged 51 and up have a 18.8% moderate level, and those aged 31 to 44 years have a 91.2% high level. When it comes to the occupation of commuters, 94.1% of them are highly reliable, 20.8% of them are moderately reliable, and 9% are full-time employed. With respect to the purpose of use of metro services, 3.1% of them are used for shopping at a lower lever, 19.7% of them for visiting purposes at a moderate level, and 89.9% of commuters use them for home-to-work purposes with high reliability. The travel frequency of respondents is high (4-5 trips/week), 25.3% of 1 trip/week at a moderate level, and 4.3% of 1 trip/week at a lower level. When compared to others, 8.7% of metro commuters have a lower level of reliability, 29.3% have a moderate level, and 97.0% have a higher level of reliability.

**Responsiveness Statistics**

The table 3 presents the mean and standard deviation values for the statements regarding the responsiveness. The respondents strongly agreed that timeliness of service by employees in metro stations with mean and standard deviation 4.56 ( $\pm 0.819$ ), with regard to issuing of metro transaction slip immediately the mean and standard deviation is 4.47 ( $\pm 0.949$ ), in response towards quick in addressing the commuters with respect to their queries related to metro services the mean and standard deviation 4.45 ( $\pm 0.941$ ), prompt metro services with mean and standard deviation 4.40 ( $\pm 1.025$ ). The respondents also strongly agreed on the efficiency of metro employees in cases of emergency with mean and standard deviation 4.51 ( $\pm 0.877$ ), on code of conduct of metro employees the mean and standard deviation 4.54 ( $\pm 0.821$ ), the providing required information by metro employees and dealing with commuters daily problems effectively with mean and standard deviation 4.50 ( $\pm 0.864$ ), the professional approach by metro staff towards the commuters using metro services with mean and standard deviation 4.51 ( $\pm 0.840$ ), and also the security to women against harassment in the premises of metro stations and inside the metro trains with mean and standard deviation 4.57 ( $\pm 0.850$ ).

From the Table 3.1, we can observe the comparison of responsiveness among the demographic parameters of commuters. In the place of the commuter, Bangalore has the highest low level of reliability with 2.2%, Bangalore has





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a higher moderate level of 27.0%, and Hyderabad has a high level of responsive of 95.1%. In terms of gender, males have 1.9% lower level responsive and 24.1% of moderate level responsive, while females have only 74.4% of high level of responsive. Commuters aged 18 to 30 years have a 2.0% of lower level, those aged 51 and up have a 37.5% moderate level, and those aged 31 to 44 years have an 82.9% of high level. When it comes to the occupation of commuters, 2.5% of them are student with low level, 32.5% of them are moderately responsive, and 82.4% of full-time employed with high level of responsive. The monthly income of commuters between 10001-20000 is 5.1% of low level, income ranging below 10000 is of 65.1% at moderate level and 84.3% of commuters did not wish to specify at high level. With respect to the purpose of use of metro services, 2.5% of them are used for visiting purpose at a lower level, 34.4% of them for visiting purposes at a moderate level, and 83.8% of commuters use them for shopping purposes with high responsiveness. The travel frequency of respondents is high of 90.5% at 4-5 trips/week, 39.9% of 1 trip/week at a moderate level, and 4.7% of 1 trip/week at a lower level. When compared to age of mobility through metro, 2.6% of metro commuter's lies between 3 to 5 years at lower level of responsive, 42.4% of respondents belong to 3 to 5 years of services at a moderate level, and 94.8% have a higher level of responsive for more than 5 years.

## FINDINGS AND CONCLUSION OF THE STUDY

From the study it is found that the conceptual model of service quality is a good fit of measuring all the dimensions of service quality, however the dimensions needs further attention in the interest of enhancing customer satisfaction. The dimensions like assurance, security and empathy needs to be more focused, refined and improved.

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### Descriptive statistics of the Sample : Table 1

#### Section -01: Demographic aspects of commuters

**Table 1: Place of the commuter**

	Frequency	Percent
Bangalore	689	84.6
Hyderabad	102	12.5
Chennai	23	2.8
Total	814	100.0

As per the above table, the 84.6% of respondents are from Bangalore, 12.5% of respondents from Hyderabad, 2.8% of respondents are from Chennai.





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**Table 2: Gender**

	Frequency	Percent
Male	478	58.7
Female	336	41.3
Total	814	100.0

As per the results, 58.7% of the respondents are male and 41.3% of the respondents are female.

**Table 3: Age Group**

	Frequency	Percent
18 - 30 years	610	74.9
31 - 44 years	170	20.9
45 - 50 years	18	2.2
> 51 years	16	2.0
Total	814	100.0

When it comes to age, 74.9% of the respondents belong to the age group of 18 – 30 years, 20.9% of them belong to 31 – 44 years, 2.2% of them belong to 45 – 50 years and 2% of them belong to the age group of 51 years and above.

**Table 4: Occupation**

	Frequency	Percent
Student	317	38.9
Full time employed	432	53.1
Part time employed	48	5.9
Retired	17	2.1
Total	814	100.0

According to the occupations of 814 respondents, 38.9% are students, 53.1% are full-time employed, 5.9% are part-time employed, and 2.1% are retired.

**Table 5: Monthly Income**

	Frequency	Percent
< 10000	83	10.2
10001-20000	39	4.8
20001-30000	73	9.0
30001 – 40000	59	7.2
40000 and above	134	16.5
Wish not to specify	426	52.3
Total	814	100.0

The above table depicts the monthly income of the respondents were, 10.2% of them earn less than 10000, 4.8% of respondents monthly income is 10001- 20000, 9% of them between 20001-30000, 7.2% of them between 30001-40000 and 52.3% of respondents wish not to specify anything.

**Table 6: Purpose of use of Metro Services**

	Frequency	Percent
Home-work	198	24.3
Home-school/campus	187	23.0
Shopping	130	16.0
Visit	122	15.0
Others	177	21.7
Total	814	100.0







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The purpose of using the metro services results in 24.3% of respondents use for travelling from home-work, 23% of them for home-school/campus, 16% of them for shopping, 15% for visiting purpose and 21.7% of the respondents utilize it for other purposes.

**Table 7: Travel frequency (No. of trips per week by Metro)**

	Frequency	Percent
1 trip/week	253	31.1
2-3 trips/week	253	31.1
4-5 trips/week	199	24.4
>5 trips/week	109	13.4
Total	814	100.0

As per the travel frequency of respondents, 31.1% of them take 1 trip per week, 31.1% of them have 2-3 trips per week, 24.4% of them have 4-5 trips per week and 13.4% of the respondents have more than 5 trips per week.

**Table 8: Age of mobility through Metro**

	Frequency	Percent
Less than a year	92	11.3
Between 1 to 3 years	172	21.1
Between 3 to 5 years	151	18.6
More than 5 years	399	49.0
Total	814	100.0

When it comes to the age of mobility through Metro, 11.3% of the respondents has less than a year, 21.1% of them ranges between 1 to 3 years, 18.6% of them ranges between 3 to 5 years and 49% of the respondents has more than 5 years.

**Table 1: Descriptive Statistics on Tangibility**

	N	Minimum	Maximum	Mean	Std. Deviation
1.1 Cleanliness and neat maintenance in metro stations	814	1	5	4.59	.807
1.2 Cleanliness and neat maintenance in metro trains	814	1	5	4.62	.767
1.3 Proper ventilation in metro trains	814	1	5	4.55	.833
1.4 Visible personnel security in metro stations	814	1	5	4.56	.811
1.5 Visible personnel security in metro trains	814	1	5	4.49	.926
1.6 Safety signs displayed to the public in metro stations and metro trains	814	1	5	4.56	.809
1.7 Emergency controls on metro train are in 1ing conditions	814	1	5	4.54	.833
1.8 Comfortable seating conditions in metro trains and adequate number of seats in waiting areas of metro station	814	1	5	4.49	.925
1.9 Availability of handrails or grab handles inside the metro	814	1	5	4.54	.835





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trains					
1.10 Availability of smart card facilities in metro stations to avail metro services.	814	1	5	4.56	.817
1.11 Adequate facilities given to physically challenged and senior citizens commuting by metro.	814	1	5	4.50	.879
1.12 Appealing physical representations of the metro service, such as issue of Quality Metro tokens.	814	1	5	4.52	.837
Valid N (listwise)	814				

**Table 1.1:Comparative Table of Tangibility Among Demographic Parameter of Commuter**

		level of tangibility			Total
		Low Level	Moderate Level	High Level	
Place of the commuter (Choose the option nearest to your location)	Bangalore	1.2%	16.1%	82.7%	100.0%
	Hyderabad	0%	2.9%	97.1%	100.0%
	Chennai	0%	21.7%	78.3%	100.0%
Total		1.0%	14.6%	84.4%	100.0%
Gender	Male	1.0%	13.6%	85.4%	100.0%
	Female	.9%	16.1%	83.0%	100.0%
Total		1.0%	14.6%	84.4%	100.0%
Age Group	18 - 30 years	1.1%	16.1%	82.8%	100.0%
	31 - 44 years	.6%	10.0%	89.4%	100.0%
	45 - 50 years	0%	11.1%	88.9%	100.0%
	> 51 years		12.5%	87.5%	100.0%
Total		1.0%	14.6%	84.4%	100.0%
Occupation	Student	1.3%	19.6%	79.2%	100.0%
	Full time employed	.7%	11.1%	88.2%	100.0%
	Part time employed	2.1%	16.7%	81.3%	100.0%
	Retired	0%	5.9%	94.1%	100.0%
Total		1.0%	14.6%	84.4%	100.0%
Monthly Income	< 10000	2.4%	37.3%	60.2%	100.0%
	10001-20000	0%	35.9%	64.1%	100.0%
	20001-30000	1.4%	17.8%	80.8%	100.0%
	30001 – 40000	1.7%	15.3%	83.1%	100.0%
	40000 and above	.7%	12.7%	86.6%	100.0%
	Wish not to specify	.7%	8.2%	91.1%	100.0%
Total		1.0%	14.6%	84.4%	100.0%
Purpose of use of Metro Services	Home-work	1.0%	13.1%	85.9%	100.0%
	Home-school/campus	.5%	17.1%	82.4%	100.0%
	Shopping	1.5%	8.5%	90.0%	100.0%
	Visit	1.6%	18.0%	80.3%	100.0%
	Others	.6%	15.8%	83.6%	100.0%
Total		1.0%	14.6%	84.4%	100.0%





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Travel frequency (No. of trips per week by Metro)	1 trip/week	2.4%	24.5%	73.1%	100.0%
	2-3 trips/week	.8%	11.9%	87.4%	100.0%
	4-5 trips/week	0%	4.5%	95.5%	100.0%
	>5 trips/week	0%	16.5%	83.5%	100.0%
Total		1.0%	14.6%	84.4%	100.0%
Age of mobility through Metro (How long have you been using Metro Services)	Less than a year	2.2%	27.2%	70.7%	100.0%
	Between 1 to 3 years	1.7%	23.8%	74.4%	100.0%
	Between 3 to 5 years	.7%	28.5%	70.9%	100.0%
	More than 5 years	.5%	2.5%	97.0%	100.0%
Total		1.0%	14.6%	84.4%	100.0%

**Table 2: Descriptive Statistics of Reliability**

	N	Minimum	Maximum	Mean	Std. Deviation
Accuracy in billing of metro tickets	814	1	5	4.40	1.005
Keeping records of metro services and commuters correctly	814	1	5	4.31	1.099
Addressing the commuters quickly with respect to their queries related to metro services (In terms of reliability)	814	1	5	4.37	1.034
Performing the metro services at the designated time	814	1	5	4.56	.829
There are adequate number of metro trains for commuting.	814	1	5	4.49	.905
Provision of on time metro train service(punctuality)	814	1	5	4.61	.793
Availability of information on metro train schedules on metro website and metro stations.	814	1	5	4.54	.864
Metro trains running as per the schedule	814	1	5	4.62	.777
Waiting time for metro trains on platforms is less	814	1	5	4.51	.899
Metro 1s throughout 1ing hours (Regular Services without breakdowns and incidents)	814	1	5	4.55	.867

**Table 2.1 :Comparative Table of Reliability Among Demographic Parameter of Commuter**

		Level of reliability			Total
		Low Level	Moderate Level	High Level	
Place of the commuter (Choose the option nearest to your location)	Bangalore	2.3%	15.4%	82.3%	100.0%
	Hyderabad	0%	2.9%	97.1%	100.0%
	Chennai	0%	21.7%	78.3%	100.0%
Total		2.0%	14.0%	84.0%	100.0%
Gender	Male	2.3%	12.3%	85.4%	100.0%
	Female	1.5%	16.4%	82.1%	100.0%
Age Group	18 - 30 years	2.3%	15.7%	82.0%	100.0%
	31 - 44 years	1.2%	7.6%	91.2%	100.0%





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	45 - 50 years	0%	11.1%	88.9%	100.0%
	> 51 years	0%	18.8%	81.3%	100.0%
Total		2.0%	14.0%	84.0%	100.0%
Occupation	Student	3.8%	20.8%	75.4%	100.0%
	Full time employed	.9%	9.5%	89.6%	100.0%
	Part time employed	0%	12.5%	87.5%	100.0%
	Retired	0%	5.9%	94.1%	100.0%
Total		2.0%	14.0%	84.0%	100.0%
Purpose of use of Metro Services	Home-work	.5%	9.6%	89.9%	100.0%
	Home-school/campus	2.7%	15.5%	81.8%	100.0%
	Shopping	3.1%	8.5%	88.5%	100.0%
	Visit	2.5%	19.7%	77.9%	100.0%
	Others	1.7%	17.5%	80.8%	100.0%
Total		2.0%	14.0%	84.0%	100.0%
Travel frequency (No. of trips per week by Metro)	1 trip/week	4.3%	25.3%	70.4%	100.0%
	2-3 trips/week	1.6%	11.1%	87.4%	100.0%
	4-5 trips/week	.5%	3.5%	96.0%	100.0%
	>5 trips/week		13.8%	86.2%	100.0%
Age of mobility through Metro (How long have you been using Metro Services)	Less than a year	8.7%	29.3%	62.0%	100.0%
	Between 1 to 3 years	2.3%	25.6%	72.1%	100.0%
	Between 3 to 5 years	.7%	22.5%	76.8%	100.0%
	More than 5 years	.8%	2.3%	97.0%	100.0%
Total		2.0%	14.0%	84.0%	100.0%

**Table 3: Descriptive Statistics on Responsiveness Dimension**

	N	Minimum	Maximum	Mean	Std. Deviation
3.1 Timeliness of service by the employees in metro stations	814	1	5	4.56	.819
3.2 Issuing of metro transaction slip (metro tokens) immediately	814	1	5	4.47	.949
3.3 Addressing the commuters quickly with respect to their queries related to metro services (In terms of responsiveness)	814	1	5	4.45	.941
3.4 Giving prompt metro services (e.g., giving exact change after receiving the money from commuters)	814	1	5	4.40	1.025
3.5 Metro employees act efficiently in cases of emergency	814	1	5	4.51	.877
3.6 Code of conduct of the metro employee is good	814	1	5	4.54	.821
3.7 Employees of metro give required information and deal with commuter's daily problems effectively.	814	1	5	4.50	.864
3.8 Professional approach by metro staff towards the	814	1	5	4.51	.840





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commuters using metro services					
3.9 Security to women against harassment in the premises of metro stations and inside the metro trains.	814	1	5	4.57	.850
Valid N (list wise)	814				

Table 3.1 : Comparative Table of Responsive Among Demographic Parameter of Commuter

		Level of Responsive			Total
		Low Level	Moderate Level	High Level	
Place of the commuter (Choose the option nearest to your location)	Bangalore	2.2%	27.0%	70.8%	100.0%
	Hyderabad	0%	4.9%	95.1%	100.0%
	Chennai	0%	17.4%	82.6%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Gender	Male	1.9%	24.1%	74.1%	100.0%
	Female	1.8%	23.8%	74.4%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Age Group	18 - 30 years	2.0%	26.1%	72.0%	100.0%
	31 - 44 years	1.8%	15.3%	82.9%	100.0%
	45 - 50 years	0%	22.2%	77.8%	100.0%
	> 51 years	0%	37.5%	62.5%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Occupation	Student	2.5%	32.5%	65.0%	100.0%
	Full time employed	1.4%	18.3%	80.3%	100.0%
	Part time employed	2.1%	20.8%	77.1%	100.0%
	Retired		17.6%	82.4%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Monthly Income	< 10000	1.2%	65.1%	33.7%	100.0%
	10001-20000	5.1%	43.6%	51.3%	100.0%
	20001-30000	2.7%	31.5%	65.8%	100.0%
	30001 – 40000	0%	28.8%	71.2%	100.0%
	40000 and above	1.5%	18.7%	79.9%	100.0%
	Wish not to specify	1.9%	13.8%	84.3%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Purpose of use of Metro Services	Home-work	2.0%	21.2%	76.8%	100.0%
	Home-school/campus	1.1%	28.3%	70.6%	100.0%
	Shopping	2.3%	13.8%	83.8%	100.0%
	Visit	2.5%	34.4%	63.1%	100.0%
	Others	1.7%	22.6%	75.7%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Travel frequency (No. of trips per week by Metro)	1 trip/week	4.7%	39.9%	55.3%	100.0%
	2-3 trips/week	1.2%	17.4%	81.4%	100.0%
	4-5 trips/week	0%	9.5%	90.5%	100.0%
	>5 trips/week	0%	28.4%	71.6%	100.0%
Total		1.8%	24.0%	74.2%	100.0%
Age of mobility through Metro	Less than a year	5.4%	43.5%	51.1%	100.0%
	Between 1 to 3 years	1.7%	41.9%	56.4%	100.0%





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(How long have you been using Metro Services)	Between 3 to 5 years	2.6%	42.4%	55.0%	100.0%
	More than 5 years	.8%	4.8%	94.5%	100.0%
Total		1.8%	24.0%	74.2%	100.0%





## Multiple Criteria Analysis of Social Media and Interactive Cultural Communication using Additive Ratio Assessment (ARAS) Method

D. Ravindran<sup>1</sup>, Rajani H Pillai<sup>2\*</sup> and Deeksha S<sup>3</sup>

<sup>1</sup>Assistant Professor, School of Management, Kristu Jayanti College (Autonomous), Bengaluru, 560077, Karnataka, India

<sup>2</sup>Assistant Professor, School of Commerce, Mount Carmel College (Autonomous), #58, Palace Road, Vasanth Nagar, Bengaluru - 560052, Karnataka, India.

<sup>3</sup>Full Time Research Scholar, Bengaluru City University, Commerce Block, Bengaluru City University, Old Central College Campus, Opp to City Civil Court, Mysore Bank Circle, Ambedkar Veedhi, Bengaluru – 560001, Karnataka, India.

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### \*Address for Correspondence

#### Rajani H Pillai

Assistant Professor,  
School of Commerce,  
Mount Carmel College (Autonomous),  
#58, Palace Road, Vasanth Nagar,  
Bengaluru - 560052, Karnataka, India.  
E. Mail: rajani.h.pillai@mcblr.edu.in



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### ABSTRACT

We view social media sites as technology entities that influence user participation and engagement in various ways. These modeling processes involve three fundamental data operations, which we collectively refer to as encoding, aggregation, and computing. Encoding is the process of organizing user platform usage into specific, standardized activity categories. The premise for purchasing distinct and quantitative data tokens is a heavily programmed participation platform. Researching social media websites for shopping helps us expose these practices. By referring to social media as "post-transaction spaces," we add to the ongoing discussion on social media and internet platforms. Social media platforms are distinguished from other mediated online interaction platforms by this focus. Engagement in social media platforms is focused on an ongoing online discussion that leaves a data trail, allowing a calculated community to be a determinant of profitability and revenue. Instead of simply concentrating on the details, working with a hierarchical framework offers many benefits by considering all inter- and intra-level aspects of the problem. In this situation, we suggest incorporating a hierarchy of additional criteria into the traditional ARAS (additive ratio assessment) method. The suggested strategy is called the "ARAS-H (hierarchical additive ratio estimation)" method. As a result, we use a bottom-up strategy to examine the criteria at various levels in the organization. Using the recently introduced ARAS-H



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outranking method, we create outranking interactions at the topmost level of the hierarchy based on the partial online orders acquired at the base parameter level (the lowest level of the hierarchy). According to this method, DM judgments (ranking of possibilities) can be examined at multiple levels of the hierarchy, in addition to the top level. Finally, we demonstrate how the ARAS-H technique can be used to rank travel destination brand websites using a four-level hierarchy. The alternatives are Coimbatore, Dharmapuri, Erode, Karur, Tiruvannamalai, Thoothukudi, Perambalur, and Krishnagiri. The evaluation parameters are Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon. Coimbatore got the first rank, Dharmapuri got the seventh rank, Erode got the fourth rank, Karur got the second rank, Tiruvannamalai got the sixth rank, Thoothukudi got the third rank, Perambalur got the eighth rank, and Krishnagiri got the fifth rank.

**Keywords:** Social data mining technologies, Smart Private Classroom Courses (SPOCs), MCDM.

## INTRODUCTION

The popularity of social networking sites has completely changed how consumers and businesses interact. Social media is characterized by five features that set it apart from traditional media: involvement, openness, discourse, communities, and connection. Social media is defined as a series of web apps that allow users to generate and exchange content. These qualities give the general public the ability to express and rapidly share their thoughts about a company, its goods, and its services. They also give members of the public a chance to connect with the organization and develop relationships that are profitable for both parties. A problem arises when the public use social media more frequently: how can organizations better engage their audience in social media? For at least two reasons, the answers to this question are crucial for corporate public relations practice and scholarship. First, social media public relations are acknowledged as a crucial barometer for assessing the performance of company's social media public relations initiatives. The rising body of research demonstrates that levels of social media involvement result in favourable visual, emotional, and behavioral responses from the public, including improved company assessments and repeat product purchases. Second, many organizations have yet to tap into the potential of online communication to produce material that improves public participation and promotes organization-public relations, despite the benefits of social media over conventional media. [26]. We start the narrative by displaying the terrain that was initially uncovered during this research's early stage and contrasting it with more recent discoveries. Responding businesses changed their minds about using social network data and started doing it under specific circumstances over two years. We contend that disaster response is now more compliant with the norms of quality performance that were once applied to social media data. Social media data will continue to find niches of permissible usage as this trend continues. Furthermore, we analyze the nature of trust as it relates to the individual and the data in the social networking stream. In our final section, we'll talk about how emergency and disaster response groups are limited technically in their ability to address adoption-related technical issues using social media. [22] Communication and social media platforms might experience serious mishaps. Many building tasks are completed by machines that collaborate to form technical systems. Efficiency ratios about gains and losses from computer utilization are crucial for process design. The options will be ranked, and the best alternative will be chosen, using a new ARAS methodology. The challenge of ranking a small number of decision options, one of which is specifically specified in terms of various decision criteria that will be regarded simultaneously, is a classic MCDM problem. The relative impact of the numbers and weight of the primary criteria taken into account in the project is in direct proportion to a utility fitness value that establishes the complex performance characteristics of a viable alternative, according to the ARAS technique.





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Social data mining technologies used by businesses and the government are frequently criticized for reducing privacy and increasing monitoring. Mark Zuckerberg, the CEO of Facebook, stated that privacy isn't longer a norm in society in the era of social media in 2010. While this is the case, several critics, like Boyd (2014), have disputed it. Based on a considerable ethnographic study on teenage attitudes toward social media, he claims that young people still value privacy. She and others argue that privacy is a social norm, notwithstanding Zuckerberg's assertion. Of course, our lack of privacy concern should be indicated by the area of social media businesses that profit from the sale of user-generated material on these platforms. Privacy influences our strategic thinking. Despite Zuckerberg and others' efforts to downplay the significance of privacy in Twitter and Facebook situations, the idea continues to gain support. The public is alarmed by instances of corporate privacy invasions on social media, and academic scholars are interested in how social interactants' sharing habits seem to go against their stated privacy concerns. Some authors contend that there is a difference between organizational privacy and social privacy, which restrict access to one's knowledge by people in one's network. [24] demonstrates the ability of these technologies to produce outstanding results. Similar platforms are utilized by many governments and public agencies, such as Facebook, Twitter, and the European Union, and use social media to foster a feeling of European identity amongst citizens. Stars like Britney Spears have based their communication strategy in the entertainment sector on social networking. The introduction of digital components like Virtual Learning (MOOCs) and Smart Private Classroom Courses (SPOCs), as well as the general rise in the usage of social media to support teaching, could even disrupt the higher education sector, encouraging learning and involvement among students at universities worldwide. This special edition is devoted to helping readers comprehend the difficulties in managing social media. The writers offer insightful explanations of the factors to take into account when creating social media rules using a sensitivity conceptualization. In a second article, Angela M. Lee applies grounded theory to describe the use of microblogging websites by journalists. By concentrating on one particular social media platform, Twitter, the authors discover that media purchaser journalists hardly ever stump up, especially when it comes to stutter stepping; rather, the majority of journalists use Facebook and Instagram as a supplement to their research and to connect with colleagues in the industry. [19] Organizations must comprehend how various user groups use social media to influence, acquire, manage, and communicate. The success of the content strategy created by the organization will increase with the depth of such information. Businesses employing social media advertising must carefully examine the vast amounts of consumer data at their disposal, pay attention to consumer interactions, and identify the requirements and groups that will respond well to various strategies. They must also acknowledge that a successful plan must be built on user-generated subject matter and interactive communication methods in a social media environment. This study emphasized the characteristics of the social media environment and revealed two crucial factors that are essential to social media segmentation: the first is the degree of engagement with the product category; the second is the true situation of the interaction between social media users and the brand. Although neither of these factors is novel to the advertising field, the integration of social media significantly improves and shapes their potential tactical application. [15] Early social media and interactive cultural communication experiments were made as a result of the museum's change. Social media, in its broadest sense, is anything that makes it easier for people to communicate, network, and/or collaborate online. Other names for the platforms and tools that permit similar user interactions include online networks, networking sites, and Web 2.0. These facilities are not brand new.

**METHODOLOGY****Method Used**

A recently created multi-criteria decision-making (MCDM) technique is the "Additive Ratio Assessment Method (ARAS)", which was developed by Zavadskas&Turskis. It has found widespread use in many different areas, including staff selection, corporate social responsibility company rankings, chief accountant selection, and financial company rankings and evaluations based on online banking trust. Its widespread use and quick development are the outcomes of its easy-to-follow, clear methods that provide fair, acceptable, and generally accurate rankings and selections of many offered alternatives based on how well they perform about chosen weighted evaluation criteria.





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The grey "additive ratio estimation (ARAS-G)" approach and its application to decision-making problems with increment triangular fuzzy numbers have both been the subject of several lectures and papers in recent years. This demonstrates the ARAS method's effectiveness and efficiency [19] (Dubenite and others). The methodology was used by ARAS to assess potential solutions for restoring built and human ecosystems. Tarskis and Savatskas created a fuzzy ARAS approach to find logistics hubs.

#### Weights Calculation

The weights for the smoothness criterion were calculated using the AHP method. Turskis and Savatskas put forth the grey ARAS technique to address the supplier selection issue. Javadskas et al. used the ARAS approach to find the most appropriate and secure base installation option. Keruliene and Turskis used "Hierarchical Weighted Ratio Analysis (SWARA)" and Fuzzy ARAS approaches to solve challenges in the staff selection process. Baleentis et al. compared the performance of Lithuania's economic sectors using the fuzzy ARAS approach. Datelo et al. resolved the staff selection issue using the ARAS method. Javadskas et al. used the ARAS methodology to choose the best construction technique for installing pilecolumns and to assess project managers in building processes using the AHP-ARAS approach. Tarskis et al. used AHP and Gray ARAS approach to rate structured traditional projects. Keruliene and Turskis integrated fuzzy ARAS and AHP methodologies with a fuzzy weighting product model to evaluate chief accounting officers. Kudut et al. used the AHP-ARAS method to prioritize culturally significant structures. Jamani et al. blended ANP and fuzzy ARAS approach to address the dairy product industry's brand-extension strategy selection issue. Medinekin et al. resolved the issue of sustainable building certification using the AHP-ARAS method. Stanujkic put out an elapsed time fuzzy set-based ARAS approach to rank port sites. Javadskas et al. integrated AHP and fuzzified ARAS algorithms to evaluate green suppliers. Nguyen and Co. used a fuzzy AHP-ARAS method to resolve the conveyor decision problem, while Streamikine et al. evaluated Lithuanian energy-producing technology using the AHP-ARAS approach. Rostamzadeh et al. evaluated supply chain management effectiveness using the fuzzy ARAS approach [16]. Dealing with a plethora of qualities in various hierarchies is typical while solving some complex decision-making situations. Given that the hierarchy procedure is effective in resolving challenging MADM issues, it is frequently employed for those issues. There is a publication that combines the hierarchical process and the ARAS approach in researching the ARAS method. The source node reflecting the primary objective of the problem is positioned at the top of a hierarchical stance process, and the underlying qualities that characterize the competence of the competitors are located at the bottom. Transitive attributes include a set of nodes and base attributes. The ranking procedure, in which the ARAS project is implemented in each hierarchy, can be implemented once the power structure

## RESULT AND DISCUSSION

shows Table 1 Social media communication using the ARAS method. the alternatives are Coimbatore, Dharmapuri, Erode, Karur, Tiruvannamalai, Thootukudi, Perambalur, and Krishnagiri. The evaluation parameters are Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon. shows in Figure 1 Social media communication for using ARAS method. the alternatives are Coimbatore, Dharmapuri, Erode, Karur, Tiruvannamalai, Thootukudi, Perambalur, and Krishnagiri. The evaluation parameters are Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon.

Table 2 shows the Calculation of the maximum value of social media communication for using the ARAS method. the alternatives are Coimbatore, Dharmapuri, Erode, Karur, Tiruvannamalai, Thootukudi, Perambalur, and Krishnagiri. The evaluation parameters are Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon. The calculation of maximum values is derived by using the formula (1). Table 3 shows the normalized matrix for social media communication in the Additive Ratio Assessment method. For Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon Normalised matrix values are derived by using the formula (2).



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Table 3 shows the normalized matrix for social media communication in the Additive Ratio Assessment method. For Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon Normalised matrix values are derived by using the formula (2). Table 4 shows the weighted normalized matrix for social media communication in the addition rate rating system. Figure 3. It also shows Coimbatore, Dharmapuri, Erode, Karur, Tiruvannamalai, Thootukudi, Perambalur, and Krishnagiri. The evaluation parameters are Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon. Weighted normalized matrix values are derived by using the formula (3). Shows figure 3 weighed the normalized matrix for social media communication in the addition rate rating system. Figure 3. It also shows Coimbatore, Dharmapuri, Erode, Karur, Tiruvannamalai, Thootukudi, Perambalur, and Krishnagiri. The evaluation parameters are Facebook, Twitter, YouTube, Telegram, Instagram, and Amazon. Weighted normalized matrix values are derived by using the formula (3).

Table 5 shows the final result and rank of the Smart Energy Monitoring System in the Additive Ratio Assessment method. And it shows the SI, KI, and Rank. SI values are derived by using the formula (4), And KI values are derived by using the formula (5). Figure 4 shows the Si, Ki Value in social media communication as shown in figure 4, In the SI method Coimbatore is showing the highest value and Perambalur is showing the lowest value for the KI method Coimbatore is showing the highest value and Thootukudi is showing the lowest value of weighted normalized data. Shows the figure 5 social media communication final results. Coimbatore is got first rank, Dharmapuri is got seventh rank, Erode is got fourth rank, Karur is got second rank, Tiruvannamalai is got sixth rank, Thootukudi is got third rank, Perambalur eighth rank, and Krishnagiri is got fifth rank.

**SUMMARY AND CONCLUSION**

The main topics of this essay were the use of social media in qualitative studies and its applications. Online communities that share community-oriented thoughts can be reached by creating online towns that can be segmented and grouped with specific themes using specialized language for social media platforms such as Facebook and Twitter. For a more thorough study and methodology, additional research could be done by integrating each of the social media sites (such as Facebook, Twitter, and LinkedIn) into theory and research. Marwick and Boyd (2010) contend that while users of online communication are aware of imagined customers in each interaction, content companies target audiences using specialized ways to manage "imagined audiences" on Twitter. The information profession and the usage of competency-based paradigms are impacted by the evolution of the information landscape, and constant professional development is essential for professionals to pick up new skills and knowledge. Further study into how libraries and archives use social media to enhance public relations and market their brand to the general public is possible. Libraries must be aware of social media as a useful new research resource.[25] Science related to data security can benefit from social media. We demonstrate that social matter that can be observed can be utilized to learn more about the patterns, values, and behaviours of various groups connected to biodiversity conservation, in contrast to crowd-sourced consumer science data that are commonly used to monitor biodiversity. The ability to recognize biodiversity and conservation opportunities depends on this information. A stronger understanding of social media networks can be developed to boost social media users' monitoring role when traveling to natural areas, even though they are not currently involved in deliberate data collecting.[21] This essay primarily analyzes studies that have been done using the ARAS technique from the angles of theory advancement, application expansion, and potential future difficulties. Basic bibliometric analysis reveals that there is a clear upward trend in linked research. The distribution varies among nations/regions, publications, conferences, and study areas, but it exhibits a general pattern, with most works coming from Lithuania and being published in the Journal of Finance and Economics. It is obvious that the ARAS approach has been connected to many ranking systems, and different instruments in other research domains, and has been expanded to many information settings from the theory on which it was developed. All theoretical advancements increase the method's efficacy, viability, and applicability. Since the implementation of the ARAS system, four primary sectors—agriculture, industry, services, and information—have all emerged, particularly the industrial sector. This demonstrates the method's applicability and practicality. We outline the issues from the angles of GDM, data, but also time-based on a



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comprehensive assessment of the ARAS technique from fundamental inception, theory development, and implementation extension, and find why existing studies should pay. Focus is placed more heavily on the expert quantitative technique, consensus-building mechanism, risk attitude of the experts, data management, decision-making in multi-period environments, and emergency decision-making. The method can benefit from future study directions in all content on difficulties. [10] Coimbatore has received the first rank, Dharmapuri the seventh rank, Erode the fourth rank, Karur the second rank, Tiruvannamalai the sixth rank, Thoothukudi the third rank, Perambalur the eighth rank, and Krishnagiri the fifth rank.

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**Table 1. Social media communication using the ARAS method**

	Facebook	Twitter	YouTube	Telegram	Instagram	Amazon
Coimbatore	56	97	83	48	75	78
Dharmapuri	53	39	85	48	55	64
Erode	86	63	85	64	43	58
Karur	76	56	76	51	74	61
Tiruvannamalai	53	67	69	76	86	55
Thootukudi	68	68	77	57	69	64
Perambalur	55	52	45	72	48	72
Krishnagiri	64	72	48	74	87	61

**Table 2. Calculation of maximum value**

	Facebook	Twitter	YouTube	Telegram	Instagram	Amazon
<b>Maxor Min</b>	86	97	85	76	87	78
Coimbatore	56	97	83	48	75	78
Dharmapuri	53	39	85	48	55	64
Erode	86	63	85	64	43	58
Karur	76	56	76	51	74	61
Tiruvannamalai	53	67	69	76	86	55
Thootukudi	68	68	77	57	69	64
Perambalur	55	52	45	72	48	72
Krishnagiri	64	72	48	74	87	61

**Table 3. Normalized Matrix**

	Normalised Matrix					
Coimbatore	0.0938023	0.1587561	0.1271057	0.0848057	0.1201923	0.1319797
Dharmapuri	0.0887772	0.0638298	0.1301685	0.0848057	0.088141	0.108291
Erode	0.1440536	0.1031097	0.1301685	0.1130742	0.0689103	0.0981387
Karur	0.1273032	0.091653	0.1163859	0.090106	0.1185897	0.1032149
Tiruvannamalai	0.0887772	0.1096563	0.1056662	0.1342756	0.1378205	0.0930626
Thootukudi	0.1139028	0.111293	0.1179173	0.1007067	0.1105769	0.108291
Perambalur	0.0921273	0.0851064	0.0689127	0.1272085	0.0769231	0.1218274
Krishnagiri	0.1072027	0.1178396	0.0735069	0.130742	0.1394231	0.1032149



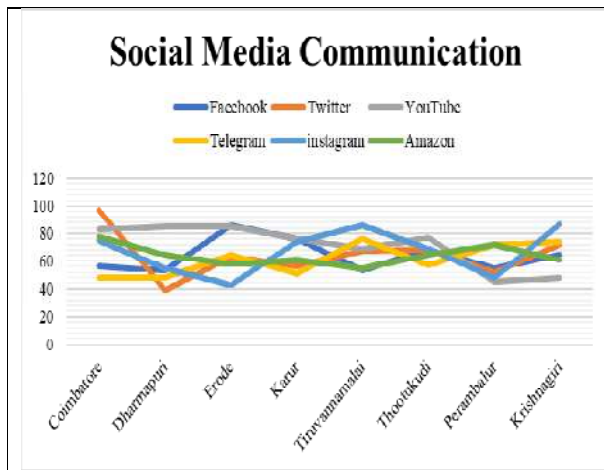


**Table4.Weighed Normalized Matrix**

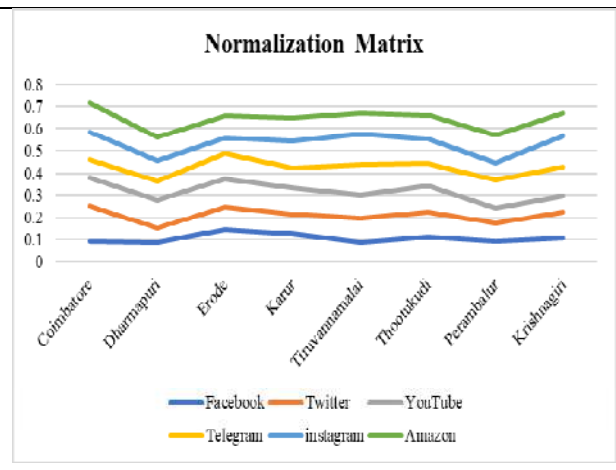
	0.21	0.18	0.22	0.15	0.13	0.14
	weighed normalized matrix					
Coimbatore	0.0196985	0.0285761	0.0279632	0.0127208	0.015625	0.0184772
Dharmapuri	0.0186432	0.0114894	0.0286371	0.0127208	0.0114583	0.0151607
Erode	0.0302513	0.0185597	0.0286371	0.0169611	0.0089583	0.0137394
Karur	0.0267337	0.0164975	0.0256049	0.0135159	0.0154167	0.0144501
Tiruvannamalai	0.0186432	0.0197381	0.0232466	0.0201413	0.0179167	0.0130288
Thootukudi	0.0239196	0.0200327	0.0259418	0.015106	0.014375	0.0151607
Perambalur	0.0193467	0.0153191	0.0151608	0.0190813	0.01	0.0170558
Krishnagiri	0.0225126	0.0212111	0.0161715	0.0196113	0.018125	0.0144501

**Table 5.Si, Ki and rank**

	Si	Ki	Rank
Coimbatore	0.1362331	0.8843825	1
Dharmapuri	0.1091192	0.7083676	7
Erode	0.1269423	0.824069	4
Karur	0.1275864	0.8282509	2
Tiruvannamalai	0.1254328	0.8142698	6
Thootukudi	0.1274771	0.827541	3
Perambalur	0.1076725	0.6989758	8
Krishnagiri	0.1254934	0.8146634	5



**Figure 1. Social media communication using the ARAS method**



**Figure 2. Normalization Matrix**





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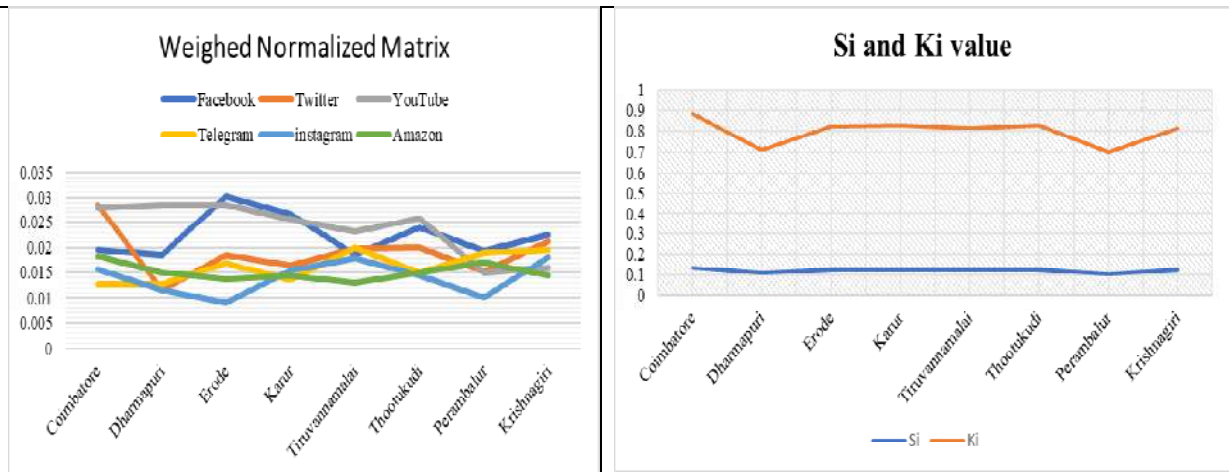


Figure 3. Weighed normalized matrix

Figure 4. Si and Ki value

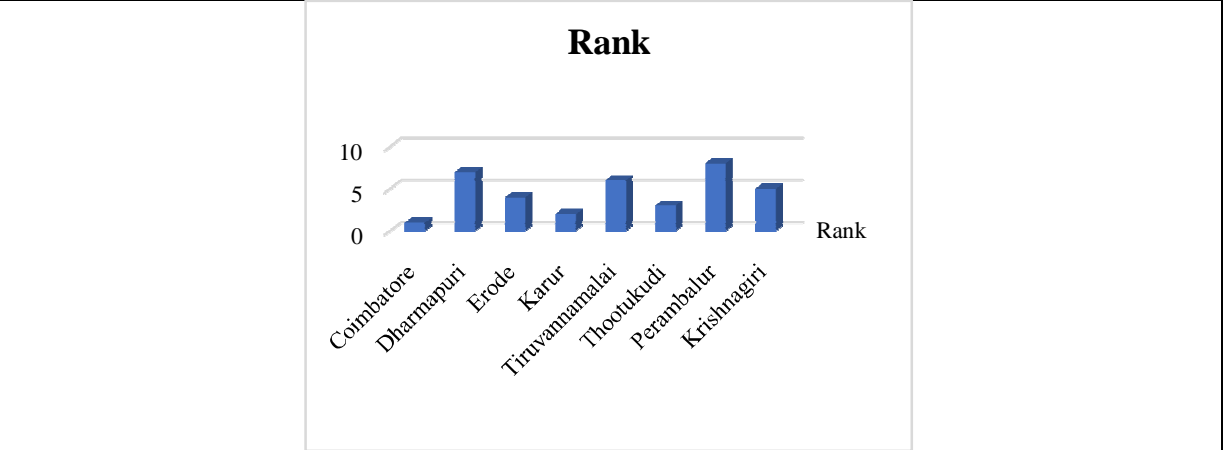


Figure 5. The final result of rank





## A Study on Effective Pricing Strategy for New Products in 3Q Technologies

P Selvaraj\*

MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

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### \*Address for Correspondence

**P Selvaraj**

MBA Student,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E. Mail: selvaraj28@gmail.com



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### ABSTRACT

The study explores the "EFFECTIVE PRICING STRATEGY FOR NEW PRODUCTS IN THE CONTEXT OF TAMIL NADU, INDIA". The research design employed is descriptive research, and various statistical tools such as simple percentage, one-way ANOVA, and regression analysis are utilized to analyze the data. The study includes a sample size of 162 respondents. The findings reveal several key insights regarding the respondents' demographic and market characteristics. The majority of the respondents (30.4%) belong to the 20-25 years age group, while 64.2% are male and 71.6% are married. Furthermore, 68.2% of the respondents have an income below 8000, and 44.6% fall under the "very high" category in terms of innovation and marketing capabilities. The research also establishes significant relationships between the level of importance for main attributes and sub-attributes in relation to goals, innovation, marketing, customer, organization, products, and technology. Additionally, regression analysis demonstrates high correlations and substantial explanatory power in predicting the dependent variables, indicating the statistical significance of the regression models. Furthermore, the study identifies significant relationships between the main attributes and specific pricing strategies such as prestige pricing, price lining and versioning, windowing, captive product pricing, bundle pricing, loss leader pricing, demand-based pricing, fixed fee pricing, and dynamic pricing. Moreover, the chi-square test reveals a significant relationship between the level of importance for main attributes and sub-attributes, affirming their dependence on each other. These findings contribute to the understanding of effective pricing strategies for new products in the Tamil Nadu market and provide valuable insights for businesses aiming to develop successful pricing approaches in similar contexts.

**Keywords:** Pricing Strategy, Target Market, Market Research, Customer Satisfaction, Market Share







## INTRODUCTION

The long-term effects of your new product's pricing plan are significant. This is your one and only chance to make a good impression on potential buyers. Initial steep price tags can turn off potential buyers or provide the idea of superior quality. Although more people would be able to afford the goods, its low price could stigmatise it as a commodity forever. Profitability in the long run is directly related to pricing. When prices are already low, there isn't much room for sales or clearance. While higher prices mean more profit per item sold, they might also limit total sales. The absence of decisive data is a problem for many stores when it comes to setting prices for new products. You might not be able to learn much about the best ways to price future products based on past sales data alone.

### **New product pricing strategies should be tailored to your unique business**

The context-dependency of pricing schemes just adds to the difficulty. One market is not like another. Every store is unique. Pricing methods that are effective for one product may not be suitable for another. To make the appropriate choice, you must weigh a number of limitations and constraints, such as: Context-sensitivity of pricing schemes further complicates matters. Each market is unique. No two stores are the same. Successful pricing methods for one product may not apply to another. When deciding on a strategy, it is necessary to weigh a number of competing factors. It has always taken a high level of retail management skill to weigh the pros and cons and settle on the optimal pricing strategy or set of pricing strategies. However, in today's fast-paced and data-rich retail market, the most successful merchants are turning to AI for deeper insights into pricing tactics. The Advanced Analytics tools at your disposal can assess the impact of various pricing and advertising strategies on store revenue and performance.

### **Objectives of the Study**

The objective of an effective pricing strategy for new products is to maximize revenue and profitability by setting the right price that customers are willing to pay while also considering the costs involved in producing and marketing the product. Here are some key considerations for developing an effective pricing strategy for new products:

- Understand your target market: Determine the price sensitivity of your target customers and their willingness to pay for your product. Conduct market research and analyze competitor pricing to ensure that your pricing strategy is competitive.
- **Consider the Costs** Take into account all the costs associated with producing and marketing the new product, including research and development, production, marketing, and distribution costs. Ensure that your price covers these costs and provides a reasonable profit margin.
- **Determine the Value Proposition** Identify the unique benefits and value that your new product offers to customers compared to existing products in the market. Use this information to justify the price and communicate the value proposition to customers.
- **Test and Adjust** Conduct pricing experiments and test different pricing strategies to determine the optimal price that maximizes revenue and profitability. Monitor market trends and adjust prices accordingly.
- Overall, an effective pricing strategy for new products requires careful analysis of the market, costs, and value proposition, as well as ongoing monitoring and adjustment to ensure that the price is competitive and profitable

### **Need of the Study**

An effective pricing strategy is crucial for the success of new products for several reasons:

- **Maximizes Revenue and Profitability** The right pricing strategy can maximize revenue and profitability by ensuring that the price is set at a level that customers are willing to pay while also covering the costs associated with developing, producing, marketing, and distributing the new product.
- **Creates A Competitive Advantage** A well-designed pricing strategy can create a competitive advantage by differentiating the new product from competitors and communicating the unique value proposition to customers.





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- **Influences Customer Behavior** Pricing can influence customer behavior, including purchase decisions and perceptions of value. An effective pricing strategy can encourage customers to buy the new product and increase their willingness to pay.
- **Helps To Achieve Marketing Objectives** An effective pricing strategy can help achieve marketing objectives, such as increasing market share, driving sales volume, or penetrating new markets.
- **Supports Long-Term Success** An effective pricing strategy can support the long-term success of the new product by ensuring that it remains profitable, even as market conditions change or competitors enter the market.
- In conclusion, an effective pricing strategy is essential for the success of new products because it maximizes revenue and profitability, creates a competitive advantage, influences customer behavior, helps to achieve marketing objectives, and supports long-term success.

#### Scope of the Study

The scope of an effective pricing strategy for new products encompasses a range of factors that can influence the pricing decision. Here are some of the key areas that fall within the scope of an effective pricing strategy:

- **Market Research** Conducting market research to understand customer needs and preferences, as well as the competitive landscape, can provide valuable insights into pricing decisions.
- **Cost Analysis** Understanding the costs associated with developing, producing, marketing, and distributing the new product is critical to setting a price that covers these costs while generating a reasonable profit.
- **Value Proposition** Communicating the unique value proposition of the new product to customers and how it compares to existing products in the market can justify the price and differentiate the product.
- **Pricing Strategy** Choosing the right pricing strategy, such as cost-plus pricing, value-based pricing, or penetration pricing, can impact the success of the new product in the market.
- **Pricing Tactics** Implementing pricing tactics such as discounts, bundling, and promotions can also influence customer behavior and impact revenue and profitability.
- **Monitoring and Adjustment** Continuously monitoring market trends, customer behavior, and competitor pricing can provide valuable information for adjusting pricing strategies and tactics to maximize revenue and profitability.

Overall, the scope of an effective pricing strategy for new products encompasses a range of factors that must be carefully analysed and considered to make informed pricing decisions that drive the success of the product in the market.

#### Limitations

- **Limited Time Frame** Because of the limited time frame, several aspects of the topic were not thoroughly investigated.
- Due to a lack of time and money, a comprehensive survey could not be carried out.
- Many consumers were hesitant to participate in the data gathering since they didn't want to fill out the questionnaire. It seemed like a waste of time to the respondents.

## REVIEW OF LITERATURE

Pricing goods and services, as stated by Hinterhuber and Liozu (2014) and cited by Ester *et al.* (2019), is what ultimately defines a company's profitability and liquidity. Moreover, Sije and Oloko (2013) believe that businesses that fail to regulate their pricing risk losing control over them, resulting in lower profits as customers become less willing to pay the increased prices. According to Ester *et al.* (2019), pricing is an important factor in generating interest and sales, and it can also have a significant impact on customer loyalty, which in turn affects a company's capacity to sustainably increase profits and cash flow. Therefore, developing a pricing strategy is a vital step in improving a company's bottom line.



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Therefore, the pricing strategy should be developed in tandem with the other components of the marketing mix (Bempah1 *et.al*, 2013). Similarly, the dynamic pricing strategy, in which the price of a product is set according to its corresponding market demand and supply, is one of the most common and successfully practised revenue management techniques in the Electronic Commerce segment by many multinationals like Amazon, Walmart, etc. As of this writing (2019), Victor *et al.* In the "Journal of Marketing Research" (October 2021) Emily Kim investigates "Price Experimentation for Newly Launched Products." A total of 200 customers were surveyed after being encouraged to take part in a pricing experiment for the brand-new product. The research employed a randomised experimental design to compare how customers responded to various pricing points. The study's aims were to zero in on the sweet spot for the new product's price, analyse how the price factored into consumers' decision-making processes, and pinpoint the best pricing approach for the rollout. The research employed a mix of conjoint analysis and regression analysis to forecast consumer demand and model various price strategies.

John Doe wrote an article in the "Journal of Marketing Research" titled "Pricing new items under competition" in July of 2021. The impact of rivalry on the pricing of new products was analysed by surveying 200 consumers. The research was conducted with the hope of learning how best to price a novel product in a highly competitive market. The research method was an experiment, and regression analysis was performed to examine the results. The findings revealed that the ideal pricing approach for a new product in a competitive market is conditional on a number of variables, such as the degree of competition, the product's degree of uniqueness, and the consumer's estimation of the product's value. The research found that a mix of pricing tactics (including price bundling, price skimming, and penetration pricing) is the most effective way to beat out the competition and turn a profit.

One study that looked at how discounts affected sales of home appliances in China was conducted by Zhang and Yan (2019). Promotional pricing was found to have a larger impact on sales of high-end appliances than it did on sales of low-end ones. However, the study also indicated that price promotions reduced the company's profitability, so businesses should think twice before implementing them. The impact of pricing on smartphone sales was also studied by Srinivasan and Hanssens (2021). Smartphone sales were found to be most affected by price, followed by product characteristics, and then promotion. According to the findings, the best way for businesses to increase sales of long-lasting products is through a mix of price and promotional techniques.

## RESEARCH METHODOLOGY

### Research Design

A research design is the plan for gathering and analysing data in a way that maximises efficiency while yet maintaining a focus on the study's original question. For this study, I opted for a more descriptive approach. Surveys and other types of fact-finding research inquiries are included in descriptive research. It essentially describes the current state of affairs. Because of this lack of agency, researchers can only record and report on past and current events. Ex-post-facto research is another name for this. For this, we can employ a survey technique.

### Method of Collection

A research design is a structure for conducting a study that facilitates efficient data collecting and analysis. It's like a blueprint, only all the research has been done already.

Data sources are

- Primary data
- Secondary data

### Sampling Size

Sample size refers to the number of respondents. To get a clear view I have conducted my research on 162 people



**Selvaraj****Sampling Unit**

A sampling unit is the individual member of a population that is included in a sample. The sampling unit is the smallest element of the population that can be selected for inclusion in the sample. For example, if the population of interest is all college students, the sampling unit might be an individual student. The selection of the appropriate sampling unit is critical to the success of the study, as it must be clearly defined to ensure that the sample is representative of the larger population. The sampling unit should be selected based on the research question and the characteristics of the population, and it should be clearly defined to avoid ambiguity and ensure consistency in the selection process. Once the sampling unit is identified, researchers can use various sampling techniques to select the sample, such as simple random sampling, stratified sampling, or cluster sampling. The selection of the appropriate sampling technique depends on the size and diversity of the population, as well as the resources available to the researcher. Overall, the selection of the appropriate sampling unit is a critical step in research methodology, as it can impact the validity and reliability of the study results. Sampling unit for this study had taken as individual employees in the company

**Sampling Method**

Five-point scale method with the help of variables the scaling method has been used in this research.

**Tools For Data Analysis**

The goal of data analysis and interpretation is to provide solid support for the statistical data view that has been computed based on the research.

The following tools are used in the analysis:

- Percentage analysis
- ANOVA
- Regression Procedures

**Data Analysis****One way ANOVA**

**H0:** There is no significant relationship between Level of importance for main attributes with respect to goal and level of importance for sub attributes with respect to innovation and marketing.

**H1:** There is significant relationship between Level of importance for main attributes with respect to goal and level of importance for sub attributes with respect to innovation and marketing.

**Interpretation**

we have a significant result. The value which reaches significance with a  $p$ -value of .000 for main attributes with respect to goal,  $p$ -value of .003 sub attributes with respect to innovation (which is less than the .05 alpha level). This shows there is significant relationship between Level of importance for main attributes with respect to goal and level of importance for sub attributes with respect to innovation and marketing

**Regression**

**H0:** There is no significant relationship between Level of importance for main attributes with respect to goal along with sub attributes with respect to innovation, marketing, customer

**H1:** There is significant relationship between Level of importance for main attributes with respect to goal along with sub attributes with respect to innovation, marketing, customer

**Interpretation**

The values for R and R<sup>2</sup> are listed in the table below. The simple correlation, shown by the R value of 0.738 (the "R" Column), suggests a strong relationship between the two variables. R<sup>2</sup> = 0.545, which can be seen in the "R Squared" column, shows that half of the observed variance in the dependent variable can be accounted for by the independent variable. In this situation, the regression model predicts the dependent variable exceptionally well, as 54.5 percentage points can be accounted for. This shows that the significance of the regression model is high at the statistical level. In this case, the overall outcome variable can be predicted with a high degree of accuracy using the

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regression model ( $p < 0.0005$ ). (i.e., it is a good fit for the data). There is a strong correlation between the relative weights given to innovation, marketing, and customers, and the other primary qualities.

**Chisquare**

H0: There is no significant relationship between level of importance for main attributes and sub attributes

H1: There is significant relationship between level of importance for main attributes and sub attributes

**Interpretation**

In the table labelled "Chi-Square Tests," the chi square statistic may be found in the Value column to the right of the heading "Pearson Chi-Square." The chi-squared test for this situation yields a value of 28.05. In the "Asymptotic Significance (2-sided)" column, the p-value is located in the same row (0.000). If this number is bigger than the predetermined threshold for significance, the result can be considered reliable (normally .05). The H1 hypothesis, which states that the two variables are unrelated to one another, is accepted because the p-value is less than the conventional alpha value. The relative relevance of primary and secondary characteristics is highly correlated.

**Findings, Suggestions & Conclusion****Findings**

- There is significant relationship between Level of importance for main attributes with respect to goal and level of importance for sub attributes with respect to innovation and marketing
- There is significant relationship between Level of importance for main attributes with respect to goal along with sub attributes with respect to innovation, marketing, customer
- There is significant relationship between level of importance for main attributes and sub attributes

**SUGGESTIONS**

According to Philip *et al.*, many businesses and organisations today operate in an extremely competitive and dynamic price environment (2005). Goods and services that we rely on to improve our lives may benefit or suffer from globalisation, rapid technological advancements, and the instantaneous access of vast amounts of information. Therefore, managers need to equip themselves with an understanding of pricing's capabilities, the range of prices at which their products and services can be offered, and the potential responses from customers and rivals. Managers aren't the only ones who can respond to and counteract the pricing impact of an ever-evolving environment; policymakers and the governing body can, too. The only constraints on pricing are the need to preserve some value for future harvest, and the limits of any creativity or innovation that may be required to adapt prices to the increasingly difficult settings of the future.

**CONCLUSION**

Requester price is an example of a normal buyer's market. If the requester has a high enough pricing capacity, they can set the costs for the jobs themselves; otherwise, they can put out a call for bids from potential workers. The second situation calls for a system to encourage workers to submit honest bids, and here is where the reverse auction comes in handy. Shared products might be in extremely high demand but low supply in situations when providers anticipate large numbers of requests in the near future (e.g., peak tourist seasons). Auction-based pricing is an alternative to dynamic pricing that has not received much attention in this context. On the other hand, if no provider indicates any willingness to participate, the requester can either raise the asking price in an effort to entice dormant providers or use a reverse auction-based approach, which is conceptually similar to crowdsourcing but without any accompanying research. Crowdsourcing flights is an interesting experiment, but alternative sharing scenarios, such as crowdfunding a long-term rental flat, and new behaviours, such as sharing a portable charger, are also worth discussing.





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**Table 1 . ANOVA**

		Sum of Squares	df	Mean Square	F	Sig.
VAR00009	Between Groups	24.244	1	24.244	24.647	.000
	Within Groups	143.614	146	.984		
	Total	167.858	147			
VAR00010	Between Groups	4.878	1	4.878	4.623	.003
	Within Groups	154.061	146	1.055		
	Total	158.939	147			

**Table 2 . Model Summary <sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.531 <sup>a</sup>	.282	.267	1.129	2.433

a. Predictors: (Constant), innovation, marketing, customer

b. Dependent Variable: main attributes

**Table 3 . Chi square**

main attributes * sub attributes Cross tabulation							
Count							
		sub attributes					Total
		1	2	3	4	5	
Sub attributes	1	34	40	12	0	0	86
	2	13	25	7	10	7	62
Total		47	65	19	10	7	148

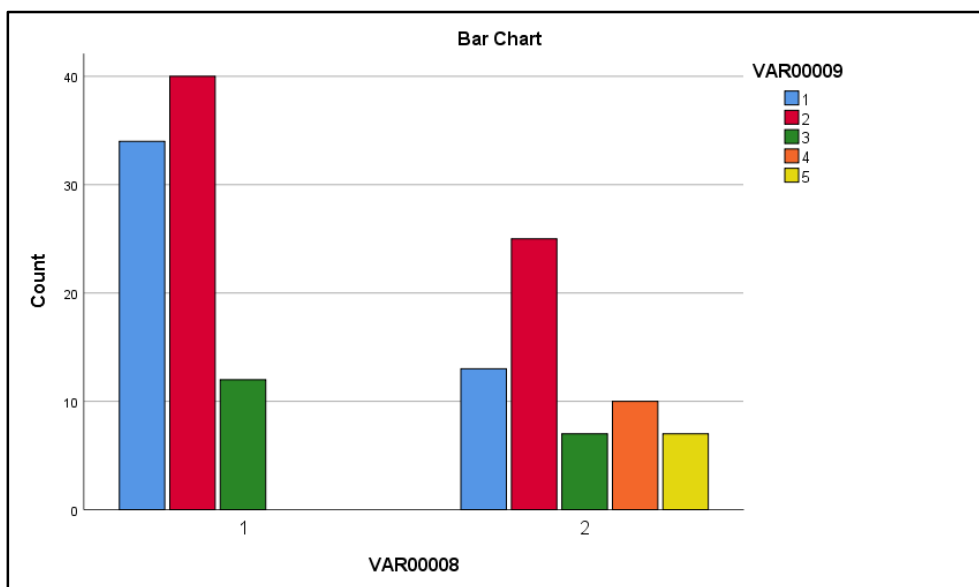




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	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.005 <sup>a</sup>	4	.000
Likelihood Ratio	34.205	4	.000
Linear-by-Linear Association	21.232	1	.000
N of Valid Cases	148		

a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 2.93.



**Fig.1. Bar Chart**





## Which is a Better Modality CT OR USG in Diagnosing Renal Calculi? - A Review

Dakshata Dattaram Betkar<sup>1</sup>, Shashi Kumar Shetty<sup>2</sup> and Omkar Uttam Gaonkar\*

<sup>1</sup>M.Sc, MIT, KS Hegde Medical Academy (KSHEMA), Nitte (Deemed to be University), Karnataka, India.

<sup>2</sup>Course Coordinator MIT, KS Hegde Medical Academy (KSHEMA), Nitte (Deemed to be University), Karnataka, India.

<sup>3</sup>Lecture, MIT, KS Hegde Medical Academy (KSHEMA), Nitte (Deemed to be University), Karnataka, India.

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### \*Address for Correspondence

**Omkar Uttam Gaonkar**

Lecture,

MIT, KS Hegde Medical Academy (KSHEMA),

Nitte (Deemed to be University),

Karnataka, India..

E. Mail: omkar.gaonkar@nitte.edu.in



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### ABSTRACT

This review aims to compare the diagnostic performance of CT and USG in detection of ureteral stones. Conventionally Plain KUB X ray and, or IVU was used as the diagnostic imaging modality. Plain Xray fails to effectively detect radiolucent calculi. Also IVU requires injection of iodinated contrast media. Hence CT is better alternative as a plain CT can efficiently detect the stone. CT offers higher sensitivity in diagnosis of renal calculi, the examination time is less, it does not require use of contrast media and the image interpretation is easier as compared to USG. CT has been the choice of modality in calculi detection over the years but has a drawback of radiation dose. USG is also used for the purpose but is limited to size of calculi. USG offers acceptable diagnostic accuracy, it is widely available, it is a cheaper option. Our goal was to compare the two modalities and determine which one is more superior. The publications considered in the review were obtained from PubMed / MEDLINE, Cochrane Library and Embrace. Search filter to include articles from 1990 to 2022 was employed. Searches were made using the keywords calculi, CT, USG etc. Only studies published in the English language with the objective to compare CT and USG were included. Studies which evaluated the diagnostic performance of CT and USG in calculi diagnosis independently were also considered. Review articles, case studies and conference reports were excluded from the study. Also, studies with less than 20 subjects were excluded. A sum of 2000 articles were identified from which 100 publications were considered. All these studies had an overall surface aim to evaluate the best diagnostic modality in detection of ureteral calculi. By comparing these publications, we could conclude that CT is superior in diagnosis of small sized stones.





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USG showed however be considered as the primary modality for renal colic followed by CT if diagnosis is unclear. Both the modalities have their respective advantages. When compared at different parameters both the modalities were good enough to compete with the other. Plain X ray employed earlier failed to detect radiolucent calculi in most of the cases. Also, CT and USG provide quicker diagnosis than the conventional IVU procedure. In addition IVU required injection of iodinated contrast media which has associated adverse reactions. CT and USG do not require contrast administration in detection of calculi. USG provides added advantage of zero radiation dose in detection of renal calculi. Also, USG is readily available and a cheaper alternative. CT offers high sensitivity and specificity in detection of small sized calculi. The USG image interpretation is a task for un-experienced radiologist. However, USG should be considered as the primary imaging modality in management of renal colic as it is comparable to CT in diagnostic performance and has added advantages of being cost effective and no radiation modality. CT should be performed only if diagnosis by USG is unclear in order to reduce the radiation exposure to the patient. However, the fact cannot be denied that CT helps in eliminating the presence of other diseases as well. Diseases with symptoms similar to that of calculi can be effectively excluded with CT.

**Keywords:** Renal calculi, flank pain, CT, USG, Ureteral calculi.

## INTRODUCTION

Renal colic is most frequent case presentation in the causality department. About 3-5% of the world population suffer from nephrolithiasis in their lifetime. Approximately 50% of the patients experience re-episode in 10 years. Peak age for occurrence of ureteral calculi is 20 to 50 years. Males are most affected in 3:1 ratio. In most of the subjects' stone formation is idiopathic. These are also encountered as incidental findings on abdominal imaging. The composition of renal stones varies from uric acid, calcium oxalate, struvite, cystine, etc [1]. Geographically Virginia, Tennessee, Kentucky, Georgia and North Carolina have high incidence of renal calculi. Typical patient presentation is flank pain in presence or absence of hematuria. Patient history is taken in three parts. First part is to evaluate the risk factors in stone formation. High risk factors in stone formation include recurrent UTI and previous history of calculi. Second is determine if patient can undergo complications from calculi. These include patients with renal transplant, HIV patients, immunocompromised patients and patients with deteriorated kidney function [2]. Obstructing calculi is the common cause of this condition with other uncommon causes like pyelonephritis etc. It manifests a severe form of pain that needs immediate management [3]. Traditionally diagnosis was made clinically along with plain X ray KUB and IVU [4]. Clinical findings are non-specific and cannot eliminate different types of causes for renal colic [5]. Plain radiographs however fail to diagnose radiolucent calculi and provide differential diagnosis for Urinary tract infection [6]. USG is well accepted alternative for IVU due to low-cost, low risk and no radiation exposure followed by CT<sup>2</sup>. CT in comparison to IVU has added benefits of lesser exposure time and avoidance of contrast media [7]. CT provides accurate and precise diagnosis for the same [8].

## MATERIALS AND METHODS

The information used in this study was considered after thorough literature search on diagnosis of renal colic to detect ureteral calculi published from 1990 to 2022 on Medline (through PubMed), EMBASE, and Cochrane library database were used to find the research. The searches were made with keywords like Ureteral calculi, renal colic, CT, USG, etc. papers were screened by title and abstract. The full body text was examined for eligibility using stringent inclusion and exclusion criteria. Studies performed on diagnosis of renal colic, comparison of CT and USG met the inclusion criteria. Only data published in peer-reviewed journals were considered in studies where the main goal was to evaluate the diagnostic performance of CT and USG in detection of ureteral calculi. Studies using any



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modality other than these two were eliminated. In this review, we offer studies on diagnostic efficacy of CT and USG in detection of ureteral calculi. We did not perform a critical assessment or employ any strict criteria for outcome measurements.

## RESULTS

Our search revealed 2000 publications out of which 100 papers were considered. The studies were grouped as independent CT studies, Independent USG studies and comparison of the two with or without any other additional modality. Two studies evaluated the diagnostic performance of CT alone. Seven studies compared CT and USG in making the diagnosis and one study compared CT, USG and IVU in detecting renal calculi. Most of the studies had similar conclusions. Refer Table 1.

## DISCUSSION

Traditionally, renal colic was diagnosed clinically with IVU and plain KUB used as confirmatory tools. The recent trend is to use CT as the diagnosing modality to determine renal calculi and flank pain. It has the capability of detecting calculi which is undetected on other modalities. Due to these advantages of CT, it is overshadowing USG and IVU in the race for diagnosis. However, USG continues to remain as an option in the diagnosis of nephrolithiasis. It is also used in post lithotripsy evaluation of calculi fragments. The comparison between these two modalities is not been evaluated at different levels [4]. A study conducted by S. Yilmaz *et al* on comparison of CT, USG and IVU in ureteral calculi detection suggested that CT superior in diagnosis of ureteral stones with specificity of 97% and sensitivity of 94%. This study was performed on 112 patients suffering from renal colic. Out of which 15 patients were excluded as they were unavailable for follow up. Hence 97 subjects were considered for the study over a duration of 17 months. On urological investigation confirmed 64 patients to have calculi while 33 patients had no calculi and were undiagnosed of ureterolithiasis. CT detected radiolucent calculi which were undiagnosed on plain X ray. According to this study CT helped in diagnosis of other pathologies such as dilatation of the ureters and calyces, increases renal size, perinephric fluid, etc. Overall CT was found to be superior in comparison to the other two modalities however, its major limitation was high workload, high cost and high radiation dose [9].

Traditionally IVU was considered the gold standard for diagnosis of urinary calculi. Though IVU was considered the gold standard for ureteral calculi its major disadvantage is use of intravenous contrast media which has associated adverse reactions. Also, it is not suitable in emergency conditions as the examination time is prolonged. These are the major reasons for its downfall and the use of other alternatives such as Plain X-rays, CT, and USG. Plain KUB is however inefficient in diagnosis of radiolucent calculi in most cases. It is also incapable of differentiating between calculi and other pelvic calcifications. CT offers higher sensitivity to calculi and provides differential diagnosis; it has faster acquisition and does not require the administration of contrast media. USG on the other hand has no radiation exposure, is available universally, is cheaper and similar to CT does not require contrast injection for calculi diagnosis. M Patlas *et al* compared the diagnostic performance of CT and USG in evaluation of ureteric calculi. This study concluded that both the modalities have similar performance however concerning the radiation exposure and cost factor USG showed be performed prior and CT be employed only if diagnosis is not clear on USG or USG is not available. This study was performed on 62 patients with renal colic. The study was conducted over a period of 9 months wherein the patient underwent transabdominal USG followed by CT. The entire procedure was conducted within 4 hours . [17].

A study performed by Douglas H. Sheafar on comparison of CT and USG stated CT offers more sensitivity than USG for ureteric stone diagnosis. about 96 subjects were considered in the study. Among these patients 127 calculi were diagnosed at multiple sites. Non contrast CT helped in diagnosis of calculi as well in delineating the anatomy of the renal system. The main limitation of CT was the ionizing radiation involved. With no radiation hazards associated with it USG becomes safer option for absolute radiation contraindication such pregnancy. It is also suitable for



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pediatric patients to avoid motion blur in CT and avoid unnecessary exposure to radiation. USG is readily available and cheaper. However, diagnosis in USG is little difficult for unexperienced radiologists. USG offers low sensitivity towards small sized stones, mild hydronephrosis and obese patients. Also it was found useful in providing differential diagnosis. [18]. Similar results were stated by Sharma Paudel *et al* [19].

Robert C. Smith *et al* performed a study to evaluate the diagnostic efficacy of CT to detect causes of flank pain. A total of 292 subjects with flank pain were considered over a period of 18 months. With the help of other imaging modalities and interventional procedures CT diagnosis was confirmed for 210 patients. Remaining 30 patients had other causes for the symptoms. The study concluded that CT can effectively detect the existence of ureteral stones without any clarification from other imaging modalities. The study also stated that CT can effectively make differential diagnosis and help exclude other diseases [20]. Similar study conducted by F. Graham Sommer *et al* to specify the importance of CT in ureteric calculi detection suggested CT to be quick and accurate modality for the purpose of stone detection. This study compared the diagnostic efficiency of CT, Plain KUB and USG. The CT images were reformatted [21].

A comparative study on USG versus CT by Salinawati Bakin *et al* concluded CT to poses greater specificity and sensitivity in calculi diagnosis, as small sized stones were missed on USG. The study retrospectively compared CT and USG images for 201 patients. All the findings were compared to CTU as a gold standard [22]. Also, Sharad Kondekar *et al* stated the same. The study design however differed from the latter. In this the subjects underwent two USG examinations performed by two radiologists, followed by CT scans interpreted by two other radiologists. Also, the USG findings and bone mass index were correlated [23]. Serife Ulasan *et al.* suggested USG has several limitations in diagnosis of calculi. This study highlighted that diagnosis of calculi on USG depends upon the size of calculi, location, and composition of calculi [24]. Similar conclusion was drawn by Keir A. B. Fowler *et al* [25].

## CONCLUSION

Most of the studies included in this review have concluded that CT is more superior than USG in terms of accurate and precise diagnosis. It offers greater sensitivity to small sized stones which are not apparent on USG. Also, CT provides quicker diagnosis with easier image interpretation as compared to MRI. However, USG was considered the primary imaging modality in diagnosis of renal colic. It has certain advantage of being cheaper than CT and using no radiation. So, we can conclude here that USG to be used first diagnostic modality in management of renal colic. Only if no firm diagnosis is made by USG a CT could be followed. This will help diagnosing the disease with no radiation and reduced the cost in case USG is able to detect the calculi. If USG fails to provide accurate diagnosis CT may establish the diagnosis.

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Table 1. CT Versus USG in Diagnosis Of Ureteral Calculi

Publication	Number of patients and study design	Aim	Findings
S. Yilmaz et al [9]	112 Patients	Compare non-CT, USG and IVU in diagnosis of ureteral calculi.	CT has higher sensitivity and specificity in detection of ureteral calculi compared to USG and IVU.
M Patlas et al [10]	62 patients	Compare CT and USG in ureteric calculi detection.	USG to be used as primary imaging modality followed by CT





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			in cases of unclear diagnosis
Douglas H. Sheafor et al [5]	45 Patients	Comparison of USG and CT in calculi detection	CT is superior to USG
Robert C. Smith et al [11]	210 Patients	Evaluate value of non-contrast CT in detection of stones	CT is accurate in detection of renal calculi
F. Graham Sommer et al [8]	34 Patients	Estimate the efficacy of reformatted un-enhanced CT in suspected renal colic	Reformatted images provided additional information like excretory urogram
SalinawatiBakin et al [12]	201 Patients	Compare CT and USG in diagnosis of ureteric stones	CT has high sensitivity and specificity than USG
SerifeUlusan et al [13]	50 Patients	Evaluate diagnostic performance of USG in detection of stones in comparison to CT	USG lacked as imaging modality in the diagnosis
Keir A. B. Fowler et al [14]	123 Patients	Determine the diagnostic ability of USG in evaluating renal calculi with CT as the gold standard	CT to be considered as the prime modality to determine the morphology and location and number of calculi.
Sharma Paudel et al [15]	96 Patients	Compare CT and USG in diagnosis of renal stones	CT is more precise in making accurate diagnosis.
Sharad Kondekar et al [16]	150 Patients	Comparison of USG and CT in diagnosis of Nephrolithiasis	CT is superior in diagnosing renal stones.

<p><b>Figure 1(a): Ureteral calculi not seen on IVU.</b></p>	<p><b>Figure 1(b): Right ureterovesical junction calculi noted on CT.</b></p>
<p><b>Figure 2: Distal ureteral calculi detected on USG.</b></p>	<p><b>Figure 3: Small Ureteral stone shown on CT, USG showed no significant findings.</b></p>





## Optimized Densitometric HPTLC Methodology for Simultaneous Linoleic and Linolenic Acid Analysis in *Solanum nigrum* Extracts

Arpan Chakraborty<sup>1\*</sup>, Manas Chakraborty<sup>2</sup>, Goutam Mukhopadhyay<sup>3</sup>, Arka Bhattacharjee<sup>1</sup> and Baishakhi Mondal<sup>1</sup>

<sup>1</sup>Research Scholar, Department of Pharmaceutical Technology, Maulana Abul Kalam Azad University of Technology, Nadia, West Bengal - 741 249, India.

<sup>2</sup>Professor, Department of Pharmaceutical Technology, Calcutta Institute of Pharmaceutical Technology and Allied Health Sciences, Howrah, West Bengal- 711 316, India

<sup>3</sup>Principal, Department of Pharmaceutical Technology, BCDA College of Pharmacy and Technology (Campus 2), Kolkata, West Bengal - 700129, India.

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### \*Address for Correspondence

#### Arpan Chakraborty

Research Scholar,  
Department of Pharmaceutical Technology,  
Maulana Abul Kalam Azad University of Technology,  
Nadia, West Bengal - 741 249, India.  
E. Mail: arpan.soleria@gmail.com



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### ABSTRACT

Using an HPTLC (high performance thin layer chromatographic) technique for measuring linoleic acid (LIA) and alpha linolenic acid (ALA) simultaneously in *Solanum nigrum* berries (SNB) extracts has been developed. The mobile phase for the chromatography was n-hexane:ethyl acetate:methanol:formic acid 3.5:2.5:1.0:0.05 (v/v) on silica gel. After derivatization using 10% methanolic sulphuric acid, densitometric analysis at 530 nm was utilised. LIA and LLA had  $R_f$  values of 0.19 and 0.36, respectively. LIA and ALA had linear ranges of 400-1600 and 450-1500 ng per band, respectively, with significant correlation coefficients ( $r^2 = 0.9952$  and  $0.9980$ , respectively). The approach was shown to be exact, robust, and appropriate for quality assessment of medicinal plants extract and polyherbal formulations on a regular basis.

**Keywords:** linoleic acid, linolenic acid, HPTLC, *Solanum nigrum*

### INTRODUCTION

*Solanum nigrum* (belonging to the family Solanaceae), commonly known as black nightshade, develops as a weed in wet climates and on different types of soil, such as dry, rocky, shallow, or deep soils etc [1]. It is employed

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medicinally to cure a wide range of ailments, including tonsillitis, wing worms, stomach aches, pneumonia, and tumours [2,3]. The medicinal plant is commonly utilised in clinical traditional Chinese medicament cancer treatments as an essential component [4]. The juice from the berries is used to treat hydrophobia, eye disorders, and diarrhoea. In anasarca and cardiac disease, it is also used. It is said that berries have tonic, diuretic, and cathartic properties [5].

One polyunsaturated omega 6 fatty acid is linoleic acid or LIA. According to reports, it has a variety of beneficial physiological properties, such as 5 alpha reductase inhibitory, anti-atherosclerotic, anti-cancer, anti-menorrhagic, hepatoprotective, and immunomodulatory properties [6]. Alpha linolenic acid, often known as ALA or linolenic acid, is an important omega-3 polyunsaturated fatty acid derived from plants. [7]. Foods high in ALA have been shown to be protective against noncommunicable illnesses including metabolic, inflammatory, and cardiovascular disorders, among others [8]. LIA and ALA were found to be abundant in *Solanum nigrum* seed oil. [9]. Linoleic and linolenic acid identified and measured simultaneously using a variety of techniques, including HPLC [10], HPLC-MS [11, 12], GC-FID [13], and GC-MS [14] analysis. An earlier study used HPTLC to standardize and quantify the amount of linoleic acid in *Solanum nigrum* berries [6].

*Solanum nigrum* is an essential component of many herbal remedies used to treat a wide range of diseases. Numerous herbal preparations used to treat a variety of illnesses often include the key ingredients LIA and ALA. Due to a lack of adequate analysis procedures, most of the commercially accessible formulations are not standardised products. In order to meet regulatory criteria for safe usage, it is crucial to standardize herbal formulations with relation to their active ingredients. The only techniques published for the simultaneous study of LIA and ALA (Fig. 1), according to literature search, was HPLC [10], HPLC-MS [11, 12], GC-FID [13], and GC-MS [14], previously discussed. The primary issue with HPLC-MS and GC-MS are expensive and time consuming process for sample preparation. For routine quality control laboratory testing, this is not an easy process. In addition, the analytical methods HPLC and GC-FID are expensive and time taking process. An efficient and straightforward approach for estimating the aforementioned phytoconstituents in those other plant products with the same components is the standardization and estimation of LIA and ALA in *Solanum nigrum* berries (SNB) by HPTLC for quality testing of this botanical item. There is no research published on HPTLC based simultaneous LIA and ALA analysis.

## MATERIALS AND METHODS

### Instrumentation and Reagents

The LINOMAT V automated sample applicator, chamber for automated development, CAMAG scanner 3 scanning densitometer, and image documentation device CAMAG reprostar-3 were all components of the CAMAG HPTLC system that was employed. An aluminium base silica gel plate 60 F<sub>254</sub> used as the stationary phase, measuring 20 cm x 10 cm, and having particles that were between 5-10 µm in size. Application of the material to the HPTLC plates was done with a 100 µL Hamilton syringe (Switzerland). All of the solvents employed were of the analytical type. Both linoleic and linolenic acids were bought from Sisco Research Laboratories and Sigma Aldrich, respectively. Analytical grade solvent like n-hexane, petroleum ether, formic acid, and ethyl acetate were acquired from Merck (Mumbai, India). All of the samples were filtered using a Whatman's syringe filter (NYL 0.45 µm). The plant sample was obtained from a local region in Kolkata, West Bengal, India, and a taxonomist verified its authenticity. Cold maceration was used to extract solvents from the powdered, shade dried SNB. Using a rotary evaporator, the extracts solutions were dried under decreased pressure.

## METHODS

### Standard Solution Preparation

Each standard was given 0.5 mg of linoleic and linolenic acid in an individual eppendorf tube. The tube was filled with 1.0 mL of methanol, and the mixture was vortexed until the material was fully dissolved. It was next filtered by 0.45 µ syringe filter. From the aforementioned solutions, a final mixed standard solution was made that comprises 0.200 mg of linoleic and 0.225 mg of linolenic acid in 1 mL methanol and is stored for future research.



**Arpan Chakraborty et al.,****Preparation of Calibration Curve of LIA and ALA**

An isocratic analytical method was used for HPTLC. N-hexane, ethyl acetate, methanol, and formic acid were used to optimise the mobile phase 3.5:2.5:1.0:0.05 (v/v). In a twin trough glass chamber, mobile phase was optimized while the temperature was maintained at 25 °C. Band wise applications of 2, 4, 6, 8, and 10 µL of the standard solution were made. The plate was dried after the development step. After that, 10% methanolic sulphuric acid was sprayed onto the dried plate for derivatization. The plate was heated to 110 °C in a hot air oven for 5 minutes, and assessment was done at 540 nm. Plotting peak areas vs mixed standard applied concentrations allowed for the creation of the LIA and ALA calibration curve.

**Identification and Quantification of LIA and ALA in SNB Extracts****Sample Solution Preparation**

5 mg of the methanol extract and 2 mg of petroleum ether extract of SNB was taken, and mixed with 1 mL methanol and 1 mL of petroleum ether, respectively. The substances were then combined with a vortex mixture and placed in an ultrasonic bath until it was entirely dissolved. After that, the solutions passed through a 0.45 µ syringe filter. As a result, solutions were administered in the range of 4, 5, 6, 7, 8, and 12 µL and were placed through the previously indicated chromatography method.

**Method Evaluation Using Some Parameters**

**Instrumental precision:** The precision of sample application was examined by the measurement of peak area. Repetitive scan (n=5) of the same spot of LIA (400, 800 ng/spot) and ALA (450, 900 ng/spot) was used to test the instrument's precision at the same day (intraday precision) and on other days (interday precision). Relative standard deviation (%RSD) as a percentage was then used to represent it in the form of concentration found.

**Repeatability**

Analyzing (n=5) 500 µg/spot of both LIA and ALA on a TLC plate and expressing the results as %RSD served to confirm the method's reproducibility.

**Recovery** Three different stages of recovery studies (50%, 100%, and 125% addition of LIA and ALA) were conducted in order to evaluate the method's accuracy. The mean percentage recoveries as well as the percent recoveries were determined.

**RESULTS****Standard Curve of LIA and ALA**

The calibration graph was revealed to be straight path with the equations for LIA and ALA, where X stands for the concentration of standards and Y for the area under the curve, being  $Y=11.314 X - 24705.505$  ( $r^2=0.99523$ ) and  $Y=12.978 X - 4580.782$  ( $r^2=0.9980$ ), respectively. Standard LIA and ALA were found to have retardation factor values of 0.19 and 0.38. The calibration curve for the LIA and ALA is shown in Figure 2.

**Quantification of LIA and ALA in Different Extracts of SNB Extracts**

The amount of LIA and ALA in the SNB methanol extract was determined to be 8.97 and 0.86 % w/w, respectively. The amounts of LIA and ALA in the SNB extract of petroleum ether were measured to be 31.28 and 1.54 % w/w, respectively.  $R_f$  values for LIA and ALA were determined to be 0.19 and 0.38, respectively. In order to verify specificity, the  $R_f$  of the standard and sample were compared. Figures 3 show an HPTLC chromatogram of an extract of SNB as well as standard LIA and ALA. Figure 3 depicts all 540 nm tracks, with 5 standard tracks and 12 samples tracks, respectively, starting from the left side.





**Arpan Chakraborty et al.,****Methodology Assessment Using Some Parameters**

In contrast, repeatability was found to be in the range of 497.20-501.21 of LIA and 498.64-502.21 of ALA, which is less than 2 % RSD. Table 1 represents instrument precision of inter-day showed, LIA and ALA was within the range of % RSD 0.261-0.383 and 0.221-0.170. Intraday data revealed LIA and ALA was within the range of % RSD 0.0331-0.520 and 0.232-0.338. Table 2 reports percentage recovery data. The average recovery for ALA was 99.91% and LIA was 100.1%.

**DISCUSSION**

Analysis of chromatographic fingerprinting has demonstrated to be a reasonable and practical method for the evaluation of the effectiveness and authenticity of many standard medicines [8-10]. It successfully creates distinct patterns of identification for phytochemicals using chromatographic methods. The derived component fingerprint may then be used to assess the ratio of all measurable analytes as well as the existence of any interesting biomarkers. Due to its simplicity, HPTLC is an efficient method for evaluating herbal medications even if it has certain drawbacks, such as a restricted developing distance and reduced plate efficiency compared to HPLC and GC. Additionally, the aforementioned restrictions can be reduced by independently growing fractions of various polarities on two or more thin layer plates [6]. The distinctive quality of the HPTLC image combined with the digitally scanning profile makes for an appealing and effective instrument for creating a herbal chromatographic fingerprint. By analyzing this same Retention factor of standards LIA and ALA with that of the extract, the LIA and ALA in the sample of extract were found and their presence was verified. The procedure is repeatable and has demonstrated satisfactory outcomes in terms of precision, accuracy, and research data recovery. There are no records of HPTLC simultaneously detecting and quantifying LIA and ALA in SNB. As a result, we created a quick and accurate approach to quantify this marker.

**CONCLUSION**

The suggested approach offers a straightforward, precise, and consistent analytical approach to detecting and assessing LIA and ALA in SNB. The proposed technique's key characteristics include a quick and easy sample preparation procedure, high sensitivity methodology, and repeatable outcomes by the mobile phase. It is anticipated that this HPTLC method would be effective for evaluating LIA and ALA as markers in various herbal extracts.

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### Competing Interests

The authors claim to have no conflicts of interest.

**Table 1: Instrumental precision of linoleic and linolenic acid.**

Marker	Conc. (ng / spot)	Intra-day		Inter-day	
		Conc. ± SD	RSD (%)	Conc. ± SD	RSD (%)
LIA	400	400.33 ± 2.08	0.520	399.33 ± 1.52	0.383
	800	800 ± 2.64	0.331	797.66 ± 2.08	0.261
ALA	450	451.66 ± 1.52	0.338	453 ± 1	0.221
	900	898.66 ± 2.08	0.232	898.33 ± 1.52	0.170

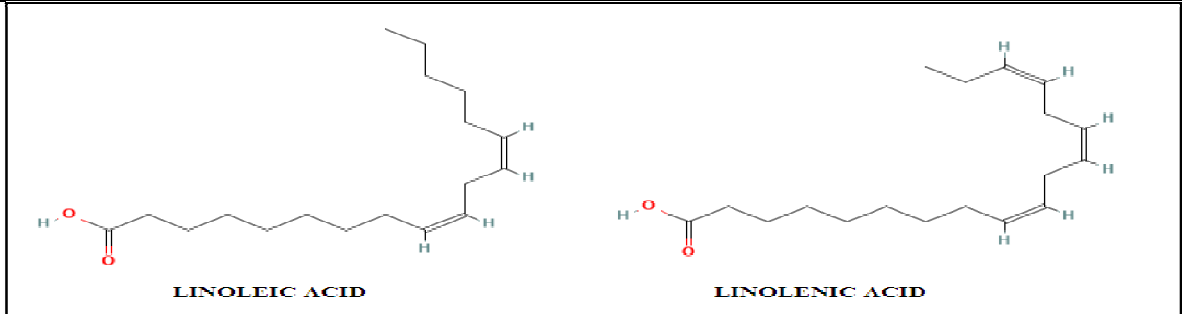
**Table 2: Recovery data of linoleic and linolenic acid.**

Marker	Conc. of marker present (ng)	Conc. of marker added (ng)	Conc. of marker found (ng)	Recovery (%)	Mean Recovery (%)
LIA	600	300	902 ± 2.1	100.22	100.11
	600	600	1198 ± 1.8	99.83	
	600	750	1354 ± 1.12	100.29	
ALA	500	250	751 ± 1.31	100.13	99.91
	500	500	998 ± 1.31	99.80	
	500	625	1123 ± 1.31	99.82	

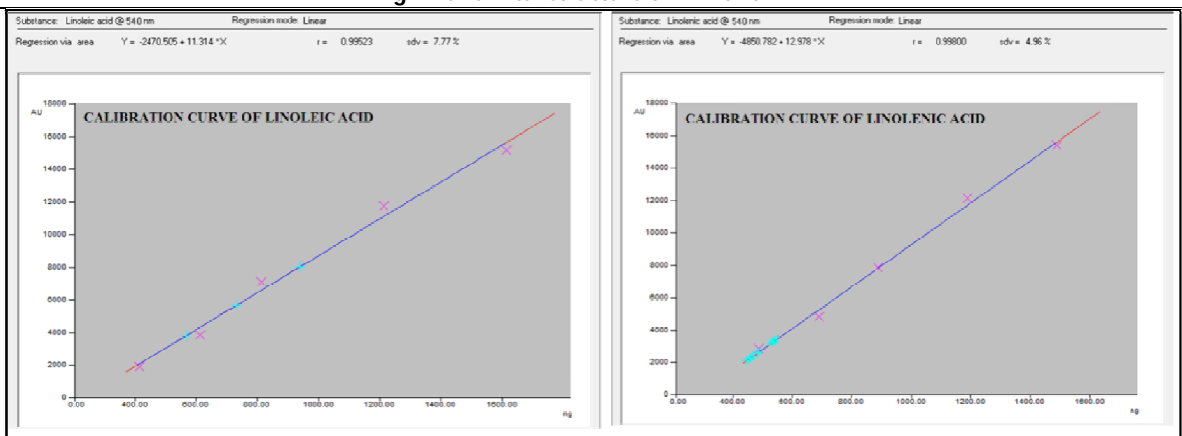




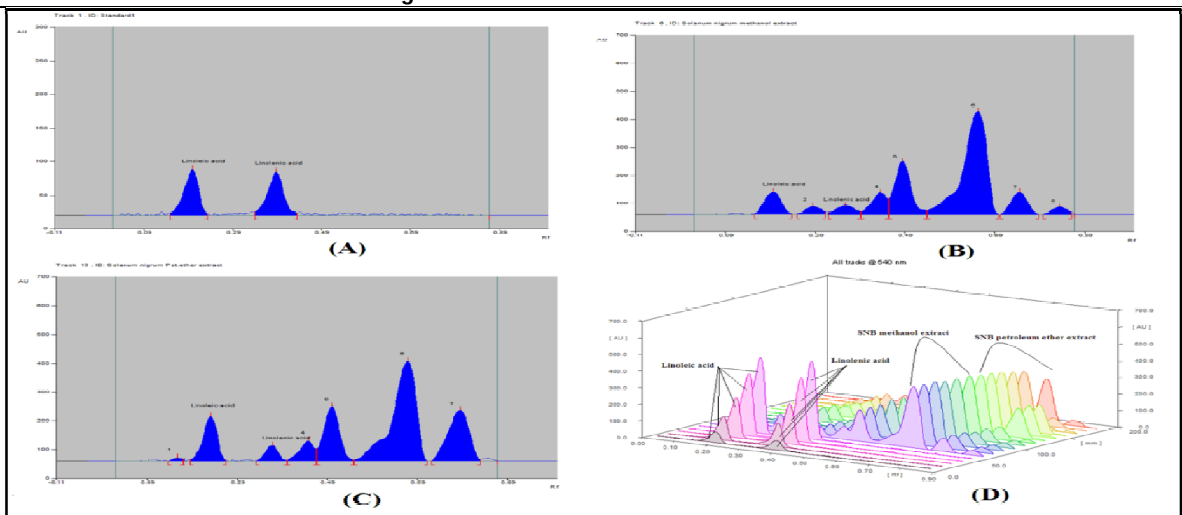
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**Fig. 1: Chemical structure of LIA and ALA.**



**Fig. 2: Calibration curve of LIA and ALA.**



**Fig. 3: (A) HPTLC Chromatogram of standard LIA and ALA; (B) HPTLC Chromatogram of methanol extract of SNB; (C) HPTLC Chromatogram of petroleum ether extract of SNB; (D) HPTLC 3D Chromatogram of LIA, ALA and SNB methanol and petroleum ether extract in UV 540 nm.**





## Understanding Culture and Beliefs of a Matrilineal Society through Folktales: A Study on Garo Tribe

Sagarika Mahanta Das\*

Assistant Professor, Assam down town University, Gandhi Nagar, Panikhaiti, Guwahati, Assam, India

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### \*Address for Correspondence

**Sagarika Mahanta Das**

Assistant Professor,

Assam down town University,

Gandhi Nagar, Panikhaiti,

Guwahati, Assam, India

E.Mail: [sagarika.mahanta777@gmail.com](mailto:sagarika.mahanta777@gmail.com)



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### ABSTRACT

The study of oral tradition refers to the recall and transmission of specific, preserved textual and cultural knowledge through vocal utterance. At the early stage of human civilization, all literary works were preserved by oral tradition. It was the sole means of communication available for forming and maintaining societies and their institutions. A better understanding of oral tradition depends on the experience gained through the study of the societies that depend upon oral tradition as a major means of communication. North-East India is the homeland of a large number of ethnic groups with a rich treasure of folklore. They belong to different racial origins and came from different directions. They settled down over time and carried with them diverse socio-cultural traditions. Much of the history of the Garo people, as well as their religious and cultural codes are contained in its oral literature handed down through ages from generation to generation. The basic aim of this endeavor is to study the creation tales of the Garo tribe of North East India, explaining different aspects of the community. A close analysis of the folktales reveals their beliefs and value system integrated into their daily life. The study has been carried out in different villages inhabited by the Garo people in the district of Goalpara district of Assam. The required data has been collected both at the primary and secondary levels. This study increases our understanding of the socio-cultural dimensions of the tribe.

**Keywords:** beliefs; culture; descent; folktales ;origin; matriliney; tradition

### INTRODUCTION

Oral tradition is defined as the inherited accumulation of materials handed down orally from generation to generation. It is a medium through which the knowledge of the forefathers can be transmitted to the subsequent



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generations (Vansina,1985).The oral tradition forms the backbone of the cultural heritage of the respective communities. In a historical tradition, oral narratives have their own functions and the study of the oral tradition becomes imperative in exploring the worldview in general and in making sense of the cultural past of a society in particular. It has been found that oral tradition has made the past relevant to the present. It is the process of binding a community through shared myths, legends, folktales, maxims, beliefs, etc. It plays a crucial role in sustaining a community's cultural and social values by integrating them into its lifestyle. Oral tradition is often identified as the folklore of a community which contains the knowledge, beliefs and traditions of the people. Folklore is produced by the people now or in the past. The authors of oral literature are usually unknown or unidentifiable. Folklore seems to meet a variety of human needs since time immemorial. They helped to explain the mysteries of the world, address our fears and dreams, showcase our customs and traditions and most importantly entertain people. According to Leach, (1984:401-402), 'Folklore is the generic term to designate the customs, beliefs, traditions, tales, magical practices, proverbs, sounds, etc.; in short, the accumulated knowledge of a homogenous unsophisticated people, tied together not only by common physical bonds but also by emotional ones which colour their every expression giving it unity and individual distinction'.

Folklores are expressions and reflections of culture and community. The folklore of the Garo is a rich storehouse of oral tradition. Their literature is an artistic expression of their thoughts, emotions, beliefs, customs, entertainment, festivals, distress and disillusionment. Garo folktales can be classified into several headings such as tales explaining the beginning of the universe and its elements, tales with moral lessons, tales of migration and settlement, tales upholding traditions and customs, etc. The Garo society is based on matrilineal principles and we find this principle reflected in their folktales and other narratives. Through the study of the Garo folktales, an attempt has been made to understand the cultural background of the tribe. They live in intimate proximity to nature and its physical manifestations. Therefore, the folk narratives have incorporated the mystical along with the experimental comprehension which in due course of time has been accepted as cultural and community beliefs.

**The People**

North East India is the homeland of a very large number of ethnic groups. These people belong to different racial origins and came to India at different points in time from different directions. The Garo is one such tribe that belongs to the Mongloid race like most of the other tribes of North East India. Their original home was somewhere in the upper course of Yangtse and Hwang- ho in North West China and eastern Tibet (Jaswal,1984). They might have entered North East India long before 1000 B.C. (Chatterjee,1951). The tradition and folklore are rich in tales about the exploits and adventures of their ancestors when they migrated from Tibet and spread out over large parts of North-East India. The Garos call themselves 'A. chik mande which means 'hill people'. Their traditional habitat in Meghalaya is known as Garo Hills. The Garos in India are also distributed over the Kamrup, Goalpara and Karbi Anglong districts of Assam, West Bengal and Tripura. They are found to be living in our neighbouring country, Bangladesh too. The traditional religion of the people is known as 'Songsarek' which has been described as animist. Most of the people are now converted to Christianity.

The Garos are one of the few remaining matrilineal societies in the world. Kinship is traced through female descent among the people. Children take the surname of their mother. Traditionally, the youngest daughter inherits the property from her mother. Sons leave their parents' house at puberty and are trained in the village bachelor dormitory called *nokpante*. After getting married, the man leaves his parental home and lives in his wife's house if she is the inheritor and if not, he has to settle on his own with the help of his parents and in-laws. Inheritance or transmission of property rights is along the female line. While the properties of Garos are owned by the women, the men manage and look after the property affairs and govern the society. There are five clans or exogamous divisions called '*chatchi*' among the tribe, viz., Sangma, Marak, Momin, Shira and Areng. Each of these clans is divided into several sub-clans called *Ma. chong* or motherhood. A *ma. chong* is also a kin group based on matrilineal relationships. It is further divided into various lineages known as *mahari*. (Sangma, 1984)



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The simplest pattern of the Garo family consists of the husband, wife and children. The family increases with the marriage of the heiress as the husband of the heiress come to live in the wife's house after marriage. He is called *nokkrom* and placed next to his father-in-law. The Garo language belongs to the Tibe to- Burmese branch of the Sino-Tibetan linguistic group. As it is not written down traditionally, customs, traditions and beliefs are handed down orally. The staple food of the people is rice. Pork and rice beer are a favourite delicacy among the people. The main occupation is agriculture- they practice both jhum and wet cultivation. Their jhum fields and forests produce several vegetables and roots for their daily food. The Garo festivals are mainly connected with agricultural activities. The biggest among them is the *Wangala*, which is celebrated after harvest. This is a thanksgiving festival to the sun God '*Misi Saljong*' for providing nature's bounties to mankind.(Playfair,1909).

**MATERIALS AND METHODS**

The present study is exploratory in nature and mainly concerned with:

- (i) To understand the oral tradition in the community,
- (ii) To assess the traditional and religious beliefs of the tribe,
- (iii) To explore the cultural reflections in the folktales.

The empirical data for the present study has been collected from the villages Bhendara, Rangsapara and Sat Bainsi Hill Block located under Balijana Circle of Goalpara district, Assam. Direct experiences of interactions with the people during the field visits have helped to collect the primary data of the study. Some of the secondary source materials have also been consulted to cross check the primary data and gather additional information about the people and their culture concerning the present study.

**RESULTS AND DISCUSSION**

The Garo community is basically an oral community. Carey (1919), writes that it can be said of the A.chiks that "Their language is their history". This oral tradition is an absolute vehicle for passing on historical accounts, myths, tales told both in prose and verse, folk songs, incantations, epic narrations, lamentations, lullabies, proverbs, games, etc. Marak (1987) , recalls the old story-telling days. There was a time when the Garo people in the villages had to travel for days to reach the weekly markets. They used to set up makeshift tents to spend the nights by the roadside. The evenings were passed with storytelling sessions. The Garo people had a rich heritage of story-telling occasions. Stories were narrated while working in the jhum fields, the house-warming functions and also when keeping watch over the dead. These were occasions of hearing, listening, sharing and forming flights of imagination where mythical worlds are created. In primarily oral cultures, human beings are the only potential repository for traditional oral narratives, myths, tales and so on. In this study, the researcher has attempted to study and analyze a few folktales to have a better understanding of the social, cultural and traditional framework of the tribe.

**Aspects of Some Garo Folktales****Bonepa and Misipa**

Bonepa was a patriarch who was preparing an area for jhum cultivation at a place called Denggadare Silkhongkhante Misi Kokdok Arapetchok. He had been clearing the jungle by cutting down huge trees and plants. The seasonal rains showed signs of delay and, therefore, he postponed the burning of the clearing and decided to pay a visit to his niece whom he had not seen for a long time. His niece named, Mejini Mechik, lived in the land of Dikrang Dikchang Chende Dodil. She had a wonderful fountain of the water of life kept at a place known as Basinaja Gimbiya. The water had magical properties, if it is kept in an earthen pitcher, it used to overflow to indicate the monsoon at hand. In the same way, it gets dried up to indicate the approach of dry, sunny days. Mejini Mechik was very happy at her uncle's visit and played the perfect host. She offered him the best of cooked rice and curry for his meal and the choicest rice-beer for his drink. She was immensely rich and took care of her uncle in a very lavish way.





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One day, in the course of conversation, she asked him if he was ready to burn the clearing for jhum cultivation. When Bonepa replied that the rains are delayed, she informed him that the water of life in the earthen pitcher is about to overflow and this is a sign of rains at hand. On hearing this, Bonepa at once decided to return home and bid adieu to his niece. He informed his neighbour and compatriot Misipa of the approaching rains. But sadly Misipa did not believe him as the water in his earthen vessel showed no signs of rain. He carried on his work of clearing the jungle and felling down huge trees. Bonepa set fire to his vast clearing. Nambok Me'a Namsang Phante, the favourite son of Misipa sat perched high on a branch of a completely pruned tree in the clearing of his father. When the fire spread over to Misipa's clearing, he lost his foothold and burned to death. This unfortunate incident led to war of words between the two friends. The next day when both of them faced each other intending to fight, a band of celestial brothers, namely, Misi Susime, Khatchi Biari and Aijangga incidentally came by and advised them to avoid war and be at peace. They also gave them a peaceful solution to their problem. They asked them to pick the bones of Nambok Me's Namsang Phante and use them as stakes in demarcating their respective jhum fields. Out of the piece of bones will grow a new plant known as *mendu* or *landu* (*Cystisus cajan*) and a creeper, known as beanstalk (*Fabaceae*), which will bear seeds and multiply, serving them visible limits to their jhum fields for generation to come.

Bonepa and Misipa were thus reconciled to each other then and there. The patriarchs obeyed the advice of the celestial brothers and in due course of time, golden beanstalks and silvery *cystisus cajan* plants grew out of the bones of Nambok Me'a. Ever since, the Garos, following their laudable examples of sweet reconciliation and thoughtful neighbourliness, have been using the *mendu* plants to date in setting up boundaries for their jhum cultivations in *Achik Asong* (Garoland). In this tale, Mejini Mechik is the only female character and plays a very small role but we comprehend the importance of her character. She is the niece of the leading male protagonist Bonepa and sets the events in the tale. It was due to her prediction that the whole narrative actually took place. She was represented as a very rich woman who indulged her maternal uncle with the best of food and comfort. In Garo society, uncles are the guardian of the nieces and they have to take care of them and address their problems. They are called *chra* and they play a very important role in the family affairs of the Garo family. As we already know that the Garo is a matrilineal society where descent and inheritance are followed along the family line, the real custodian and manager of the property are the male relatives of the inheritress, especially the brothers. No important decision can be taken without consulting them on matters like marriage, property issues and conflict resolutions. In this tale, Bonepa's visit to his niece's place is a traditional affair, wherein we find a concerned uncle dropping by to take stock of the well-being of the niece. We also find a glimpse of the traditional system of cultivation followed by the hill dwellers since time immemorial.

#### The First Death

The Achiks believed that man was born immortal in the beginning. They were immune from all illnesses, accidents, diseases and sufferings. It is due to enmity with gods and spirits, that humankind lost their immortality. The first to die was Megham Ghairipa Mande Dimrim, Megham Dimrang Chadar Gongman Mande Dimrim megham Dimsim. He was tall, muscular and energetic man. He lived beside the deep pool, Dingring Kitchi Wari Chora in the Simsang river in Achik Ahsong. The tale that led to the death of Mugham Gairipa is thus narrated as follows: One day he went to market with his daughter Gairi Singeri. On the way back home, they met a man named Shangma Sangreng Shning Ranja Dohpa Chiring, building a fishing weir across the Gijangbra Dilsingitel river to catch fish. He requested them not to cross the river in front of his weir. But Megham Gairipa ignored his request, and continued paddling on his way in front of his weir. His movement scared the fishes that were swimming towards the weir and as a result swam back up the river. This infuriated Shangma Sangreng and he cursed him to be punished by the gods Sae Dinna, Mangga Dinna and Gilne Sae Dihbet. These curses were in reality invocations to malignant spirits to strike them down. Megham Gairipa felt frightened at the curse, but he was not daunted and continued his journey. Rimerinok Kalmedoh-ol Misi Chenmatpa Saljong Chenchipa, the son of Kharupa Chonggalpa and servant of Misi Saljong had an ominous dream the previous night. He dreamt that he was captured alive by Megham Gairipa and bored a hole in his head from ear to ear. Then he was dragged away to be killed and roasted. Just as he finished narrating his dream to his relatives, Megham Gairipa reached there and seized him. He bound his limbs and bored a



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hole through his head. The Garo people believe that when a dream comes true, it is called *jumang matpu* or the 'Land-lizards's' dream.

At midnight the god Misi Saljong scourged Megham Gairipa for capturing his servant and he fell fatally ill and died. This was the first death of human being. Gairipa Singeri cried woefully over her father's death. The capture escaped as the spirit of Megham untied his hands and feet. The body of Megham Gairipa was taken to his village for his funeral. His body was bathed with rice-beer and cremated on a funeral pyre in front of the courtyard of his house. Many items of food and valuables were placed with him at the funeral. When his wife went fishing with his nephew, he came to his house carrying the necklace and beef given to him at the cremation. His children saw the apparition and shouted with joy to their mother that their father had come back. The wife never imagined such a thing and shouted back that he is dead and gone forever. Megham Gairipa was shocked and deeply saddened at his wife's response. He was unable to reconcile the fact that his wife has accepted the fact of his death and moved on. Full of remorse, he decided to forsake the earthly life and settle down at Mangru Mangram Chitmag Ahsong Balmang Chiga, the abode of the departed souls.

When Grimchi returned home she was taken aback when she saw the beef and necklace. She could understand her folly and made up her mind to bring her husband back home. She followed the trail of her husband to the spirit land. She encountered innumerable obstacles and hardships on the way but never gave up. Finally, at Mangru Mangram, she overtook him and prayed to return home with her. Megham Gairipa declined her prayers and suggested she marry his nephew who can take charge of all the duties which he used to perform. The nephew will finish the incomplete tasks and become the householder. He also told her to perform all the necessary funeral and post-funeral rites and set up a memorial post for him so that he can take birth in the same motherhood the next time. He bade her farewell and resumed his journey to his final destination. Grimchi returned home and married her late husband's maternal nephew as per his wishes. She also performed the necessary rites and ceremonies for her late husband. Thus from that time onwards, the custom of a nephew marrying his maternal uncle's widow in the Garo community was established. The word '*nokkrom*' has special connotations and this is linked with this tale. '*Nok*' means 'house' and '*krom*' means 'the stone put over the place where the cremation took place. It is taboo to remove the stone from its original place and stands as a memorial post of the departed. It was only after the death of the first man that these customs were established and passed on over generations till day.

In Grimchi's character we find traces of Behula, the protagonist of *Behula Lakhinder*, a famous folktale, found among the Assamese and the Bengalis. Behula exemplified undying love for her husband, Lakhinder. She fought against all odds to revive her dead husband back to life again (William 2002). Here we find Grimchi following her husband's trail to win him back. The similarities between the folktales of different communities exemplify the universal appeal of the folktales across boundaries. She dared to travel through the unknown path that was full of obstacles and hindrances. She cared for none nor did she rest until she found her husband Megham Gairipa and sincerely prayed for his return. To speak of gender roles in Garo households, women not only do the household work but also work in the fields and need to go fishing, fetch water and the like. The elder daughter is seen to help the mother in managing household activities. Fishing is a common occupation among the Garo women. They go fishing for an additional item of food and also for economic returns. The Garos believe that the custom of marrying the husband's nephew started from the story of Megham and Grimchi. Grimchi is an obedient wife who followed her husband's command and married accordingly thus establishing the tradition of the widow remarrying the late husband's nephew, which is still prevalent in the Garo society.





**Sagarika Mahanta Das****Origin of Rice**

In the olden days human beings used to live on wild yams (*discosæ*), colocasia, and other such edibles tuberous roots. Rice, millet, corn and other grains were then unknown to mankind. There existed a gigantic Tree of Wealth in the world known as Gisil Bol Gitol Bol Rikge Samol Japhang Monol (literally, the mighty tree overshadowing the whole world), which had twelve branches towards the East and twelve branches towards the West. These branches bore fruits of wealth like precious stones, silk, cotton, rice and so on. The branch which bore fruits of different kinds of rice spread over the garden of Giting Dingje (the mother Banyan tree) at Ahjarek Chijapa (the vaulted foundation of water). Nobody could pluck the seeds from the branch. It was the god of winds, who conspired with the god of hail and storm and shook the fruits of rice from the branch with his strong legs.

The god of winds did not bother with the fallen fruits and spent his time playing the flutes and indolently whistling. One Ahning Noksiksik Chining Nomindil Ahning Diperi Chining Dipra (dweller of a subterranean region) picked up the vital and life-sustaining grains from the ground and sowed them in her garden. Misi Apilpa Saljong Galapa, the wealthy god of the celestial regions (Sun- Divinity) got some rice grains from her and planted them in his fields. One day on the way to the marketplace, Misi Apilpa met a terrestrial man who lived a very hard life of poverty and hard labour. They sat down to have food and in the ensuing conversation, Ahni Apilpa expressed his ignorance of the food, when he was offered cooked rice by Misi Saljong. Misi Apilpa took pity on him and promised to send him paddy seeds so that the man can sow in his jhum field. This is the main plot of the tale explaining how Man got the first seeds of rice from a celestial being. In the course of this folktale, there are many incidents of misunderstanding between Misi Saljong and Ahni Apilpa due to the misdeeds of the servants from both sides. But finally, they reconciled and the terrestrial man performed the offering of the first fruits of the harvest in honour of Misi Saljong as wished by the god. When the paddy crops were ripe for harvest, Ahni Apilpa set aside some grains of his paddy, and just before the actual commencement of the harvest and offered his thanksgiving to Misi Apilpa performing the ritual on a small altar of flat stone at the foot of the central pillar of his dwelling house. He performed the ceremony by burning sweet-smelling incense and pouring rice-beer, uttering his gratitude to Misi Saljong. The God of the celestial region was very pleased with the man and blessed him and his descendants with bounty forever.

The story mentions the actions of the celestial gods in worldly affairs. As the story goes, the first grains of rice were cultivated by a woman who shared them with a celestial god, who was generous enough to share the seeds with a terrestrial being. We get to know the Garo people held in very high esteem the natural forces like the sun, rain, wind, etc. personified them in gods and goddesses to offer their prayers. The people believe that these powerful gods and goddesses have strong roles to play in the earthly life of humans. This belief is central to the following of the pristine religion of the Garo tribe called *Songsarek*. The Songsarek people believe in the existence of one Supreme power who commands to create the universe, man, sun, moon and all other natural and living things. He is the regulator of the universe, the source of life and the dispenser of justice. He is known as Tatara Rabuga, the Universal God or king of gods of the sky, heaven and earth. Pantheism is the basic feature of the Songsarek religion. The people believe in multiple gods who are under the Supreme God. There is a belief that some elements of nature have been endowed with divine status and powers, such as thunder, fire, water, wind earthquake and most importantly the sun. The sun is represented as the God of fertility and is worshipped to gain his favour for a good harvest. The custom of offering the first fruits to the Sun God after harvest is seen to have started with the first cultivation of rice by man in the Garo Hills. Ever since, they have continued to follow this tradition to date. The Garo people never ate anything before offering the first fruits to the God who blessed their land and cultivation. The great festival of the year, the Wangala, is mainly celebrated in his honour. The actual sacrifice to the Sun –God is offered in the field before the village festivals begin. This festival is known as Chu Rugala among the Garos. The descendants of Ahni Apilpa continued the tradition of this festival by burning sweet smelling incense during the oblations and pouring out a little quantity of rice beer at the foot of the central post of the household.



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## CONCLUSION

These folk tales represent the culture of the people with their beliefs, customs, values and social order. The common thread of understanding in all these tales refers to the interference of divinity, magical powers, actions of benevolent and malevolent spirits, celestial contact with the humans and other living beings and most importantly the inter-presence of the three worlds. These tales are narrations conveying profound truths, metaphorically and symbolically. They are often considered sacred accounts and can be found in their *Songsarek* (traditional religion) religious traditions. They are all stories with a plot and characters who are deities, spirits, humans and animals. Even though these tales are set in primordial times and nonspecific past, they are relevant to the present time giving meaning to the cultural and traditional beliefs of the people.

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## Structural Elucidation, Hirshfeld Surface and Energy Framework Analysis of a Benzene Sulfonamide Derivative

G. Dhanalakshmi<sup>1\*</sup>, Palani Manikandan<sup>2</sup> and A. K.Mohanakrishnan<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Physics, Mannar Thirumalai Naicker College (Autonomous), Madurai, Tamil Nadu, India.

<sup>2</sup>Research Scholar, Department of Organic Chemistry, University of Madras, Chennai, Tamil Nadu, India.

<sup>3</sup>Professor and Head, Department of Organic Chemistry, University of Madras, Chennai, Tamil Nadu, India.

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### \*Address for Correspondence

#### G. Dhanalakshmi

Assistant Professor,  
Department of Physics,  
Mannar Thirumalai Naicker College (Autonomous),  
Madurai, Tamil Nadu, India  
E.Mail: gdhansi82@gmail.com



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### ABSTRACT

Benzene sulfonamide derivatives are important from medicinal point of view because of their widespread biological significance. In the present work title compound, (*E*)-*N*-(2-(2-(1-(phenylsulfonyl)-1*H*-indol-2-yl)vinyl)phenyl)-*N*-(prop-2-ynyl)benzenesulfonamide has been synthesized and characterized by XRD, Hirshfeld Surface, and Energy framework analysis. Single crystal X-ray diffraction analysis shows that the title compound crystallizes in orthorhombic system with space group *Pbca*. The benzene sulfonamide ring are almost orthogonal to the indole ring system, indicating equatorial orientation. The molecules features C-H... $\pi$ , and  $\pi$ ... $\pi$  interactions. The intermolecular interactions of title compound was analyzed using Hirshfeld surface analysis and two dimensional fingerprint plots, which confirms the XRD data. Energy frameworks were used to calculate the intermolecular interaction energies and their distribution over the crystal structure.

**Keywords:** Benzene sulfonamide, intermolecular hydrogen bonds, Packing features, Hirshfeld surface analysis, Energy framework.





## INTRODUCTION

Benzene sulfonamides have been viewing an ample variety of biological activities such as anti-bacterial [1], insecticidal [2], anti-fungal [3], anti-hepatitis, anti-inflammatory, anti-HIV [4], and anti-tubercular activities [5-6] insulin release stimulation, and anti-thyroid properties. The SO<sub>2</sub>-NH group included Sulfonamides are called sulfa drugs. The sulfonamide moiety is repeatedly used in contemporary medicine [7-9]. These drugs are used today to cure infectious diseases such as malaria. These effective drug molecules have an important role in the medical field, including as promising chemotherapeutic agents, and have been used in the treatment of many bacterial infections due to their physical, chemical and biological properties. Recently, sulfonamides have also been used in the organic synthesis reactions for the synthesis of linear or cyclic oligomers and the introduction of nucleophilic heteroatom functionality to the synthesized molecule.

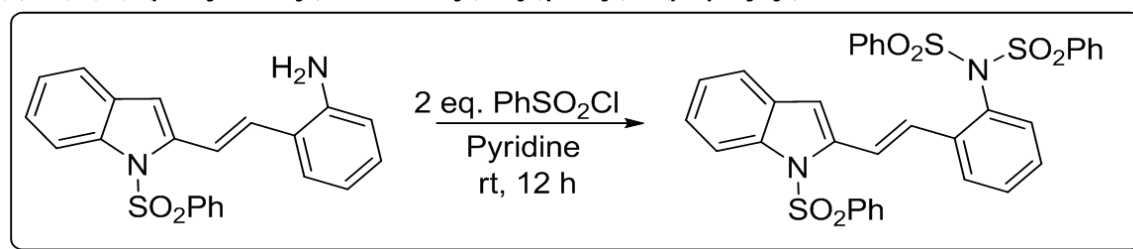
In recent years, extensive research studies have been carried out on the synthesis and evaluation of the pharmacological properties of molecules containing the sulfonamide moiety, which have been reported to be important pharmacophores [10]. It is also useful in extensive sort of disorders, which include various arthritic conditions, urological and gynecological problems, post-surgical and cancer pain, and vascular diseases. Because of a wide-ranging multiplicity of the biological importance of the benzene sulfonamides, the synthesis of several substituted benzene sulfonamides, their crystal structure, physical, chemical and biochemical studies have become a remarkable field of research.

With this in mind, a new benzene sulfonamide derivative (*E*)-*N*-(2-(2-(1-(phenylsulfonyl)-1*H*-indol-2-yl)vinyl)phenyl)-*N*-(prop-2-ynyl)benzenesulfonamide was synthesized, and their properties were studied. Other structures that are closely related to the title compound are *N*-[5-(4-chlorophenyl) furan-2-ylmethyl] 4-methyl-*N*-(prop-2-ynyl) benzene sulfonamide, *N*-[5(2-chlorophenyl)furan-2-ylmethyl]-4-methyl-*N*-(prop-2-ynyl) benzene sulfonamide. The title compound is superior to the related structures because of the difference in the structural and intermolecular features. The reported compounds has two benzenesulfonamide rings, which are connected by carbon atoms which acts as a bridge. In the related compounds the crystal packing is mainly determined by C-H...O and C-H... $\pi$  interactions, whereas in the title compound we observe C-H...O interactions.

## MATERIALS AND METHODS

### Experimental

#### (*E*)-*N*-(2-(2-(1-(phenylsulfonyl)-1*H*-indol-2-yl)vinyl)phenyl)-*N*-(prop-2-ynyl)benzenesulfonamide



To a solution of (*E*)-*N*-(2-(2-(1-(phenylsulfonyl)-1*H*-indol-2-yl)vinyl)phenyl) benzenesulfonamide (0.5 g, 1.336 mmol) in dry DCM (10 mL), pyridine (0.21 g, 2.673 mmol) and PhSO<sub>2</sub>Cl (0.47 mL, 2.673 mmol) were added and stirred at room temperature for 12 h. After completion of the reaction (monitored by TLC), it was poured into crushed ice (50 g) containing Conc. HCl (5 mL), extracted with DCM (2 × 20 mL) then washed with water (2 × 20 mL) and dried (Na<sub>2</sub>SO<sub>4</sub>). Removal of solvent in *vacuum* followed by crystallization from diethylether (4 mL) afforded benzenesulfonamide as a white solid.





## METHODS

### X-Ray Data collection, structure refinement and solution

X-ray diffraction intensity data were collected at room temperature on a Bruker axis SMART APEXII single crystal X-ray diffractometer [11] equipped with graphite monochromatic MoK $\alpha$  ( $\lambda=0.71073$  Å) radiation and a CCD detector. The intensity data collection, frames integration, Lorentz and polarization corrections and decay correction were carried out using SAINT-NT (version 7.06a) software. An empirical absorption correction (multi-scan) was performed using the SADABS program. The crystal structures were solved by direct methods and then refined by the full matrix least-squares method using SHELXL [12-13]. Figures were created using MERCURY and ORTEP-PLATON [14-16].

### Hirshfeld Surface Analysis

Intermolecular contacts and their influence on the packing of the crystal structures were identified using Hirshfeld surface analysis. The CIF files were used as input in the Crystal Explorer 17.5 software package [17] to draw the Hirshfeld surface mapped over  $d_{norm}$ . [18]. The shape of the electron density surface around the molecular interactions is indicated by the shape index. 2D fingerprint plots show the contribution of different type of intermolecular interactions of the molecule in the crystal.

## RESULTS AND DISCUSSION

### Structural Features

The benzene sulfonamide sample crystallizes in orthorhombic, with space group Pbca. The crystal data and other related details of title compound are given in Table 1. Fig. 1 shows the ORTEP plot of the title compound. In the title compound the geometric parameters are in close agreement with those of similar structures[19]. The benzene sulfonamide ring [(C29-C34)/S3/O5/O6] are almost orthogonal to the indole ring system (N1/C1-C8), making a dihedral angle of 85.76(14)° indicating equatorial orientation. The benzene sulfonamide ring [(C23-C28) /S2/O3/O5] forms a dihedral angle of 56.74(14)° with the benzene sulfonamide ring [C17-C22/S1/O1/O2] indicating bisectonal orientation. In title compound, the torsion angle for the atoms C30-C29-S3-N1 is -76.5(3)°, which indicates they are (-) syn-clinal to the indole ring. The torsion angle for the atoms N(2)-S(2)-C(23)-C(28) is 94.3(3)° indicating they are (+) anti-clinal to benzene sulfonamide ring. The torsion angle for the atoms C(22)-C(17)-S(1)-N(2) is 81.7(3)° indicating they are (+) syn-clinal to benzene sulfonamide ring. The torsion angle for the atoms C(8)-C(9)-C(10)-C(11) is -176.4(3)° which indicates they are in equatorial orientation to the indole rings. The benzene sulfonamide rings are connected by C9-C10 which acts as a bridge. The bond angle values for the atoms O6-S3-O5, O4-S2-O3, O2-S1-O1 are 119.82(15)°, 120.67(15)° and 120.19(15)° respectively. The sum of the bond angles for title compound is 356.7°, which indicates sp<sup>2</sup> hybridization. [20]

### Packing Features

The crystal packing of title compound is shown in Fig.2. (C 28)- H(28)...O(2), C(2)-H(2)...O(5), C(30)-H(30)...O(3) types of intermolecular hydrogen bond interactions are observed in title compound.

### Displacement ellipsoids are drawn at a 40% probability level (Fig.1)

### Hirshfeld Surface Analysis

The Hirshfeld surface of the title compound was mapped over  $d_{norm}$ , electrostatic potential, shape index, curvedness, and fragment patches (Fig.3). The C-H...O interaction is visualized as small red spot on the Hirshfeld surface mapped over  $d_{norm}$  [Fig.3(a)]. The Hirshfeld surface mapped over the electrostatic potential reveals the presence of negative potential around the acceptors and positive potential around the donors and it is shown by the red and blue clouds on the surface, respectively [Fig.3(d)]. The existence of  $\pi$ - $\pi$  interactions is visualized as red and blue triangles on the Hirshfeld surface mapped over shape indexed surfaces [Fig.3(b)] and as flat regions on the



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curvedness [Fig.3(c)]. The nearest neighbour coordination environment of a molecule is found to be 14, which is identified from the colour patches on the Hirshfeld surface [Fig.3 (e)]. Two dimensional fingerprint plots for the Hirshfeld surface of the compound are shown with characteristic pseudo symmetry wings in the upper left and lower right sides of  $d_e$  and  $d_i$  diagonal axes that represent the overall two-dimensional fingerprint plot and those delineated into H...H, C...H/ H...C, O...C/C...O and C...C contacts (Fig.4).

The H...H interactions appear as the largest region of the fingerprint plot with high concentration in the middle region at  $d_e=d_i \approx 1.2\text{\AA}$  with overall Hirshfeld surface of 37.9%. The C...H/H...C interactions appear as the next largest region of the fingerprint plot, highly concentrated at the edges, having almost the same  $d_e + d_i \approx 2.7\text{\AA}$ , with an overall contribution of 26.8%. The C...O/O...C interactions on the fingerprint plot, which contributes 1.2% of the total Hirshfeld surface with  $d_e + d_i \approx 2.8\text{\AA}$  are shown as two symmetrical wings. The C...C contacts, which refer to  $\pi$ - $\pi$  stacking interactions, contribute 3.5% of the Hirshfeld surface and this appear as a unique triangle at around  $d_e=d_i \approx 1.8\text{\AA}$ . These weak interactions mostly contribute to the packing of the title compound.

### Energy Framework Analysis

The interaction energies between the molecules of title compound are obtained using monomer wave functions at the HF level. The total interaction energy, which is the sum of scaled components, was calculated for a  $3.8\text{\AA}$  radius cluster of molecules around the selected molecule (Fig. 5). The energies calculated by the energy model reveals that the dispersion energy contributes significantly to the interactions in the crystal. (Table 6). The energy frameworks were performed for a cluster of molecules present in  $2 \times 2 \times 2$  unit cells (Fig. 5). Energy framework analysis also shows the dominance of the dispersion term. The green cylinders in the dispersion energy framework thoroughly reflects, the blue cylinders in the total energy framework. Thus the supramolecular architecture of the crystal structure of title compound is visualized uniquely by Energy Frameworks (Fig.5).

## CONCLUSION

The title compound was synthesized and the structures were confirmed using x-ray diffraction method. In the crystal, molecules are linked by C-H...O hydrogen bonds. The molecule also features C-H... $\pi$  interactions. The existence of  $\pi$ - $\pi$  interactions is visualized as red and blue triangles on the Hirshfeld surface mapped over shape indexed surfaces. The Hirshfeld surface analysis confirms the XRD data of intermolecular interactions as bright red spots. Energy framework analysis also shows the dominance of the dispersion term. The green cylinders in the dispersion energy framework closely mirrors, the blue cylinders in the total energy framework. Thus the supramolecular architecture of the crystal structure of title compound is visualized uniquely by energy frameworks

### Conflict of Interest

The authors have no conflicts of interest regarding this investigation.

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Table 1. Crystal data for title compound

Parameters	Title compound
Empirical formula	C <sub>34</sub> H <sub>26</sub> N <sub>2</sub> O <sub>6</sub> S <sub>3</sub>
Formula weight	654.75
Temperature	296(2) K
Wavelength	0.71073 Å
Crystal system, space group	Orthorhombic, P b c a
Unit cell dimensions	a = 14.9155(4) Å b = 13.5562(4) Å c = 30.4041(9) Å
Volume	6147.6(3) Å <sup>3</sup>
Z, Calculated density	8, 1.415 Mg/m <sup>3</sup>
Absorption coefficient	0.291 mm <sup>-1</sup>
F(000)	0.291 mm <sup>-1</sup>
Crystal size	0.180 x 0.150 x 0.120 mm
Theta range for data collection	1.913 to 24.996 deg.
Limiting indices	-17<=h<=17, -11<=k<=16, -36<=l<=35
Reflections collected / unique	71891 / 5401 [R(int) = 0.0771]
Completeness to theta = 24.996	100.00%
Max. and min. transmission	0.7454 and 0.6794
Refinement method	Full-matrix least-squares on F <sup>2</sup>
Data / restraints / parameters	5401 / 0 / 419
Goodness-of-fit on F <sup>2</sup>	1.051
Final R indices [I>2sigma(I)]	R1 = 0.0403, wR2 = 0.0871
R indices (all data)	R1 = 0.0915, wR2 = 0.1198

Table 2. Bond lengths (Å) involving non-hydrogen atoms of title compound

Atom	Length	Atom	Length
C(1)-C(2)	1.390(4)	C(21)-C(22)	1.372(5)
C(1)-C(6)	1.401(4)	C(23)-C(24)	1.380(4)
C(1)-N(1)	1.421(4)	C(23)-C(28)	1.384(4)
C(2)-C(3)	1.377(5)	C(23)-S(2)	1.751(3)
C(3)-C(4)	1.386(5)	C(24)-C(25)	1.387(5)
C(4)-C(5)	1.374(5)	C(25)-C(26)	1.374(5)
C(5)-C(6)	1.394(4)	C(26)-C(27)	1.365(5)
C(6)-C(7)	1.419(4)	C(27)-C(28)	1.373(4)
C(7)-C(8)	1.349(4)	C(29)-C(34)	1.375(4)
C(8)-N(1)	1.425(4)	C(29)-C(30)	1.383(4)
C(8)-C(9)	1.461(4)	C(29)-S(3)	1.751(3)







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C(9)-C(10)	1.333(4)	C(30)-C(31)	1.373(5)
C(10)-C(11)	1.461(4)	C(31)-C(32)	1.365(5)
C(11)-C(12)	1.400(4)	C(32)-C(33)	1.364(5)
C(11)-C(16)	1.401(4)	C(33)-C(34)	1.386(5)
C(12)-C(13)	1.371(5)	N(1)-S(3)	1.668(3)
C(13)-C(14)	1.377(5)	N(2)-S(1)	1.683(2)
C(14)-C(15)	1.376(5)	N(2)-S(2)	1.692(2)
C(15)-C(16)	1.392(4)	O(1)-S(1)	1.426(2)
C(16)-N(2)	1.449(4)	O(2)-S(1)	1.416(2)
C(17)-C(22)	1.373(4)	O(3)-S(2)	1.427(2)
C(17)-C(18)	1.375(4)	O(4)-S(2)	1.418(2)
C(17)-S(1)	1.754(3)	O(5)-S(3)	1.427(2)
C(18)-C(19)	1.385(5)	O(6)-S(3)	1.426(2)
C(19)-C(20)	1.356(5)		
C(20)-C(21)	1.351(5)		

Table 3. Bond Angles (°) involving non-hydrogen atoms of title compound

Atom	Angle	Atom	Angle
C(2)-C(1)-C(6)	121.6(3)	C(23)-C(24)-C(25)	118.6(3)
C(2)-C(1)-N(1)	131.3(3)	C(26)-C(25)-C(24)	119.8(4)
C(6)-C(1)-N(1)	107.1(3)	C(27)-C(26)-C(25)	121.1(3)
C(3)-C(2)-C(1)	117.6(3)	C(26)-C(27)-C(28)	120.0(3)
C(2)-C(3)-C(4)	121.6(4)	C(27)-C(28)-C(23)	119.1(3)
C(5)-C(4)-C(3)	120.9(4)	C(34)-C(29)-C(30)	120.6(3)
C(4)-C(5)-C(6)	118.9(3)	C(34)-C(29)-S(3)	120.1(3)
C(5)-C(6)-C(1)	119.3(3)	C(30)-C(29)-S(3)	119.2(3)
C(5)-C(6)-C(7)	133.1(3)	C(31)-C(30)-C(29)	119.5(3)
C(1)-C(6)-C(7)	107.5(3)	C(32)-C(31)-C(30)	120.1(4)
C(8)-C(7)-C(6)	109.6(3)	C(33)-C(32)-C(31)	120.7(4)
C(7)-C(8)-N(1)	108.1(3)	C(32)-C(33)-C(34)	120.2(4)
C(7)-C(8)-C(9)	126.5(3)	C(29)-C(34)-C(33)	118.9(4)
N(1)-C(8)-C(9)	125.3(3)	C(1)-N(1)-C(8)	107.4(2)
C(10)-C(9)-C(8)	120.7(3)	C(1)-N(1)-S(3)	123.2(2)
C(9)-C(10)-C(11)	126.2(3)	C(8)-N(1)-S(3)	126.0(2)
C(12)-C(11)-C(16)	116.7(3)	C(16)-N(2)-S(1)	118.29(19)
C(12)-C(11)-C(10)	121.3(3)	C(16)-N(2)-S(2)	118.21(19)
C(16)-C(11)-C(10)	122.0(3)	S(1)-N(2)-S(2)	123.11(15)
C(13)-C(12)-C(11)	121.7(3)	O(2)-S(1)-O(1)	120.19(15)
C(12)-C(13)-C(14)	120.6(4)	O(2)-S(1)-N(2)	106.87(13)
C(15)-C(14)-C(13)	119.7(4)	O(1)-S(1)-N(2)	106.22(13)
C(14)-C(15)-C(16)	119.9(3)	O(2)-S(1)-C(17)	109.54(15)
C(15)-C(16)-C(11)	121.4(3)	O(1)-S(1)-C(17)	108.57(15)
C(15)-C(16)-N(2)	118.4(3)	N(2)-S(1)-C(17)	104.25(13)
C(11)-C(16)-N(2)	120.2(3)	O(4)-S(2)-O(3)	120.67(15)
C(22)-C(17)-C(18)	120.1(3)	O(4)-S(2)-N(2)	107.47(13)
C(22)-C(17)-S(1)	119.6(3)	O(3)-S(2)-N(2)	104.06(13)
C(18)-C(17)-S(1)	120.3(3)	O(4)-S(2)-C(23)	109.47(15)
C(17)-C(18)-C(19)	119.7(3)	O(3)-S(2)-C(23)	108.50(15)





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C(20)-C(19)-C(18)	119.7(4)	N(2)-S(2)-C(23)	105.57(13)
C(21)-C(20)-C(19)	120.4(4)	O(6)-S(3)-O(5)	119.82(15)
C(20)-C(21)-C(22)	121.3(4)	O(6)-S(3)-N(1)	106.08(14)
C(21)-C(22)-C(17)	118.9(3)	O(5)-S(3)-N(1)	106.00(14)
C(24)-C(23)-C(28)	121.3(3)	O(6)-S(3)-C(29)	109.39(15)
C(24)-C(23)-S(2)	118.5(2)	O(5)-S(3)-C(29)	108.82(16)

Table 4. Torsion angles (°) involving non-hydrogen atoms of title compound

Atom	Angle	Atom	Angle
C(6)-C(1)-C(2)-C(3)	0.7(5)	C(18)-C(19)-C(20)-C(21)	-1.4(6)
N(1)-C(1)-C(2)-C(3)	176.9(3)	C(19)-C(20)-C(21)-C(22)	0.9(6)
C(1)-C(2)-C(3)-C(4)	1.4(5)	C(20)-C(21)-C(22)-C(17)	-0.6(6)
C(2)-C(3)-C(4)-C(5)	-1.1(6)	C(18)-C(17)-C(22)-C(21)	0.7(5)
C(3)-C(4)-C(5)-C(6)	-1.3(5)	S(1)-C(17)-C(22)-C(21)	-178.8(3)
C(4)-C(5)-C(6)-C(1)	3.3(5)	C(28)-C(23)-C(24)-C(25)	0.1(5)
C(4)-C(5)-C(6)-C(7)	-174.3(3)	S(2)-C(23)-C(24)-C(25)	-178.6(3)
C(2)-C(1)-C(6)-C(5)	-3.1(5)	C(23)-C(24)-C(25)-C(26)	0.1(6)
N(1)-C(1)-C(6)-C(5)	179.9(3)	C(24)-C(25)-C(26)-C(27)	0.0(6)
C(2)-C(1)-C(6)-C(7)	175.1(3)	C(25)-C(26)-C(27)-C(28)	-0.2(6)
N(1)-C(1)-C(6)-C(7)	-1.9(3)	C(26)-C(27)-C(28)-C(23)	0.3(5)
C(5)-C(6)-C(7)-C(8)	176.7(3)	C(24)-C(23)-C(28)-C(27)	-0.3(5)
C(1)-C(6)-C(7)-C(8)	-1.2(4)	S(2)-C(23)-C(28)-C(27)	178.4(2)
C(6)-C(7)-C(8)-N(1)	3.7(3)	C(34)-C(29)-C(30)-C(31)	0.6(5)
C(6)-C(7)-C(8)-C(9)	-176.4(3)	S(3)-C(29)-C(30)-C(31)	-177.9(3)
C(7)-C(8)-C(9)-C(10)	40.4(5)	C(29)-C(30)-C(31)-C(32)	0.7(5)
N(1)-C(8)-C(9)-C(10)	-139.7(3)	C(30)-C(31)-C(32)-C(33)	-1.5(6)
C(8)-C(9)-C(10)-C(11)	-176.4(3)	C(31)-C(32)-C(33)-C(34)	0.9(6)
C(9)-C(10)-C(11)-C(12)	21.9(5)	C(30)-C(29)-C(34)-C(33)	-1.1(5)
C(9)-C(10)-C(11)-C(16)	-156.7(3)	S(3)-C(29)-C(34)-C(33)	177.3(3)
C(16)-C(11)-C(12)-C(13)	2.3(5)	C(32)-C(33)-C(34)-C(29)	0.3(6)
C(10)-C(11)-C(12)-C(13)	-176.4(3)	C(2)-C(1)-N(1)-C(8)	-172.5(3)
C(11)-C(12)-C(13)-C(14)	-0.8(5)	C(6)-C(1)-N(1)-C(8)	4.1(3)
C(12)-C(13)-C(14)-C(15)	-0.6(6)	C(2)-C(1)-N(1)-S(3)	-11.8(4)
C(13)-C(14)-C(15)-C(16)	0.4(5)	C(6)-C(1)-N(1)-S(3)	164.7(2)
C(14)-C(15)-C(16)-C(11)	1.1(5)	C(7)-C(8)-N(1)-C(1)	-4.9(3)
C(14)-C(15)-C(16)-N(2)	-179.3(3)	C(9)-C(8)-N(1)-C(1)	175.2(3)
C(12)-C(11)-C(16)-C(15)	-2.4(4)	C(7)-C(8)-N(1)-S(3)	-164.8(2)
C(10)-C(11)-C(16)-C(15)	176.3(3)	C(9)-C(8)-N(1)-S(3)	15.3(4)
C(12)-C(11)-C(16)-N(2)	178.0(3)	C(15)-C(16)-N(2)-S(1)	78.2(3)
C(10)-C(11)-C(16)-N(2)	-3.3(4)	C(11)-C(16)-N(2)-S(1)	-102.2(3)
C(22)-C(17)-C(18)-C(19)	-1.2(6)	C(15)-C(16)-N(2)-S(2)	-94.8(3)
S(1)-C(17)-C(18)-C(19)	178.3(3)	C(11)-C(16)-N(2)-S(2)	84.8(3)
C(17)-C(18)-C(19)-C(20)	1.5(6)	C(16)-N(2)-S(1)-O(2)	-156.2(2)
		S(2)-N(2)-S(1)-O(2)	16.5(2)
		C(16)-N(2)-S(1)-O(1)	-26.7(2)





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Table 5. Hydrogen bond interactions for title compound [ $\text{\AA}$  and  $^\circ$  ]

D-H...A	d(D-H)	d(H...A)	d(D...A)	$\angle$ (DHA)
C(28)-H(28)...O(2)	0.93	2.62	3.088(4)	111.8
C(2)-H(2)...O(5)	0.93	2.44	3.006(5)	119.1
C(30)-H(30)...O(3)	0.93	2.65	3.322(4)	129.4

Table 6. Interaction energies ( $\text{kJ mol}^{-1}$ ) for title compound between a reference molecule and its neighbours

	N	Symop	R	Electron Density	E_ele	E_pol	E_dis	E_rep	E_tot
	1	-	9.73	HF/3-21G	6.5	-4.5	-21.0	6.9	-9.6
	2	x, y, z	9.42	HF/3-21G	-4.7	-1.8	-11.3	1.0	-15.3
	1	-	7.07	HF/3-21G	-47.5	-16.2	-82.1	40.1	-100.4
	1	-	17.02	HF/3-21G	1.0	-0.8	-7.3	1.5	-4.7
	1	-	18.87	HF/3-21G	5.0	-0.7	-3.4	0.2	1.7
	2	x, y, z	16.04	HF/3-21G	-6.3	-1.7	-11.7	4.0	-14.9
	1	-x, -y, -z	5.85	HF/3-21G	-60.9	-20.3	-124.5	63.6	-135.9
	1	-x, -y, -z	6.29	HF/3-21G	-34.5	-14.1	-108.2	57.9	-94.8
	1	-	9.42	HF/3-21G	2.3	-1.3	-15.9	6.7	-7.4
	1	-x, -y, -z	14.00	HF/3-21G	-1.8	-2.8	-24.3	9.9	-17.5
	1	-	16.24	HF/3-21G	-3.5	-0.6	-10.7	5.6	-9.1
	1	-x, -y, -z	14.17	HF/3-21G	-7.3	-7.7	-17.6	8.8	-21.2
	1	-	9.39	HF/3-21G	-12.3	-4.0	-14.8	6.7	-23.1
	1	-	17.27	HF/3-21G	-0.1	-0.8	-6.9	1.4	-5.7

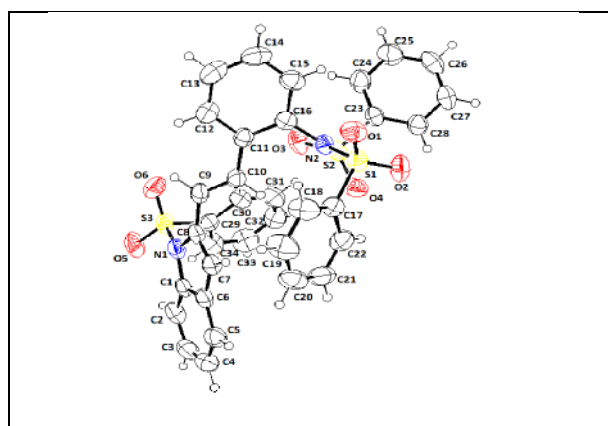


Figure 1 : The ORTEP plot of title compound with the atom numbering scheme.

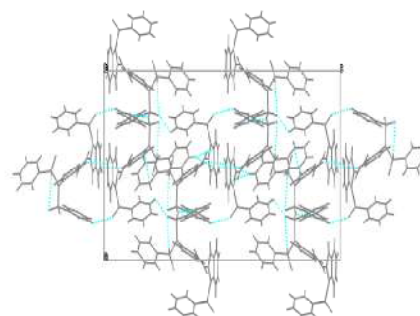


Figure 2: Packing of the molecules for title compound





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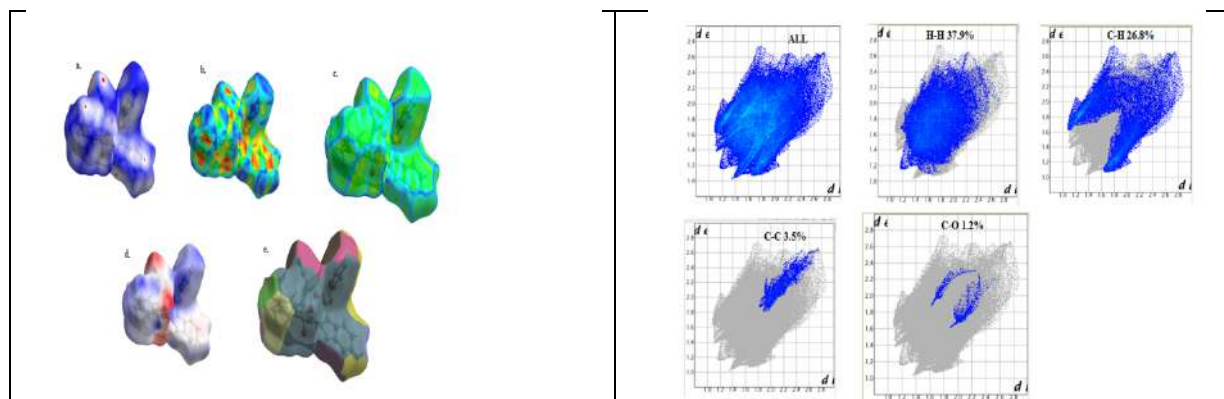


Figure 3. View of the Hirshfeld surface of title compound mapped over (a)  $d_{norm}$  and (b) shape index (c) curvature (d) electrostatic potential (e) fragment patches

Figure 4. Two-dimensional fingerprint plots for (a) all interactions (b) H...H (c) C...H (d) C...C (e) C...O

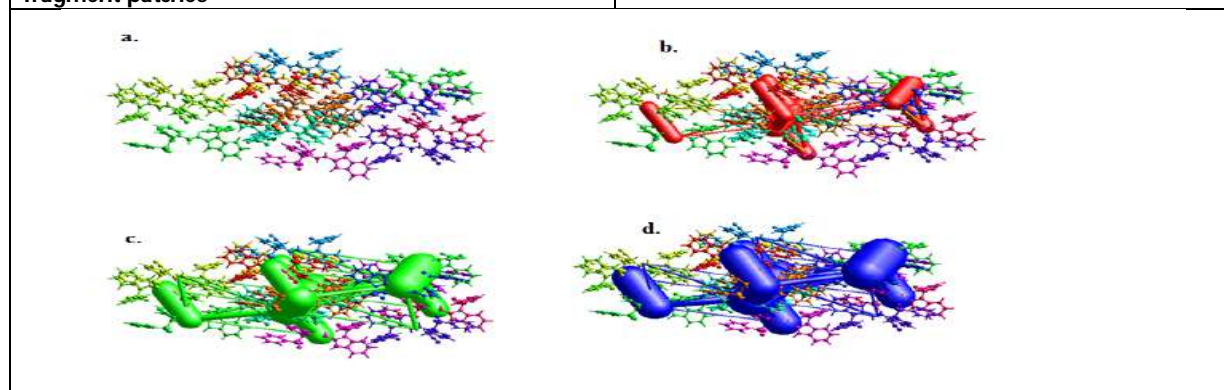


Figure 5. (a) Interactions between the selected reference molecule (highlighted in yellow) and the molecules present in a 3.8 Å cluster around it (b) Coulomb energy framework, (c) dispersion energy framework and (d) total energy framework





## A Review on Herbal Immunomodulators

Priyanka Mishra<sup>1\*</sup>, Chandra Shekhar Tailor<sup>2</sup>, Nikhil Nigi<sup>1</sup> and Kalpana Mishra

<sup>1</sup>Research Scholar in B.Pharm, School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India.

<sup>2</sup>Associate Professor, School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India.

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### \*Address for Correspondence

#### Priyanka Mishra

Research Scholar in B.Pharm,  
School of Pharmaceutical Sciences,  
Shri Guru Ram Rai University,  
Dehradun, Uttarakhand, India.



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### ABSTRACT

The component of immune system including both nonspecific immune system (innate immune responses) and specific immune system (adaptive immune responses) is stimulate or inhibit by the substance known as herbal immunomodulators. There is now research being done worldwide on how different medicinal plant products affect the immune system. It has been asserted that some Indian medicinal plants and several Rasayana have immunomodulatory properties. *Allium sativum*, *Mangifera indica*, and *Tinospora cordifolia*, *Curcuma longa*, *Ocimum sanctum* Linn., *Hibiscus rosa sinensis* Linn. are a few of these plants. There are many more that have yet to be discovered and provide room for additional research.

**Keywords:** Herbal immunomodulators, immuno-stimulation, immuno-suppression.

## INTRODUCTION

In this 21 century the major problem is population growth, increased number of diseases, unemployment and changes in ethical values [1]. Because of development of antibiotic [2] and antiviral resistance [3], the scientific team is focusing on the immunomodulation. Immunomodulation is a process in which change in the body immune system response by the help of synthetic or by natural/herbal agents that inhibits or activate its function. The immune system's uses items made from medicinal herbs has emerged as a potential treatment option popular therapeutic strategy. Since the dawn of civilization, plants and minerals have been utilized to deal a wide variety of illnesses.





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### Immunity

Body's natural defense system opposed to numerous infectious diseases. Previous infection, immunization, and several external stimuli triggers the immunity [4] Immunity is a Latin word 'immunes' which means 'exempt from'. Immunity have the ability to differentiate between body's proteins/cells and forge in agents. After the identification of the forgein substance the joint and interrelate action of specific cells and mediators against foreign substance constituents the immune response. Components which causes stimulation of immune mechanism known as antigens. Entry of unwanted substances is protected by a protein known as antibody (immunoglobulin). Antibody is a Y-shaped protein it identify and neutralize forge in substances.

### Types of Immunity

Acquired immunity / Specific

1) Active

2) Passive

Innate immunity / Nonspecific

### Immunomodulators

Immunomodulators are botanical or man - made agents that can stimulate, suppress or change any characteristic of the immune system which includes both the type of immune system- adaptive and innate immune system.

### Classes of Immunomodulators

Immunosuppressants

Immunoadjuvants

Immunostimulants

### Immunosuppressants

An action that lessens the immune system's activation or effectiveness is known as immunosuppression. Immunosuppression can happen as a negative reaction to the treatment of other illnesses or as a result of the immunosuppressive effects of some immune system components on other immune system components. Immunosuppressants are used to manage severe allergy, autoimmune, and transplant-related disease symptoms. While some medications have a general impact on the immune system, others have specialised targets. However, the efficiency of the more targeted medications may be diminished if their action can be circumvented by alternate metabolic pathways. Drugs having diffuse effects are more likely to have harmful side effects. First recognized immunosuppressant was cortisone but it's use has been restricted due to it's wide range side effects.

### Immunoadjuvants

Immunoadjuvants are added to vaccinations to increase their effectiveness; as such, they could be regarded as particular immune stimulants. The possibility exists that immunoadjuvants will actually be the ones to modulate the immune response. It has been suggested that they could be used as filters between cellular and humoral helper T1 (Th1) and helper T2 cells (Th2), immunoprotective, immunodestructive, and reagenic [immunoglobulin E (IgE)] vs IgG type immune responses, offering a significant challenge to vaccine designers [5].

### Immunostimulants

Immunostimulants are the agents which increases the immune response in order to fight against infections and diseases.

### Type of Immunostimulants

Specific immunostimulators - Generate an immunological response to a particular antigen, such as a vaccination, which is a toxin or other foreign substance that triggers an immune reaction in the body.



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Nonspecific immunostimulators - Are utilised in immunodeficiency and chronic infections and act without regard to antigenic specificity .

**Herbal Immunomodulators**

Scientists have become interested in a number of medicinal plants employed in the conventional Rasayana system of India, which aims to boost the immune system. Numerous medicinal plants exhibit a wide range of antioxidant , antiasthmatic , and antiarrhythmic characteristics in addition to their protective qualities , as will be covered below . Medications for hepatitis , hypocholesterolemia , antifungal , cardiogenic , and diuretic side effects . For instance , Yarrow , Ninjin , and Tulsi . Numerous investigations have documented the discovery of substances that are pharmacologically active and have a modest level of toxicity but also immunomodulatory properties . The most significant method for finding intriguing and practical pharmaceutical compounds is ethnopharmacology in this setting . Tannic acid , flavonoids , tocopherol , curcumin , ascorbate , and carotenoids are just a few of the substances that Rasayana plants' phytochemical study has shown . Numerous substances, including polyphenols, have been found to possess strong immunomodulatory effect. Due to their content in plants that have immune systems that might cooperate , herbal treatments derived from traditional Indian medicine may improve immunity . To comprehend their use both historically and currently, this definition and their lack of toxins may be crucial. The aforementioned review should have made it abundantly evident that numerous medicinal plants can somewhat mimic immunological function in experimental animals.

**Chemical Constituents of Herbal Immunomodulators**

- ⇒ Alkaloids
- ⇒ Glycosides
- ⇒ Flavonoids
- ⇒ Thiosulfinates
- ⇒ Polysaccharides
- ⇒ Volatile oils and terpenoids

**Techniques for Testing Immunological Factors**

- *In vivo* Technique
- *In vitro* Technique
- 1) Inhibition of dihydroorotate dehydrogenase
- 2) Inhibition of T-cell proliferation
- 3) Inhibition of histamine release from mast cells
- 4) Mitogens induced lymphocyte proliferation [25]

**Ginseng**

**Synonyms:** Panax , Pannag , Ninjin

**Biological source:** Dried root of various species of Panax like *Panax ginseng* , *Panax japonica* , *Panax notoginseng* .

**Family :** Araliaceae

**Description:** In East Asia and Russia, Panax ginseng can be found. It is a member of the Araliaceae family. Although it naturally grows in isolated forests in Manchuria and North Korea, other portions of Asia are now over-harvested. It is grown in Korea, China, and Japan for export and therapeutic purposes. The shade-loving, deciduous perennial Panax ginseng has five-lobed leaves, tiny white flowers, red berries, and a yellowish-brown root. It also has red berries. Although all other plant parts contain active ingredients, only the root is used medicinally.

**Chemical constituents:** In Panax ginseng , triterpene glycosides are found . These substances are also referred to as saponins or ginsenosides. Amino acids , alkaloids , phenols , proteins , polypeptides , and vitamins B1 and B2 are among the active compounds found in all parts of the plant .

**Uses:** Ginseng has been employed for a variety of purposes since about 5000 years ago . It has been used to increase focus , improve stress tolerance , and build physical stamina while reducing physical weariness . Asthma , anaemia ,



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diabetes , gastritis , erectile dysfunction , impotence , and male fertility are other conditions for which it is used . Panax ginseng is used to treat a variety of conditions , including menopause-related hot flashes , cancer , insomnia , neuralgia , rheumatism , headache , convulsions , and issues during pregnancy and childbirth . It can also be used to prevent or delay the ageing process [26-28].

***Allium sativum***

Synonym: Garlic , Allium

Biological source : Obtained from bulbs of the plant *Allium sativum* Linn.

Family : Liliaceae

Uses : Antibacterial , stimulant , expectorant , antioxidant , reduces serum lipid level , immunomodulator .

Chemical constituents : 29 % carbohydrates , 0.1 % fat , 56% proteins , 0.06 to 0.1% volatile oil .

***Curcuma longa***

Synonym : Haldi , Indian saffron , Turmeric

Biological source : Turmeric consists of dried as well as fresh rhizomes of *Curcuma longa* linn plant .

Family :Zingiberaceae

Chemical Constituents : Curcuminoids: curcumin ; demethoxy curcumin ; bi demethoxy curcumin , volatile oil , starch

Uses : Anti-inflammatory , anti -depressive , treating common skin ailments .

***Acacia catechu***

Synonym : Cutch Tree , Black Cutch Catechu , Cachou

Family : Mimosaceae

Chemical constituents : Catechin , epicatechin , epigallocatechin , epicatechingallate , phloroglucin , protocatechuic acid , quercetin , poriferasterol glycosides , lupenone , procyanidin , kaemferol , L-arabinose , D-galactose , afzelchin gum , mineral and taxifolin .

Uses : As mouthwash , dental infection , gum , sore throat , gingivitis .

***Tinospora cordifolia***

Synonym : Heart – leaved moonseed , guduchi , giloy .

Family :Menispermaceae

Chemical constituents : Alkaloids , glycosides , steroids , diterpenoid lactones , aliphatic compounds

Uses : Anti – diabetic , anti- cancer , antioxidant , antimicrobial , antitoxic , immunomodulatory

***Terminalia arjuna***

Synonym : Arjuna bark , kakubha , dhavala , white murdh

Biological source : Dried bark of plant *Terminalia arjuna*

Family :Combretaceae

Chemical constituents : Tannins , arjunolic acid , arjunic acid , arjunglycosides , arjungenin

Uses : Anginal pain , hypertension , congestive heart failure , and dyslipidemia .

***Ginger***

Synonym: : Zingiber , Zingiberis.

Biological source: The rhizomes of the plant *Zingiber officinale* are what make up ginger.

Family : : Zingiberaceae.

Description : One of the most popular members of the ginger family (Zingiberaceae), ginger is a rhizome from the plant *Zingiber officinale* and is frequently used as a condiment for a variety of cuisines and drinks. In China and India, ginger has been used medicinally for more than 2,500 years to treat ailments like headaches, nausea, rheumatism, and colds. Although it is grown in the Caribbean islands, Africa, Australia, Jamaica, Taiwan, and India, it is supposedly native to South East Asia.





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Chemical constituents: 0.25-3% volatile oil, 5-8% resinous matter and starch. Zingiberene and Gingerol.  
Uses: cold, migraine, hypertension, nausea [28-29]

***Aloe vera* Tourm. ex Linn**

Synonyms : Aloe, Musabbar, Kumaari

Family :Asphodelaceae

Chemical constituents : Anthracene glycosides, amino acids, minerals, saponins, steroids, sugar

Uses : As purgative, laxative, ulcers, burns, in cosmetics

***Azadirachta indica***

Synonym : Neem, margosa

Family :Meliaceae

Chemical constituents :Nimbidin, nimbin, polysaccharides, cyclic trisulphide, cyclic tetrasulphide, azadirachtin

Uses : Hypoglycemic, antifungal, antibacterial, antipyretic, anti-inflammatory, immunomodulator

***Hibiscus Rosa sinensis* L.**

Synonym : China rose, Hawaiian hibiscus, rose mallow and shoeblack plant, gudhal

Family : Malvaceae

Chemical constituents : Tannins, anthraquinones, quinines, phenols, flavanoides, alkaloids, terpenoids, saponins, cardiac glycosides, protein, free amino acids, carbohydrates, reducing sugars, mucilage, essential oils and steroids

Uses : Antibacterial, antioxidants, anti-hypertensive immunity booster, lower blood sugar, lower cholesterol.

**Immune-Boosting Formula That is Sold Commercially**

Numerous immune-boosting and health-promoting herbal medications are sold in the market in the form of powders, tablets, capsules, juices, syrups, extracts, chyawanprash, drops, tea, and more. These products are intended for both adults and children and have a number of advantages, including improved strength and stamina, relief from colds and coughs, and blood purification [30]

Numerous herbal medications that process immunomodulatory activity are mentioned in this review. An individual's body system depends on the immunomodulatory action of herbal medicines, which is the word used to refer to every condition that results in mortality globally. As a result, we must concentrate on the immunomodulatory properties of herbs and take a fresh look at their protective functions in order to develop more specific solutions for phytomedicine research and the development of new treatments for this type of illness. A higher level of protective antibodies against various infections, as well as the production and development of a more potent cell-mediated immune response for defense against a variety of bacterial, viral, and other diseases, may be obtained by using various plant extracts and herbal fed additives in a specific dose during the scheduled vaccination regimen. As a result, using herbal formulations as effective immunomodulators may be advised. Numerous botanical compounds have the potential to be used therapeutically due to their great efficacy, low cost, and minimal toxicity. This article provides a general summary of the many herbal medications and immune system boosters that can be utilised to potentially safeguard a person's health and immune system. However, it is safe to say that herbal remedies have a great deal of potential to produce some extraordinary pharmaceuticals.

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**List of Herbal Immunomodulators [6-24]**

Plant name	Common name	Tissue	Chemical constituents
<i>Allium sativum</i>	Garlic	Bulbs	Allicin
<i>Aloe vera Tourn. ex Linn</i>	Kumaari	Gel from leaves	Anthraquinone glycosides
<i>Acacia catechu Willd.</i>	Cutch Tree , Black Cutch Catechu , Cachou	Leaf	Tannins and flavonoids
<i>Curcuma longa</i>	Turmeric	Rhizome	Curcumin
<i>Citrus aurantifolia</i>	Key lime	Fruits	Volatile oils
<i>Tinospora cordifolia Miers.</i>	Guduchi	Entire herb	Alkaloids
<i>Trapa bispinosa</i>	Water chestnut	Fruits	Flavonoids , proteins , and Carbohydrates









<i>Terminalia arjuna Roxb.</i>	Arjun tree	Leaves and bark	Flavonoids , oligomeric Proanthocyanidins , and Tannins
<i>Panax ginseng Wall.</i>	Asian ginseng , Chinese ginseng or Korean ginseng	Fruits and root	Ginsenosides, panaxdiol, panaxtriol, and oleanolic acid
<i>Piper longum L.</i>	Indian long pepper or thippali	Fruits	Alkaloids
<i>Mangifera indica</i>	Mango, aam	Stem bark	Alkaloids , tannins , and Flavonoids
<i>Moringa oleifera L</i>	Drumstick tree	Leaves	Vitamin A, B, C, carotenoids, and saponins
<i>Morus alba Linn.</i>	White mulberry, common mulberry and silkworm mulberry	Fruits , leaves , and bark	Flavonoids , anthocyanins
<i>Ocimum sanctum Linn.</i>	Tulsi	Entire plant	Essential oils such as eugenol Carvacrol, derivatives of ursolic acid , apigenin
<i>Urena lobata Linn</i>	Caesarweed or Congo jute	Fruits	Flavonoids and glycosides

Sr.No.	BRAND NAME	ACTIVE INGREDIENTS	DOSAGE FORMS
1.	Dabur Ltd.	Ginger, Guggul	Powders
2.	Himalaya global holding Ltd.	Shatavari, Punarnava	Capsules
3.	Patanjali Ayurveda Ltd	Ashoka, Amaki, Tulsi	Syrups
4.	Zandu reality Ltd.	Amla, Neem	Juices
5.	Zandu reality Ltd.	Chawanprash, Avleha	Pastes
6.	Dabur Ltd.	Ashwagandha, Giloy, Haldi, Amla	Tablets





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<div style="border: 1px solid #0056b3; padding: 5px;"> <p><b>Parts</b></p> <ul style="list-style-type: none"> <li>Cellular immunity</li> <li>Humoral immunity</li> <li>Immunoglobulin</li> </ul> </div> <div style="border: 1px solid #0056b3; padding: 5px; margin-top: 5px;"> <p><b>Of</b></p> <ul style="list-style-type: none"> <li>Spleen</li> <li>Thymus</li> </ul> </div> <div style="border: 1px solid #0056b3; padding: 5px; margin-top: 5px;"> <p><b>Immune system</b></p> <ul style="list-style-type: none"> <li>Lymphocytes</li> <li>Lymph nodes</li> </ul> </div>		
<p><b>Fig.1. Immunity System</b></p>	<p><b>Fig.2. garlic</b></p>	<p><b>Fig.3. Turmeric</b></p>
		
<p><b>Fig. 4.ginger</b></p>	<p><b>Fig.5. Aloe vera Tourn. ex Linn</b></p>	<p><b>Fig. 6. Hibiscus Flower</b></p>
		
<p><b>Fig.7. Amla</b></p>	<p><b>Fig.8. Ashwagandha</b></p>	<p><b>Fig.9. Chawanprash</b></p>





## A Review on Herbs used in Polycystic Ovary Syndrome

Kalpana Mishra<sup>1\*</sup>, Bhawana Bhatt<sup>2</sup>, Sudhakar Kaushik<sup>2</sup>, Priyanka Mishra<sup>1</sup> and Nikhil Negi<sup>1</sup>

<sup>1</sup>B.Pharm Student, Shri Guru Ram Rai University, Dehradun, Uttar Pradesh, India

<sup>2</sup>Assistant Professor, Shri Guru Ram Rai University, Dehradun, Uttar Pradesh, India.

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### \*Address for Correspondence

#### Kalpana Mishra

B.Pharm Student,  
Shri Guru Ram Rai University,  
Dehradun, Uttar Pradesh, India



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### ABSTRACT

The polycystic ovary syndrome (PCOS) an endocrinopathy disorder. It is characterised by polycystic ovaries, increased androgen levels, anovulation. Approx 5%-7% of reproductive women are prone to diagnosed with PCOS. Anovulation leads to infertility. Women with PCOS have insulin resistance caused by obesity. Various plants are used in treatment of PCOS such as *Gymnema*, *Linum usitatissimum*, *Aloe barbadensis*. In this review, some plants along with their effect on PCOS, symptoms of PCOS will be summarized.

**Keywords:** Polycystic ovary syndrome, endocrinopathy, polycystic ovaries, anovulation.

## INTRODUCTION

### Polycystic Ovarian Syndrome

Polycystic ovary syndrome is the most common syndrome in women seen throughout the world, mostly in Asians. It is a hormonal disorder and has multiple components such as reproductive, metabolic, and cardiovascular. Women with PCOS suffer through chronic anovulation, increased androgen level (hyperandrogenism) [1]. Insulin resistance is the major significance and inhibition of hepatic sex hormone. PCOS was first described by Stein and Leventhal in 1935. It can further lead to physiological impairments. Insulin resistance can cause hyperinsulinemia which can further result in altered androgen production and metabolism in reproductive age [2]. The syndrome can cause infertility, also known as Stein-Leventhal syndrome, obesity, type 2 diabetes mellitus, cardiovascular disease and eating disorders [3]. Treatment is mainly focused on lifestyle modifications, diet monitoring, weight reduction and exercise. Spironolactone and finasteride are used to treat hyperandrogenism, infertility can be treated by clomiphene, laparoscopic ovarian drilling, ovary induction can be achieved by use of metformin, oral contraceptives are used to treat irregular menstruation [4]. Such treatments can cause adverse side effects, gastrointestinal symptoms, weight gain, increased insulin resistance. These adverse side effects further lead to herbal medicines studies and investigations. Many herbal medicines have been reported useful in PCOS and showed significant results in the treatment of PCOS.





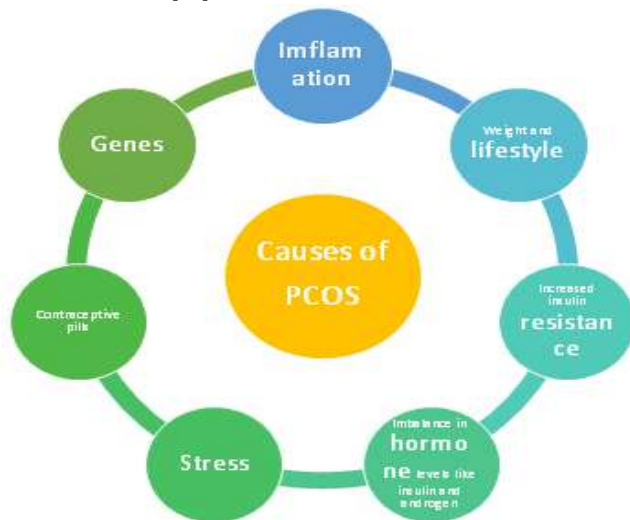
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**Symptoms**

Symptoms of PCOS can start from first menstrual period or can be developed later. Symptoms can vary from one female to other. Following symptoms have been reported in polycystic ovarian syndrome and one need suffer from atleast two symptoms to be diagnosed with PCOS- [29]

- Irregular periods
- Excess body hair
- Weight gain
- Thinning hair
- Small pieces of excess skin on neck or armpits
- Acne or oily skin
- Prolonged periods
- Darkening of skin
- Fatigue
- Fluid retention
- Ovaries with cysts
- Infertility

**Causes of PCOS**[38] The accurate cause of PCOS is unknown. Few known causes are-



**Diagnosis of PCOS**

- Ultrasound
- Pelvic exam
- Blood test

**Pathophysiology**

The hypothalamic-pituitary axis, insulin secretion and action, and ovarian function are all main targets for PCOS pathogenesis [5]. Obesity and insulin resistance have been linked to PCOS, despite the fact that the exact reason is



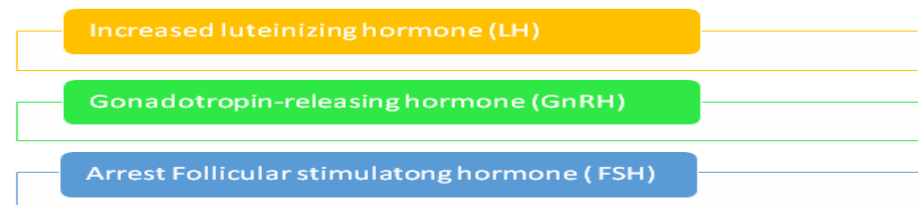


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uncertain. Since excess insulin causes the ovaries to produce androgens, which can cause anovulation, the link with insulin function is to be expected. Insulin regulates ovarian function [6]. One of the telltale signs of ovarian abnormalities is the stop of follicular maturation.

#### Clinical Signs of PCOS Include

The rise in GnRH results in production of androgens by stimulating ovarian thecal cells. FSH levels can be increased naturally or exogenous FSH can be given to treat follicular arrest. Prolactin levels are high in about 25% of PCOS patients. In order to normalise the levels of sex hormone-binding globulin (SHBG), therapeutic measures are intended to lower insulin levels and ovarian androgen production. SHBG level increase can be used in PCOS symptoms management. Patients with PCOS produce more testosterone, progesterone, and 17-hydroprogesterone from their thecal cells than healthy patients do. Patients with PCOS who have high amounts of the cytochrome P450 (CYP) 11A, 3-HSD2, and CYP17 genes have altered versions of these cells. 12 Although it is not necessary for diagnosis, obesity is a common comorbidity of PCOS [7].



#### Overview of steroidogenesis- Biochemical and Molecular

In both the gonads and the adrenal glands, cholesterol side-chain cleavage, which is catalysed by the enzyme cytochrome P450<sub>scc</sub> (encoded by CYP11A), is the rate-determining step for the production of all steroid hormones in response to tropic hormones [8]. LH activates the steroidogenic acute regulatory protein, which transports cholesterol into mitochondria, speeding up the ovarian steroidogenic response, which was initially delayed in the early follicular phase [9]. The rate-limiting enzyme for the synthesis of androgens in the gonads and adrenal cortex is cytochrome P450<sub>c17</sub> (CYP17A1) [10]. Its expression is wholly reliant on the stimulation of tropic hormones, specifically dose-dependent LH in the ovary and dose-independent ACTH in the adrenal cortex. The 17-hydroxylase and 17,20-lyase activity are both present in one single enzyme. Both cortisol in the adrenal cortex and powerful sex hormones in the gonads are produced by the first of these processes, 17-hydroxylase. Inefficiently, the second of these activities, 17,20-lyase, sequentially converts 17-hydroxylated substrate coupled to the enzyme into 17-ketosteroids such dehydroepiandrosterone (DHEA) or androstenedione. Parallel P450<sub>c17</sub> 17-hydroxylation of progesterone results in 17OHP. Androstenedione production has been observed in ovarian and adrenal homogenates and minces, despite the fact that 17OHP is a poor substrate for P450<sub>c17</sub> 17,20-lyase activity in theca cells or cell-free systems [11] it is possible that paracrine interactions with granulosa cells might increase 17,20-lyase activity for this substrate, or that another enzyme might be responsible for this activity [12]

#### Control of Ovarian Activity

The production of estradiol uses androgens as more than just necessary intermediates. Additionally, they have complicated effects on follicular growth, such as an increase in aromatase activity [13]. In order for these processes to be optimal for ovulation, ovarian androgen secretion must be synchronised with the production of oestrogen. The coordinated operation of the ovarian follicle depends on a range of intrafollicular modulators, despite the fact that these processes are highly dependent on LH and FSH concentrations.

- Gonadotropin secretion control
- controlling ovarian steroidogenesis
- Regulation of folliculogenesis
- control over the production of adrenal androgen
- control on the synthesis of peripheral androgens



**Kalpana Mishra and Bhawana Bhatt****Herbs Used FOR PCOS Medicines*****Vitexagnus-castus*(Chaste berry)**

A native of the Mediterranean, *Vitexagnus-castus* is also known as vitex, chaste tree (or chaste tree), chaste berry, Abraham's balm, lilac chaste tree, or monk's pepper. In *Vitexagnus-castus*' chemical investigation, flavonoids (vitexin, casticin), iridoid glycosides (agnuside, aucubin), p-hydroxybenzoic acid, alkaloids, essential oils, fatty oils, diterpenoids, and steroids have all been found. They can be found in the leaves and the fruits [14] *Vitexagnus-castus* has been shown to reduce prolactin, enhance menstrual regularity, and treat infertility in preclinical and clinical studies. There are several substances in *vitexagnus-castus* that bind to dopamine type 2 (DA-2) receptors in the brain, reducing prolactin production and cyclic adenosine monophosphate (cAMP) levels [15]. After three months of *Vitexagnus-castus* medication, the mean prolactin concentrations considerably decreased from 946 mIU/l (173) to 529mIU/l (297) (p 0.001).

***Asparagus racemosus*(Shatavari)**

*Asparagus racemosus* also known as satvar ,shatavari or shatamull, shatawari is a variety of asparagus that can be found all over India and the Himalayas and Northern Australia [16] It can reach heights of 1-2 m (3 ft 3 in to 6 ft 7 in) and loves to establish itself in stony, gravelly soils high in the piedmont plains, at an elevation of 1,300-1,400 m (4,300-4,600 ft) [17] It is highly preferred traditionally in Indian medicine. Due mostly to its phytoestrogen (natural plant-based oestrogen), which helps to promote healthy ovarian follicle development, regulate the menstrual cycle, and regenerate the female reproductive system [18]

***Glycyrrhizaglabra* (Licorice)**

*Glycyrrhizaglabra* Fabaceae flowering plant whose root can be used to make a flavouring that is sweet and aromatic. In the luteal phase of the menstrual cycle, nine healthy women between the ages of 22 and 26 examined the impact of licorice on androgen metabolism. They received 3.5 g of a commercial licorice preparation with a glycyrrhizic acid content of 7.6% W/W every day for two cycles [19]. They weren't receiving any further medical care. Aldosterone, cortisol, serum adrenal and gonadal androgens, and plasma renin activity were using radioimmunoassay to measure. Within two months, the total serum testosterone level gradually fell. Licorice can lower serum testosterone, most likely as a result of the enzymes 17-hydroxysteroid dehydrogenase and 17-20 lyase being blocked. Licorice may be used as a complementary treatment for hirsutism and polycystic ovary syndrome.

***Aloe barbadensis*( Aloe vera)**

In a study, the effectiveness of an Aloe vera gel formulation was evaluated in a rat model of PCOS. Female Charles Foster rats aged five months were fed orally inducing PCOS with the non-steroidal aromatase inhibitor letrozole. The Aloe vera gel formulation was then administered to the rats orally in a quantity of 1 ml daily for 45 days. This returned their glucose and estruscyclicity , sensitivity, and steroidogenic activity [20]. Aloe vera gel therapy of the inductive drug (letrozole) inhibited the emergence of the PCOS phenotype. By restoring the ovarian steroid status and changing important genes, aloe vera gel formulation protects against the PCOS phenotype and changed steroidogenicbehaviour.

***Linumusatissimum* (Flax seed)**

It is grown as a food and fibre crop in temperate climate zones around the world. Its oil is referred to as linseed oil. In a study, the hormonal responses to flaxseed supplementation (30 g/day) in a 31-year-old PCOS patient were noted. The patient consumed 83% of the recommended flaxseed dose over the course of four months. Fasting blood samples and height-weight measurements conducted at baseline and at 4-month follow-up revealed a substantial decline in levels of insulin, total and free serum testosterone, body mass index (BMI), and insulin. At the end of the research period, the patient also noted a reduction in hirsutism. A clinically substantial drop in androgen levels and a corresponding drop in hirsutism were both documented in this case study [21].





**Kalpana Mishra and Bhawana Bhatt*****Gymnemasylvestre*(Gymnema)**

Traditional Ayurvedic herb *gymnema* supports weight loss and is used as an anti-diabetic, hypoglycemic, lipid-lowering, and hypoglycemic agent. Possible trophorestorative effects of *gymnema* on the beta cells of the pancreas. Leaf is used for medicinal purposes. Due to its ability to modulate insulin and the additional advantages of lowering the high triglycerides related to PCOS, *gymnema* is a good candidate for treating PCOS [22-24] Saponins, particularly *gymnemic* acids, are important *Gymnema* components. *Gymnemic* acid conceals the sweet flavour when taken before food since it lowers the sweet taste on the taste buds. *Gymnema* is taken orally as 3.5 to 11 mL of 1:1 liquid extract daily. One of the most important herbs for the therapy of the underlying cause of insulin resistance may turn out to be *gymnema*.

***Foeniculumvulgare* (Fennel)**

A species of blooming plant in the carrot family is fennel. It is a tough perennial herb with feathery leaves and yellow flowers. It is native to the Mediterranean coasts, but it has spread widely around the world, especially on dry soils near the sea and on riverbanks. Fennel seeds contain anti-hirsutism characteristics and are thought to help treat PCOS by lowering levels of androgen (male hormones) [25].

***Cinnamomumverum* (Cinnamon)**

Cinnamon extract has been demonstrated in both in vitro and in vivo experiments to decrease insulin resistance by enhancing the insulin signalling pathway's phosphatidylinositol 3-kinase activity and amplifying the effects of insulin. For eight weeks, 15 PCOS patients were randomly assigned to receive either daily oral cinnamon or a placebo [26] Fasting and 2-hour oral glucose tolerance tests used to compare post-treatment to baseline insulin sensitivity indices revealed significant improvements in insulin resistance in the cinnamon group but not in the placebo group indices revealed significant improvements in insulin resistance in the cinnamon group but not in the placebo group.

***Urticadioica* (Stinging Nettle)**

In order to assist balance hormone levels, the root of this plant boosts the formation of SHBG (sex hormone-binding globulin), which lowers the amount of free testosterone in the blood. In women with polycystic ovarian syndrome, SHBG is frequently low.

**Adverse Effects:** Nettle root shouldn't be consumed over a lengthy period of time due to potential side effects. If you are on a blood pressure-lowering drug or diuretics, avoid using this herb because it can drop blood pressure.

***Trifoliumpretense* (Red Clover)**

This herb contains isoflavones, which, once inside the body, transform into phytoestrogens [27]. Thus, red clover mimics the effects of oestrogen. Red clover is used to treat acne brought on by diseases like polycystic ovarian syndrome and purify the blood.

**Adverse Effects:** Headaches, nausea, vaginal bleeding, muscle aches, and rashes have all been linked to red clover. Avoid using this herb if you have any disorders that are made worse by oestrogen exposure, such as endometriosis, breast cancer, ovarian cancer, or if you are pregnant or nursing.

***Phyllanthusemblica* (Amla)**

Its natural habitat is throughout southern and tropical Asia. Amla does wonders to reduce cholesterol and aid in detoxification. The body's hormonal balance can be restored with the aid of its anti-inflammatory and free radical scavenging properties.

**Green Tea**

The strong antioxidants found in green tea, specifically catechins, are what reduce the hormone levels that cause ovarian cysts and other associated symptoms. The antioxidants found in green tea also reduce insulin levels. The weight increase that is frequently associated with PCOS is also impacted by daily green tea consumption, which also aids in losing this extra weight.



**Kalpana Mishra and Bhawana Bhatt*****Sesamum indicum* (Sesame)**

It is farmed for its edible seeds, which grow in pods, and is widely naturalised in tropical areas all over the world. Blood glucose levels are regulated by the beneficial fats in it. It is rich in calcium, magnesium and zinc.

***Cucurbita* (Pumpkin)**

The beneficial omega-3 fatty acids found in pumpkin seeds can also help control the elevated insulin and cholesterol levels associated with PCOS. Additionally, they contain beta-sitosterol, which reduces excess androgens and treats PCOS symptoms like hirsutism, acne, and weight gain [28].

***Curcuma longa* (Turmeric)**

In female Wistar rats with Letrozole-induced PCOS, curcumin shown therapeutic effects. Its effects were comparable to those of Clomiphene citrate, the drug most frequently used to induce ovulation in PCOS patients.

***Tinospora cordifolia* (Guduchi)**

A well-known medicinal plant in the Menispermaceae family for its hypoglycemic properties is *Tinospora cordifolia*. The herb *Tinospora cordifolia* has potent anti-inflammatory properties. Insulin dysregulation and ovarian cysts are mostly caused by chronic inflammation in the tissues. It aids in reducing insulin resistance, rejuvenating all body tissues, and naturally enhancing metabolism [30]

***Ocimum tenuiflorum* (Basil)**

Tulsi is a traditional herbal remedy made from the plant *Ocimum tenuiflorum* L. (Lamiaceae). *Ocimum tenuiflorum* may be useful in treating polycystic ovarian syndrome. It has great anti-androgenic qualities that help reduce androgen production (hyperandrogenism). Additionally, they have a number of medicinal uses and show promise in the treatment of obesity and its associated conditions [31].

***Lepidium meyenii* (Maca)**

*Lepidium meyenii*, a member of the Brassicaceae family, is a traditional herbal remedy used to treat menopausal symptoms. It also stimulates the endocrine system and acts as a safe, natural hormone balancer. The body's progesterone and oestrogen hormones aid in promoting a regular menstrual cycle. It is a powerful superfood for fertility and an adaptogen. Males' testosterone levels are raised by *Lepidium meyenii* [32]

***Areca catechu* (Betel Palm)**

Female hormone production is gently maintained by *Areca catechu* (Arecaceae), which also calms clogged blood vessels in the abdomen. *Areca catechu* supports a healthy libido and menopause transition while preserving a healthy female reproductive system. It aids in boosting the uterus' retentive capacity and is employed to treat postpartum debility [33]

***Grifola frondosa* (Maitake Mushroom)**

A perennial fungus known as *Grifola frondosa* (Meripilaceae) has a well-known hypoglycemic impact and may be helpful in the treatment of diabetes. In animal experiments, *grifolafrondosa* extract was able to trigger ovulation in women with polycystic ovarian syndrome (PCOS). *Grifolafrondosa* is thought to work by modulating blood glucose levels and improving insulin sensitivity [34]

***Taraxacum officinale* (Dandelion Root)**

An efficient liver detoxifier and stimulator of bile flow is *Taraxacum officinale* (Asteraceae). It is utilised to eliminate any hormone accumulation and cleanse the liver. Because menstruation irregularities are frequently caused by the liver, which is backed up with too many hormones, this cleaning up can boost the creation of SHGB, which lowers the free testosterone in the blood and is utilised in PCOS treatment. Additionally, it aids in the clearance of toxins from the body, assisting women who struggle with menstruation and fertility troubles [35]



**Kalpana Mishra and Bhawana Bhatt*****PergulariaDaemia* (Veliparuthi)**

The Asclepiadaceae plant *Pergulariadaemia* is referred to as "Veliparuthi" in Tamil and "Uttaravaruni" in Sanskrit. *Pergulariadaemia* has historically been used for its many medicinal properties. It may help to normalise irregular menstrual cycles and maintain a regular estrous cycle. Therefore, the return of the estrous cycle slows the growth of follicular cysts. According to Poornima *et al.*, PCOS-induced albino wistar rats showed lower levels of LDL, FSH, LH, Estradiol, Progesterone, and testosterone. However, upon supplementation with *Pergulariadaemia*, the levels of LH and FSH returned to normal [36]

***Galegaofficinalisi* (Goats Rue)**

More clinical research is needed to determine *Galegaofficinalisi*'s (Fabaceae) therapeutic effects on women with polycystic ovarian syndrome. *Galegaofficinalisi* was developed into guanidine, a chemical that lowers blood sugar by reducing insulin resistance, and has been used since the Middle Ages to alleviate the symptoms of diabetes mellitus. However, it is the natural source of guanidine, a biguanide medication used to treat diabetes. The biguanide medication class includes Metformin, which is frequently prescribed for PCOS. This connection alone should prompt a second study at this plant as a potential treatment for polycystic ovarian syndrome [37]

**CONCLUSION**

An increasingly prevalent medical problem today is an ovarian cyst. Natural ovarian cyst therapies from herbs can be utilised in conjunction with other medications you are taking in both benign and malignant situations. These herbs enhance the effectiveness of other treatments, and in some cases, their potency is sufficient to treat ovarian cysts naturally on their own. The body's immunity is increased by herbal medications, which also regulate the menstrual cycle without causing hormonal levels to fluctuate. In India, a variety of different herbal supplements are used to control the menstrual cycle, including the Evcaresyrupcapsule and Geriforte pills from Himalaya Healthcare, M2 Tone Forte syrup from CharakPharma, Mensta syrup from Dabur India, and Mensonorm capsule from Mensonorm (ChirayuPharma). Ovarian cysts are not only treated but also prevented by these herbal supplements. While it can take some time for herbal supplements to treat PCOS, regular use could help the condition at its source. The medicinal herbs we studied have a variety of possible health benefits for polycystic ovarian syndrome, insulin resistance, hyperandrogenism, oligo/amenorrhea, and obesity. Therefore, additional pre-clinical and clinical research are needed to investigate the efficacy of herbal medications in PCOS. The effectiveness of medicinal plants for the more effective treatment and management of polycystic ovarian syndrome is better understood with the aid of this review.

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**Table 1. Other Herbs used in Polycystic Ovary Syndromes: [39-44]**






SN NO.	COMMON NAME	BOTANICALNAME	FAMILY	PART USED	CHEMICAL CONSTITUENT	USES OTHER THAN PCOS
1.	Bitter melon	<i>Momordicacharantia</i>	Curcubitaceae	Fruit	Glycoside, resin	Anti diabetic, Amenorrhoea
2.	Indian madder	<i>Rubiaccordifolia</i>	Rubiaceae	Root	Phenolic compounds	Dysmenorrhoea, Menopause, Menorrhagia,
3.	Angelica	<i>Angelica glauca</i>	Umbelliferae	Root	Coumarin, Sesquiterpene	Liver and Heart disorder
4.	Myrrh	<i>Commiphoramolmol</i>	Burseraceae	Oil	Volatile oil	Laxative, Anti-inflammatory
5.	Cumin	<i>Cuminumcyminum</i>	Umbelliferae	Fruit	Volatile oil	Digestant
6.	Rose	<i>Rosa spp</i>	Rosaceae	Flower	Carotenoid	Perfumary
7.	Black seed	<i>Nigella sativa</i>	Ranunculaceae	Seeds	Fatty acid	Anti oxidant
8.	Colic root	<i>Dioscoreavillosa</i>	Dioscoreaceae	Root	Steroidal saponin	Rheumatism
9.	Kelp	<i>Nereocystisleutkeana</i>	Laminariaceae	Seaweed	Algin	Hormone balance
10.	Dandelion root	<i>Taraxacumofficinale</i>	Asteraceae	Whole plant	Germacronalide	Bitter
11.	Bladder wrack	<i>Fucusvesiculosus</i>	Fucaceae	Aerial part	Iodine	Cosmetics





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12.	Sqauw vine	<i>Mitchellarepens</i>	Rubiaceae	Aerial part	Resin	Cosmetics
13.	Oat straw	<i>Avena sativa</i>	Poaceae	Seed leaves	Carbohydrate	Food
14.	Mugwort	<i>Artemisia vulgaris</i>	Asteraceae	Seed oil	Essential oil	Antidote
15.	Blue cohosh	<i>Caulophyllumthalicroides</i>	Berberidaceae	Root, Rhizome	Saponin	Female problem
16.	Dong quai	<i>Angelica sinensis</i>	Apiaceae	Root	Coumarine	Female problems, Anti coagulant
17.	Hops	<i>Humuluslupulus</i>	Cannabinaceae	Female cons	Essential oil	Flavouring agent
18.	Alfalfa	<i>Medicago sativa</i>	Fabaceae	Seed	Protein	Anti oxidant
19.	Sarsaparilla	<i>Smilax officinalis</i>	Smilacaceae	Rhizome	Resin	Anti oxidant
20.	Saraca	<i>Saracaindica</i>	Fabaceae	Flower, leaves	Tannin	Uterine tonic

		
<b><i>Aloe barbadensis</i>( Aloe vera)</b>	<b><i>Linumusatissimum</i> (Flax seed)</b>	<b><i>Foeniculumvulgare</i> (Fennel)</b>
		
<b><i>Cinnamomumverum</i>( Cinnamon)</b>	<b><i>Phyllanthusemblica</i> (Amla)</b>	<b><i>Sesamumindicum</i>( Sessame)</b>
		
<b><i>Cucurbita</i>(Pumpkin)</b>	<b><i>Curcuma longa linn</i>(Turmeric)</b>	<b><i>Ocimumtenuiflorum</i>( Basil)</b>





## A Status Review of Research Opportunities for Next Generation Mobile Communication Network

Amarsinh Baburao Farakte<sup>1,2\*</sup> and K.P.Sridhar<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of E & TC Engineering, Sant Gajanan Maharaj College of Engineering Mahagaon, *Gadhinglaj (Maharashtra), India*

<sup>2</sup>Ph.D, Scholar, Department of Electronics and Communication Engineering, Karpagam Academy of Higher Education, Coimbatore - 641021, Tamil Nadu, India

<sup>3</sup>Professor, Department of Electronics and Communication Engineering, Karpagam Academy of Higher Education, Coimbatore -641021, Tamil Nadu, India.

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### \*Address for Correspondence

#### Amarsinh Baburao Farakte

Assistant Professor,

Department of E & TC Engineering,

Sant Gajanan Maharaj College of Engineering Mahagaon,

*Gadhinglaj (Maharashtra), India*

Ph.D, Scholar, Department of Electronics and Communication Engineering,

Karpagam Academy of Higher Education,

Coimbatore - 641021, Tamil Nadu, India.

E.Mail: faraktesir@gmail.com



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### ABSTRACT

In this article, the study has been done for primary obstacles and opportunities to operate with 5th generation (5G) mobile communication network. The next generation wireless networks must be robust, scalable, and energy efficient, while providing users with high-quality, low-cost services. Wireless spectrum capacity is being depleted as the market for high-quality telecommunication networks and applications grows. The industrial, scientific, and medical (ISM) bands are experiencing rising channel demand and dispute, resulting in a scarcity of spectrum. The utilisation of spectrum demand and techniques such as the use of multi radio access technology (RAT), multi-antenna, multi-carrier schemes, machine learning, and the most optimised routing algorithm for power management and energy efficiency are taken into account in the design of next generation network typologies such as long term evaluation (LTE) and 5G. However, with all of the characteristics to handle these emerging demands, the key area for next generation wireless network designs is improved utilisation of spectrum, resource allocation and design of optimized routing algorithm.

**Keywords:** 5G, ISM, LTE, RAT, M-MIMO, MM.





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## INTRODUCTION

The 5th Generation (5G) mobile network is a significant revolution in the world of mobile communication for obtaining larger data rates, with improvements in data rates, speed of operation, and coverage area far beyond individuals' expectations [1]. The ultra-high-speed operational capabilities of the future generation network transformed the definition of cell phone usage [2]. The next generation wireless networks should be robust, scalable, and energy efficient, while providing users with high-quality, low-cost services [2]. The next generation of mobile networking standards promises to increase end-user experience by giving the exceptionally high data rates and coverage with low latency and enhanced overall performance in terms of spectral efficiency and node carrying network capacity [2]. An increase in spectral efficiency is dependent on the data rate and energy consumed by the specific node to provide the best solution. An algorithm in which higher energy consumption with more energy efficient network utilisation must be deployed; 5G enables the services offered by long-term evolution (LTE) in a more systematic manner, as well as bringing new revenue opportunities for the telecom industry by leveraging new solutions that LTE could not provide to society. [3]. The key advantages of 5G are expanded multimedia system options, zero latency, shorter time intervals, superior sound, and high-definition (HD) video streaming capability without compromising audio and video standards and quality. The figure 1 illustrates the network architecture because the IP link communicates with the outside internet world, each radio technology is analysed separately. IP addressing-based systems ensure adequate data frame control for optimal routing of IP packets associated with specific user connections. The protocol architecture of 5G is depicted in Figure 2, where the application layer has a collection of protocols that emphasize process-to-process communication across an IP network and provides a fixed communication interface and services.

Network layer defines the routing path in the network and is categorized into two sub layers i) Lower and ii) Upper [4]. Open transport layer performs the operation of managing the different sessions with transparent transfer of information between the nodes, despite the applications, several challenges were addressed by Xiaofei Wang et al. [4] and Tianqing Zhou et al. [5] discussed the design constraints of efficient 5G network as summarized; Reduction in interference expecting high demand to work with next generation wireless network, effective traffic shaping for better congestion control and improvement in data rate, extensive implementation of various modulation schemes for enhancing throughput and effective power management scheme to enhance the efficiency.

The network layer defines the routing path in the network and is divided into two sublayers: i) Lower and ii) Upper [4]. Despite the applications, several challenges were addressed by Xiaofei Wang et al. [4] and Tianqing Zhou et al. [5] discussed the design constraints of efficient 5G network as summarized; reduction in interference expecting high demand to work with next generation wireless network, effective traffic shaping for better congestion control Data rate improvement, broad use of multiple modulation schemes to increase throughput, and an effective power management scheme. Table 1 provides a detailed literature review of energy-efficient design and performance improvements for 5G networks [6-31]. Table 1 shows that understanding the receiver characteristics while constructing the network is critical, and handover difficulties must be addressed correctly [10]. The usage of M-MIMO and NOMA in conjunction with machine learning technologies for determining routing strategy would undoubtedly increase the performance of 5G networks [19].

### 5G Architecture

Although 5G technology compatible mobile phones are already in the market, the 5G structure is still under research [13]. The spectrum range is defined as millimetre waves from 30 GHz to 300 GHz, with millimetre (MM) waves being the less utilised and new band suitable for next generation mobile communication. The high frequency wave carries the maximum data at higher speed. This structure distinguishes the performance of MM waves than the others type of frequencies [14].





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The M-MIMO idea employs a high number of antennas at base stations to service the different user interface nodes/terminals, which enhances the total coverage area capabilities of the future generation mobile communication network. A review on massive MIMO addresses the existence of various channel losses [20] whereas problem associated in hardware implementation case studies elaborated in [21]. The small cell network is used to reuse spectrum and increase network capacity [13]. The development of a small cell network is a simple and straightforward operation; nevertheless, the small cell design suffers from variations in signal intensity owing to barriers, as high frequency signals have a low amplitude. As a result, it is difficult to overcome these obstacles, and thus the connection is lost [23]. Beamforming is the major upgrade employed in the 5G as in 4th Generation (4G) the transmitted signal is not Omni-directional. As a result, the signal tends to lose its energy more quickly. To make matters worse, users may interfere with each other if they are standing close to each other, making transmission between user and base or cell station more directional, which can be visualised as laser beam communication between the cell station and user terminal [24].

Higher beamforming density results in reduced interference and lower energy usage, allowing for quicker data rates [29]. Traditional multiple access strategies do not produce satisfactory results for next-generation mobile communication. Hence the unique approach NOMA will be employed to attain the good spectral efficiency low latency with high coverage area as mentioned in [18]. NOMA allows numerous nodes to share frequency, time, and code for specific operations. It also allows for the usage of orthogonality in node power levels, which perfectly solves the power optimization challenges stated in [19,22]. The majority of cloud-hosted apps are concerned with mobile edge computing. Cloud computing is used to share diverse frameworks and data; various services apps for end users, as well as hardware and system software, may be shared with the cloud; and, eventually, cloud providers provide better control over the various shared resources [25]. The various cloud approaches and their parameter-based applications are briefly explored [26]. In comparison to radio technologies, 5G has advanced to the point where it is practically possible to obtain super speeds ranging from 1 to 10 Gbps, latency of 1 millisecond (end-to-end round trip), 1000x bandwidth per unit area, the ability to connect 10 to 100 devices, worldwide coverage, and approximately 90% reductions in network energy usage with much longer node battery life [1].

## RESULT AND DISCUSSION

**Here in this section the potential solutions to 5G difficulties discussed,**

- Reduced power under Signal to Interference Noise Ratio (SINR) by using numerous antennas at the transmitter end. Massive MIMO is used to improve network connection. When building M-MIMO, one must consider the mapping of deployed antennas as well as network requirements. The extensive use of beamforming allows for speedier connection while reducing inter-channel interferences. The light wave steered between the node and the antenna in beamforming.
- Another challenge for improving the capabilities of a 5G network is effective traffic shaping. Routing optimization like advanced JAYA, Practical Swam, Shepherded and Vulture based hybrid algorithms in association with effective machine learning, neural network approach leads to enhance the network performance. NOMA architecture to improve the throughput and compensate with the desired power levels.
- Optimal power and spectral efficiency may be improved by combining M-MIMO with a sharing circuit power adoption approach and eliminating interference within channels, as well as the usage of tiny cell architecture.

## CONCLUSION

This study explored 5G technology protocol architecture, critical obstacles, and unique techniques to tackle problems encountered when constructing 5G networks. The deployment of an effective radio resource utilisation strategy, traffic offloading strategy, and a systematic approach are proposed to address issues related to service quality and energy efficiency, traffic load for next generation heterogeneous networks by improving inter-tier interference and





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power consumption. The technique outlined in this study will be an important component for evaluating 5G networks.

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**Table 1 The detailed literature review of for improvement in performance of 5G networks**

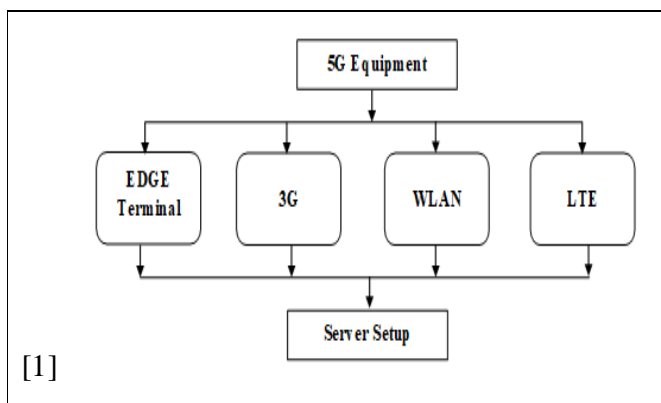
Findings	Ref.
This article specifics of how 3GPP and LTE promise to meet the need for high-speed data rates and related applications.	[6]
This article provides a summary of portable communication technologies that have evolved to this point, in addition to insight into expectations from the future of the portable world.	[7]
This study discusses the significance of considering receiver characteristics while developing resource allocation systems for next-generation mobile networks.	[8]
Broadly discussed the demands of the ICT industry when contemplating utilisation in next-generation networks.	[9]
The various multiplexing systems Generalized Frequency Division Multiplexing (GFDM), Universal Filtered Multicarrier (UFMC), and Filter Bank Multi Carrier (FBMC) are discussed. Examining the benefits and cons of various AI-based strategies for different HetNets challenges demonstrates the full taxonomy of HetNets AI-based techniques.	[10]
The paper compares the essential concepts of supervised, unsupervised, and reinforcement learning.	[11]
The issues with 5G handovers are explored.	[12]
A careful review and survey of the 5G network and its vision for the smart grid is presented.	[13]
Background on new licensing arrangements, as well as an overview of a newly finalised Digital Signature Algorithm (DSA) standard. Network management systems, along with the numerous designs proposed for ensuring legacy user security.	[14]
This article discusses effective radio resource management, mobility management, and necessary service provisioning management.	[15]
For accomplishment, the spectrum management concerns highlighted in this article must be addressed by equipment and network designers in conjunction with policymakers.	[16]



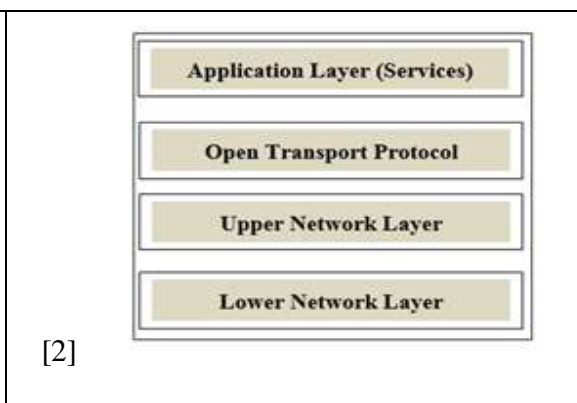


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The research describes an energy-efficient model for 5G heterogeneous networks, as well as concerns for both the access and backhaul network elements.	[17]
This article discusses many design difficulties for Centralised Radio Access Network (CRAN) in 5G and beyond networks, along with future possibilities for resolving these concerns.	[18]
This study presents a receiver system for a cooperative multi-relay system with Non-orthogonal multiple access (NOMA) in cellular networks. The findings were compared to current and new algorithms.	[19]
This work carries out an implementation and considerable application of Massive Multiple Input Multiple Output (M-MIMO).	[20]
This paper presents case studies on various channel losses and hardware implementation challenges in order to create an effective 5G network.	[21]
This work discusses and solves NOMA structure power optimization challenges.	[22]
Small cell design, as defined in this work, has a problem with high frequency signals with low magnitude levels, resulting in call drops.	[23]
This paper outlines how beamforming is the best option for avoiding channel interference.	[24]
The significance of cloud services and their efficient usage in improving the routing technique described in this study.	[25]
This research systematically compares several cloud parameters with various cloud approaches.	[26]
The unique approach presented in this research is based on integrated machine learning and a coordinated beamforming strategy, allowing for extremely mobile applications. It focuses on the deep learning model, Omni received uplink pilots, and beam training outcomes.	[27]
Different ML methods to wireless communication and traditional methodologies are explored, as well as their performance comparison with ML-based alternatives. Following that, the emphasis is on ML paradigms, open data sets and platforms for researchers, and theoretical advice for ML implementations.	[28]
This study suggests combining massive MIMO beamforming with low band up-link to give equivalent coverage for the 5G downlink at 3.5 GHz as for the present LTE at 1.8 GHz.	[29]
The Dynamic Spectrum Sharing (DSS) gives full benefits when paired with SA architecture for Maximum coverage and innovative 5G services, and with CA for maximum 5G data rates, according to this article.	[30]
This study focuses on potential 5G solutions from an ML perspective. It explains the basic ideas of supervised, unsupervised, and reinforcement learning.	[31]



**Figure 1. Network Architecture**



**Figure 2. 5G Protocol Architecture**





## A Study on the Phytochemical Screening, GC-MS Analysis and Antioxidant Activity of *Hemidesmus indicus* (Linn.) R.Br

Chandran Nisha<sup>1\*</sup>, Sivashanmugam Preethi<sup>1</sup>, MT Rosmin<sup>1</sup> and Pawlin Vasanti Joseph<sup>2</sup>

<sup>1</sup>Ph.D Research Scholar, Department of Zoology, Nirmala College for Women, Coimbatore- 641018, Tamil Nadu, India.

<sup>2</sup>Associate Professor and Head, Department of Zoology, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India.

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### \*Address for Correspondence

#### Chandran Nisha

Ph.D Research Scholar,  
Department of Zoology,  
Nirmala College for Women,  
Coimbatore- 641018, Tamil Nadu, India.  
E.Mail : nishacpallavur@gmail.com



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### ABSTRACT

The main aim of this present study was to analyse the bioactive phytochemicals and antioxidant potential of different extracts of *Hemidesmus indicus*. *Hemidesmus indicus* [L.] is a potential source of several active principles of therapeutic value. It is an important medicinal herb used in India's traditional medicine system. 30g of the powdered sample was taken and subjected to 24-hour continuous hot extraction in a Soxhlet apparatus using 150 ml of each hexane, ethyl acetate, ethanol and distilled water respectively. The crude extracts were further subjected to preliminary phytochemical screening, GC-MS analysis, and DPPH free radical assay. From the present study reports numerous phytochemicals present in the root extracts viz Alkaloids, Terpenoids, Flavonoids, Carbohydrates, Glycosides, Tannins and Phenolic compounds, Amino acids and Proteins. The GC-MS analysis of the root extracts identified 15 compounds. The significant metabolites from root extracts were Lup-20[29]-en-3-ol, acetate, [3.beta.] [30.300] and 1,2-Benzenedicarboxylic acid, mono[2-ethylhexyl] ester [29.689]. The in vitro antioxidant activity by DPPH assay of ethyl acetate extract showed the highest antioxidant activity with an IC<sub>50</sub> value of 30.61 µg/ml. This research helps to predict the therapeutic potential of *H.indicus* metabolites, which can be used in drug formulations and are considered promising candidates for the pharmaceutical industry.

**Keywords:** Herbal medicine, Bio-constituents, Root extract, Drug discovery, Therapeutic Potential





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## INTRODUCTION

Since ancient times Indian traditional medicine practices such as Ayurveda, Siddha, Unani, and Homeopathy have been popular in the healthcare system as they have close dependence on nature and also due to the vast repository of medicinal plants in India [1]. This rich tradition of herbal medicine in India paves the way for discovering new drugs from herbal treatments with no side effects. According to reports, more than 80% of the world's population relies primarily on complementary and alternative medicines, with natural resources accounting for approximately 60% of clinical drugs [2]. The presence of pharmacologically active bio constituents in herbal plants may vary from different parts including barks, flowers, fruits, leaves, resins, rhizomes, roots, seeds, and stems [3]. Plants produce secondary metabolites such as phenolics, terpenes, steroids, alkaloids, and flavonoids mainly concerned with the defence and stress response of the plants. These secondary metabolites can be utilised in medicine [4]. The medicinal value of these plants lies in the derivatives of plant phytochemicals, which produce a specific physiological effect in the human body [5]. It is considered that 80% of synthetic drugs are made from natural resources and hence function as raw materials for drug discovery [6]. Furthermore, nearly 70,000 medicinal plants in the world ranging from lichens to trees could be used to treat diverse life-threatening ailments [7]. In principle, the importance of a plant for treatment depends on its bioactive content they possess [8]. Furthermore, pharmacological applications such as in the production of antibiotics, anticancer agents, anti-inflammatory compounds and analgesics have been discovered. Due to this quest for new therapeutics leads from natural resources [9]. *Hemidesmus indicus* [L.] R. Br. ex Schult. [Apocynaceae] is important in both traditional Indian medicine and European medicine due to the various pharmacological properties of active phytochemicals in their different parts, mainly in the roots [10]. It has been used in ancient times for treating snakebites, scorpion stings, diabetes, urinary diseases, dyspnea, menorrhagia, oligospermia, anorexia, fever, abdominal colic and pain, dysentery, diarrhoea, cough, rheumatism, headache, inflammation, pyrosis, skin diseases, leprosy, sexually transmitted diseases [11]. Therefore the investigation of bioactive Phyto-constituents from native plants will enlighten the field of drug discovery and pave the way for the advancement of new therapeutics in the field of medicine [12]. Therefore, This research aims is to perform a comparative analysis of the phytochemical, antioxidant, and GC-MS profile of hexane, ethyl acetate, ethanol and aqueous extracts of *Hemidesmus indicus* root responsible for their numerous pharmacological properties. To the best of our knowledge, no work has been done for the preliminary phytochemical, antioxidant and GC-MS analysis of hexane, Ethyl acetate, ethanol and aqueous extracts of *Hemidesmus indicus* root to elucidate their active pharmacological properties and new therapeutic purpose.

## MATERIALS AND METHODS

### Sample Collection

*Hemidesmus indicus* L. R.Br. plants were collected from Palakkad, Kerala. The authentication of the plant was done from India's Botanical survey, Coimbatore [Ref No. BSI/SRC/5/23/2022/TECH/410] and the voucher specimen was deposited for further reference.

### Preparation of the Sample

The fresh roots of the plants were washed thoroughly under tap water until it is clean and shade dried. The dried roots were ground into a fine powder using an electronic blender to get a coarse powder and stored in an airtight bottle for further analysis.

### Extraction of the Sample

About 30g of the powdered sample was taken and subjected to continuous hot extraction in a Soxhlet apparatus [Borosil Glass Workers Ltd, Mumbai, India] using 150 ml of each hexane, ethyl acetate, ethanol and distilled water respectively. The obtained extracts were filtered and evaporated to get crude extracts for future analysis.





### Phytochemical Screening

All four extracts were subjected to qualitative phytochemical screening to identify the presence of active bio-constituents like alkaloids, carbohydrates, glycosides, phenols, saponins, phytosterols, flavonoids, proteins and terpenoids by using standard methods [13,14].

### GC-MS Analysis

The Clarus 680 GC was used in the analysis employed a fused silica column, packed with Elite-5MS [5% biphenyl 95% dimethylpolysiloxane, 30 m × 0.25 mm ID × 250µm df] and the components were separated using Helium as carrier gas at a constant flow of 1 ml/min. The chromatographic run of the sample was under the temperature of 260°C. The 1µL of extract sample was injected into the instrument. The oven temperature was as follows: 60°C [2 min]; followed by 300 °C at the rate of 10 –1°C min; and 300°C, where it was held for 6 min. The mass detector conditions were: transfer line temperature of 240°C; ion source temperature of 240 °C; and ionization mode electron impact at 70 eV, a scan time of 0.2 sec and scan interval of 0.1 sec. The obtained spectra with fragments ranging from 40 to 600 Da have been analysed with the GC-MS NIST [2008] library.

### DPPH Radical Scavenging Activity

The free radical scavenging activity of the extract's of *Hemidesmus indicus* was evaluated based on the method reported by Brand-Williams *et al* [15] with slight modification. The antioxidant activity was determined by the ability of the extracts to scavenge the DPPH [1, 1-diphenyl-2-picryl hydroxyl] radical to determine free radical scavenging activity 1 ml of the hexane, ethyl acetate, ethanol and aqueous extracts with various concentrations of *H. indicus* [30, 50, 70, 90, 110, 130 µg/ml] was added to 4 ml of 0.004 % [w/v] methanol solution of DPPH. The reaction mixture was mixed thoroughly and incubated at room temperature for 30 minutes. Finally, the spectrophotometric analysis was done to measure the absorbance at 517 nm. The following equation calculated the percentage of free radical scavenging

$$\text{DPPH radical scavenging activity [\%]} = \frac{[A_1 - A_2]}{[A_1]} \times 100$$

Where: A<sub>1</sub> is the absorbance of the control

A<sub>2</sub> is the absorbance of the sample

As a standard, IC<sub>50</sub> values for hexane, ethyl acetate, and ethanolic extracts of *Hemidesmus indicus* and ascorbic acid were calculated by plotting a graph concentration [µg/ml] vs [%] per cent of the scavenging activity by using linear regression. IC<sub>50</sub> means the sample concentration required to scavenge the solution's 50 % DPPH free radicals.

## RESULTS

### Phytochemical Screening of *Hemidesmus indicus* Root Extracts

The phytochemical compounds of the four extracts of *Hemidesmus indicus* root are presented in [Table1]. The qualitative phytochemical study of *Hemidesmus indicus* root extracts exhibited various phytochemicals. The ethyl acetate and ethanol extracts of roots of *Hemidesmus indicus* have the key phytochemical components, such as flavonoids, tannins, carbohydrates, alkaloids, cardiac glycosides, steroids, phenols, diterpenes and saponins and proteins. The aqueous and hexane extract is devoid of phenolic compounds and flavonoids respectively.

### Gas Chromatography-Mass Spectroscopy [GC-MS] Analysis

The GC-MS chromatogram of hexane, ethyl acetate ethanol and aqueous root extracts of *H.Indicus* recorded a total of 15 peaks corresponding to the bioactive compounds that were recognized by relating their peak retention time, peak area [%], height [%] and mass spectral fragmentation patterns to that of the known compounds described by the National Institute of Standards and Technology [NIST] library. Results revealed that 4,3 and 8 compounds were identified in hexane, ethyl acetate and ethanol *H.Indicus* root extracts, respectively [Table 2 ]. Overall, the structure of



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15 phytochemicals were identified in hexane, ethyl acetate and ethanol extracts from *H.Indicus* roots and are presented in Table 2 along with their retention time.

The following bioactive compounds were present in the GC-MS analysis carried on hexane extract of *H.Indicus* roots: 2,2,3,3,3-Pentafluoro-1-propanol, Acetic acid, 3-methyl-6-oxo-hex-2-enyl ester, 2,2-Dimethylpropanoic acid, undec-2-enyl ester, 1,2-Benzenedicarboxylic acid, mono[2-ethylhexyl] ester. [Fig. 1, Table 2]. The phytoconstituents in ethyl acetate extract of leaf *H.Indicus* roots were found to be 1,2,3-Butatriene, 1-chloro, 1,3-Bis[hydroxymethyl] urea, Diethyl phthalate [Fig. 2, Table 2]. The phytoconstituents in ethanol extract were found to be Methylene chloride, [2s,13s]-12,13-Dihydroxy-1,4,7,10-tetraoxacyclotetradecane, Diglycolic acid, 5h-3,5a-Epoxynaphth[2,1-c]oxepin, dodecahydro, Urs-12-en-24-oic acid, 3-oxo-, methyl ester, [+]-,1,4-Bis[1-methyl-1-silacyclobutyl]benzene, Lup-20[29]-en-3-ol, acetate, [3.beta.] [Fig.3, Table 2].

**Antioxidant Activity**

In the present study, the different concentrations of root extracts of *H.Indicus* were subjected to the 2,2-diphenyl-1-picryl-hydrazine-hydrate [DPPH] free radical scavenging method. The maximum antioxidant activity was found in ethyl acetate extract, reducing DPPH radicals at 64.59% while ascorbic acid, ethanol, aqueous and hexane extracts were recorded at about 75.56, 57.52, 53.52 and 52.52 respectively [Table 3]. The ethyl acetate extract of *H.Indicus* exhibited the highest DPPH radical scavenging activity with an IC<sub>50</sub> of 30.61 µg/ml, followed by ethanol, aqueous and ethyl hexane extracts with IC<sub>50</sub> values of 64.31 µg/ml and 68.27 µg/ml and 76.50 µg/ml respectively, In contrast, the ascorbic acid exhibited IC<sub>50</sub> values of 26.91 µg/ml.

**DISCUSSION**

In the present study, the investigation of hexane, ethyl acetate, ethanol and aqueous extracts from the roots of *H.Indicus* revealed the presence of various phytoconstituents, including flavonoids, carbohydrates, cardiac glycosides, tannins, phenols, alkaloids, steroids, proteins, terpenoids, saponins and terpenes. Also, it exhibited the potential of DPPH free radical scavenging activity. The GC-MS analysis found various kinds of bioactive phytoconstituents make the plant beneficial for multiple therapeutic purposes in medicine. The identification of these phytoconstituents was done by gas chromatography-mass spectrometry [GC-MS], one of the most commonly used techniques for the separation of bio compounds. The presence of secondary metabolites triterpenes and flavonoids exert free radical scavenging activity on the crude extract of *H.indicus* [16]. Sayyed *et al.* [17] investigated the presence of carbohydrates, glycosides, alkaloids, phenols, flavonoids and tannin in *Swertia chirata* and *H. indicus*. Malarvizhi and Manoharan [18] studied qualitative phytochemical analysis of *H. indicus* where the presence of phenols, glycosides, flavonoids, steroids, oils and saponins were absent. Based on the study of Nutan *et al.*, [19] ethyl acetate, petroleum ether and methanol extracts of roots of *H. indicus*. found the presence of flavonoid and phenolic compounds responsible for antioxidant activity and isolated Lupeol the potent antioxidant by the compound isolation. Boominathan *et.al* [20] stated that the ethanolic root extracts of *Hemidesmus indicus* showed the maximum DPPH radical scavenging activity of 68.85 ± 0.28% at 120 µg/mL concentration and the IC<sub>50</sub> was 57.90 µg/mL. The GC-MS analysis found the presence of 2,4- bis [1,1-dimethylethyl]-phenol and flavone responsible for antioxidant activity. According to Statti *et al.*, [21] the hydroalcoholic extract of the *H.Indicus* root exhibited DPPH free radical scavenging potential with 58.79% inhibition at a dose of 37.5 µg/ml.

Block *et al.*, [22] stated that a diet rich in phenolic compounds reduces the risk of colon cancer and is also helpful to reduce the effects of oxidative damage in tissues. Lupeol isolated from *H. 2 indicus* decoction showed potent anti-HIV-1 activity via inhibiting the reverse transcriptase [RT]-associated RNase H, the HIV-1 RT-associated RNA-dependent DNA polymerase and the cellular α-glucosidase [23]. Chatterjee *et al.*, [24] purified Lupeol acetate [1–160 mg/kg] from the methanolic root extract have antivenom property neutralized the venom of *Daboia russelii* and *Naja kaouthia* and also inhibited the consequences of venom-induced physiological problems in mice. The above evidence shows that the *H. indicus* plant has enormous potential for pharmacological constituents, and therapeutic





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phytocompounds are responsible for multiple biological activities attributed to its different parts, especially the roots. It has antioxidant, antimicrobial, anti-inflammatory, antipyretic, analgesic, antinociceptive and immunomodulatory activity etc. The major chemical compounds identified from different crude extracts could explain the plants' pharmacological properties. Thus, the identification of various phytochemical compounds from hexane, ethyl acetate, ethanol and aqueous extracts from roots display significant medicinal properties of the plant *H. indicus*. Further studies like bio-prospecting are essential to support its biological properties and the biological importance of these innovative bio-molecules will be interesting to be studied.

**Study Limitations**

Research on the characteristics of metabolites from *Hemidesmus indicus* is ongoing. The bio constituents from root extracts are used extensively in various industries such as pharmaceuticals, food and cosmetics, dentistry, agriculture and others. Although there is extensive research on plant toxicity, studies related to the toxic effects of the metabolites from the plant are still minimal. Especially chronic toxicity, cytotoxicity and genotoxicity studies are lacking. Furthermore, different properties and activities of *H.indicus* are still undiscovered very well and should be further explored by more *in vitro* and *in vivo* long-term human research

**CONCLUSION**

*Hemidesmus indicus* may be a potent therapeutic agent due to many secondary metabolites such as flavonoids, tannins, alkaloids, carbohydrates, polyphenols, saponins, glycosides, terpenoids, and proteins. The strong correlation between the contents of total polyphenols, flavonoids, flavanones, flavones and flavonols, and radical scavenging activity indicates that these phytochemical constituents are responsible for the antioxidant potential of the plant. It could be exciting to carry out investigations to determine the role of phytochemical constituents in preventing free radical-related disease. Further investigations are needed to study the documentation of structural compounds from *H. indicus* for the structure-based drug design for broad-spectrum drug discovery.

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
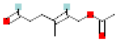
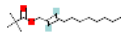
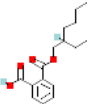



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Table 1. Phytochemical screening of hexane, ethanol, ethyl acetate and aqueous extracts of *Hemidesmus indicus* root.

S. No.	Metabolite	Test	Extract			
			Hexane	Ethyl acetate	Ethanol	Aqueous
1.	Alkaloids	Mayer's test	+	+	+	+
2.	Flavonoids	Alkaloids	-	+	+	+
3.	Steroids	Liebermann test	+	+	+	+
4.	Terpenoids	Liebermann test	+	+	+	+
5.	Proteins	Xanthoproteic test	+	+	+	+
6.	Phenolic compounds	Ferric chloride test	-	+	+	-
7.	Carbohydrates	Fehling's test	+	+	+	+
8.	Tannin	Braymer's test	+	+	+	+
9.	Cardiac glycosides	Keller-killani test	+	+	+	+
10.	Saponins	Foam test	+	+	+	+

Table 2. Phytoconstituents detected in the hexane, ethyl acetate and ethanol extracts of *Hemidesmus indicus* root using gas chromatography-mass spectrometry

S. No.	RT	Name of the compounds	Compound Structure	MF	MW	Area %	Biological activity
<b>HEXANE</b>							
1	3.664	2,2,3,3,3-Pentafluoro-1-propanol		C <sub>3</sub> H <sub>3</sub> O <sub>5</sub> F <sub>5</sub>	150	80.090	Immunomodulatory effects [25]
2	3.804	Acetic acid, 3-methyl-6-oxo-hex-2-enyl ester		C <sub>9</sub> H <sub>14</sub> O <sub>3</sub>	170	8.759	Anticancer activity [26] Antimicrobial activity [27]
3	4.044	2,2-Dimethylpropanoic acid, undec-2-enyl ester		C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>	254	5.224	Anticancer activity [28] Antimicrobial activity [29]
4	29.689	1,2-Benzenedicarboxylic acid, mono[2-ethylhexyl] ester		C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	390	5.928	Cosmetics, Pesticides, plasticizers, Cytotoxic activity, Anti-fouling, Antimicrobial [30]
<b>ETHANOL</b>							
5	3.058	1,2,3-Butatriene, 1-chloro		C <sub>4</sub> H <sub>3</sub> Cl	86	64.529	Insecticides, fungicides, bactericides [31]





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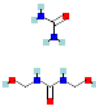






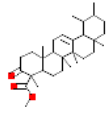

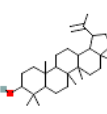
6.	3.899	1,3-Bis[hydroxymethyl]urea		C <sub>3</sub> H <sub>8</sub> O <sub>3</sub> N <sub>2</sub>	120	35.471	Fertilizers used in agricultural fields [32] Antispasmodic, Analgetic, Herbicidal activity [34]
7.	19.445	Diethyl phthalate		C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	222	9.20	Antimicrobial activity, Insecticidal Activity, Allelopathic/Phytotoxic Activity, Plasticizer [35]
<b>ETHYL ACETATE</b>							
8.	3.158	Methylene chloride		CH <sub>2</sub> Cl <sub>2</sub>	84	2.490	Cytotoxic activity [35]
9.	4.164	[2s,13s]-12,13-Dihydroxy-1,4,7,10-tetraoxacyclotetradecane		C <sub>10</sub> H <sub>20</sub> O <sub>6</sub>	236	75.442	Food additives, Antioxidant potential [36]
10.	4.284	Diglycolic acid		C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	134	3.488	Anticancer activity [37]
11.	26.548	5h-3,5a-Epoxy naphth[2,1-c]oxepin, dodecahydro-3,8,8,11a-tetramethyl-		C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	278	2.588	Fragrance agents [38]
12.	29.199	5h-3,5a-Epoxy naphth[2,1-c]oxepin, dodecahydro-3,8,8,11a-tetramethyl-		C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	278	2.590	Antiviral property [39]
13.	29.539	Urs-12-en-24-oic acid, 3-oxo-, methyl ester, [+]-		C <sub>31</sub> H <sub>48</sub> O <sub>3</sub>	468	2.945	Potent anti-cancer efficacy [40], Anti-inflammation [41]
14.	29.804	1,4-Bis[1-methyl-1-silacyclobutyl]benzene		C <sub>14</sub> H <sub>22</sub> Si <sub>2</sub>	246	3.568	No activity reported
15.	30.300	Lup-20[29]-en-3-ol, acetate, [3.beta.]		C <sub>32</sub> H <sub>52</sub> O <sub>2</sub>	468	6.889	Antimicrobial [42] Anti-inflammation, antitumor capability and antioxidant activity [43]

Table 3: DPPH scavenging activity of different extracts of *Hemidesmus indicus*

S.No	Con. [µl]	Standard	% INHIBITION MEAN±SE			
			H	EA	E	A
1.	30	45.61±0.51**	34.63±0.51**	30.61±0.72**	40.61±.66**	32.61±0.60**
2.	50	57.46±0.46**	36.40±0.69**	44.46±0.63**	44.44±0.57**	36.47±0.76**
3.	70	65.76±0.52**	47.91±0.58**	48.91±0.57**	48.96±.56**	43.94±0.54**
4.	90	68.56±0.57**	49.52±0.57**	55.56±0.46**	49.55±.53**	47..53±0.55**





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5.	110	72.81±0.67**	53.84±0.58**	59.82±0.53**	51.86±.61**	49.81±0.22**
6.	130	75.56±0.46**	57.52±0.58**	64.59±0.61**	53.52±0.56**	52.52±0.56**
<b>IC<sub>50</sub> value [µl]</b>		26.91±1.03**	71.93±0.13**	30.61±1.00**	64.31±0.90**	68.27±1.10**

Values are means of three replicates of each parameter ± standard error

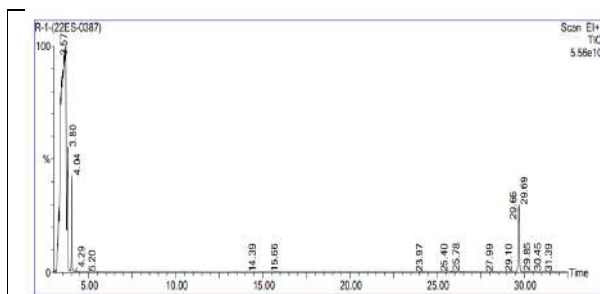


Figure 1. [a] Phytoconstituents detected in the hexane extract of *Hemidesmus indicus* root using gas chromatography-mass spectrometry

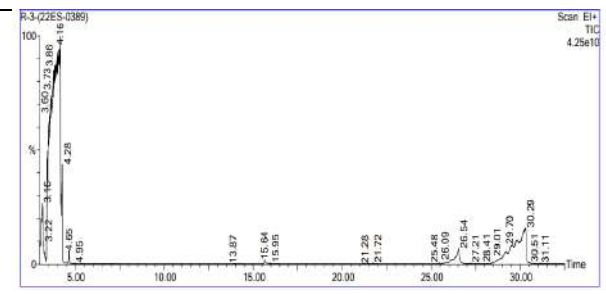


Figure 2. [a] Phytoconstituents detected in the ethyl acetate extract of *Hemidesmus indicus* root using gas chromatography-mass spectrometry

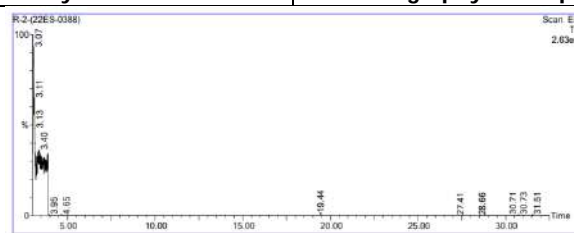


Figure 3. [a] Phytoconstituents detected in the ethanol extract of *Hemidesmus indicus* root using gas chromatography-mass spectrometry





## Impact of Compression Ratio on the Performance and Emission of VCR Diesel Engine with Blended *Leucaena leucocephala* Biodiesel

V.Sukumar<sup>1\*</sup>, M Thambidurai<sup>1</sup>, P.Deivajothi<sup>1</sup> and R.Senthilkumar<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Mechanical Engineering, Annamalai University, Annamalai Nagar, Tamil Nadu, India

<sup>2</sup>Associate Professor, Department of Mechanical Engineering, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

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### \*Address for Correspondence

**V.Sukumar**

Assistant Professor,  
Department of Mechanical Engineering,  
Annamalai University,  
Annamalai Nagar, Tamil Nadu, India.  
E.Mail: sukumar.rp87@gmail.com



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### ABSTRACT

The world population is rapidly growing, which is one cause of the energy crisis, and people's changing lifestyles are the other. Developing alternatives to fossil fuels that will be as renewable as current sources of energy is necessary today. Solar, wind, geothermal, tidal, and bioenergy are examples of alternative sources of energy. The best alternatives to diesel fuel are vegetable oils and their chemical transformations. In this project, experimental work is carried out performance, emission and combustion characteristics of diesel and B20MEOLL (*Lucaena Leucocephala*) in various injection pressure (180 bar, 200 bar and 210 bar) are analyzed. The B20MEOLL with 210 bar injection pressure is having the better characteristics in terms of performance emission and combustion. The result with 180 bar injection pressure NO<sub>x</sub> emission is reduced.

**Keywords:** Compression Ratio; Emission; VCR Diesel Engine; *Lucaena Leucocephala* Biodiesel.

### INTRODUCTION

The development of a nation is significantly influenced by the availability of energy resources. Almost all of the world's energy requirements are currently met by rapidly depleting fossil fuels, which have major environmental effects (Babusankar *et al* 2022). Energy consumption has increased more than 20 times since the turn of the century, and as a result, it is conceivable that we will run out of it soon. The growth in consumption of fossil fuels is contributing to climate change, which is regarded as the most significant environmental issue of the century

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(Manienyanet *al* 2020 and Muthuswamyet *al* 2020). Recent research has suggested that the atmospheric release of hazardous gases has played a role in the century-long rise in the average world temperature. India's energy demand currently ranks sixth in the world, and it is anticipated to rise. The international interest in creating engines with enhanced performance and reduced exhaust emissions has been sparked by the steady depletion of the petroleum supply, rising petroleum prices, and climate change. Due to the advantages of increasing mobility in terms of the economy and other factors, it is not possible to slow the expansion of the use of vehicles (Sonachalam *et al* 2021). The next issue is to control the increase in vehicle use in a way that maximizes its positive effects and minimizes its negative effects on society and the environment. Global warming and the energy crisis are the two major issues of the twenty-first century as a result of this development. India ranked behind China, the United States, and Russia as the world's top three consumers of crude oil and natural gas in 2011–12. India's energy needs increased despite a sluggish global economy (Viswanathan *et al* 2022). Due to the increasing rise of vehicle ownership, petroleum demand in the automotive industry is anticipated to increase at a rapid rate in the upcoming years. Despite having a sizable indigenous energy resource base, notably in the case of crude oil, India nevertheless imports a sizable portion of the energy it uses. As of the 31st of March 2015, India was expected to have 763.48 million tonnes of crude oil reserves (Kanth *et al* 2021). According to the geographic distribution of crude oil, the Western Offshore has the largest reserves (43.67%), followed by Assam (22.19%), while the Eastern Offshore has the largest deposits of natural gas (37.10%), followed by the Western Offshore (29.34%). The projected crude oil reserve for the nation as a whole increased by 0.56% from 2014 to 2025 (Velumani *et al* 2019). It follows that the nation must rely on crude oil imports to meet its demands. Due to this substantial import of crude oil, the nation will undoubtedly experience a fuel crisis in the near future when there will be a shortage of crude oil on the global market. This is one of the primary causes of the great interest that has grown in creating engines with enhanced performance and reduced fuel consumption (Deivajothi *et al* 2018).

### Experimental Setup

The experimental engine is a single-cylinder, four-stroke, direct-injection, variable compression ratio (VCR) diesel engine made by Kirloskar. An eddy current dynamometer with water cooling is mounted on the engine. The system is equipped with the instruments needed to measure the applied load, air and fuel flow rates, crank angle, combustion chamber pressure, and temperatures at various places. The engine is linked to a system for acquiring data from computers. The system employed in the current investigation can assess brake thermal efficiency and particular fuel consumption. For the analysis of exhaust emissions, a gas analyzer and smoke metre are additionally connected to the engine's exhaust pipe. Technical details of the experimental setup used in the experiment are provided in Table 1 and Fig. 1 displays the schematic layout. The actual experimental setup in the lab is shown in Fig. 2. In an engine with a variable compression ratio (VCR), the space between the top dead centre and the cylinder head can be adjusted to modify the compression ratio. To obtain the desired compression ratio, this is done by tightening or loosening a nut bolt combination specified in the setup.

## RESULT AND DISCUSSION

The various compression ratios was varied for the blends B20 MEOLL to optimize the compression ratio in steps of (180 bar, 200 bar and 210 bar) for the best blend based on performance, combustion and emission.

### Performance Characteristics

Figure 2 compares the diesel fuel, B20MEOLL blend's brake thermal efficiency versus braking power. The brake thermal efficiency likewise increases as brake power of the engine increases. Diesel fuel has a brake thermal efficiency of 27.88% for 200 bar and 28.34% for 210 bar at maximum load. For both 200 and 210 bar pressures, the braking thermal efficiency of B20 is higher up to part load than that of diesel fuel and about equal at maximum load. When compared to diesel fuel with 210 bar pressure, the thermal efficiency is slightly lower at 180 bar retarded pressure. This is because of the improved atomization, fine fuel spraying, and greater combustion rate at the higher pressure (Sonachalam *et al* 2021).





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### Emission Characteristics

The comparison of brake power and smoke density is shown in Figure 3. With an increase in engine load, the smoke density rises. This is due to the fact that when engine load increases, fuel consumption per unit of time also increases, leading to an increase in smoke. Diesel fuel has a smoke density level of 71.8 HSU at maximum load, B20 has a smoke density level of 74.1 HSU at 210 bar pressure, and 71.4 HSU. The advance pressure of 200 bar and 210 bar follows the same pattern as the normal pressure, while pressure of 180 bar significantly exceeds that of diesel fuel and biodiesel. Due to the delayed pressure, thorough combustion takes place, which lowers the smoke density (Manieniyan *et al* 2019 and Silambarasan *et al* 2017).

Figure 4 depicts the variation of nitrogen oxides with engine braking power. The temperature and residence duration of the combustion gas are the key determinants of NO<sub>x</sub> emission. Zeldovich and oxygen availability govern the kinetics of NO<sub>x</sub> production. The graph shows that with B20 in comparison to diesel fuel, the NO<sub>x</sub> emission at 200 bar and 210 bar pressure increased from part load. The NO<sub>x</sub> emission level for diesel fuel at maximum load is 775 ppm, whereas for B20MEOLL at 200 bar and 210 bar pressures, it is 801 ppm, which is 3.2% more than diesel. This is due to the abundance of extra oxygen found in the B20MEOLL (Sukumar *et al* 2019 and Manieniyan *et al* 2008). The demonstrates lower Emissions of nox over fossil diesel for 180 bar pressure.

Figure 5 displays the engine's hydrocarbon emissions along with brake force for diesel fuel, B20MEOLL. Incomplete combustion is the primary cause of HC emissions (Yadav *et al* 2022 and Manieniyan *et al* 2022). The graph shows that the hydrocarbon of B20MEOLL for both 200 bar and 180 bar pressure biodiesel and diesel fuel increases noticeably from no load to full load. Diesel fuel emits 94 ppm of HC at full load, B20MEOLL emits 97 ppm at a pressure of 200 bar, and B20MEOLL emits 107 ppm at a pressure of 210 bar. The 180 bar retarded pressure is to blame for the incomplete combustion.

Figure 6 depicts the variation in carbon monoxide emission as a function of brake power for diesel fuel and B20MEOLL mixes. The lack of oxygen, inadequate air inflow, inappropriate mixing preparations, and incomplete combustion are the main sources of CO emissions during the combustion process. The graph demonstrates that up to part load, both B20MEOLL and diesel fuel pressures of 200 bar and 210 bar exhibit a similar tendency to that of the diesel fuel, however at maximum load, both B20MEOLL and diesel fuel pressures of 180 bar exhibit a strikingly different trend from that of the diesel fuel. This is because under retarded pressure, an excessive amount of B20MEOLL causes incomplete combustion, which raises carbon monoxide emissions at maximum load (Seeniappan *et al* 2022 and Veerabadran *et al* 2022).

### Combustion Characteristics

The maximum load (cylinder pressure with braking power) of the engine for diesel fuel and B20MEOLL mixes at various crank angles is shown in Figure 7. The graph illustrates that the in-cylinder pressure for diesel fuel is higher than for B20MEOLL. For B20MEOLL gasoline, the maximum cylinder pressure is 65.51 bar at 210 bar. The rationale is that B20MEOLL blends under retarded pressure exhibit poor atomization and, as a result, have lower in-cylinder pressure than diesel fuel does (Hoang *et al* 2022 and Deivajothi *et al* 2019). The rate of heat emission in relation to crank angle is shown in Figure 8. Gas pressure and temperature inside the engine cylinder change depending on how quickly the fuel releases heat at maximum load (Zhang *et al* 2022 and Sukumar *et al* 2020). As can be observed from the graph, diesel fuel releases heat at a maximum rate of 151 kJ/m<sup>3</sup>deg, with 157 kJ/m<sup>3</sup>deg for B20MEOLL at 210 bar pressure and 144 kJ/m<sup>3</sup>deg for B20MEOLL at 180 bar pressure. The B20MEOLL blends' high viscosity causes poor combustion and slows the pace at which heat is released.

## CONCLUSION

Diesel and B20MEOLL blends' performance and emission characteristics are examined and contrasted. The following conclusions are reached in light of the experimental findings.



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- ✓ Blends of B20MEOLLat 210 bar pressure are discovered to have brake thermal efficiency that is more comparable to diesel fuel. This is as a result of its oxygen concentration and ability to reduce the blend's viscosity, which improved combustion.
- ✓ At maximum load, all mixes of B20MEOLLat 210 bar pressure use less fuel specifically than other blends.
- ✓ Every combination of B20MEOLLat 210 bar pressure produces more smoke. B20MEOLLat 210 bar pressure blends do not significantly increase smoke intensity at no load or half load circumstances.
- ✓ Blends made from B20MEOLLat 180 bar pressure reduce NOx emissions.
- ✓ When compared to other blends, using B20MEOLL at 210 bar pressure has shown lower CO and HC emissions at maximum load. As a result, it can be said that, in terms of performance and emission characteristics, B20MEOLLat 210 bar pressure blends are the best blends.

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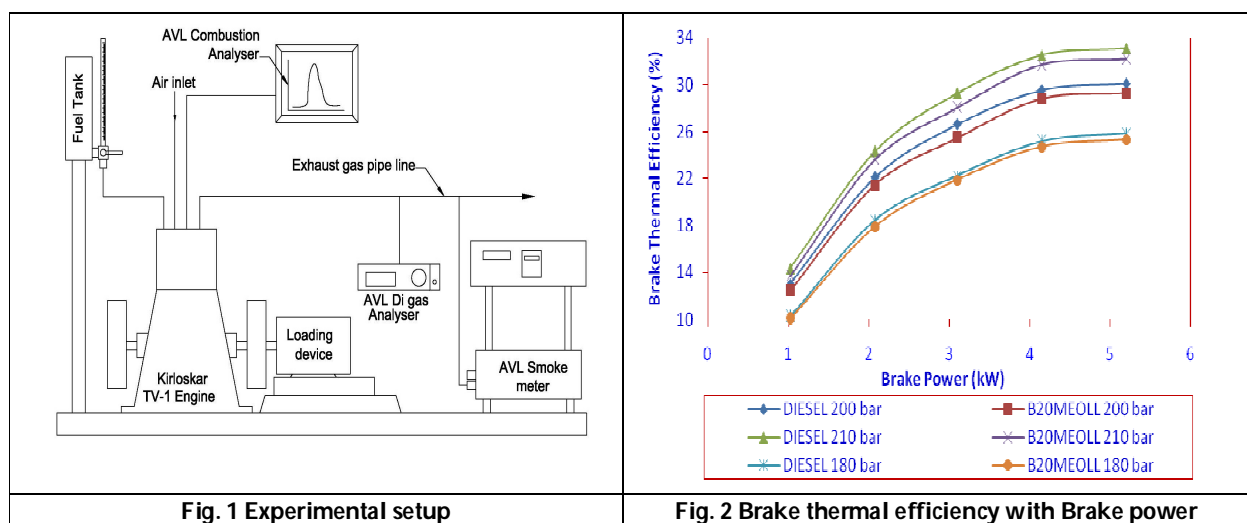


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**Table 1. Specifications of the Test Engine**

Type	Vertical, Water cooled, Four stroke
Number of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing	23° before TDC
Injection pressure	220 kgf/cm <sup>2</sup>



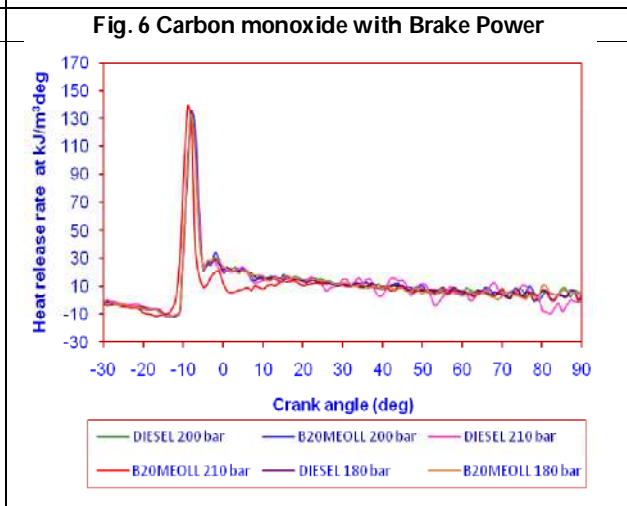
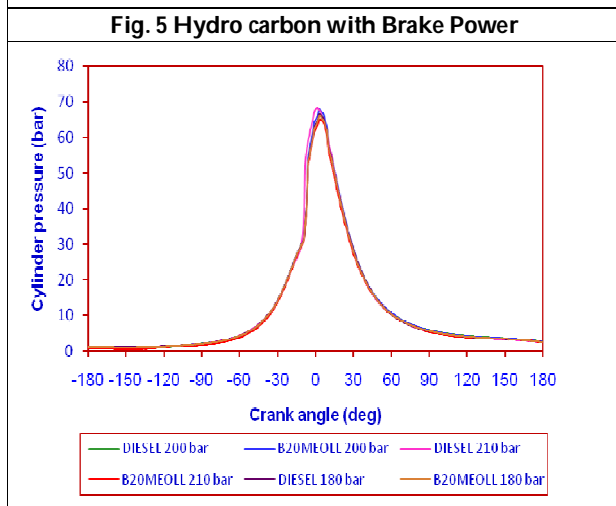
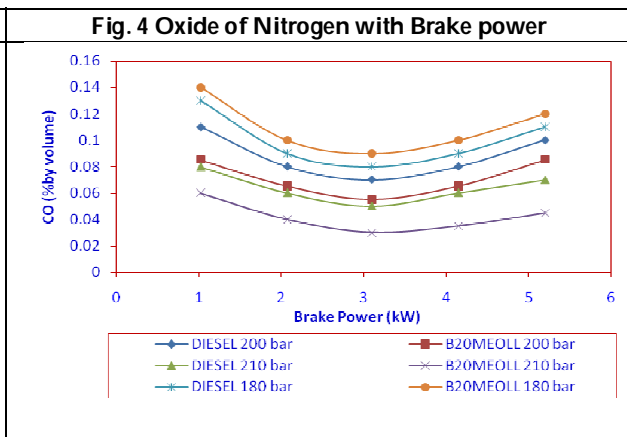
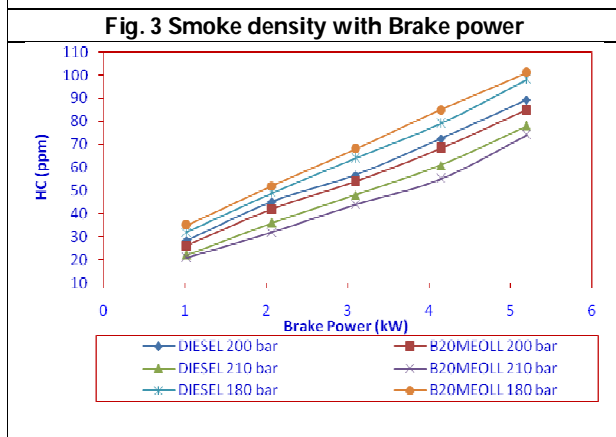
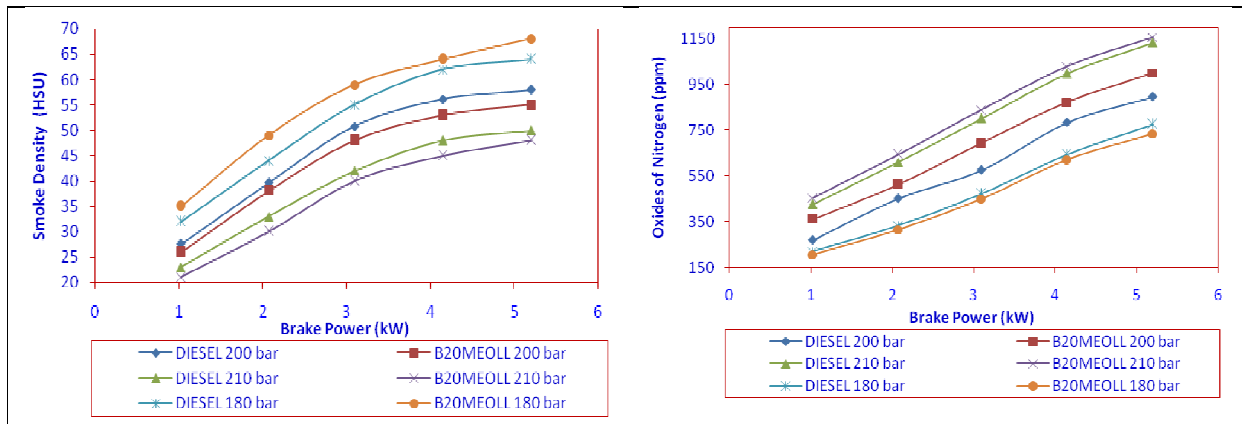
**Fig. 1 Experimental setup**

**Fig. 2 Brake thermal efficiency with Brake power**





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**Fig. 7 Cylinder pressure with Crank angle**

**Fig. 8 Heat release rate with crank angle**





## Studies on the Effect of Nutrients on Growth, Yield and Quality of *Asparagus densiflorus* 'Sprengeri' L. Cut Foliage

P. Sowmiya<sup>1\*</sup>, P. Karuppaiah<sup>2</sup>, R. Sendhilnathan<sup>3</sup> and D. Venkatakrishnan<sup>4</sup>

<sup>1</sup>Research Scholar, Department of Horticulture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

<sup>2</sup>Professor, Faculty of Agriculture, Department of Horticulture, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, Department of Horticulture, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

<sup>4</sup>Associate Professor, Department of Soil Science and Agricultural Chemistry, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

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### \*Address for Correspondence

**P. Sowmiya,**

Research Scholar,

Department of Horticulture,

Annamalai University,

Annamalai Nagar,

Tamil Nadu, India.

E.Mail: vpkhortic@yahoo.com



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### ABSTRACT

A study was conducted during the year 2020-2021 to find out an optimum level of nutrients to increase the growth, yield and quality of *Asparagus densiflorus* 'sprengeri' L. cut foliage. The experiment was laid out in Factorial Randomized Block Design [FRBD] with four levels of nitrogen and four levels of phosphorus in 3 replications, such as N<sub>0</sub> (0 g/m<sup>2</sup>/l), N<sub>1</sub> (3 g/m<sup>2</sup>/l), N<sub>2</sub> (6 g/m<sup>2</sup>/l), N<sub>3</sub> (9 g/m<sup>2</sup>/l), phosphorus P<sub>0</sub> (0 g/m<sup>2</sup>/l), P<sub>1</sub> (3 g/m<sup>2</sup>/l), P<sub>2</sub> (6 g/m<sup>2</sup>/l), P<sub>3</sub> (9 g/m<sup>2</sup>/l) and their combinations at weekly intervals and potassium 6 g/m<sup>2</sup>/l was added as constant to all the treatments except control. The various levels of nitrogen, phosphorus and their interaction significantly influenced the growth, yield and quality attributes of asparagus. Among the interactions, application of N<sub>3</sub>×P<sub>3</sub> (9 g/m<sup>2</sup>/l N × 9 g/m<sup>2</sup>/l P<sub>2</sub>O<sub>5</sub>) recorded the maximum values on growth parameters like cladophyll length (45.75 cm), cladophyll breadth (14.43 cm), number of primary branches per cladophyll (36.23), length of primary branches per cladophyll (13.17 cm), plant spread in North-South (63.06 cm), plant spread in East-West (67.66 cm), number of leaflets per cladophyll (1250.19), chlorophyll content (0.573 mg g<sup>-1</sup>), cladophyll production interval (9.72 days), fresh weight of cladophylls per plant (178.24 g), dry weight of cladophylls per plant (25.86 g), number of bulbs per plant (50.71), fresh weight of roots and bulbs per plant (304.15 g), dry weight of roots

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and bulbs per plant (83.68 g) and dry matter production per plant (111.69 g). With regards to yield and quality parameters viz., cut foliage yield per plant (36.54), cut foliage yield per m<sup>2</sup>(292.17), visual scoring (8.46), freshness index (8.15), colour index (7.91) and vase life (5.19 days) were recorded to be the best in interaction effect of N<sub>3</sub>×P<sub>3</sub> (9 g/m<sup>2</sup>/l N × 9 g/m<sup>2</sup>/l P<sub>2</sub>O<sub>5</sub>). The minimum values on growth, yield and quality parameters were obtained in treatment interaction N<sub>0</sub>×P<sub>0</sub>. On the basis of above findings, it was concluded that for better growth, yield and quality characters of *Asparagus densiflorus* 'Sprengeri' L. cut foliage, combined application of nitrogen and phosphorus at 9 and 9 g/l/m<sup>2</sup> along with K @ 6 g/l/m<sup>2</sup> at weekly intervals could be effective for the best production of *Asparagus densiflorus* "Sprengeri" L. cut foliages.

**Keywords:** Asparagus, Cut foliage, Growth, Nitrogen, Phosphorus, Quality, Vase life and Yield.

**INTRODUCTION**

Floriculture is the science of growing, harvesting, storing and processing of flowers and ornamental crops. It is one of the high value industries in many countries, where cut foliages plays as a major component of the floricultural industry and can be a gateway for economic development (Herath *et al.*, 2013). Cut foliage is used as a filler, lining and background material in various floral arrangements. They are also used for bringing life to the bouquets, wreaths and garlands, which would otherwise look dull. They find their use in interior decoration and make an office, home or a public restaurant look lively with colours (Whiriskey and Carthy, 2006). *Asparagus densiflorus* "Sprengeri" L. is a popular ornamental cut foliage plant cultivated widely in tropical and subtropical regions globally (Li *et al.*, 2020). It is a scrambling perennial herb with enormous variety of appearance that leads to the large number of cultivars in count. The leaves are actually leaf-like branchlets called cladophylls and these tiny cladophylls are linear, feathery, flattened structures that are attractive emerald green to bright green in colour. The cut foliage can be incorporated as filler with cut flowers in bouquets and other floral arrangements for its attractive, fine textured and bright emerald green foliage. It also can be used as mass, cascading, container, above ground border, ground cover plants and suitable for interiors aping.

Efforts on promoting commercial floriculture in our country have started and protected cultivation of cut flowers opens up newer avenues for quality production and export to earn valuable foreign exchange. However, different aspects of production technology need to be developed for getting higher quality/yield of cut foliage as well as helps to fetch attractive returns. The balanced fertilizer application is considered as an essential norm for quality production of cut greens. Nitrogen fertilization is one of the important factor in canopy formation and photosynthesis. It is the essential macro element that improves the chemical and biological properties of soil and thereby improves the production of higher yield and quality in plants (Kumar *et al.*, 2017). Among essential nutrients, phosphorus is an essential nutrient and second most important deficient macronutrient which plays significant role in respiration, photosynthesis, cell enlargement, cell division that leads to the gradual increase of leaf area, stem diameter, plant height and number of leaves as reported by Asif *et al.* (2022). To date, the effects of nitrogen and phosphorus have been largely considered in isolation but many literatures report that these elements are interacting at several levels of integration (Krouk and Kiba, 2020). But, these kind of study are limited with regarding *Asparagus* cut foliage production. In this context, the present study leads to determine the effect of nitrogen, phosphorus individually and their interactions on *Asparagus densiflorus* 'Sprengeri' L. cut foliage production.

**MATERIALS AND METHODS**

The study was carried out in the Department of Horticulture, Annamalai University, Annamalai Nagar, Tamil Nadu during 2020-2021. The experiment was laid out in factorial randomized block design with four levels of nitrogen and four levels of phosphorus in 3 replications such as nitrogen N<sub>0</sub> (0 g/m<sup>2</sup>/l), N<sub>1</sub> (3 g/m<sup>2</sup>/l), N<sub>2</sub> (6 g/m<sup>2</sup>/l), N<sub>3</sub> (9 g/m<sup>2</sup>/l),



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phosphorus  $P_0(0 \text{ g/m}^2/l)$ ,  $P_1(3 \text{ g/m}^2/l)$ ,  $P_2(6 \text{ g/m}^2/l)$ ,  $P_3(9 \text{ g/m}^2/l)$  and their combinations at weekly intervals and potassium  $6 \text{ g/m}^2/l$  was added as constant to all the treatments except control. The fertilizers were all diluted in water according to their concentrations and 1000 ml were manually applied to every plot. The raised beds of 30 cm height were formed in uniform size plots measuring  $1.0 \times 1.0 \text{ m}$  by the mixture of two parts of garden soil with one part of farm yard manure, decomposed coir pith and pressmud on volume basis. The well maintained, uniform size seedlings having 3 – 4 foliage stalks per plant were planted at a spacing of  $45 \times 45 \text{ cm}$ . Life irrigation was given immediately and two subsequent irrigations were given at two days interval through rose can. Subsequent irrigations were done as per the requirements. Uniform culture practices were maintained for all the treatments. Specific fertilizer doses for nitrogen, phosphorus and potassium were applied by the fertilizers urea, DAP and muriate of potash respectively according to the treatments. The biometric observations on growth parameters like cladophyll length (cm), cladophyll breadth (cm), number of primary branches per cladophyll, length of primary branches per cladophyll, plant spread in North-South (cm), plant spread in East-West (cm), number of leaflets per cladophyll, chlorophyll content ( $\text{mg g}^{-1}$ ), cladophyll production interval (days), fresh weight of cladophylls per plant (g), dry weight of cladophylls per plant (g), fresh weight of roots and bulbs per plant (g), dry weight of roots and bulbs per plant, dry matter production per plant (g), yield and quality parameters such as cut foliage yield per plant, cut foliage yield per  $\text{m}^2$  and quality characters such as visual scoring, freshness index, colour index and vase life (days) were observed at 270 days after planting. Third foliage stalk from the top was used to measure the biometric observations. Chlorophyll content in leaf samples were estimated as per the procedure given by Arnon (1949). The data on various parameters were analysed statistically as per the procedure suggested by Panse and Sukhatme (1997).

**RESULTS AND DISCUSSION**

Individual and interaction effects of nitrogen and phosphorus levels on growth, yield and quality characters in *Asparagus densiflorus* 'Sprengeri' L. were found to be significantly influenced. The *per se* effect of nitrogen  $N_3(9 \text{ g of N per liter per m}^2)$  and *per se* effect of phosphorus  $P_3(9 \text{ g of P per liter per m}^2)$  recorded significantly higher values on plant growth, yield and quality parameters during all the stages of crop growth. The combined application of nitrogen  $9 \text{ g per liter per m}^2$  and phosphorus  $9 \text{ g per liter per m}^2$  ( $N \times P$ ) significantly increased the growth, yield and quality characters during all the stages of crop growth. The plants raised in  $N_0P_0$  was found to be the least in growth, yield and quality parameters.

**Growth Parameters**

Higher growth parameters like cladophyll length of 45.75 cm and breadth of 14.43 cm (Table 1) were observed in the interaction  $N_3P_3(9 \text{ g N per liter per m}^2 \times 9 \text{ g P per liter per m}^2)$  which might be due to the combined application of nitrogen and phosphorus in sufficient amount to plants. The role of nitrogen in enhancing cell division and cell elongation leading to increase the plant height, which ultimately resulted in the maximum cladophyll length. Also phosphorus is an important constituent in energy metabolism and synthesis of growth stimulating compounds which might result in vigorous growth of cladophylls. Nitrogen and phosphorus deficiency generally results in under developed and shorter stature plants. These findings are in accordance with Abirami *et al.* (2018) in *Cordyline fruticosa* L. cv. Purple Compacta. The more number of primary branches (36.23) with maximum length of primary branches (13.17 cm) were obtained at  $N_3P_3(9 \text{ g N per liter per m}^2 \times 9 \text{ g P per liter per m}^2)$  the higher nutrient doses as compared to lower nutrient doses. The application of appropriate level of nitrogen and phosphorus might have encouraged for stimulation of growth promoting substances and production of auxiliary buds resulting in development of more number of primary branches per cladophyll. The above results are corroborated with the findings of Aslam *et al.* (2016) in African marigold and Pamela Elisheba (2021) in ornamental sunflower.

The number of leaflets and plant spread (Table 1) are the main photosynthetic characters in plants. Among the interaction effect of nitrogen and phosphorus levels, the number of leaflets per cladophyll (1250.19), plant spread NS (63.06 cm) and plant spread EW (67.66 cm) in *Asparagus densiflorus* 'Sprengeri' L., were found to be higher in





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treatment  $N_3P_3$ . The extensive number of laterals in treatment  $N_3P_3$  ultimately resulted in the maximum leaflet counts and plant spread in both directions. Nitrogen helped in improving structural parameters because it is an important constituent of proteins and phosphorus on the other hand is an important structural component of phospholipids helping in absorbing and translocation of food materials which significantly increased root geometry, nutrient access and supply resulting in the development of sound and healthy rhizosphere and this might be the reason behind the increased plant spread as reported by Chadha *et al.* (2012). Chlorophyll is also the prime factor that determines the colour of foliage, which is the foremost standard for cut foliage production. The maximum chlorophyll content ( $0.573 \text{ mg g}^{-1}$ ) was recorded in  $N_3P_3$ , followed by  $N_3P_2$  ( $0.552 \text{ mg g}^{-1}$ ). This result was a reflection of improved nitrogen and phosphorus assimilation and beneficial effect of nitrogen on photosynthetic pigments, which may be due to its role in elevating the rates of photochemical reduction. These results were also stated by Nabih and El-Khateeb (1991) in *Philodendron erubescence* 'Emerald Queen' and Dahab *et al.* (2017) in *Chamaedorea elegans*, Mart. foliage plants.

Improved nutritional management by the combined application of nitrogen and phosphorus in appropriate dose significantly influenced cladophyll production interval (Fig. 1). The data on average number of days taken for cladophyll production were observed the minimum in  $N_3P_3$  (9.72 days) followed by  $N_3P_2$  (10.04 days). This is because of enhanced uptake of available nutrients resulting in better root development, faster cell division and cell elongation, which consequently hastened cladophyll production as reported by Sankari *et al.* (2019) in *Asparagus spregeri* L. The maximum number of day's interval taken for cladophyll production was observed in  $N_0P_0$  (13.17 days). The data on fresh and dry weight of cladophylls per plant were higher in treatment  $N_3P_3$  with the values of 178.24 g and 25.86 g, followed by  $N_3P_2$  with the values of 174.28 g and 25.09 g. The initial vigor and better metabolic activities especially with the photo assimilates due to the application of nitrogen and phosphorus, which would have favored more production of vegetative growth that leads to the improvement in fresh and dry weight of cladophylls per plant. The present findings had closely conformity with Alkurdi *et al.* (2014) in *Helichrysum bractum*.

The root parameters *viz.*, number of bulbs per plant (50.71), fresh weight and dry weight of roots and bulbs per plant (304.15 g and 83.68 g) were significantly influenced by  $N_3P_3$  among the interactions. Application of nitrogen and phosphorus at certain levels had also been found to increase bulb production in dahlia and tulip (Khan *et al.*, 2006). The less number of bulbs recorded in  $N_0P_0$  might be due to the lack of nutrients in growing medium. Dry matter production per plant in asparagus is one of the important growth parameter of the crop to be considered for determination of the economic yield while assessing the effect of nitrogen and phosphorus interactions. Dry matter production per plant was significantly increased with the increment of nutrient levels and recorded the maximum in  $N_3P_3$  (111.69 g). Higher levels of nitrogen and phosphorus in the soil contributed to higher dry matter production, which is a vital requirement for photosynthetic ability in a given canopy and in turn might have helped other synthetic process during growth and development as reported by Rashid *et al.* (2013). Also, the various vegetative, rooting and chlorophyll characters in best treatment leads to more accumulation of dry matter in plant as reported by Darwish (1994) in *Casuarina glauca*.

#### Yield and Quality Parameters

The nutrient combination of ( $N_3P_3$ ) nitrogen 9 g/liter/m<sup>2</sup> + phosphorus 9 g/liter/m<sup>2</sup> resulted in the production of the maximum number of cut foliage yield per plant (36.54) and cut foliage yield per m<sup>2</sup> (292.17), followed by  $N_3P_2$ . The lower number of cut foliage yield per plant (20.71) and cut foliage yield per m<sup>2</sup> (162.16) was registered in the  $N_0P_0$ . Higher level of nitrogen helps to increase the availability of cytokinins that are known to encourage the growth and development of plant and hence manifested in the production of more number of cut stems in plants. Also, high levels of phosphorus application encourage the lateral growth and number of leaves. This may be the possible reason for increased cut foliage yield in *Asparagus densiflorus* 'Sprengeri' L. cut foliage. Similar results have been reported in Sujatha *et al.* (2015) in leather leaf fern (*Rumohra adiantiformis*) and Shanmugi (2021) in *Philodendron xanadu*.

Regarding the quality aspects such as visual scoring (8.46), freshness index (8.15), colour index (7.91) and vase life (5.19 days), the best values were observed in the interaction ( $N_3P_3$ ) nitrogen 9 g/liter/m<sup>2</sup> + phosphorus 9 g/liter/m<sup>2</sup>, followed by  $N_3P_2$ . The minimum values were observed with the interaction of  $N_0P_0$ . The best interaction contains







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optimum levels of nitrogen, phosphorus and potassium are known to play a significant role in stimulating some enzymes and the accumulation of carbohydrate in plant cells, which in turn increases leaf carbohydrate content. Higher carbohydrate content and other essential elements stored in vegetative cells thickened the foliage which resulted in production of high quality cut foliages with longer vase life, good visual appearance, freshness and colour index. These results are in concurrence with the findings of Abinaya and Karuppaiah (2018) in *Philodendron erubescens*. On the basis of above findings, it was concluded that, combined application of nitrogen and phosphorus each at 9 g per liter/m<sup>2</sup> along with potassium at 6 g per liter/m<sup>2</sup> could be effective for better growth, yield and quality characters of *Asparagus densiflorus* 'Sprengeri' L. cut foliage.

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**Table: 1 Effect of nutrients on growth parameters of *Asparagus densiflorus'sprengeri* L.**

Treatments	Cladophyll length (cm)	Cladophyll breadth (cm)	No of primary branches per foliage stalk	Length of primary branches per cladophyll (cm)	Plant spread (North-South) (cm <sup>2</sup> )	Plant spread (East-West) (cm <sup>2</sup> )	No. of leaflets per cladophyll
<b>Nitrogen</b>							
N <sub>0</sub>	27.39	10.45	27.90	10.09	41.07	45.38	818.96
N <sub>1</sub>	34.71	12.10	31.19	11.12	49.56	54.13	981.83
N <sub>2</sub>	38.92	12.96	32.97	11.86	54.51	59.01	1078.84
N <sub>3</sub>	40.89	13.37	33.90	12.24	56.93	61.47	1128.65
<b>S.Ed</b>	<b>0.32</b>	<b>0.07</b>	<b>0.12</b>	<b>0.05</b>	<b>0.39</b>	<b>0.44</b>	<b>7.03</b>
<b>CD (P=0.05)</b>	<b>0.65</b>	<b>0.14</b>	<b>0.26</b>	<b>0.11</b>	<b>0.78</b>	<b>0.90</b>	<b>14.06</b>
<b>Phosphorus</b>							
P <sub>0</sub>	30.41	11.11	29.27	10.53	38.07	48.96	884.72
P <sub>1</sub>	35.13	12.12	31.21	11.25	40.41	54.38	990.4
P <sub>2</sub>	37.55	12.73	32.51	11.65	42.47	57.72	1053.61
P <sub>3</sub>	38.82	12.92	32.97	11.89	43.32	58.94	1079.42
<b>S.Ed</b>	<b>0.32</b>	<b>0.07</b>	<b>0.12</b>	<b>0.05</b>	<b>0.39</b>	<b>0.44</b>	<b>7.03</b>
<b>CD (P=0.05)</b>	<b>0.65</b>	<b>0.14</b>	<b>0.26</b>	<b>0.11</b>	<b>0.78</b>	<b>0.90</b>	<b>14.06</b>
<b>N×P</b>							
N <sub>0</sub> × P <sub>0</sub>	24.49	9.74	26.72	9.72	38.07	42.14	770.18
N <sub>0</sub> × P <sub>1</sub>	26.84	10.36	27.63	10.03	40.41	44.73	806.26
N <sub>0</sub> × P <sub>2</sub>	28.78	10.81	28.46	10.27	42.47	46.97	841.88
N <sub>0</sub> × P <sub>3</sub>	29.46	10.92	28.78	10.35	43.32	47.70	857.51
N <sub>1</sub> × P <sub>0</sub>	31.02	11.31	29.56	10.59	45.11	49.74	893.13
N <sub>1</sub> × P <sub>1</sub>	35.02	12.12	31.17	11.19	49.59	54.17	982.64
N <sub>1</sub> × P <sub>2</sub>	35.58	12.46	31.85	11.23	51.46	56.09	1018.62
N <sub>1</sub> × P <sub>3</sub>	37.21	12.53	31.99	11.49	52.08	56.51	1032.94
N <sub>2</sub> × P <sub>0</sub>	32.73	11.67	30.30	10.86	47.06	51.72	928.97
N <sub>2</sub> × P <sub>1</sub>	38.59	12.84	32.68	11.74	53.90	58.39	1068.72





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N <sub>2</sub> × P <sub>2</sub>	41.52	13.52	34.13	12.30	57.75	62.07	1140.63
N <sub>2</sub> × P <sub>3</sub>	42.86	13.81	34.83	12.54	59.33	63.88	1177.05
N <sub>3</sub> × P <sub>0</sub>	33.41	11.76	30.48	10.95	47.69	52.23	946.62
N <sub>3</sub> × P <sub>1</sub>	40.07	13.16	33.39	12.04	55.84	60.24	1104.51
N <sub>3</sub> × P <sub>2</sub>	44.32	14.13	35.51	12.82	61.15	65.75	1213.30
N <sub>3</sub> × P <sub>3</sub>	45.75	14.43	36.23	13.17	63.06	67.66	1250.19
<b>SE (d)</b>	<b>0.64</b>	<b>0.14</b>	<b>0.25</b>	<b>0.11</b>	<b>0.77</b>	<b>0.88</b>	<b>14.06</b>
<b>CD (p=0.05)</b>	<b>1.31</b>	<b>0.29</b>	<b>0.52</b>	<b>0.23</b>	<b>1.56</b>	<b>1.80</b>	<b>28.12</b>

**Table: 2 Effect of nutrients on growth parameters of *Asparagus densiflorus* 'sprengeri' L.**

Treatments	Chlorophyll content (mg g <sup>-1</sup> )	Fresh weight of cladophylls per plant (g)	Dry weight of cladophylls per plant (g)	Number of bulbs per plant	Fresh weight of roots and bulbs per plant (g)	Dry weight of roots and bulbs per plant (g)	Dry matter production per plant (g)
<b>Nitrogen</b>							
N <sub>0</sub>	0.359	131.41	18.43	31.79	165.56	43.22	83.01
N <sub>1</sub>	0.444	147.63	21.01	39.70	226.15	61.50	97.32
N <sub>2</sub>	0.494	158.97	22.82	42.68	246.44	67.36	101.21
N <sub>3</sub>	0.516	164.55	23.64	43.76	255.46	69.52	102.54
<b>S.Ed</b>	<b>0.002</b>	<b>0.87</b>	<b>0.12</b>	<b>0.39</b>	<b>1.70</b>	<b>0.64</b>	<b>0.29</b>
<b>CD (P=0.05)</b>	<b>0.004</b>	<b>1.77</b>	<b>0.24</b>	<b>0.80</b>	<b>3.42</b>	<b>1.31</b>	<b>0.60</b>
<b>Phosphorus</b>							
P <sub>0</sub>	0.404	137.90	19.50	34.48	186.21	49.21	87.30
P <sub>1</sub>	0.447	149.25	21.27	37.47	208.10	56.02	93.85
P <sub>2</sub>	0.476	156.05	22.29	41.92	241.56	65.93	100.02
P <sub>3</sub>	0.487	159.36	22.85	44.12	257.72	70.44	102.91
<b>S.Ed</b>	<b>0.002</b>	<b>0.87</b>	<b>0.12</b>	<b>0.39</b>	<b>1.70</b>	<b>0.64</b>	<b>0.29</b>
<b>CD (P=0.05)</b>	<b>0.004</b>	<b>1.77</b>	<b>0.24</b>	<b>0.80</b>	<b>3.42</b>	<b>1.31</b>	<b>0.60</b>
<b>N×P</b>							
N <sub>0</sub> × P <sub>0</sub>	0.337	126.51	18.43	30.39	145.74	36.43	74.16
N <sub>0</sub> × P <sub>1</sub>	0.358	130.22	18.24	31.10	161.46	42.24	82.97
N <sub>0</sub> × P <sub>2</sub>	0.369	133.84	18.89	32.75	175.68	46.45	87.04
N <sub>0</sub> × P <sub>3</sub>	0.374	135.08	19.05	32.92	179.36	47.77	87.88
N <sub>1</sub> × P <sub>0</sub>	0.408	138.73	19.68	34.58	188.71	51.04	90.24
N <sub>1</sub> × P <sub>1</sub>	0.445	147.68	21.09	38.38	215.75	58.32	95.43
N <sub>1</sub> × P <sub>2</sub>	0.461	149.74	21.26	42.11	244.24	66.34	100.61
N <sub>1</sub> × P <sub>3</sub>	0.465	153.42	21.92	43.75	255.89	70.29	103.02
N <sub>2</sub> × P <sub>0</sub>	0.432	142.33	20.32	36.25	202.73	54.12	92.13
N <sub>2</sub> × P <sub>1</sub>	0.483	157.44	22.59	40.04	225.99	61.27	98.29
N <sub>2</sub> × P <sub>2</sub>	0.522	165.89	23.87	45.53	265.53	74.03	105.37
N <sub>2</sub> × P <sub>3</sub>	0.538	170.23	24.51	48.92	291.50	80.04	109.04
N <sub>3</sub> × P <sub>0</sub>	0.438	144.05	20.46	36.71	207.68	55.27	92.69
N <sub>3</sub> × P <sub>1</sub>	0.501	161.65	23.16	40.36	229.21	62.27	98.72
N <sub>3</sub> × P <sub>2</sub>	0.552	174.28	25.09	47.28	280.81	76.89	107.06
N <sub>3</sub> × P <sub>3</sub>	0.573	178.24	25.86	50.71	304.15	83.68	111.69
<b>SE (d)</b>	<b>0.004</b>	<b>1.75</b>	<b>0.24</b>	<b>0.78</b>	<b>3.41</b>	<b>1.29</b>	<b>0.59</b>
<b>CD (p=0.05)</b>	<b>0.009</b>	<b>5.55</b>	<b>0.49</b>	<b>1.60</b>	<b>6.84</b>	<b>2.63</b>	<b>1.21</b>





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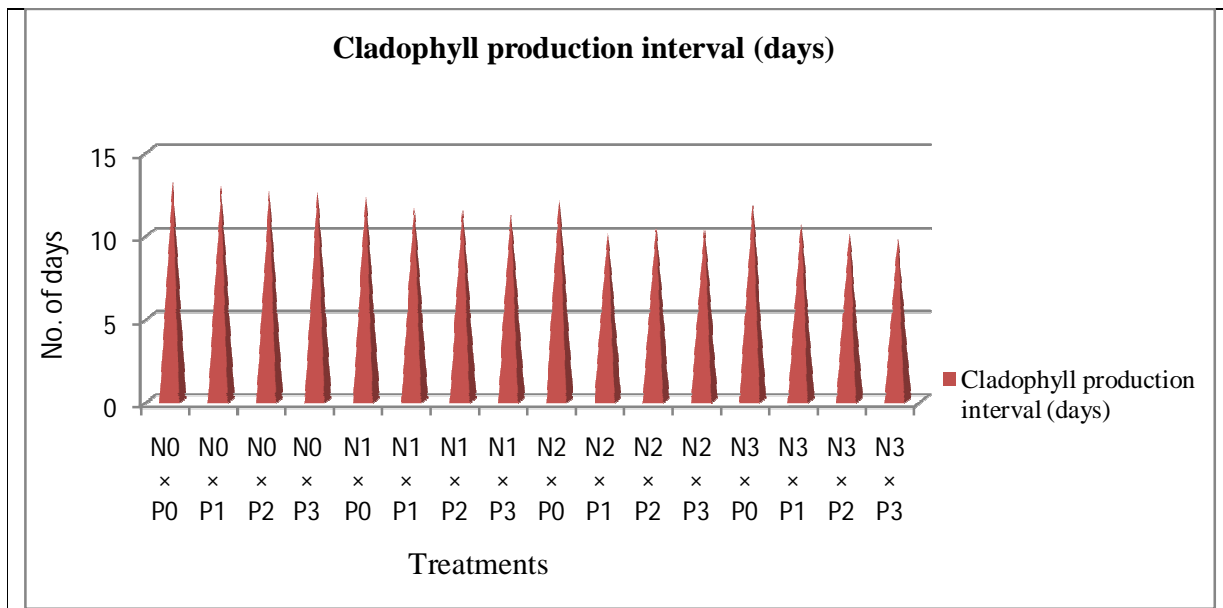
Table: 3 Effect of nutrients on yield and quality parameters of *Asparagus densiflorus'sprengeri*'L.

Treatments	Yield per plant (nos.)	Yield per m <sup>2</sup> (nos.)	Visual scoring	Freshness index	Colour index	Vase life (Days)
<b>Nitrogen</b>						
N <sub>0</sub>	22.41	177.62	6.01	6.33	6.28	3.80
N <sub>1</sub>	27.64	221.57	7.01	7.07	6.9	4.37
N <sub>2</sub>	30.97	247.79	7.51	7.48	7.29	4.66
N <sub>3</sub>	32.53	260.43	7.79	7.67	7.46	4.82
<b>S.Ed</b>	<b>0.24</b>	<b>2.12</b>	<b>0.02</b>	<b>0.03</b>	<b>0.02</b>	<b>0.02</b>
<b>CD (P=0.05)</b>	<b>0.49</b>	<b>4.34</b>	<b>0.05</b>	<b>0.06</b>	<b>0.04</b>	<b>0.04</b>
<b>Phosphorus</b>						
P <sub>0</sub>	24.49	195.45	6.43	6.63	6.52	4.03
P <sub>1</sub>	28.04	223.66	7.03	7.10	6.95	4.39
P <sub>2</sub>	30.02	240.74	7.37	7.36	7.18	4.59
P <sub>3</sub>	31.01	247.56	7.50	7.46	7.28	4.66
<b>S.Ed</b>	<b>0.24</b>	<b>2.12</b>	<b>0.02</b>	<b>0.03</b>	<b>0.02</b>	<b>0.02</b>
<b>CD (P=0.05)</b>	<b>0.49</b>	<b>4.34</b>	<b>0.05</b>	<b>0.06</b>	<b>0.04</b>	<b>0.04</b>
<b>N×P</b>						
N <sub>0</sub> × P <sub>0</sub>	20.71	162.16	5.71	6.04	6.07	3.57
N <sub>0</sub> × P <sub>1</sub>	22.03	173.57	5.94	6.27	6.25	3.76
N <sub>0</sub> × P <sub>2</sub>	23.25	185.03	6.15	6.46	6.37	3.92
N <sub>0</sub> × P <sub>3</sub>	23.66	189.71	6.24	6.54	6.44	3.97
N <sub>1</sub> × P <sub>0</sub>	24.86	199.16	6.48	6.72	6.58	4.10
N <sub>1</sub> × P <sub>1</sub>	27.53	221.74	7.03	7.07	6.88	4.38
N <sub>1</sub> × P <sub>2</sub>	28.39	230.76	7.23	7.23	7.04	4.49
N <sub>1</sub> × P <sub>3</sub>	29.58	234.61	7.28	7.27	7.10	4.53
N <sub>2</sub> × P <sub>0</sub>	26.01	208.07	6.70	6.85	6.69	4.19
N <sub>2</sub> × P <sub>1</sub>	30.72	244.82	7.48	7.45	7.25	4.65
N <sub>2</sub> × P <sub>2</sub>	33.02	264.53	7.88	7.73	7.53	4.85
N <sub>2</sub> × P <sub>3</sub>	34.15	273.74	8.00	7.88	7.68	4.96
N <sub>3</sub> × P <sub>0</sub>	26.39	212.43	6.82	6.91	6.75	4.25
N <sub>3</sub> × P <sub>1</sub>	31.88	254.50	7.67	7.60	7.41	4.76
N <sub>3</sub> × P <sub>2</sub>	35.99	282.63	8.22	8.01	7.79	5.09
N <sub>3</sub> × P <sub>3</sub>	36.54	292.17	8.46	8.15	7.91	5.19
<b>SE (d)</b>	<b>0.48</b>	<b>4.25</b>	<b>0.05</b>	<b>0.06</b>	<b>0.04</b>	<b>0.04</b>
<b>CD (p=0.05)</b>	<b>0.99</b>	<b>8.69</b>	<b>0.11</b>	<b>0.12</b>	<b>0.09</b>	<b>0.08</b>





**Sowmiya and Karuppaiah**



**Figure 1: Effect of nutrients on cladophyll production interval of *Asparagus densiflorus* 'sprengeri' L.**





## A Bibliometric Study and Visual Representation of Consumer's Online Shopping Behavior

Mudasir Ahmad Tass<sup>1\*</sup> and Iqbal Ahmad Hakim<sup>2</sup>

<sup>1</sup>Research Scholar, Department of Management Studies, University of Kashmir, Jammu and Kashmir, India.

<sup>2</sup>Professor, Department of Management Studies, University of Kashmir, Jammu and Kashmir, India.

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### \*Address for Correspondence

**Mudasir Ahmad Tass**

Research Scholar,

Department of Management Studies,

University of Kashmir,

Jammu and Kashmir, India.

E.Mail: sahil.tass@gmail.com



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### ABSTRACT

There is an increase in global interest in studying consumers' online shopping behaviors. Over the past decade, this field of study has seen tremendous growth and development. We have conducted a bibliometric analysis of the "Online Shopping Behavior" research area based on data from Scopus and Web of Science databases from 1996 through 2022. A total of 2062 publications were extracted from Scopus and WOS. In this paper, journals, researchers, and publications related to the "Online Shopping Behavior" research area are assessed in terms of their productivity, viability, and influence. Journal of Retailing and Consumer Services, Sustainability (Switzerland), Journal of Business Research, and Internet Research are the top journals in each of the three assessment categories, according to the bibliometric study. Almost 54% of the world's publications were contributed by the US, China, and India, indicating that these countries contributed significantly to online shopping behavior. Countries, authors, affiliations, most cited documents, and most used authors keyword plus were identified as the most relevant and influential actors. According to the bibliometric analysis, the research suggests a certain future research agenda for online shopping behavior. In the field of behavioral research on online shopping, this study has practical implications both for academics and researchers.

**Keywords:** Online Shopping, Online Buying Behavior, e-commerce, bibliometric analysis, e-business, R Studio, VOS viewer, co-citation analysis, bibliographic coupling, Word Cloud.





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## INTRODUCTION

The e-commerce industry has dominated the global retail landscape for the past several years. With the introduction of the internet and the continuous digitization of modern life, retailers, like many other industries, have changed dramatically since the introduction of the internet which is benefiting the convenience of online purchases. E-commerce, or the electronic purchasing and selling of items using online services or the Internet, has been practiced for decades (Li & Ku, 2018; Sullivan & Kim, 2018). Every year the number of digital purchasers increases as internet access and usage expands throughout the world. The year 2020 has seen the purchase of goods and services by nearly two billion people (Statista.com, 2022a), with global e-commerce sales exceeding 4.9 trillion U.S. dollars (statista.com, 2022). Internet users may explore, compare, and purchase goods or services using a variety of online platforms. The term e-tail can also refer to the transactional processes involved in online retail shopping (Hargrave, 2019). Online marketplaces account for the majority of online transactions worldwide as of 2022 (bigcommerce.com, 2022). In terms of traffic, Amazon is at the top of the global list of online shopping websites: In June 2020, the Seattle-based e-commerce behemoth (thebehemoth.com), which includes e-commerce, computer services, consumer goods, and digital content, had over 5.2 billion unique visits. However, Amazon comes in third place in terms of Gross Merchandise Value (GMV) behind Chinese rivals Taobao and Tmall (Statista.com, 2022b). The Alibaba Group, Asia's top online e-commerce supplier, manages both platforms Globally, online retail sales totaled 4.9 trillion dollars. An increase of more than 50% is expected within the next four years (Statista.com, 2022b)

### The objective of the Study

The objective of this study is to analyze the scientific research literature on online shopping behavior, address the limitations of prior studies, and present to practitioners and scholars a recent, detailed progression of the study on online shopping behavior. As per the authors' knowledge, there are only a few bibliometric studies that deal with this topic, and those include either Scopus or Web of Science. We are using both databases. The study would be the first to use two databases to analyze online shopping behavior. The following questions were addressed using bibliometric analysis. From 1996 to 2022, what was the publishing and citation structure of online shopping behavior research? In the study of online shopping behavior, which countries, organizations, and authors have been most productive and cited? In research on online shopping behavior, what are the patterns of authorship and collaboration? In online shopping behavior, what are the most frequently used keywords and major themes? Where does the literature on online shopping behavior stand conceptually (or in the main research domains)?

## LITERATURE REVIEW

In recent years, online shopping behavior has been the area of research, although comprehending it has proven challenging due to changes in main players such as customers and companies, as well as their behavior (Loketkrawee & Bhatiasevi, 2018). Digital technology is continuing to change the way manufacturers, suppliers, and consumers communicate and trade with one another all around the world. E-commerce is becoming increasingly essential in the global economy (Roca *et al.*, 2009). Today, e-commerce enterprises that want to be competitive in the long run must adjust their e-commerce strategy to their consumer's online shopping behavior (San Martín & Camarero, 2009; Pereira *et al.*, 2016). The E-commerce ecosystem alters buying behavior not just for online customers but also for offline shoppers, forming new habits (Khushboo Makwana, Dr. Anuradha Pathak, 2017; Svatosova, 2022). Consumer behavior in the purchase decision-making process has evolved significantly throughout the years, thanks to advanced times and technological advancements (Palvia, 2009; Pereira *et al.*, 2016; Richard *et al.*, 2010; San Martín & Camarero, 2009; Svatosova, 2020).

## RESEARCH METHODOLOGY

We employed bibliometric analytic tools to examine the available literature on the topic of online purchasing Behavior. The bibliometric analysis provides a complete understanding of the body of knowledge and its many





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features such as co-citations, co-occurrence, etc. It also aids in the description of data in the form of main contributions, most prolific author, most influential organization, production during a specific period, keyword growth, and so on (Chen, 2017; Singh & Bashar, 2021; Smyrnova-Trybulska *et al.*, 2018; Zhou *et al.*, 2013). Scopus and Web of Science databases were used to search for articles on online shopping behavior, and a combination of keywords was utilized to extract the most relevant articles in this context.

On December 14, 2022, the keywords, "TITLE-ABS-KEY ("online shop\*" OR "shop\* online" OR "Buy\* Online" OR "online Purchas\*" OR "Purchas\* online" OR "online Buy\*" OR "purchas\* Online" AND "behavi\*")", were used to retrieve all published papers and their citations. In total, 5948 research papers/articles were retrieved.

In literature, the first reference to online shopping behavior appeared in 1996, so we used that reference and, extracted data from 1996 to 2022. The extract was in BibTeX format and used for further processing and analysis. R Studio was used to convert the BibTeX file to excel. This allowed the two files to be merged and the delicacy was removed.

#### Screening Criteria Strategy

The articles are reviewed over the period of 1996 to 2022, across databases like:

- Web of Science
- Scopus

PRISMA is a standard method to give a systematic review of existing research (Haddaway *et al.*, 2022). We adopted this method to conduct a bibliometric analysis and evaluated the research on consumer's online shopping behavior. PRISMA flow chart is shown in figure 1.

#### Inclusion and Exclusion Criteria

From an initial search using the above keywords a total of 5948 articles were found, in both the databases Scopus and Web of Science, which was further analyzed by the authors to keep the most appropriate articles on online shopping behavior. Using the aforementioned criteria, we were able to narrow down our sample from 5948 to 2062 articles, which we used to create our sample for further research. For descriptive data analysis, the R Package's Biblioshiny application was used; the program was run on the Microsoft Edge browser at <http://127.0.0.1:5413/>. The Biblioshiny application is a tool that provides a detailed and comprehensive analysis of data characteristics, such as production trend in the field of study, best contributing affiliations, most influential country, most contributing authors, total local and global citations, most used keywords, and so on, with a beautiful web interface (Moral-muñoz *et al.*, 2020; Xie *et al.*, 2020). Biblioshiny is also used to map the network of co-citations and other intellectual and social structures in the field of knowledge. VOS viewer 1.6.18 was installed for network analysis and data visualization. VOSviewer is a data visualization software program that aids in author cooperation network visualizations well as the identification of study areas and sub-areas via co-citation analysis (Singh & Bashar, 2021). The strength of the network links and the clustering of literature are based on multiple criteria such as bibliographic coupling, co-occurrence, and so on (Smyrnova-Trybulska *et al.*, 2018) (Eck & Waltman, 2022). In order to create various graphs and tables for a better understanding and presentation of the results, we extracted the data from Biblioshiny and reprocessed it using Excel.

#### Data Analysis

The data obtained from Scopus and the Web of Science were analyzed using R software. We analyzed the data using bibliometric methods such as performance analysis and science mapping. The present study examines performance analysis (nation and author production) and science mapping analysis (co-occurrence, thematic mapping, network collaboration). To launch the web interface of R - software, the biblioshiny () package was added to R - software. A BibTeX file was then uploaded to the web interface of Biblioshiny and analyzed. Biblioshiny(), a function included in R-software, is used to launch the web interface. Our analysis was performed using an online interface created by Biblioshiny using a BibTeX file uploaded by Biblioshiny.





**Mudasir Ahmad Tass and Iqbal Ahmad Hakim****Performance Analysis**

Performance analysis evaluates the overall contribution that various research components provide to a certain field. Performance analysis is a widespread technique for gathering data from a variety of research parameters, including authors, organizations, countries, and journals. As a result, this is found in practically every review, including those that do not use scientific mapping (Donthu *et al.*, 2021). A total of 2062 documents related to online shopping behavior were extracted from 582 sources (journals) between 1996 and 2022. These documents were published in about 582 sources, which include journals only. In total, 5083 keywords were provided by authors, more than double the number of documents. With an average document age of 6.46, the growth rate is 20.44. The documents were written by 4106 authors, of which 198 were single-authored and the remaining (3908) were multi-authored. With an average of 2.85 co-authors per document, the collaboration index is 8.39. With 42.81 citations per document, the research on online shopping behavior is relatively popular. The annual production of articles can be seen from the below bar graph from 1996-2022.

Based on the number of publications per year, Fig-2 illustrates the influence of published documents from 1996 to 2022. In year 1, the number of publications reached a higher peak. It started in 1996 with only one publication, and it began to increase year by year. The number of publications in 2022 is 126, but it is expected that the number will increase and more contributions will be made to the field of research on online shopping behavior. Among the most cited papers in the field of online shopping behavior, the paper authored by David Gefen in the year 2003 has 4468 total citations and an average citation rate of 223.40 per year. An integrated model for trust and TAM in online shopping was published in the journal of Management Information Systems Research Center. In the Journal of Marketing Science, Thomas P. Novak published a paper titled "Measuring the Customer Experience in Online Environments: A Structural Modeling Approach" in 2000. With an average of 79.35 citations per year, this paper received 1825 total citations. In 2001, Terry L. Childers published a study exploring the Hedonic and Utilitarian motivations for online retail shopping behavior. A total of 1790 citations were received, with an average citation rate of 81.36 per year. Mary Wolfenbarger published his papers in the field of eTailQ: dimensionalizing, measuring, and predicting eTail quality and received 1317 citations with 65.85 citations per year. A paper titled "E-Loyalty: Your Secret Weapon on the Web" by Frederick F. Reichheld received 1101 total citations with an average of 47.87 citations per year. A total of 4205 citations have been received for the papers published by Gerald Häubl, Vicki McKinney, David Gefen, Sandra M Forsythe, and Sevgin A. Eroglu between 2000 and 2004. As a result of publishing articles, significantly expanding knowledge and exploring the topic of online shopping.

What are the most cited countries in terms of online shopping behavior between 1996 and 2022? For a better visual representation of the bibliographic data, we used VOS Viewer software (van Eck & Waltman, 2010). On the map, the most cited countries are clustered into three groups, which are colored differently. With 38342 citations and an average of 94.21 citations per article, the United States was the most cited country, followed by China with 11585 citations and an average of 28.89 citations per article. Among the countries with the lowest citation counts, Germany has 1420 citations with an average of 33.02, and India has 1516 citations and an average of 11.75. Korea, the UK, Spain, Canada, Netherlands, and Hong Kong contribute 3940, 3531, 3284, 2185, 2070, and 1828 respectively.

The above table shows the annual research productivity in online shopping behavior in terms of publications, citations, mean citations, and citable years. This topic was first published in 1996 and has received 9 citations to date. Research productivity on online shopping behavior increased steadily after the first publication appeared in 1996. Over 59 % of all publications were published during 2016–2022, an increase of 1219 publications. 10 publications were cited 16771 times in 2001. 2021 was the year with the most publications (N = 256).

Table 6, summarizes the top ten authors, countries, and organizations on consumers' online shopping behavior research productivity in terms of publications. The top countries with the highest number of publications included the United States (N = 850), China (731), India (273), United Kingdom (N = 162), Spain (161), South Korea (129), Australia (n = 96) Germany (83), Canada (70), and Malaysia at the bottom of the list, produced (67). As far as the top 10 organizations in online shopping Behavior are concerned, the University of North Texas is at the top with 24

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publications. CITY UNIV HONG KONG and the YONSEI UNIV both are at number two and three with 21 and 18 publications, respectively followed by the CITY UNIVERSITY OF HONG KONG (17) publications. FUDAN UNIV and UNIV WISCONSIN are having 16 publications each. University of science and technology China is having 15 publications in the said field. The remaining three organizations contributed 14 publications each. There may be various reasons behind the highest contributions by institutions from developed countries. For instance, there is an increase in the Enrollment of international students in the universities in OECD (developed) countries. These enrolments are not only diverse from age perspectives but nationality perspectives as well. As mentioned by Mishra, during the last ten years the enrolment of students aged 25 to 34 years in the universities of Australia, Czech Republic, Greece, Iceland, Italy, Netherlands, and Switzerland has increased by more than 10% (Mishra, 2020). Furthermore, there is an increase in international students by 85% in the United States only (Shu *et al.*, 2020). All students irrespective of their cultural background require social support and in particular immigrant (international) students (Vedder *et al.*, 2005). Hence the increasing number of students in universities in terms of diversity necessitates a social support system in the education sector and related research. Lists the most productive authors for Online Shopping Behavior research. The author, Kim J. affiliated with the UNIVERSITY OF NORTH TEXAS had 25 publications (the most on the list). Nine other authors (WANG Y, LI Y, WANG X, CHEN Y, KIM S, CHEN C, LI X, PARK J, WU J) produced 142 publications out of (162), 25, 19, 16, 15, 15, 14, 14, 12, 12 respectively. On the other side, countries are having a total number of 2622 publications, and affiliation institutions are having a total of 169 total articles. The overall productive author's result indicates that this is an emerging area and has scope for significant research in the future. This table lists the top authors, countries, and affiliations on Online shopping behavior between 1996 and 2022.

Bradford's law states that "if scientific journals are arranged in decreasing order of productivity of articles on a given topic, they can be divided into a nucleus more closely focused on that topic" If journals in a subject are divided into three groups based on the number of articles published, each with around one-third of all articles, the number of journals in each category will be proportional to  $1:n:n^2:n^3$ , where  $n$  is a multiplier (Bailón-Moreno *et al.*, 2005). Journal of Retailing and Consumer Services, Sustainability (Switzerland), Journal of Business Research, Electronic Commerce Research and Applications, Computers in Human Behavior, Asia Pacific Journal of Marketing and Logistics, Decision Support Systems, International Journal of Retail and Distribution Management, Journal of Theoretical and Applied Electronic Commerce Research are the primary sources of online shopping behavior research, according to Bradford's law of scattering.

The study applies Lotka's law to describe the number of publications by authors in online shopping behavior research. Lotka's Law, named after Alfred J. Lotka, expresses the frequency with which authors in a certain field publish (Lotka, 1926). The results of Lotka's law indicate that 0.788% of authors contribute one article, 0.126% of authors contribute two articles, 0.044% of the authors published three documents and 0.013% of the authors contribute four documents, as shown in Figure 4. Table 8, indicates that 0 % of the authors published ten articles in the online shopping behavior research journals.

**Top 10 Most Influential Journals**

Table 8: presents the top 10 research journals that produced literature on online shopping behavior. These ten journals produced 473 publications; one of those journals produced over 135 publications. Journal of Retailing and Consumer Services, Sustainability (Switzerland), Journal of business research, and internet research emerged as top sources with a total of 281 publications, followed by electronic commerce research and applications with 44 publications. The other five journals, Computers in Human Behavior, Asia Pacific Journal of Marketing and Logistics, Decision Support Systems, International Journal of Retail and Distribution Management, and Journal of Theoretical and Applied Electronic Commerce Research are having, 35,29,29, 28, and 27 publications respectively. As found in the present bibliometric study, more than 24 % of the research in the social support area has been done in the Journal of Retailing and Consumer Services, and the supremacy of this area might be related to its evolution and relevance (Aparicio-Martinez *et al.*, 2019). This shows that the research in this area has a better chance to get published in impact factor journals.



**Mudasir Ahmad Tassand Iqbal Ahmad Hakim****Science Mapping**

Bibliometric maps are used in science mapping to show how certain disciplines, scientific areas, or research areas are conceptually, intellectually, and socially organized (Cobo *et al.*, 2011). Data retrieval, pre-processing, network extraction, normalization, mapping, analysis, and visualization are often included in scientific mapping studies. Citations and keyword concordance are two bibliometric analysis techniques used in science mapping (Gaviria-Marin *et al.*, 2019).

Cloud” is to visually highlight the “keywords” appearing more frequently on the web texts by forming a “keyword cloud layer” or “keyword rendering.” Word cloud diagrams filter out large amounts of text information to enable web browsers to create a general impression of the main idea of the text by scanning it (Heimerl *et al.*, 2014). The word cloud diagram shown in Figure 5, was generated using biblioshiny. In the diagram, parameters Field was set as keywords plus. The main advantage of selecting the keywords plus is that it provides insights into important topics and research trends. Among other parameters, the number of words was set as 50. The word sales itself occupies the largest area and is located right in the middle of the word cloud diagram shown in figure 5. In addition to sales, the most representative and eye-catching words were internet, online shopping, and consumption behavior, which represent important research directions in the field of online shopping behavior. However, the other words were consumer behavior, model, trust, and retailing which are also important in the field of online shopping behavior.

**Intellectual structure**

Thematic evolution and thematic mapping of online shopping behavior.

This part of the study looks at the thematic development and thematic mapping of literature on online buying behavior over time. The number of articles produced for each topic area is displayed on a two-dimensional thematic evolution graph, and the thematic areas are represented by vertical divisions. These lines have come together conceptually or thematically throughout time due to several common characteristics. The figure explains how several themes arose from 1996 to 2017 to 2018 to 2022. The term “electronic commerce” is significant since it is connected to practically every action. But just once has the word “model” been used. Stage one (1996-2017) and two (2018-2022) are closely related since they share more keywords, as shown in Figure 6.

Thematic keyword mapping identifies study themes, key terms, and their relationships. Themes in the upper right quadrant are critical to the domain because of their high centrality and density. These themes identify research areas that have been created and are important in a specific field of study (Akter *et al.*, 2021). In thematic mapping, themes are positioned according to the quadrants: upper-right quadrant: motor themes; lower-right quadrant: basic themes; lower-left quadrant: emerging or disappearing themes; and upper-left quadrant: very specialized/niche themes. Online shopping, e-loyalty, e-service quality, and social presence are the motor themes that were well developed and important to the field of online shopping behavior, and these are spotted on the high density and high relevancy spectrum in the above image. The Hydronic value, utilitarian value, opinion mining, omnichannel, and omnichannel retailing are the niche themes with high density and low relevance.

Although basic themes are important for the development of a study topic, they are not thoroughly explored inside (Martínez *et al.*, 2015). The themes such as consumer behavior, electronic commerce, the internet, online reviews, and data mining are most relevant but have a low density as shown in Figure 7. Words such as machine learning and show rooming fall under the theme of low density and low centrality in other words these are emerging themes or declining themes in the field of online shopping behavior.

Figure 8, indicates a country's global collaboration, with blue representing country-specific publications and gray representing no publications from the country. When it comes to online shopping behavior, the darker blue represents the most productive country. As shown in the red lines, there are collaborative relationships between the producing countries (Akter *et al.*, 2021). According to the collaboration map, the red lines indicate countries that are more active in working with others. In terms of online shopping behavior, the United States has collaborated with almost every other country, including the United Kingdom, Canada, China, Korea, Australia, India, and Singapore.



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In the field of Online shopping behavior, the United States and China have the highest collaboration, followed by the United States and Korea, the United States and Canada, and the United States and the United Kingdom.

**Research Limitations and Future Directions**

In this study, the first limitation includes the fact that research articles are continuously being added to Scopus and Web of Science databases, thereby increasing the number of articles. Second, we excluded gray literature (reviews, books, conference papers) from the analysis by restricting the selection to empirical studies. Therefore, bibliometric analyses on a particular topic will show significant variation over time. Future research should incorporate articles, books, and conference sources. The impact factor and social science citation index must be considered when conducting bibliometric analysis. Researchers, and academicians, in the online consumer behavior domain, will certainly benefit from the results of this study to gain a better understanding of this research field. Likewise, marketing professionals can use this research to gain insight into future research trends and to better understand complex consumer behaviors.

**DISCUSSION AND CONCLUSION**

In this study, the main objective was to evaluate the literature in the area of online shopping behavior in detail. It has become quite popular among academicians and professionals to discuss online consumer behavior. This study examined the evolution of online shopping behavior from 1996 to 2022. This study included 2062 papers, which show that online shopping behavior research has progressed every year. Due to the huge increase in the number of articles from 2016 to 2021, we consider this period to be the most significant in the development of online shopping behavior research. Several bibliometric characteristics are examined, such as author-country collaboration, thematic mapping, keyword co-occurrence, and the most productive authors, institutions, and countries. Some of the most in-depth approaches used throughout the research include performance analysis, science mapping analysis, and bibliometrics utilizing the R package. Studies on online shopping behavior are most commonly published in the Journal of Retailing and Consumer Services, Sustainability (Switzerland), Journal of Business Research, and Internet Research, according to Bradford's law of scattering. Researchers interested in studying online consumer behavior might gain a lot of knowledge by analyzing the various themes and providing suggestions for future research.

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**Table 1 Inclusion and exclusion criteria**

"Inclusion criteria"	"Exclusion criteria"
Article full text available	Article full text not available
English as a language	Non- English
Within the domain of online shopping Behavior	Qualitative study
Time frame 1996 to 2022	Reviews, Book chapters, conference proceedings, etc.

**Table 2 Main information about the publications**

MAIN INFORMATION ABOUT DATA	
Total number of Documents	2062
Timespan	1996:2022
Type of Sources (Journals)	582
Annual Growth Rate %	20.44
Document Average Age	6.46
Average citations per doc	42.81
References	103117
DOCUMENT CONTENTS	
Keywords Plus (ID)	4223
Author's Keywords (DE)	5083
AUTHORS	
Authors	4106
Authors of single-authored docs	198
Authors of multi-authored docs	3908
AUTHORS COLLABORATION	
Single-authored docs	219





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Co-Authors per Doc	2.85
International co-authorships %	8.39
<b>DOCUMENT TYPES</b>	
Article	2062

**Table 3 Top 10 Most Global Cited Documents**

Year	Author	source	Title of the document	Total Citations	TC per Year
2003	David Gefen	Management Information Systems Research Center	Trust and TAM in Online Shopping: An Integrated Model	4468	223.40
2000	Thomas P. Novak	Marketing Science	Measuring the Customer Experience in Online Environments: A Structural Modeling Approach	1825	79.35
2001	Terry L. Childers	Journal of Retailing	Hedonic and utilitarian motivations for online retail shopping behavior	1790	81.36
2003	Mary Wolfenbarger	Journal of Retailing	eTailQ: dimensionalizing, measuring, and predicting etail quality	1317	65.85
2000	Frederick F. Reichheld	Harvard Business Review	E-Loyalty: Your Secret Weapon on the Web	1101	47.87
2000	Gerald Häubl	Marketing Science	Consumer Decision Making in Online Shopping Environments: The Effects of Interactive Decision Aids	999	43.43
2002	Vicki McKinney	Information Systems Research	The Measurement of Web-Customer Satisfaction: An Expectation and Disconfirmation Approach	934	44.48
2004	David Gefen	Omega, The International Journal of management Science	Consumer trust in B2C e-Commerce and the importance of social presence: experiments in e-Products and e-Services	855	45.00
2003	Sandra M Forsythe	Journal of Business Research	Consumer patronage and risk perceptions in Internet shopping	737	36.85
2001	Sevgin A. Eroglu	Journal of Business Research	Atmospheric qualities of online retailing: A conceptual model and implications	680	30.91

**Table 4 10 Most cited countries**

Country	TC	Average Article Citations
USA	38342	94.21
China	11585	28.89
Korea	3940	55.49
United Kingdom	3531	44.14
Spain	3284	40.54
Canada	2185	70.48
Netherlands	2070	69.00





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Hong Kong	1828	114.25
India	1516	11.75
Germany	1420	33.02

**Table 5 Research Productivity over the years**

Year	Articles	Citations	Citable years	Mean citation per article
1996	1	9	26	9.00
1997	0	0	0	0.00
1998	1	14	24	14.00
1999	1	345	23	329.00
2000	7	6267	22	666.57
2001	10	16771	21	330.00
2002	17	6300	20	164.24
2003	26	9648	19	385.85
2004	29	13770	18	138.10
2005	26	4742	17	99.38
2006	45	4270	16	107.58
2007	45	3290	15	80.31
2008	35	2144	14	78.80
2009	70	2406	13	64.91
2010	81	4369	12	57.49
2011	82	1453	11	62.10
2012	71	1177	10	54.49
2013	86	778	9	46.40
2014	89	960	8	51.84
2015	89	566	7	35.99
2016	128	1347	6	37.14
2017	148	1100	5	30.77
2018	150	1649	4	23.18
2019	202	572	3	12.63
2020	209	543	2	12.73
2021	256	207	1	4.60
2022	126	26	0	1.11

**Table 6 Ten Most Productive Different Scientific Actors**

Authors	Frequency	Country	Frequency	Affiliation	Articles
KIM J	25	USA	850	UNIVERSITY OF NORTH TEXAS	24
WANG Y	25	CHINA	731	CITY UNIV HONG KONG	21
LI Y	19	INDIA	273	YONSEI UNIV	18
WANG X	16	UK	162	CITY UNIVERSITY OF HONG KONG	17
CHEN Y	15	SPAIN	161	FUDAN UNIV	16
KIM S	15	SOUTH KOREA	129	UNIV WISCONSIN	16
CHEN C	14	AUSTRALIA	96	UNIV SCI AND TECHNOL CHINA	15
LI X	14	GERMANY	83	KATHOLIEKE UNIV LEUVEN	14
PARK J	12	CANADA	70	SCHOOL OF MANAGEMENT	14
WU J	12	MALAYSIA	67	UNIV BURGOS	14







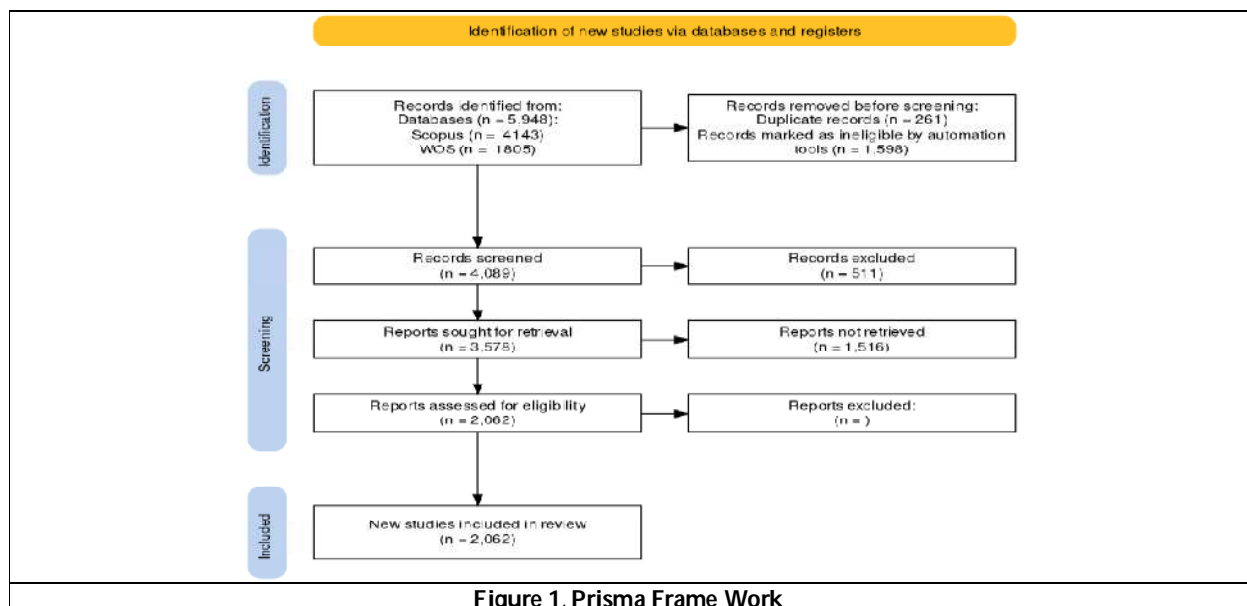
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**Table 7 Bradford's Distribution in 3 zones**

Bradford's Distribution in 3 zones, 1996–2022		
Zones	No. of articles	% Share of total articles
Zone 1	690	33.46
Zone 2	695	33.71
Zone 3	677	32.83
Total	2062	100

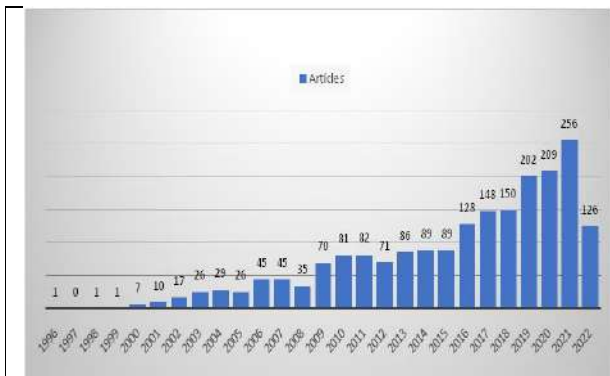
**Table 8 Lotka's Law and Most productive Sources**

Lotka's Law			Most productive Sources	
Documents written	N. of Authors	Proportion of Authors	Sources	Articles
1	3237	0.788	JOURNAL OF RETAILING AND CONSUMER SERVICES	115
2	518	0.126	SUSTAINABILITY (SWITZERLAND)	59
3	180	0.044	JOURNAL OF BUSINESS RESEARCH	54
4	54	0.013	INTERNET RESEARCH	53
5	49	0.012	ELECTRONIC COMMERCE RESEARCH AND APPLICATIONS	44
6	18	0.004	COMPUTERS IN HUMAN BEHAVIOR	35
7	18	0.004	ASIA PACIFIC JOURNAL OF MARKETING AND LOGISTICS	29
8	10	0.002	DECISION SUPPORT SYSTEMS	29
9	6	0.001	INTERNATIONAL JOURNAL OF RETAIL AND DISTRIBUTION MANAGEMENT	28
10	2	0	JOURNAL OF THEORETICAL AND APPLIED ELECTRONIC COMMERCE RESEARCH	27

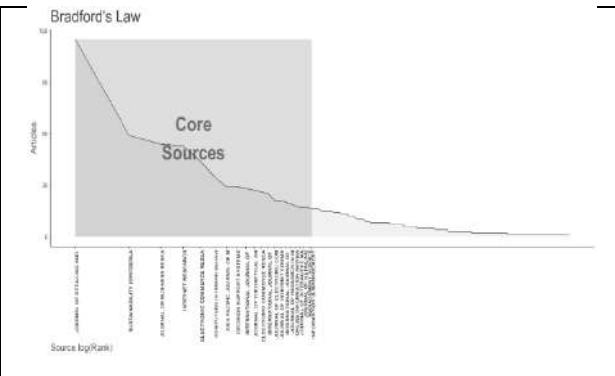




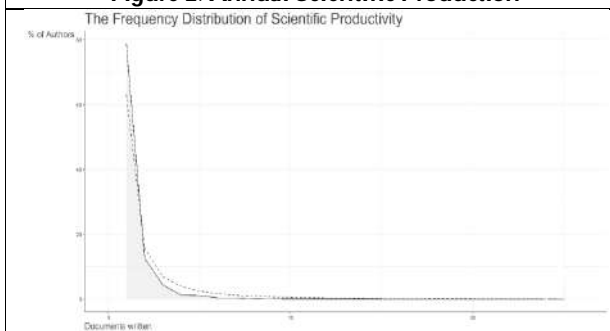
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**Figure 2. Annual Scientific Production**



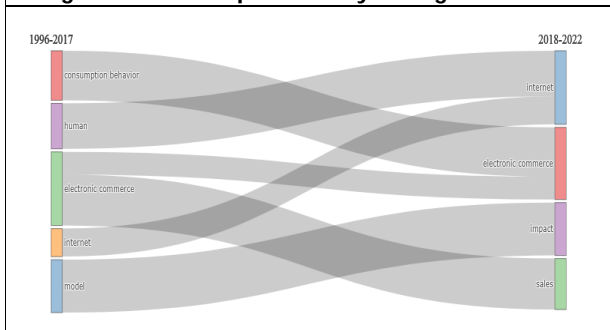
**Figure 3. Bradford's Law**



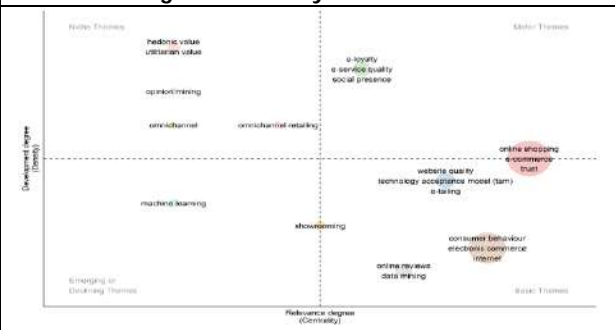
**Figure 4. Author's productivity through Lotka's law**



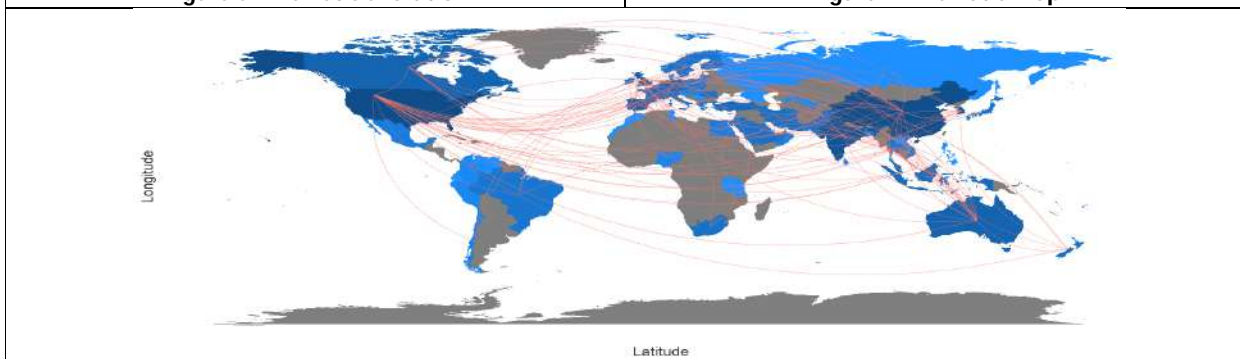
**Figure 5. Country Collaboration**



**Figure 6. Thematic evolution**



**Figure 7. Thematic Map**



**Figure 8. Country Collaboration**





## Knowledge, Awareness, Attitude and Practice of Telerehabilitation among the Physiotherapists of India

Gurman Kaur<sup>1\*</sup>, Amber Anand<sup>2</sup> and Suresh Mani<sup>3</sup>

<sup>1</sup>Department of Physiotherapy, Lovely Professional University, Phagwara, Punjab, India

<sup>2</sup>Ph.D.Scholar, Department of Physiotherapy, Lovely Professional University, Phagwara, Punjab, India

<sup>3</sup>Associate Professor, Department of Physiotherapy, Lovely Professional University, Phagwara, Punjab, India

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### \*Address for Correspondence

**Gurman Kaur**

Department of Physiotherapy,  
Lovely Professional University,  
Phagwara, Punjab, India.

E. Mail : gurman.ishu2808@gmail.com



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### ABSTRACT

The exponential increase in the global population for the past few decades resulted in age-related musculoskeletal and neurological impairments. This requires a sufficient rehabilitation workforce particularly the physiotherapist (PT) in both urban and rural areas. Insufficient physiotherapists and the non-availability of physiotherapy service in rural demand an alternative mode of service delivery. Emerging evidence supports that telerehabilitation (TR) may provide a potential platform to deliver physiotherapy services for patients in remote areas. However, the successful implementation of TR is determined by the PT's knowledge and attitude towards TR. Therefore, this study was aimed to evaluate the knowledge, attitude, awareness and practice about TR among PTs in India. Using a qualitative survey study design, a semi-structured questionnaire to assess knowledge was prepared using Google forms and sent to PTs who were working in India. The survey questionnaire had several open-ended and closed-ended questions. The data were analyzed using descriptive statistics. A total of 200 experienced (140 PTs = 0-5years, 22 PTs= 6-10 years, 38 PTs = >10 years) PTs (female=118, male=82) were surveyed. The awareness about TR was good and a majority (78.0%) of participants were aware of telerehabilitation. Out of 200 PTs, 10 (5.0%) were aware of TR and are using it on regular basis, 32 (16.0%) are using it intermittently, 114 (57.0%) have not started using it whereas 44 (22.0%) are not aware of it. Among these PTs, the knowledge was complete in 62.5%, partial knowledge in 18.0% and 19.5% have no knowledge. TR can be a potential tool for strengthening the current mode of delivering PT services in India. Physiotherapists working in India were aware and had good knowledge and attitude towards the implementation of TR. However, the usage and implementation were limited due to time and cost.

**Keywords:** Telerehabilitation, knowledge, awareness, attitude, physiotherapist, survey.



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## INTRODUCTION

The recent advancement in communication and information technology (ICT) has improved the quality of healthcare [1], [2]. Advances in technology and progress in health informatics have prompted the medical care organization to offer improved services with high quality [3]. Now, healthcare organization is known by a new name i.e. Telehealth. In general, Telehealth is the approach that employs ICT technology to provide remote healthcare assistance [4]. World Health Organization (WHO) has cited the benefit of Telehealth in healthcare and supported the use of this approach in strategic planning in the health system [5]. Telehealth is an amalgam of various areas like telematics, telemedicine, Telerehabilitation (TR) and e-health [5]. Telerehabilitation is of utmost importance, as it remotely provides rehabilitation services with the help of ICT [4]. This approach provides a wide range of rehabilitation services which are provided in various formats involving teleassessment, telecoaching, teleconferencing, teleconsultation, tele-education, telemonitoring, teleplay, telesupport and tele-treatment [6]. It uses different approaches which have been classified into three broad categories i.e. asynchronous, synchronous and hybrid approaches [7]. In an asynchronous approach, the patient information is comprehended and stored for later use. On the other hand, the synchronous approach involves the live interaction of the patient and service provider. And, at last, it is the hybrid approach that involves the combination of the above two approaches [7]. This hybrid approach involves technologies like audio-based (i.e. audio recordings, telephone answering machines and phones), textual-based (i.e. e-mails), video-based (i.e. video conferencing) [8]. This highlights the real potential of telerehabilitation and the benefits it can provide to both service providers and patients as it reduces the cost involved in patient transfer and unnecessary visits [9]. Still, this approach is not extensively used in India and physiotherapists lack awareness about it [10]. Therefore, TR may provide a potential platform to deliver physiotherapy service to patients at a remote location [11].

PT rehabilitation involves a series of sessions of treatment including formulation of exercise protocol, progressively updating exercises and measuring the improvement in patient's performance at regularly [12]. Normally, the patient is required to visit a health care center along with his caretaker or the therapist needs to schedule a home visit. This results in travel time and expenditure which is not affordable for many people. TR enables rehabilitative services and specialists equitably accessible and affordable [13]–[17]. TR is cost-effective and beneficial as it saves time and travel expenses spent by the patient and the caregiver traveling along with the patient [12]. TR service is found to be a user-friendly, simplified access, low-cost technology. Therefore, the current study aims to study the knowledge, attitude, awareness of telerehabilitation among Indian physiotherapists, and their attitudes and perceived barriers towards the implication of telerehabilitation in hospital and clinical settings.

## MATERIALS AND METHODS

### Study Design and Population

This study was a descriptive cross-sectional survey that was conducted on the various physiotherapists currently working in different parts of India from 2018-2021. A total of 350 physiotherapists were contacted for participation in the survey. A total of 200 people responded for participation in the survey.

### Semi-structured Questionnaires' Tool

A semi-questionnaire was formulated by the authors after reviewing the literature related to TR comprised of demographic questions, seven knowledge-related questions, 20 practice-related questions, and six attitude-related questions. Prior to the finalization of the questionnaire, the draft of the questionnaire was reviewed several times to improve the clarity by the experts in the field of a physiotherapist who are not involved in the original version of the questionnaire development. The whole questionnaire was further converted into Google forms for the respondents to respond. A weekly reminder was sent for those who have failed to respond to the survey invitations.



**Gurman Kaur et al.,****Sample**

Physiotherapy professional from academic and industry with a minimum qualification of undergraduate in Physiotherapy and currently working in India was invited to participate in the study. Similarly, the physiotherapist trained in India, but not currently practicing in India, and under-graduate physiotherapy students were excluded from the study.

**Procedure**

Based on the inclusion and exclusion criteria, a list of physiotherapists working in academics and clinical in India was contacted through email and social media platforms such as LinkedIn, Facebook, and personal contacts of the researchers and invited to participate in the study, and shared the questionnaire with all the participants after received digital consent via Google form. After that, the Google form was attached with the mail and was sent to the subjects for the responses. All the study participants have filled the survey voluntarily without any incentives. Those responses were collected was converted into a Google excel sheet for data analysis.

**Statistical Analysis**

The data from the survey forms were converted into a Microsoft Excel spreadsheet and was analyzed descriptively using Statistical Package for the Social Sciences version 19.0 (SPSS Inc., Chicago, IL, USA). The analyzed descriptive data presented as frequency and percentage in the form of tables and figures.

**RESULTS**

Out of the 200 participants, 59.0% were females and 41.0% were male. The participants were categorized into the age-groups such as the highest number of participants 140 (70.0%) belong to 20-30 years age group whereas the least number of participants 8 (4.0%) belong to 41-50 years. and, 26.0% were 31-40 years, 4.0% were 41-50 years. 68.0% of the total participants reported their highest education as BPT, 30.5% were MPT whereas 1.5% had completed a Ph.D. The selected population has good experience in the field of physiotherapy which ranges from one to more than 10 years of experience. 70.0% of the total population have experience of 0-5 years, 11.0% have 6-10 years whereas 19.0% of them have experience of more than 10 years. (Table 1).

**Knowledge**

The awareness about TR was evaluated and found that 22.0% of the total participants were not aware of the technology; while 57.0% of participants were aware of the technology but haven't used it. Whereas 16.0% of participants were aware of the technology and were using it on an intermittent basis and only 5.0% of participants were aware of TR and are using it on regular basis. Out of the total no of subjects, 62.5% were able to correctly describe TR whereas 18.0% were partially correct and 19.5% were unable to describe the same. (Table 2).

**Attitude**

The main criteria for a TR to be successful are the attitude of the users towards it. In the case of TR, 49.0% of participants reported that it is a good option to treat patients and 5.5% of participants do not consider the same whereas 45.5% think intermediately. Any field does require the update according to the digital world; 96.5% of the therapists prefer this thought and 3.5% do not prefer the same. Almost 75.0% of participants were willing to implement TR in their clinical practice whereas 20.5% found the implementation of TR difficult. Of all the participants 86.5% believe that TR is beneficial while the remaining 13.5% of participants believe TR to be non-beneficial. There are different ways to promote TR, according to this survey, 27.5% of therapists voted for awareness programs, 39.5% for educating PT and patients, 27.5% for media and advertisement, and 5.5% do not prefer to promote in any way. (Table 3) (Figure 1).



**Gurman Kaur et al.,****Practice**

TR is not widely used in India as 74.5% of PTs reported not using TR in their clinical practice whereas 25.5% are using the TR. Although 82.5% of the participants believe TR is beneficial and only 17.5% don't feel the same. Those participants who were using TR have found that it is cost-effective 71.0% and the rest 29.0% considered TR as out of their expense. Online appointments by doctors were 48.5% and by other means were 51.5%. Nearly half of the participating therapists, 42.0% felt TR be helpful in planning treatment and 58.0% do not consider TR to be much helpful. Out of all the respondents, 47.0% are using electronic patient databases and 53.0% do not use the same. Information Communication Technology (ICT) is essential for TR delivery, in this regard 61.5% feel that the patient has access to ICT while 38.5% do not think the same. Based on their patient's feedback, 90.0% of the participants believe that patients are satisfied while, 10.0% do not believe that patients are satisfied using TR. Out of all the respondents, 90.0% want that the therapist should use TR whereas only 10.0% do not want so.

The Internet was an integral part of this unique change, 1.5% of PTs were using 2G network in their device, 5.5% of PTs were using 3G, a maximum of 88.5% using 4G and 4.5% were using other means. The respondents are communicating with the patient through various approaches i.e. via Physiotherapy OPD is 26.0%, home visit 5.0%, video call 13.0%, phone 32.5%, and all of the mentioned ways were 23.5%. PTs reported, TR is believed to be a better choice for the PT in different aspects like assessment/monitoring (11.5%), prescribing exercises (14.5%), follow up/changing exercise (30.5%), all aspects of TR (34.0%) and (9.5%) was not sure about this. TR is so diversified in its availability and application such that its benefit varies among different professionals, i.e. orthopedics 15.0%, occupational therapist 14.0%, traumatologist 4.0%, pediatrics 1.0%, cardiologist 5.5%, all of the above 52.0% and none 8.5%, based on responses received from our participants. The main reasons why TR came into play were distance traveled by the patient, the patient who cannot travel 25.5%, therapist's clinic is far away from patient's place 10.0% and absence of transport/person to take to clinic 42.0% and most importantly patient have access to remote specialist 21.5% and all of above 1.0%. TR can be beneficial in treating different conditions i.e. gynecologist/obstetrics 8.0%, pre/postoperative conditions 16.5%, changing or prescribing assistive devices and furniture 18.0%, for follow-ups and ergonomics is 21.5%, all the above 31.0% and none 5.0%. TR is being used to treat many conditions like orthopedics and musculoskeletal conditions 19.0%, neurological conditions 5.0%, geriatric conditions 1.0%, pediatrics 0.5%, ergonomic/prescribing exercises is 20.5%, in all the above 19.0% and none of the condition 35.0%. TR being cost-effective and beneficial, it is highly necessary to promote TR. Participants believe TR can be promoted using awareness program 27.5%, educating PT and patients 39.5%, media and advertisement 27.5% whereas 5.5% do not want to promote the same. (Table 4)

**Current Practice and Barriers**

The Physiotherapists in India are using different modes for the delivery of treatment like patients coming to their clinic 24.5%, giving home treatment 5.5%, and using both 70.0%. The frequency of home visits by the physiotherapist on a daily visit is 42.5%, on alternate days 41.5%, weekly 10.0%, and monthly 6.0%. About 26.0% of physiotherapists found it difficult to travel long distances to give home treatment whereas 63.5% face problems occasionally and 10.5% don't have any problem. Managing to visit different patients' homes on a single day was found difficult in 83.0% and was managed by 17.0%. The number of patients treated by physiotherapists per day ranges between 1-5 is 76.5%, between 6-10 is 13.0%, between 11-15 is 6.0% and 4.5% do not see at all. Whenever travel comes, it comes up with other suitable conditions. 85.0% of our respondents reported that they need to change their schedule due to weather conditions whereas others 15.0% suggest that it doesn't affect their schedule. Our respondents suggest that in emergency conditions their preferred mode of communication is audio calls 18.5%, video calls 30.0%, home visits 33.0% and asking patients to come to physiotherapy OPD 18.5%. (Table 5)

**DISCUSSION**

The purpose of this study was to evaluate their knowledge, attitude, and barriers towards TR among Indian PTs. Knowledge helps people to grow as an individual as it opens up one's minds to things they have not yet been



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exposed to and builds their perspective and opinion over various things in life[18]. Academic communities like research institutes play an essential role in the transmission and creation of scientific knowledge [18]. They are considered to be the fundamental resource for development and progress based on knowledge management (KM) theory which suggests that the strength of an organization resides in the knowledge of its members and it should be shared with other members of the community or organization [19]. The KM theory stands true for rehabilitation, just like for any other community / field [20]. Nowadays, with the introduction of TR across the globe, physical rehabilitation is not just limited to the wall of the rehabilitation or medical facility. However, the literature, as well as knowledge of TR among the Indian physiotherapists, is limited. Studies have reported that the majority of the respondents were aware of TR but have not used it yet. Very few amongst them have relevant knowledge and the maximum of participants consider TR to be the best method to deliver physiotherapy services. A study conducted in Iran found that out of all the participants 92% had a poor level of awareness and knowledge and none (0%) had a high level of awareness and knowledge about the TR technology[5]. Our research indicates that TR being low-cost consumer technology is widely used in India for the delivery of rehabilitation services in both urban and rural areas. A maximum of the respondents was aware of TR but are minimally using it; however, very few people are using TR regularly. Just knowing any technology is not sufficient, attitude or mindset is also essential as it drives the individual to practice the same.

Attitude is a cognitive-oriented process that represents an individual's feelings, actions, beliefs, behavior, and thoughts towards any idea, people, or object [21]. The attitude of any person is determined by their education, environment, and experiences. It is important to measure the attitude of a person as it maintains a meaningful, organized and stable structure of the world [21]. Several scales such as Thurston and Likert, or customized questionnaires can be used to assess the attitude [22]Attitude towards the implementation of TR has changed over time and reflects the potential benefits and efficacy of the application of TR in therapeutic systems and therapy[5]. TR promotes independence in patients to contact any professional across the globe. TR has been considered to be an advanced technology to provide physiotherapy treatment in remote locations. A study conducted in Saudi Arabia reported that TR is advantageous to patients who have very limited access to health care services especially in rural areas [23]. Similarly, our study also suggests that more than 90% of all the respondents PT feel it is important to update the practice of physiotherapy in the digital world. The TR is found to be beneficial and a very good option to treat patients especially during a pandemic situation like COVID-19 where there is a restriction of movement.

Knowledge and a positive attitude towards a new intervention/ technology motivate individuals to practice and implement the technology in a productive way to benefit society. Practice is important to learn something new and gain perfection in a particular skill. Malcolm Gladwell has suggested in his book that to become an expert in something requires the practice of 10,000 hours [24]. Similarly, Josh Kaufman reported that an expert requires 20 hours of practice ie. each day 45 minutes regularly for a month to become an expert [24]. Healthcare professionals need regular practice to improve the quality of healthcare delivery. Our study shows that there are very few PTs are practicing TR regularly. Moreover, it also reported that all the fields of healthcare professionals including physiotherapists, occupational therapists, orthopedics cardiologists, pediatrics, and geriatrics are benefit from TR. A study reported that traumatology, orthopedics and cardiology are the specialties open for Tele-rehabilitation[25]. Similarly, many of our respondents expressed that they are using TR more for follow-ups/prescribing exercises than in assessment and monitoring. Also, distance has not created a barrier to getting treatment facilities as the patient does not require to travel far distances to get treatment. TR has been declared to be similarly effective as face-to-face care along with it improving the QOL of patients [26]. Thus, TR using consumer technologies has the potential to increase access to rehabilitation services in every situation.

**Limitation**

In our study, the questionnaire was sent to more than 350 participants but only 200 subjects made an effort to participate in it. Some of the physiotherapists who were not currently working in India who was excluded from the study and even physiotherapy students were not included in the same. As TR is the budding field knowledge about the same is lacking behind in the professionals.





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## CONCLUSION

Despite many participants agreeing on the benefits of TR, it should be promoted via awareness programs by educating physiotherapists and patients through media and advertisement. Thus, our research has found that many physiotherapists are willing to use TR in their daily practice. TR is the best solution for Tele-monitoring patients' performance and situations where in-person rehabilitation is neither possible nor accessible.

### Conflict of Interest

No conflict of interest

### Contribution of Authors

Gurman Kaur and Suresh Mani developed the survey questionnaire. Gurman Kaur, Amber Anand, and Suresh Mani circulated the survey form to the potential participants via email and other social media platforms. Gurman Kaur, and Suresh Mani analyzed the collected data. Gurman Kaur, and Amber Anand prepared the manuscript for the study.

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**Table 9 Demographic characteristics of survey subjects**

		Frequency	Percentage
Gender	Male	82	41.0%
	Female	118	59.0%
Age (Years)	20-30	140	70.0%
	31-40	52	26.0%
	41-50	8	4.0%
Education	BPT	136	68.0%
	MPT	61	30.5%
	PhD	3	1.5%
Year of Experience (Years)	0-5	140	70.0%
	6-10	22	11.0%
	More than 10	38	19.0%

BPT= Bachelor of Physiotherapy, MPT= Master of Physiotherapy, PhD = Doctorate of Philosophy





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**Table 10 Level of Knowledge in telerehabilitation among Physiotherapist from academic and industry practicing in India**

	n= 200	Frequency	Percentage
Are you aware of TR?	Don't aware	44	22.0%
	Aware but haven't used it	114	57.0%
	Aware and using it on intermitted basis	32	16.0%
	Aware and using it on regular basis	10	5.0%
What is TR?	Correct	125	62.5%
	Partially correct	36	18.0%
	Incorrect	39	19.5%
Is it being used in India?	Yes	132	66.0%
	No	68	34.0%
Should Indian therapists rely on TR?	Yes	92	46.0%
	No	108	54.0%
TR = Telerehabilitation			

**Table 11 Attitude towards telerehabilitation among physiotherapist from academic and industry practicing in India**

n= 200	Response	Frequency	Percentage
TR is a good option to treat patients	Yes	98	49.0%
	No	11	5.5%
	May be	91	45.5%
Update physiotherapy practice in digital world.	Yes	193	96.5%
	No	7	3.5%
Deciding to start TR in practice	Yes	159	79.5%
	No	41	20.5%
Benefit of TR	Yes	173	86.5%
	No	27	13.5%
Strategies to promote TR in India	Awareness Program	55	27.5%
	Educating PT and patients	79	39.5%
	Media/ advertising	55	27.5%
	None	11	5.5%
TR = Telerehabilitation , PT= Physiotherapist			

**Table 12. Telerehabilitation practice among physiotherapist from academic and industry practicing in India**

n= 200	Frequency	Percentage
Type of Internet Access	2G	3 (1.5%)
	3G	11 (5.5%)
	4G	177 (88.5%)
	Other	9 (4.5%)
Method of communication with patients	Physiotherapy OPD	52 (26.0%)
	Home visit	10 (5.0%)
	Video call	26 (13.0%)
	Phone	65 (32.5%)
	All of the above	47 (23.5%)
TR is a better choice for	Assessment /monitoring	23 (11.5%)
	Prescribing exercise	29 (14.5%)





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	Follow up / changing exercise program	61	(30.5%)
	All of the above	68	(34.0%)
	Not sure	19	(9.5%)
Professionals most benefited with TR	Orthopedics	30	(15.0%)
	Occupational therapist	28	(14.0%)
	Traumatologist	8	(4.0%)
	Pediatrics	2	(1.0%)
	Cardiologist	11	(5.5%)
	All of the above	104	(52.0%)
	None	17	(8.5%)
When to use TR?	Patient cannot travel to clinic	51	(25.5%)
	Clinic is far away from home	20	(10.0%)
	Absence of transport / person to take to clinic	84	(42.0%)
	Access remote specialist	43	(21.5%)
	All of above	2	(1.0%)
TR benefiting conditions / disorders	Gynecologist/ obstetrics	16	(8.0%)
	Pre/post-operative conditions	33	(16.5%)
	Changing/prescribing assistive devices and furniture	36	(18.0%)
	Follow up/ ergonomics	43	(21.5%)
	All of the above	62	(31.0%)
	None	10	(5.0%)
Conditions therapist treating via TR	Orthopedics and Musculoskeletal conditions	38	(19.0%)
	Neurological conditions	10	(5.0%)
	Geriatric conditions	2	(1.0%)
	Pediatrics conditions	1	(0.5%)
	Ergonomic/ exercises prescription	41	(20.5%)
	All of the above	38	(19.0%)
Way to promote TR in India	None	70	(35.0%)
	Awareness program	55	(27.5%)
	Educating PT and patients	79	(39.5%)
	Media/ advertisement	55	(27.5%)
	None	11	(5.5%)

**Table 13 Current level of physiotherapy practice among physiotherapist from academic and industry practicing in India**

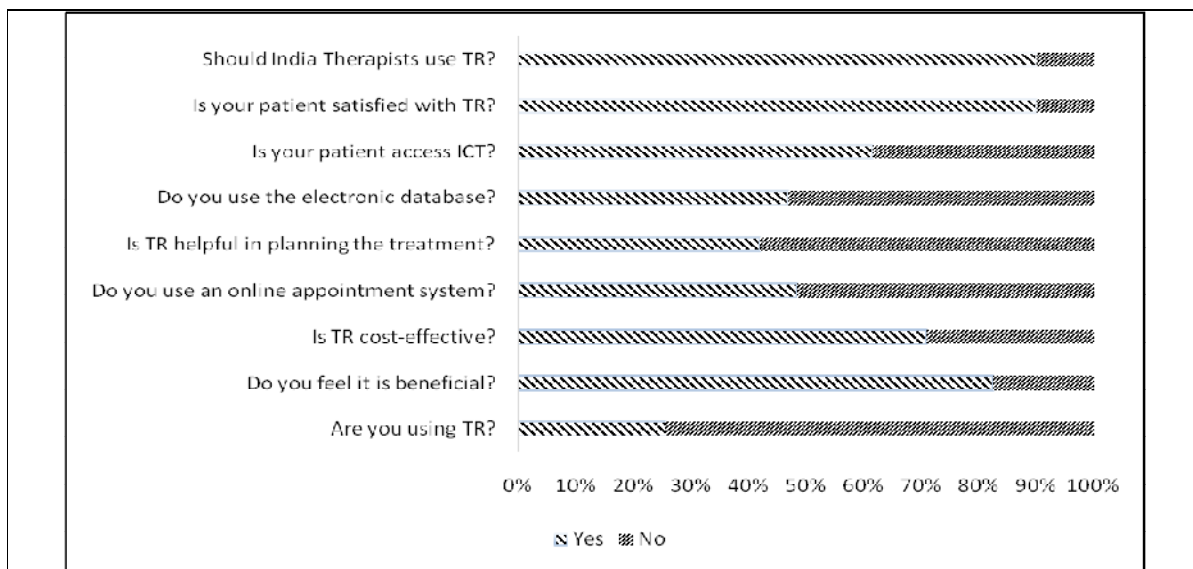
n=200		Frequency	Percentage
Mode of physiotherapy services	Patients coming to your clinic	49	(24.5%)
	Giving home treatment	11	(5.5%)
	Both	140	(70.0%)
Frequency of home visit	Daily	85	(42.5%)
	Alternate days	83	(41.5%)
	Weekly	20	(10.0%)
	Monthly	12	(6.0%)





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Therapist travel long distance for home care	Yes	52	(26.0%)
	No	21	(10.5%)
	Sometimes	127	(63.5%)
Difficult to make multiple home visit in day	Yes	166	(83.0%)
	No	34	(17.0%)
Number of patients treated per day	0	9	(4.5%)
	Between 1-5	153	(76.5%)
	Between 6-10	26	(13.0%)
	Between 11-15	12	(6.0%)
Extreme climates affect physiotherapy services	Yes	170	(85.0%)
	No	30	(15.0%)
Mode of communication during emergency	Audio call	37	(18.5%)
	Video call	60	(30.0%)
	Home visit	66	(33.0%)
	Physiotherapy OPD	37	(18.5%)



**Figure 5 Telerehabilitation practice among physiotherapist from academic and industry practicing in India**





## Assessment of the Phytoremediation Potential of *Ricinus communis* L. Plant under Cr<sup>+6</sup> Stress

Pallavi Sahoo<sup>1</sup>, Kunja Bihari Satapathy<sup>1\*</sup> and C R Panda<sup>2</sup>

<sup>1</sup>Post Graduate, Department of Botany, Utkal University, Bhubaneswar – 751004, Odisha, India

<sup>2</sup>Environment and Sustainability Department, CSIR-Institute of Minerals and Materials Technology, Bhubaneswar- 751013, Odisha, India.

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### \*Address for Correspondence

#### Kunja Bihari Satapathy

Post Graduate,

Department of Botany,

Utkal University, Bhubaneswar – 751004,

Odisha, India.

E. Mail: kbs\_bot@rediffmail.com



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### ABSTRACT

The experiment was carried out at the Department of Botany, Utkal University, India conducted in a plant species (*Ricinus communis* L.) by adding different concentrations of Cr<sup>+6</sup> to assessed the toxicity of chromium on its germination, growth and biochemical parameters. It was noted that the Seedling vigour index, Metal tolerance index were found to be reduced and the percentage of phytotoxicity was increased while biochemical parameters showed a declining trend with increasing Cr<sup>+6</sup> concentrations in 14 d old plant. The seedlings treated with chromium complexes exhibited chlorophyll and soluble protein content with the increase in chromium level whereas a decrease in proline content was observed as compared to control were analyzed after 60 d of treatment. The result showed that a relationship between an increase the accumulation of chromium in root and shoot. The antioxidative enzymes activity was increased with the application of increase concentration of chromium. This experiment reveals that *Ricinus* plant can be effectively carried for Cr<sup>+6</sup> phytoremediation.

**Keywords:** Cr<sup>+6</sup>, phytotoxicity, chromium, chlorophyll, proline

### INTRODUCTION

Soil and water contamination through toxic metals is a serious concern because now-a-days the toxicity of metals is very high and highly poisonous to plants as well animals (Patra *et al* 2020a). There is huge effect of Cr<sup>+6</sup> on plant life which depend on environmental condition, growth stage and development. The oxidizing properties of hexavalent chromium (Cr<sup>+6</sup>) is very strong which can pass the membrane freely and make oxidative damages to many types of





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biomolecules by producing oxyfree radicals. The free radicals are highly aggressive and attacks on polyunsaturated fatty acids of plasma membrane and prompts the peroxidation of lipids (Shah *et al.*, 2001). Several techniques are applied to decontaminate the Cr contaminated soil, but most of them are costly and make disturbances in physio-chemical soil properties. Hence phytoremediation is a green technology to decontaminate Cr contaminated soil (Mohanty and Patra, 2011). *Ricinus communis* L. is an important oil yielding shrub found as wildly cultivable nature and considered as a non-edible phytoremediator. This plant has an exceptional capability for the extraction of toxic metals like Ni, Pb, Cu, Cd and organic pollutants like pesticides (Buddha *et al* 2015). Therefore *Ricinus communis* L. is a good option for phytoremediation research. In the state Odisha mining pollution is a big issue for which there is a requirement for remedial action to minimize the contamination of chromium. Therefore the objectives of the experiments were (i) evaluate the toxic effect of different concentration on germination, growth of plant species. (ii) Biochemical alterations using the plant. (iii) Evaluating bio-concentration factor (BCF), transportation index (Ti) and Total accumulation rate (TAR).

## MATERIALS AND METHODS

### Selection of Plant Material

*Ricinus communis* L. is a common wild plant species (family Euphorbiaceae). The dry seeds were obtained from "OUAT", Bhubaneswar and seeds stored in dark and cool place for experimental use. The seeds were treated 0.1% HgCl<sub>2</sub> for sterilization followed by washing with distilled H<sub>2</sub>O.

### Experimental Design

The treated seeds were germinated in petriplates over soaked cotton. In 6 to 7d the seeds were germinated. Three seedlings were transplanted into each pot containing soil and manure (3:1). After 7d of plantation of seedling, the soil was treated with Cr<sup>+6</sup> at different concentrations such as 20, 40, 60, 80 and 100 ppm. The physic chemical parameters of garden soil was analyzed and mentioned below

pH	EC (dsm-1)	WHC(%)	Total Cr (mg kg-1)	OC (g kg-1)
7.01	0.51	54.02	0.00	10.33

EC-Electrical Conductivity, WHC- Water Holding Capacity, OC-Organic Carbon

### Cr<sup>+6</sup> Effect on Seeds Germination of *Ricinus communis* L.

Germination % = No. of seed germinate/Total no. of seed × 100

The percentage of phytotoxicity of the metal was calculated by the formulae suggested by Chou *et al* (1976).

$$\text{Percentage of phytotoxicity} = \frac{\text{Radicle length of control} - \text{Radicle length of test}}{\text{Radicle length of control}} \times 100$$

Seedling vigour indices were calculated by using the formulae proposed by Baki and Anderson (1973).

Vigour index = Germination percentage × Length of the embryonic axis

The tolerance indices of the seedlings were calculated by using the formulae proposed by Turner and Marshal (1972).

$$\text{Tolerance index} = \frac{\text{Radicle length of seed in test}}{\text{Radicle length of control}} \times 100$$

### Estimation of Chlorophyll, Protein and Proline

Estimation of total chlorophyll, protein and proline is done by the method of Arnon (1949), Lowery *et al* (1951) and Bates *et al* (1973).

### Antioxidant Activity

The activity of catalase done by the method of Aebi, 1984





### Stress Tolerance Indices

Stress tolerance indices for different growth parameters were calculated using the formula (Wilkins, 1957)

Root length of stress Tolerance Index (RLSTI) = (Root length of stressed plant/ Root length of control plant) × 100

Root dry stress Tolerance Index (RDSTI) =

(Root dry weight of stressed plant/ Root dry weight of controlled plant) × 100

Shoot length of stress Tolerance Index (SLSTI) = (Shoot length of stressed plant/ Shoot length of control plant) × 100

Shoot dry stress Tolerance Index (SDSTI) =

(Shoot dry weight of stressed plant/ Shoot dry weight of controlled plant) × 100

### Statistical Analysis

In triplicate manner data was collected and represented as mean ± Standard deviation (SD). ANOVA studies were used to evaluate the different parameters of the experiment and the statistical significance was maintained at P<0.05.

## RESULT AND DISCUSSION

### Germination Study

The rate of germination of *Ricinus* seeds responded differently to different doses of Cr<sup>+6</sup> concentrations. It decreased with increasing concentrations of Cr<sup>+6</sup> which is shown in Table - 1. The germination percentage was 97.2 % in control (0 ppm) and 30.54% in 100ppm. The radical length was found 6.9 cm in control and 1.95 cm in 80 ppm. Metal tolerance index was recorded 94.21% in control where 3.96% in 100 ppm. Phytotoxicity percent was 0% at control and 92.91% at 80 ppm respectively. The reduced germination of seeds under Cr stress would be due to the depressive effect of Cr on the subsequent transport of sugars to the embryo axis. Protease activity increases simultaneously with the chromium treatment which could also contribute to the reduction in germination of chromium treated seeds. Hence, from all the above results it can clearly conclude that hexavalent Chromium has a negative effect on the germination rate and growth of *Ricinus* seedlings when exposed to increasing Cr<sup>+6</sup> toxicity.

### Effect of Cr on Biochemical Parameters

The content of chlorophyll and protein of *Ricinus* is decreased with increasing quantity of chromium concentration. Due to stress of chromium, total content of chlorophyll reduced because chromium cause iron insufficiency in stressed plant through which decrease in chlorophyll synthesis (Liu *et al*, 2008). There decrease in protein content with the increase chromium stress due to denature of proteins (Patra *et al*, 2018a, 2018b). In this experiment the proline level is high with increase in concentration of chromium which indicates defense system to against oxidative stress (Patra *et al* 2019) which are mentioned in Table-2 and figure-1,2,3.

### Evaluation of Cr Toxicity on Antioxidant Enzyme Activity

Catalase activities decreased with increase of percentage of chromium toxicity due to excess production of reactive oxygen species while activities of peroxidase enzyme shows increase trend with increasing concentration of chromium because this enzyme act as tool to combat chromium induced oxidative stress (Table-3).

### Bioaccumulation of Chromium in Plants

The chromium bioaccumulation in root and shoots of the plant were evaluated with increasing in the concentration of Cr. It was observed that maximum bioaccumulation occurs in roots as compared to shoot which mentioned in table.

### Translocation, Bio Concentration Factors and Tolerance Index

Translocation, bio concentration factors and tolerance index considered as effective tool to know the hyper accumulator species. When metal concentrations in shoot are less than the root the plant is known metal excluder (Ahmad *et al* 2007, Wang *et al* 2005). Therefore the tested plant considered as a metal excluder which data were explained in the Table-4.





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### Stress Tolerance Indices

This method is used to define the stress tolerance potential of the plants under plant stress disorder. STI and TI were used to analyze the ability of plants in chromium stress condition. The stress tolerance potential of the plant *Ricinus* decreased with the increase in the chromium concentration (Table-5).

## CONCLUSION

The available Cr<sup>+6</sup> in soils affected the growth, chlorophyll, protein and proline content and antioxidant defense system indicating the tolerance ability of the plant towards chromium stress. The plants defend themselves from oxidative stress by modifying various metabolic processes. 60 Days after plantation, root/shoot length, chromium content, bioconcentration factor, tolerance index and transportation index were recorded. The above investigation revealed the phytoremediation ability of the species *Ricinus* which may consider as effective green tools for evaluating the stress of chromium toxicity in contaminated environment. This finding may help to select the other resistance capacity of plant species to execute further investigation in the field of phytoremediation strategy and efficiency.

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**Table 1: Effect of hexavalent chromium on seed germination, Radical length, Metal tolerance index, Phytotoxicity on 14<sup>th</sup> d of treatment.**

<i>Ricinus communis</i> L.				
Treatments (ppm)	Rate of germination (%)	Radical length (cm)	Metal tolerance index (%)	Phytotoxicity (%)
0 ppm (control)	97.2 ± 0.48	8.96 ± 0.03 a	94.21	0
20 ppm	84.1 ± 0.76	4.58 ± 0.07 b	52.55	35.74
40 ppm	80.42 ± 1.06	2.84 ± 0.05 c	35.72	49.11
60 ppm	69.83 ± 1.10	1.65 ± 0.10 c	21.00	75.03
80 ppm	45.10 ± 1.67	1.08 ± 0.01 d	12.67	84.16
100 ppm	30.54 ± 2.63	0.10 ± 0.05 e	3.96	92.91

Values presented as mean ± SEM (n=9).

**Table 2: Effects of Cr (VI) on Total Chlorophyll content (µg/g fresh wt.), Protein content and Proline content in 60 d of treatment.**

Treatments (ppm)	Total Chlorophyll content in 60 d	Protein content in 60 d	Proline content in 60 d
0 ppm (control)	202.07 ± 0.04	2.47 ± 0.03	6.33 ± 0.31
20 ppm	174.94 ± 0.09	2.35 ± 0.05	8.93 ± 0.44
40 ppm	174.97 ± 0.11	2.04 ± 0.04	9.9 ± 1.18
60 ppm	165.73 ± 0.05	1.71 ± 0.11	11.15 ± 1.52
80 ppm	147 ± 0.02	1.35 ± 0.11	12.41 ± 1.13
100 ppm	142.62 ± 0.11	1.05 ± 0.09	15.54 ± 0.05

Values of 3 replicate ± SEM, d: days

**Table 3: Cr toxicity stress on antioxidant enzyme activity**

Plant species	Cr <sup>+6</sup> treatments (mg/kg or ppm)	Superoxide dismutase (SOD) (Units g <sup>-1</sup> fresh wt.)	Catalase (CAT) (Units g <sup>-1</sup> fresh weight. min <sup>-1</sup> )	Glutathione Peroxidase (Units g <sup>-1</sup> fresh weight. min <sup>-1</sup> )
<i>Ricinus communis</i> L.	0 (Control)	13.60±0.345 d	34.70±0.45c	11.35±0.44 c
	20	28.33±0.634 c	59.00±0.35 b	17.00±0.33 c
	40	38.88±0.754 ab	68.38±0.39ab	27.42±0.53 b
	60	49.54±0.567 b	69.76±0.45ab	35.68±0.55 ab
	80	52.78±0.507 a	100.78±0.56 a	46.62±0.37 a
	100	61.56±0.452 a	112.55±0.46 a	49.55±0.44 a





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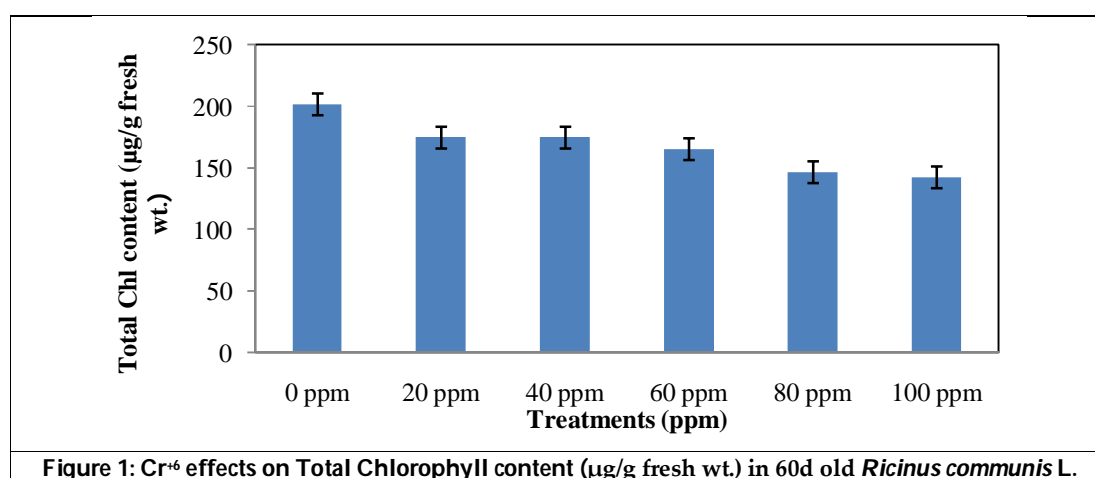
**Table 4: Effect of Cr<sup>6</sup> on Transportation index, Tolerance index and Bio-concentration factor in 60 d old *Ricinus* plants.**

Treatments	Transportation index	Tolerance index	Bio-concentration factor
0 ppm	0	100	0
20 ppm	30.10	68.23	0.39
40 ppm	26.15	42.80	0.41
60 ppm	32.76	16.83	0.38
80 ppm	23.50	7.33	0.33
100 ppm	16.80	0.54	0.28

**Table 5: Effect of Cr treatment and toxicological interpretation in 60 days old *Ricinus* plant under chromium stress**

Treatments	Stress tolerance index (%)			
	RLSTI	SLSTI	RDSTI	SDSTI
0 ppm	100	100	100	100
20 ppm	92.76	69.81	85.16	63.51
40 ppm	91.10	61.08	70.97	54.73
60 ppm	84.29	50.89	47.74	36.49
80 ppm	67.36	33.73	13.55	7.43
100 ppm	52.33	29.24	1.93	1.35

\*Values of 3 replicate± SEM

**Figure 1: Cr<sup>6</sup> effects on Total Chlorophyll content (µg/g fresh wt.) in 60d old *Ricinus communis* L.**



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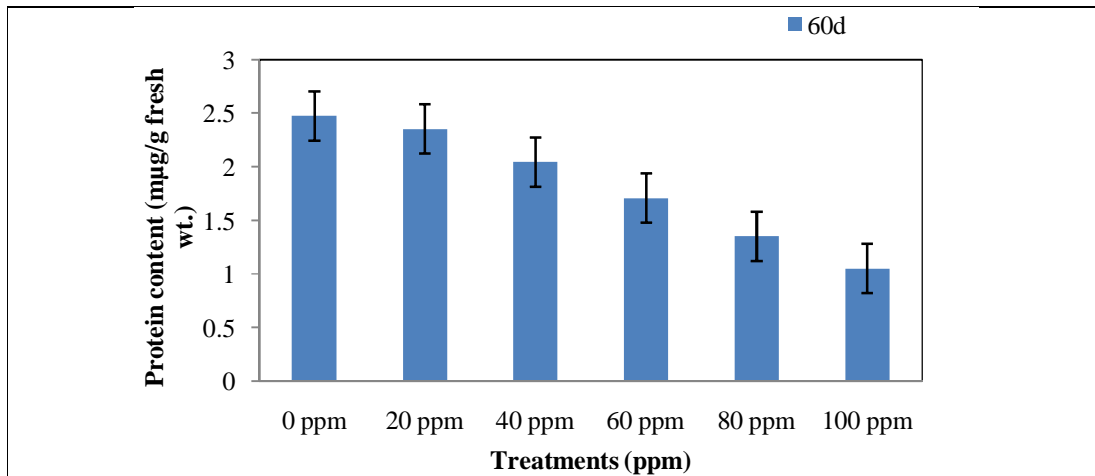


Figure 2: Cr (VI) effects on Protein content in 60d old *Ricinus communis* L.

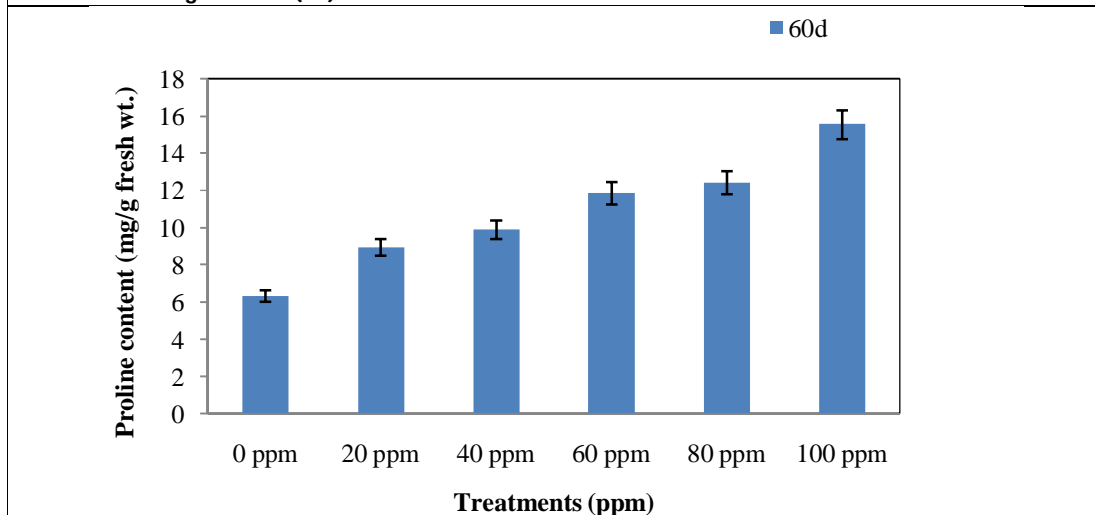


Figure 3: Cr (VI) Effects on Proline content in 60d old





## Insecticidal Efficacy of Certain Plant Extracts against the Larvae of Brinjal Stem and Fruit Borer, *Leucinodes orbonalis* Guenee (Lepidoptera; Crambidae)

M. Madhavi<sup>1</sup>, B. Srikanth<sup>2</sup>, L. Mahesh<sup>3\*</sup>, S. Guruswamy<sup>2</sup>, L. Mayookha<sup>4</sup>,

<sup>1</sup>Professor and HoD, Department of Zoology, Osmania University, Hyderabad, Telangana, India

<sup>2</sup>Research Scholar, Department of Zoology, Osmania University, Hyderabad, Telangana, India

<sup>3</sup>Assistant Professor of Zoology, Tara Govt. College, Sangareddy, Telangana, India

<sup>4</sup>Department of Zoology, Kasturba Gandhi Degree and PG College for Women, Secunderabad, Telangana, India.

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### \*Address for Correspondence

#### L. Mahesh

Assistant Professor of Zoology,  
Tara Govt. College, Sangareddy,  
Telangana, India.

E. Mail: maheshlingakari@gmail.com



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### ABSTRACT

Farmers rely mostly on synthetic pesticides to control vegetable pests. Synthetic pesticides affect our health and enter into water bodies and other environmental compartments, adversely affecting biodiversity. Hence, finding suitable alternatives to these synthetic pesticides is the need of the hour. In the present study, the pesticidal properties of the crude aqueous extracts of *Parthenium hysterophorus*, *Murraya paniculata*, and *Acacia arabica* were tested against the fourth instar larvae of the brinjal stem and fruit borer, *Leucinodes orbonalis*. The plant extracts were tested at 400, 200, 100, 50, and 25 PPM concentrations. The results showed concentration-dependent larvicidal activity. *M. paniculata* extracts performed better than the remaining two extracts with 100% mortality at 400 PPM concentration. LC50 & LC90 values of *M. paniculata* extracts were calculated to be 38.23 & 242.39 respectively. *P. hysterophorus* and *A. arabica* also exhibited promising results with 86.96 % & 78.26 % larvicidal activity respectively at the same concentration. LC50 & LC90 values of these two plant extracts were calculated to be 59.59 & 546.59 and 86.08 & 891.39 respectively. The study concludes that the tested *M. paniculata* plant extracts may be used as an alternative to synthetic pesticides in the control of *L. orbonalis*.

**Keywords:** Synthetic pesticides, Water pollution, Biopesticides, Sustainable development.





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## INTRODUCTION

Eggplant or brinjal (*Solanum melongena* L.), is native to India and is a popular and economically important vegetable in Asia [1,2,3]. Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) is one of the major insect pests of egg plant in the Indian subcontinent [4]. The larvae of *L. orbonalis*, reduce plant growth and reduce the number and size of fruits [5]. The feeding tunnels made by the larvae make the fruit unfit for marketing [3]. 37-63% damage was reported in eggplant crops in different states in India [6]. Pesticides are important tools in controlling insect pests of agricultural and health importance [7]. Chlorpyrifos 50% EC and Cypermethrin 5% EC are the most commonly used synthetic pesticides to control this pest. The indiscriminate and improper use of insecticides can lead to a multitude of problems, including the loss of their effectiveness [3], the development of insect resistance, pollution, and health hazards [8]. The presence of residual pesticides in brinjal also poses a threat to vegetable exports in foreign markets [9]. It is imperative to adopt an environmentally friendly management approach to address these issues. To manage insect pests, non-chemical methods such as biopesticides, botanicals, clean cultivation, and mechanical control, such as handpicking and destroying infected plant parts, are commonly used [10].

The use of plant extracts for controlling pests in agriculture has been gaining popularity in recent years due to growing concerns about the harmful effects of synthetic pesticides on the environment and human health [11]. Plant extracts contain natural compounds that can repel or kill pests, making them a promising alternative to conventional pest control methods. Several plant extracts have been found to be effective against the brinjal shoot and fruit borer (*Leucinodes orbonalis*), a common pest of eggplant crops. Neem leaf and seed extracts (*Azadirachta indica*) [12], marigold flower extracts (*Tagetes erecta*) [13], and papaya leaf extracts (*Carica papaya*) [14] have been found to reduce the number of eggs laid and increased the mortality of larvae and pupae, resulting in reduced damage to eggplant crops. In order to address these issues, the present study aimed to evaluate the larvicidal efficacy of crude aqueous extracts of *Parthenium hysterophorus*, *Murraya paniculata*, and *Acacia arabica* against *L. orbonalis*.

## MATERIALS AND METHODS

### Collection of Plant Material

The fresh leaves of *Parthenium hysterophorus*, *Murraya paniculata*, and *Acacia arabica* were collected from the Zaheerabad region of Sangareddy District, Telangana State. They were washed and dried for 15 days. Later they were powdered using a grinder and stored in a sealed bag until use.

### Extract Preparation

50 grams of the prepared leaf powders of the test plants were added to 250 mL of distilled water separately and boiled at 50°C for 1 hour. Later it was filtered using Whatman filter paper no.1 and the extracts were subjected to rotary evaporation. 1 gram of the extract was added to 1000 mL of distilled water to prepare 1000 ppm of stock solution. From this, different test solutions (25, 50, 100, 200, and 400 ppm) were prepared by dilution method.

### Insect Culture

The larvae of *L. orbonalis* were collected from the infested fruits of eggplants grown in an organic garden located in Zaheerabad of Sangareddy District, Telangana State. They were reared on the organic fruits in the laboratory. The fourth instars from the reared larvae were used for the Larvicidal bioassay.

### Larvicidal Activity

The larvicidal activity of the crude aqueous extracts of *Parthenium hysterophorus*, *Murraya paniculata*, and *Acacia arabica* against *L. orbonalis* was studied using the immersion method. 5 larvae of the same size for each test batch from the 4th instars were selected and dipped in the respective solutions for 5 seconds. Treated larvae were then put into a Petri dish having a 12-cm diameter and sliced eggplant fruit was kept in the Petri dishes and observed till all the larvae are dead of control larvae molt into the next instars. for larval feeding. The temperature of  $30 \pm 1^\circ\text{C}$

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temperature and Relative humidity of  $70 \pm 3.0\%$  were maintained throughout the experiment. The experiment was repeated five times. The number of dead larvae was counted and recorded. Larvae with abnormal symptoms such as body contraction, feeding cessation, and/or paralysis were counted as dead. The percent mortality was calculated and mortality data were corrected by the [15] formula.

### Statistical Analysis

The obtained results were subjected to probit analysis in SPSS software. The level of significance was set at  $\leq 0.05$ . LC50 and LC90 values were calculated.

## RESULTS AND DISCUSSION

The results of the study are presented in table 1. All three plant extracts showed concentration-dependent larvicidal efficacy. Figure 1 illustrates the mortalities of the tested plant extracts against the larvae of *L. orbonalis* at different concentrations. *M. paniculata* extracts were the most effective, with 100% mortality observed at a concentration of 400 ppm. At 50 ppm concentration also, it showed 52.17% mortality. The LC50 and LC90 values of *M. paniculata* extracts were calculated to be 38.23 and 242.39, respectively. *P. hysterothorus* and *A. arabica* also exhibited promising results, with 86.96% and 78.26% larvicidal activity at 400 ppm, respectively. *P. hysterothorus* showed more than 50 % mortality was delivered at 100 ppm (52.17%) while *A. arabica* at 200 ppm (69.57%). Figure 2 shows the LC50 and LC90 values of the tested plant extracts against the larvae of *L. orbonalis*. The LC50 and LC90 values of these two plant extracts were calculated to be 59.59 and 546.59 and 86.08 and 891.39, respectively.

It is evident from the study that *M. paniculata* was effective in controlling the larvae of *L. orbonalis* while *P. hysterothorus* and *A. arabica* delivered moderate results. In other studies, several phytochemicals were found effective in controlling the larvae of *L. orbonalis*. Liupai oil (2%) and Pungam oil(2%) were effective against the *L. orbonalis* larvae [12]. Oil palm bunch ash, soursop seeds, and goat weed leaf extract were proven effective against *Leucinodes orbonalis* [16]. The results showed that the lowest mean percentage of fruit damage was recorded in the plants treated with Lambda-cyhalothrin (20.38%), followed by goat weed (29.03%), soursop (40.69%), palm bunch ash (43.30%), and the control (67.08%).

Alkaloids, flavonoids, Triterpenoids, Phenols, Saponins, and steroid glycosides presence were confirmed [17] in aqueous leaf extracts of *P. hysterothorus*. These extracts were proven to control the larvae of *Aedes aegyptii* [18]. *M. paniculata* leaves were reported to possess alkaloids, flavonoids, phenols, and tannins [19] and they were effective as larvicides against *Culex quinquefasciatus* [20].

## CONCLUSION

This study provides evidence that crude aqueous extracts of *M. paniculata* have significant larvicidal activity against *L. orbonalis*. These findings indicate that *M. paniculata* may be a promising alternative to synthetic pesticides in the control of this pest. Further studies are needed to confirm the efficacy of these plant extracts under field conditions and to determine their potential for commercialization as a biopesticide. The use of botanical extracts for pest control can provide a sustainable solution to the challenges posed by synthetic pesticides and contribute to the development of eco-friendly pest management strategies.

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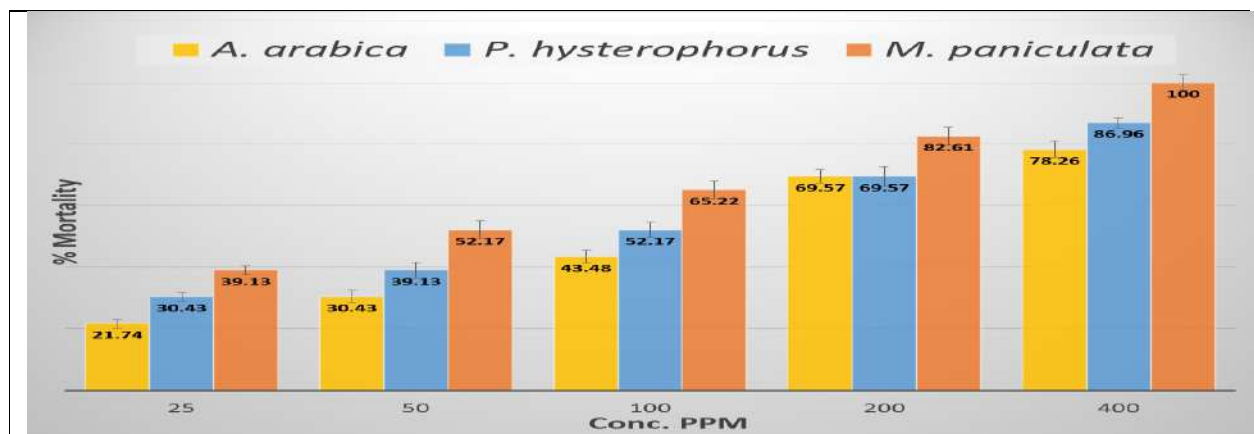




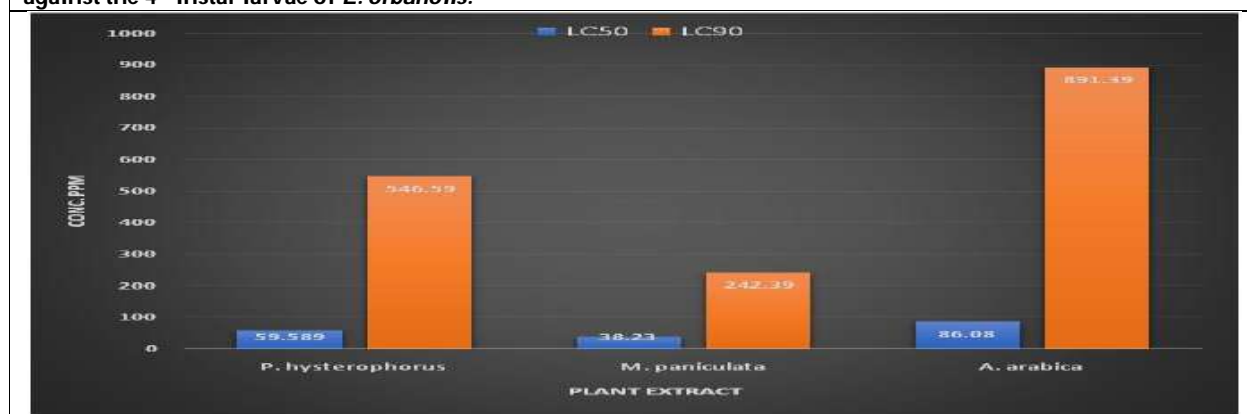
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**Table 1.** Larvicidal bioassay results of the *P. hysterothorus*, *M. paniculata*, and *A. arabica* against the 4<sup>th</sup> instar larvae of *L. orbanolis*.

		<i>P. hysterothorus</i>	<i>M. paniculata</i>	<i>A.arabica</i>
<b>Mortality % obtained with different Conc.</b>	<b>0</b>	0 ± 1.41	0 ± 1.41	0 ± 1.41
	<b>25</b>	30.43 ± 2.53	39.13 ± 2.81	21.74 ± 2.07
	<b>50</b>	39.13 ± 2.37	52.17 ± 2.81	30.43 ± 2.03
	<b>100</b>	52.17 ± 3.2	65.22 ± 2.97	43.48 ± 2.24
	<b>200</b>	69.57 ± 1.66	82.61 ± 2.53	69.57 ± 2.7
	<b>400</b>	86.96 ± 3.34	100 ± 1.95	78.26 ± 2.47
<b>Standard Error</b>		0.29	0.34	0.29
<b>LC 50 (LCL - UCL)</b>		60.50 (31.33 - 93.73)	38.23 (19.87 - 55.94)	86.80 (51.960 - 134.69)
<b>LC 90 (LCL - UCL)</b>		670.01 (320.84 - 4262.34)	242.39 (151.09 - 643.53)	891.39 (411.41 - 5851.45)
<b>Regression equation</b>		y = 2.25 + 1.26 x	y = 1.94 + 1.25 x	y = 2.43 + 1.26 x
<b>R<sup>2</sup></b>		0.96	0.98	0.97
<b>χ<sup>2</sup> Value</b>		0.75	2.59	0.67



**Figure 1.** Larvicidal efficacy of the crude aqueous extracts of *P. hysterothorus*, *M. paniculata*, and *A. arabica* against the 4<sup>th</sup> instar larvae of *L. orbanolis*.



**Figure 2.** Lethal concentrations of the crude aqueous extracts of *P. hysterothorus*, *M. paniculata*, and *A. arabica* against the 4<sup>th</sup> instar larvae of *L. orbanolis*.







## Hepatoprotective Activity of Ethanolic Extract of *Barleria longiflora* L.F. Leaves and its Effects on Biochemical Parameters in Paracetamol Intoxicated Rats

A Periyasamy<sup>1</sup>, S Muruges<sup>1\*</sup> and M Kannan<sup>2</sup>

<sup>1</sup>Department of Botany, School of Life Sciences, Periyar University, Periyar Palkalai Nagar, Salem – 636 011, Tamil Nadu, India.

<sup>2</sup>Department of Botany, Directorate of Distance Education, Vinayaka Missions Research Foundation (Deemed to be University), Salem - 636 308, Tamil Nadu

Received: 03 Feb 2023

Revised: 23 Mar 2023

Accepted: 02 May 2023

### \*Address for Correspondence

**S Muruges**

Department of Botany,  
School of Life Sciences,  
Periyar University, Periyar Palkalai Nagar,  
Salem – 636 011, Tamil Nadu, India.



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### ABSTRACT

Ethanolic extract of *Barleria longiflora* L.f. leaves were evaluated for its hepatoprotective potential against paracetamol intoxicated Wistar Rats. The experiments were carried out in normal and paracetamol intoxicated animals treated with doses of 200 mg/kg and 400 mg/kg of *B.longiflora* leaf extracts for 14 days, where Silymarin is used as standard drug. Among the test animals treated with ethanolic extract of the selected plant, the toxic effect of paracetamol was significantly controlled by restoration of serum bilirubin, protein and enzymes as compared to the normal and control groups. The hepato protective activity was further evidenced by histopathological studies of liver tissue sections of the animals from the respective groups.

**Keywords:** *Barleria longiflora*, Hepatoprotective activity, Paracetamol, Silymarin.

### INTRODUCTION

Liver is one of the largest organs in human body and the chief site for intense metabolism and excretion [1]. It is primarily responsible for the metabolism of endogenous and exogenous agents. It plays an important role in drug elimination and detoxification. The liver damage may be caused by xenobiotics and consumption of alcohol [2]. According to the surveys carried out among men, liver is one of the five most common sites of cancer [3]. Liver disease is a common cause of death in the world [4] and drug-induced hepatotoxicity is a frequent cause of liver injury [5]. Drug habits and alcohol are responsible for certain ailments like hepatitis, cirrhosis and alcoholic liver

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disease [ 6,7]. Paracetamol, a widely used counter analgesic and antipyretic drug and it is comfortable for the therapeutic purposes. It is commonly used in relieving of fever, headaches etc. Though it is safe under therapeutic doses, it was reported that paracetamol could produce liver diseases resulting in the acute liver necrosis in humans[8]and also in experimental animals in toxic doses [9].

Paracetamol is primarily metabolized by the liver, most of which are inactive, non-toxic and excreted by kidneys. But, excessive use of paracetamol produces hepatotoxicity caused by the reaction metabolite N-Acetyl-p-benzoquinonimine (NAPQI). It is a toxic byproduct produced during the xenobiotic metabolism of the analgesic paracetamol. It is normally produced only in small amounts and then almost immediately detoxified in the liver. If NAPQI is not effectively detoxified due to the paracetamol overdose, it leads to severe liver damage and after 3–4 days of ingestion, may leads to death due to the liver failure. Hence in the present investigation paracetamol is employed as an experimental hepatotoxic agent. In the absence of a reliable liver protective drug in the modern system of medicine, a number of medicinal preparations in Siddha, the Indian system of medicine, are suggested for the treatment of liver disorders. This herbal based therapeutics for liver disorders is in use since long time in India and has been popularized world wide by leading pharmaceuticals. ((Jannu et. al.,2012) [8]. Use of *Barleria longiflora* L.f. leaves for the treatment of liver disorders is in practice among the tribal communities of Jambuthu Malai Hills of Salem district, Tamil Nadu. Hence, the present study was aimed to evaluate the influence of ethanolic extract of *B.longiflora* L.f. leaves on hepatoprotective activity in paracetamol intoxicated rats.

## MATERIALS AND METHODS

### Chemicals

Paracetamol (Sigma Aldrich, USA) and Silymarin (Sigma Aldrich, USA) were used in the present investigation. All other chemicals and reagents used were of analytical grade.

### Plant Description

*B.longiflora* L.f. belongs to family Acanthaceae. Habitat is dry deciduous forest and scrub jungles.It is an annual or perennial erect herb with sub quadrangular stem. Leaves sessile, in whorls of 6-8, with axillary spines at each node, lanceolate, lineolate, with numerous stiff hairs on the lamina and small hairs on the margin; spines straight or curved. Flowers in axillary whorls of 4-8 at each node, surrounded by slightly recurved spines; bracts leafy, lanceolate, spatulate; bracteoles linear-lanceolate, Calyx-lobes 4, unequal; outer lobe large, lanceolate, Corolla bluish purple; 2-lipped; lobes obtuse, ciliate. Stamens united in pairs, anther-thecae. Ovary oblong, ovules 4 per locule style pubescent. Capsules linear-oblong, seeds 4-8, orbicular. Flowering and fruiting between November and February.

### Collection and Extraction of Plant Material

The fresh material of the research plant, *B.longiflora* was collected from Jambuthu Malai Hills of Salem district, Tamil Nadu. The plant was identified with the help of standard local flora[10,11]. The herbarium specimen (Specimen No.BSI/SRC/5/23/2017/Tech/1673) was authenticated by Botanical survey of India, Coimbatore Division, Tamil Nadu. Freshly collected plant materials were washed under running tap water followed by distilled water in order to remove adhering dust and then dried under shade. The dried samples were coarsely powdered using a mechanical grinder and extraction procedure was carried out using soxhlet apparatus to perform methanolic extraction. Thereafter the extracts were wiped in a vacuum through distillation method. The extracts were preserved in sample bottles covered with aluminium foil and stored at 4°C. The extracts were subjected to preliminary phytochemical analysis.





## Evaluation of Hepatoprotective Activity

### Experimental Animal

Male *Albino wistar* rats weighing between 150-200 g were used for the experiments. They were kept in polypropylene cages under standard laboratory conditions (12 h light/dark cycle at 25± 2°C). Rats were provided with commercial rat diet and water *ad libitum*. Animals were quarantined and acclimatized to laboratory conditions for 7 days prior to initiation of the study. Animals were observed for general health and suitability throughout the study.

### Experimental Protocol

A total of 30 rats were used in five groups of six each. All the animals, except normal control group were intoxicated with Paracetamol (750 mg/kg, p.o) daily for 7 days.

Group I - Served as normal control animals, fed orally with normal saline 5ml/kg body weight daily for 14 days.

Group II – Served as negative control and treated with Paracetamol (750 mg/kg, p.o) daily for first 7 days.

Group III - Served as positive control and treated with Paracetamol (750 mg/kg, p.o) daily for 7 days and fed with 25 mg / kg Silymarin for 14 days.

Group IV & Group V – Served as experimental groups received the test drug 200 mg/kg and 400 mg/kg respectively for 14 days through oral routes.

The blood samples were collected by retro-orbital puncture on 14<sup>th</sup> day. The serum were separated by centrifugation at 3000rpm for 15 min and used for estimation of biochemical parameters including Total protein (TP), Serum Glutamic-Oxaloacetic Transaminase (SGOT), Serum Glutamic-Pyruvic Transaminase (SGPT), Alkaline Phosphatase (ALP), Bilirubin, Urea and Creatinine. The animals were sacrificed with excess of light ether anaesthesia. The liver was dissected out and processed for histopathological studies.

### Histopathological Studies

#### Isolation of Liver and Processing

Standard methods were followed for the fixation of liver tissues. The isolated liver was sliced into 5mm pieces and fixed in neutral formalin (10% solution) for 3 days. They were washed under running tap water for about 12 hours followed by dehydration with alcohol of increasing strength (70%, 80% and 90%) for 12 hours each. Final dehydration was carried out using absolute alcohol with about 3 changes at 12 hours interval. Cleansing was done by using xylene with changes at 15 to 20 min interval. After cleansing, the pieces were subjected to paraffin infiltration in automatic tissue processing unit. The pieces were washed under running water to remove formalin completely. Hard paraffin was melted and poured into L-shaped blocks. The liver pieces were then dropped into the liquid paraffin quickly and allowed to cool.

#### Sectioning and Staining

The tissue blocks were cut using microtome to get sections of 5µ thickness. The sections were fixed on a glass slide using egg albumin and allowed to dry. Eosin and hematoxylin were used for staining the liver sections. The excess stain was removed by washing the slide in running tap water and air dried. Using Dibutylphthalate Polystyrene Xylene (DPX) mounting medium, the sections were mounted. The tissue sections were observed under microscope and photomicrographs were taken.

#### Statistical Analysis

Results were expressed as mean ± SEM. Statistical analysis was performed using one-way analysis of variance (ANOVA) followed by Dunnett's Multiple Comparison test. P< 0.05 was considered statistically significant.





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## RESULT AND DISCUSSION

Since, so many chemicals are passed through the liver through the circulatory system, the liver is at a higher risk than the other organs [12]. Due to the limited pharmacological options available for the treatment of liver diseases, identification of effective hepatoprotective agents derived from natural sources is an urgent necessity. Therefore it is important to evaluate plant extracts that can help in restoring liver functions [13]. So in the present study, paracetamol was employed for the intoxication and the leaves of *B. longiflora* are used for its protective effect against paracetamol induced hepatotoxicity. The toxic effect was estimated by biochemical enzyme studies and for further confirmation, histopathological studies were carried out. The hepatoprotective activity of methanolic extracts of *B. longiflora* on Paracetamol intoxicated animals is presented in the Table 1.

### Hepatoprotective Activity

In the present study, the plant extract exhibited significant hepatoprotective activity against paracetamol induced liver models by improving liver function as indicated by the reduction in the levels of liver enzymes aspartate transaminase and alanine transaminase compared with the control group. Administration of paracetamol caused a significant increase in TP, Urea, Creatinine, SGOT, SGPT, ALP and Bilirubin in the animals treated with plant extract as compared to normal control groups indicating liver damage. Treatment of animals with test drug showed a significant reduction in TP and creatinine at  $P < 0.05$  level whereas in Urea, SGOT, SGPT, ALP and Bilirubin at  $P < 0.01$  level in both dosages of the test drugs. Among them the animals treated with 400mg/kg extract showed more reduction than the animals treated with 200mg/kg extract.

Paracetamol toxicity occurs due to the formation of toxic metabolites when a part of it is metabolised by cytochrome P<sub>450</sub> [14]. Introduction of cytochrome or depletion of hepatic glutathione is a prerequisite for paracetamol induced hepatotoxicity [15]. The hepatoprotective activity depends on the capacity to sustain the normal physiological functions of the hepatocytes that were exposed to paracetamol toxicity. This agent induces hepatic injury with subsequent release of reactive metabolites. These free radicals cause oxidative stress with significantly increasing serum TP, Urea, Creatinine, SGOT, SGPT, ALP and Bilirubin. These findings are in agreement with the findings of many investigations [16,17,18]. The present investigation showed the potential hepatoprotective activity of *B. longiflora* leaves against hepatic toxicity induced by paracetamol in rats.

### Histopathological Studies

This part of the investigation provides further confirmation for the hepatoprotective activity of methanolic extracts of *B. longiflora* leaves against hepatic injury produced by paracetamol in rats through the histopathological examination of the liver samples from the respective groups (Plate 1). Histopathological architecture of liver in normal control animal showed normal lobular architecture with individual hepatocytes possessing normal portal tract and central vein. The TS of liver in negative control animal showed congestion of blood vessel and cytoplasmic vacuolation. In the positive control animals TS of liver showed normal lobular architecture, mild hepatocytes inflammation and central vein congestion. The histopathology of liver tissues of animals treated with extract 200mg/kg showed normal lobular architecture with mild inflammation and portal tract shows bile duct hyperplasia. The animals treated with extract of 400mg/kg showed normal lobular architecture with mild central vein and sinusoidal dilation.

The hepatic cytochrome P<sub>450</sub> enzyme system metabolize paracetamol and forms the alkylating metabolite called NAPQI and this may irreversibly conjugates with the sulphhydryl groups of glutathione [19]. NAPQI depletes glutathione and initiates covalent binding to cellular proteins. These events initiate the disruption of calcium homeostasis, mitochondrial dysfunction, oxidative stress and may leads to cellular damage and death [15]. Due to these mechanisms, significant increase is occurred in the biochemical parameters among the control groups. So the histopathological profile also reflected the same among the study groups. Hence, the present study clearly reveals that paracetamol toxicity may be occurs due to the depletion of glutathione storage, free radical generation or lipid





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peroxidation. In the same time Silymarin maintained the normal architecture of hepatic tissues with minimal injuries and better protection than the test extracts. On comparison of the protective effects exhibited by control and test groups, the test group treated with 400mg/kg dose showed more significant result than the 200mg/kg dose group. In the phytochemical study, it is reported that the plant extracts contain polyphenols, flavonoids, terpenoids, tannins etc., possess hepatoprotective activity. The hepatoprotective activity studies carried out in *Kingangella reticulata* [20] and in *Chenopodium album* [21] also supports the presence of the above phytochemicals in *B. longiflora* extract may be responsible for its hepatoprotective activity. The phytochemical may exhibit the hepatoprotective activity either alone or in combinations [22].

## CONCLUSION

Since the results of biochemical studies of blood samples of paracetamol treated rats showed significant increase in the levels of serum enzyme activities, reflecting the liver injury caused by Paracetamol and blood samples from the animals treated with the ethanolic extracts of *B. longiflora* showed significant decrease in the levels of serum markers, indicating the protection of hepatic cells. The results of the study showed that hepatoprotective effects of *B. longiflora* may be due to the marked changes in various parameters of liver enzyme. The physical parameters also proved that the plant extract has hepatoprotective activity in nature against paracetamol induced liver toxicity. Hence, the present study reveals the potential hepatoprotective activity of the ethanolic extracts of *Barleria longiflora* L.f. against the hepatic injury induced by paracetamol. However, the mechanism of action of the extracts and active particle responsible for the hepatoprotective activity are needed to be clarified in further investigations.

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**Table 1: Effect of ethanolic leaf extract of *Barleria longiflora* L.f on biochemical parameters in rats treated with Paracetamol**

Groups	Treatment	Total Protein	Urea	Creatinine	SGOT	SGPT	ALP	Bilirubin
Group I	Normal Control 5ml/kg Normal saline	7.24±0.22	15.16±0.38	0.68±0.02	51.6±0.82	40.1±0.76	160.2±9.2	0.82±0.01
Group II	Negative Control Paracetamol 750 mg/kg	11.32±0.36*	28.14±0.72*	1.42±0.04*	109.8±0.94*	91.0±0.52*	254.4±8.6*	1.85±0.08*
Group III	Positive Control Paracetamol 750 mg/kg + Silymarin 25 mg/kg	8.41±0.64**	17.03±0.66**	0.78±0.02**	62.1±0.62**	37.6±0.88**	179.8±7.6**	1.01±0.04**
Group IV	Experimental Group Paracetamol 750 mg/kg +	10.62±0.42***	25.62±0.24**	1.28±0.06***	82.9±0.94**	56.7±0.72**	226.6±6.8**	1.59±0.06**





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	Test drug 200 mg/kg							
<b>Group V</b>	Experimental Group Paracetamol 750 mg/kg + Test drug 400 mg/kg	9.16±0.52***	22.84±0.48**	1.12±0.04***	76.8±0.58**	44.6±0.86**	198.0±5.2**	1.25±0.03**

Values were mean± SEM; n=6.

\*P<0.001 when compared to control. \*\*P<0.01, \*\*\*P>0.05 when compared to Paracetamol control (one way ANOVA followed by Dunnett's test. Total protein= g/dl, Urea= mg/dl, Creatinine=mg/dl, SGOT= U/L, SGPT= U/L, ALP= U/L and Bilirubin= mg/dl.

<p><b>(a) Normal Control: TS of liver showed normal lobular architecture with individual hepatocytes possessing normal portal tract and central vein.</b></p>	<p><b>(b) Negative Control: TS of liver showed congestion of blood vessel and cytoplasmic vacuolation</b></p>
<p><b>(c) Positive Control: TS of liver showed normal lobular architecture, mild hepatocytes inflammation and central vein congestion.</b></p>	<p><b>(d) <i>B. longiflora</i> extract 200mg/kg:T.S. of Liver Showed normal lobular architecture with mild inflammation. Portal tract shows bile duct hyperplasia.</b></p>
<p><b>(e) <i>B. longiflora</i> extract 400mg/kg : T.S. of liver showed normal lobular architecture with mild central vein and sinusoidal dilation</b></p>	
<p><b>Fig 1: The slides shows the Transverse Section of liver treated with ethanolic extract of <i>Barleria longiflora</i> L.f on paracetamol intoxicated rats</b></p>	





## A Self Active Movement with Mobilization Device: a Device to Increase Shoulder Abduction Range of Motion

Harnoor Kaur<sup>1</sup> and Varun Kalia<sup>2\*</sup>

<sup>1</sup> Student of Master of Physiotherapy, Department of Physiotherapy, Lovely School of Allied Medical Sciences, Lovely Professional University, Punjab, India.

<sup>2</sup> Assistant Professor, Department of Physiotherapy, Lovely School of Allied Medical Sciences, Lovely Professional University, Punjab, India.

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### \*Address for Correspondence

#### Varun Kalia

Assistant Professor,  
Department of Physiotherapy,  
Lovely School of Allied Medical Sciences,  
Lovely Professional University, Punjab, India.  
E.Mail : varun.26576@lpu.co.in.



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### ABSTRACT

Adhesive capsulitis is the leading cause of adult disability. Some devices for shoulder rehabilitation were designed earlier such as Shoulder rotator, Static progressive stretch orthosis/device, and dynamic splinting. However, patients have limited access to such devices due to the complexity, cost, and bulk. To counter this problem, we developed a lightweight, inexpensive Self Active Movement With Mobilization (SAMM) device which requires no external/therapist's assistance. The device provides the self postero-lateral glide and subjects simultaneously perform the active shoulder abduction movement, this not only helps to improve the pain and shoulder abduction range of motion but the device also helps in improving the muscle strength of the shoulder joint by doing some modifications which includes adding weight cuffs while performing the shoulder abduction ROM with the help of shoulder pulley attached to the device.

**Keywords:** Adhesive capsulitis, Self-Active Movement with Mobilization device, Pain, Range of motion, Muscle strength.

### INTRODUCTION

A common musculoskeletal disorder known as Adhesive Capsulitis (AC) causes rapid onset of pain and a steady, cumulative deterioration in active and passive range of motion (ROM), which can result in a complete loss of





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shoulder function [1]. AC specifically targets people between the ages of 40 and 60, with female pervasiveness [2]. However, the cause has yet to be determined [3], but it can be primary (Idiopathic) or secondary. The causes of primary AC are still unknown and may develop due to immunologic, biochemical, or hormonal imbalances [4]. Secondary AC, on the other hand, can develop from obvious causes of stiffness and immobility, including prior shoulder trauma or surgery [5]. Besides that, AC is said to influence 2% to 5% of the general population, rising to 10% to 38% in people with metabolic diseases like hyperglycemia and thyroid disease [6]. Similarly, when AC affects one shoulder, the likelihood of the contralateral shoulder being affected increases by 5% to 34%, and simultaneous bilateral shoulder involvement can happen as frequently as 14% of the time [7]. AC has four clinical stages, the second of which is known as the "freezing stage," lasts 3-9 months, and is characterized by a noticeable gradual loss of all shoulder ROM and pain [8].

The thickening of the Capsular and Coracohumeral Ligament, inadequate capsular distension, extracapsular contrast leakage, synovial hypertrophy, scar tissue formation at the rotator interval brought on by elevated collagen, and nodular band formation are typical characteristics of AC [9]. Also, based on arthroscopic findings, several studies claimed that there is cytokine-mediated synovial inflammation with fibroblastic proliferation. The glenohumeral joint capsule thickens and contracts in advanced phases, significantly restricting the ROM in all directions [10]. The ideal AC treatment protocol to achieve the best therapeutic effect is still being debated [11]. Traditional treatments for AC include thermotherapy at the beginning of the session accompanied by stretching exercises, shoulder mobility exercises such as pendulum, wand, shoulder pulley, shoulder wheel or finger ladder exercises, and last cryotherapy [12]. Except for the aforementioned treatment options, other conventional therapies have been proposed, including Transcutaneous Electrical Nerve Stimulation (TENS), Massage Therapy, Dynamic Splinting, Total End Range Time (TERT), Extracorporeal Shockwave Therapy (ECSWT), Ultrasound Therapy (UST), Low-Level Laser Therapy (LLLT), Continuous Passive Motion (CPM), and Joint Mobilization [11], [13] but the patient's chances of recovery are indeed very limited. Among all mobilization techniques, Mobilization with movement (MWM), the principal mobilization technique for peripheral joints, focuses on the immediate restoration of full, pain-free ROM while addressing joint dysfunctions of the upper and lower extremities [14]. According to the Mulligan concept, the therapist provides a postero-lateral gliding force to the shoulder joint followed by active abduction movement performed by the subject simultaneously, the movement must be pain-free [15] and literature reported that this mobilization technique is having good efficacy to improve shoulder abduction ROM, and pain [16]. However, the level of recovery is tied to the intensity of therapy, and subjects need to visit the clinics for the MWM daily which is very time-consuming and expensive for the subjects.

To address the problems associated with AC survivors suffering from a large range of negative effects such as pain, decreased shoulder ROM, and muscle weakness which affects their activities of daily living, we introduced the present wall-mounted self-active movement with a mobilization device (SAMM device) which provides self-mobilization and reduces the therapist's efforts or any external assistance. Earlier we need the therapist's assistance to provide gliding force to the shoulder joint followed by active shoulder movement performed by the subject. However, this device provides self-mobilization and doesn't require therapist assistance. Moreover, it also includes a pulley bar which helps the subject to perform mobility exercises on the shoulder. This ultimately reduces the burden of society as this device is easily accessible, cost-effective, and has unimpeded access to the subjects, also can be recommended for home treatment programs as well.

Our goal is to assist the AC subjects by providing them with the present wall-mounted self-active movement with a mobilization device that is easily accessible and affordable. We demonstrated that this device vanishes the therapist's assistance as the device itself performs the work of the therapist and the subject can actively perform the movement simultaneously. Also, shoulder mobility exercises can be performed with the help of a pulley system. We experimentally verify that the device maximally impacts the subject's ROM in the shoulder joint specifically working on the restricted capsular pattern of AC.



**Harnoor Kaur and Varun Kalia****Device Design and Construction**

We designed and built a present wall-mounted device (100) that relates to a system and methods for active self-mobilization of the shoulder joint with movement. The entire pioneer device is made up of iron with one C-shaped structure (106) at its edge which is made up of molded, low-temperature thermoplastic material. The device consists of a vertical bar (101) with 2 wall mounting clamps (119,120) one inner vertical bar (102) which is moveable along with screws for the adjustment of the height (103,104), a horizontal bar (105) is attached to the moveable vertical bar (102) so that the height would be adjusted with the help of screws in such a way that the height of the horizontal bar is equivalent to the subject's affected shoulder level. A height-adjustable horizontal bar (105) has C-shaped structure (106) at its edge where it cups the subject's shoulder while performing the shoulder abduction ROM. Additionally, the present wall-mounted device (100) can also be used for active ROM exercise for the shoulder joint using a pulley system (112,113), which consists of a pulley bar (110) that is attached to the horizontal bar (105) with one vertical connector (109) that can be attached by using screw based locking mechanism (111). The pulley bar (110) consists of a rope (114) with grab handles or weights passed through the hooks (117,118) present at both ends (Figure 1).

**EXPERIMENTAL METHODS****Device Characterization**

The present wall-mounted device consists of two vertical bars out of which the inner one is movable for the adjustment of the height followed by a horizontal bar attached to the vertical bar. A c-shaped structure is attached at the edge of the horizontal bar and is adjustable according to the subject's height. We adjusted the height of the device for all five users so that the 'C' shaped structure must fit with the anterior aspect of the shoulder just lateral to the joint line. Then users lean forward and exert his/her body weight over the 'C' shaped structure and it drives the humerus toward the postero-lateral direction and at the same time users performed shoulder abduction with pain-free conditions. After the completion of the mobilization protocol with the device, users performed shoulder stretching exercises with the help of a pulley system which is attached to the device, as well as users performed strength training for the shoulder muscles by using a hanging weight on one side of the pulley system.

**Participants**

Five subjects were referred by a physician from an OPD of a multispecialty hospital (Table 1). Subjects who were (a) clinically diagnosed with AC based on the medical history, and physical examination (b) age range of 40 to 65 years (c) male or female (d) enduring shoulder pain and restriction for three months or longer yet maintaining normal cognitive function were taken into the study. Additionally, the participants who had (a) skin disease around the shoulder and neck (b) surgical history around the neck (c) taken anticoagulant medication within three days before study recruitment (e) a history of malignancy-related pain within six months before the study (f) Uncooperative behavior were excluded from the study. Then they underwent the pre-intervention assessment and later were treated with SAMM Device along with Conventional physiotherapy every three days for three weeks. The outcome measures used in this study were the Visual Analog Scale, Universal goniometry, MRC Grading, and Shoulder pain and Disability Index (SPADI). Post-intervention assessment was done after three weeks of intervention.

**Outcome Measures****Pain Intensity**

For assessing pain in patients with AC, the Visual Analog Scale (VAS) has been employed. Two extreme positions on the 100-mm horizontal line are said to stand for "worst pain imaginable" and "no discomfort at all." As a result, it is an effective and practical ideal method that uses the ratio scale qualities to express severe or acute pain [17].

**Range of Motion**

To determine how our device affects the upper extremity abduction ROM in subjects with AC, we used a Universal Goniometer to measure the pre- post-ROM of shoulder abduction after 3 weeks of treatment for 5 subjects of AC. Universal Goniometry has ICC  $\geq 0.85$ , which shows it's a reliable tool with construct validity [18].



**Harnoor Kaur and Varun Kalia****Muscle Strength**

To determine whether the device improves the muscle strength of the upper extremity in subjects with AC. We used manual muscle testing to evaluate the muscle strength of the upper extremity before and after 3 weeks of treatment [19].

**Functional Disability**

Functional ability in subjects with AC was evaluated with the help of a self-assessment questionnaire known as SPADI (The Shoulder Pain and Disability Index) contains two subscales, namely the pain and disability subscales. Due to its excellent internal consistency (Cronbach's alpha is typically greater than 0.90) and construct validity, SPADI has an ICC > 0.89, demonstrating its reliability as a tool[20].

**RESULT**

We designed and constructed a present wall-mounted SAMM Device that requires no therapist assistance with adjustable height according to every individual that assists the subject to perform shoulder abduction, also attached a pulley system with it. The device is inexpensive (USD 49.13) and made from entirely iron material.

**Shoulder Pain**

Figure 2 represents the Pre& Post-intervention pain score of every participant. We found that the mean Pain score decreased by 60.97%. These findings indicate that the SAMM device reduces shoulder pain in subjects with AC.

**Shoulder Range of Motion**

Figure 3 represents the Pre& Post-intervention readings of Shoulder abduction ROM and we found that ROM increased by 24% after the intervention with the SAMM device. These results suggest that the SAMM device is effective in improving shoulder ROM in subjects with AC.

**Muscle Strength Effect**

Figure 4 represents the pre & post-intervention readings of shoulder muscle of all the subjects with AC. We found that Muscle strength (Manual muscle testing) increased by 31.25% after the intervention with the SAMM device. These results suggest that the SAMM device is effective in improving shoulder muscle strength in subjects with AC.

**Shoulder Disability**

Figure 5 represents the pre & post-intervention readings of the Shoulder Pain and Disability Index of all the subjects with AC. We found that shoulder disability (SPADI) decreased by 51% after the intervention with the SAMM device. These findings imply that the SAMM device is successful in reducing shoulder impairment in subjects with AC.

**DISCUSSION**

AC is a self-limiting disorder that is more common among diabetics than in other population segments, however, it can affect anyone[21]. Physiotherapy treatment has offered numerous pieces of evidence to resolve this condition and symptoms at the early stages of life, almost it may take 2-3 years for symptoms to Totally resolve [4]. Several treatments have been advocated for AC such as thermotherapy, electrotherapy, and exercise therapy as conventional treatment[12]. Also, some devices for shoulder rehabilitation were designed earlier such as Shoulder rotator, Static progressive stretch orthosis/device, and dynamic splinting [22]–[24]. A shoulder rotator device is quite similar to a Continuous Passive Motion (CPM) device of the upper extremity mainly focusing on providing the analgesic effect helping in reducing pain, compression, and distraction mode helping in providing joint proprioception and muscle relaxation, resistive rotator exercises strengthen the glenohumeral muscles [22]. Therefore, this device only focuses on relaxing the muscle by providing an analgesic effect and strengthening one particular group of rotatory glenohumeral



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muscles through resistive exercises. Another one is a self-applied Static Progressive Stretch Orthosis /device that facilitates patient compliance. This usually can be used after the surgery or any trauma to the shoulder joint or also in the treatment of AC shows significant results in increasing ROM and decreasing the pain score [23]. Furthermore, by attaining permanent elongation of connective tissue, Dynamic Splinting, which uses a low-load prolonged duration stretch in combination with the therapeutic principle of increased time at the end range, enables the patient to lessen contracture[24].

Therefore, In shoulder rehabilitation, the use of static progressive stretch (SPS) and low-load prolonged stretch (LLPS) is a tried-and-true method. With the hope that plastic remodeling of the tissue and improvements in ROM will take place, the approach involves holding a joint, applying tension to the scarred or constricted tissue near the end of the ROM, and gradually increasing the joint's displacement. To reduce the risk of overstretching and tissue damage, it is ideal for splints that employ a principle to provide the patient control over the amount of stretch. When used to treat other joints, these splints have been effective. Unfortunately, research supporting the use of an SPS device in people with shoulder adhesive capsulitis has been constrained by a poor methodological approach and a tiny sample size. For pain reduction and functional improvement in people with AC, multimodal therapy appears to be useful, including mobilization, shoulder orthoses, stretching, and strengthening exercises. Prior work shows that Mulligan mobilization with movement is effective in restoring a joint's function after impairment by correcting positional faults. This was corroborated by B. Chakradhar Reddy's (2015) showing that the treatment of AC using Mulligan's MWM is effective [25]. Mulligan's concept requires therapist assistance to provide the postero-lateral glide and the subject simultaneously performs the active shoulder abduction movement, which must be pain-free [15]. We designed the present wall-mounted device which requires no external/ therapist's assistance. The device provides the self postero-lateral glide and subjects simultaneously perform the active shoulder abduction movement, this not only helps to reduce the pain and increase the shoulder abduction ROM but also helps in improving the muscle strength of the shoulder joint by doing some modifications which include adding hand weight cuffs while performing the shoulder abduction ROM helps in improvement of shoulder muscle strength.

This device also includes the pulley system which helps to maintain the mobility of the shoulder joint. Some of the modification exercises can be performed in the pulley system as well by adding or changing the weights instead of using simple holding handles which further helps to increase the muscle strength of the shoulder joint. The device not only helps to reduce the pain level, increase the shoulder abduction ROM, and increase muscle strength but also helps in improving the functional ability of the subjects with AC which ultimately leads to improvement in the quality of life of the subject and further reduces the burden of society. Further, we documented changes in VAS, shoulder abduction ROM, muscle strength, and functional ability in five subjects post-treatment. We found that subjects with AC showed Pain scores decreased by 60.97%, Shoulder abduction ROM increased by 24%, Muscle strength increased by 31.25%, and functional ability increased by 51%. We have demonstrated promising performance of our device in subjects with AC including Stages 1 & 2.

**CONCLUSION**

SAMM Device shows significant improvement in shoulder abduction ROM, lessening the pain, and increasing the muscle strength and functional ability of the upper extremity which ultimately leads to improvement in the quality of life of the subjects with AC.

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**Conflict Of Interest**

To the best of the authors' knowledge, no individual or organisation has a conflict of interest.





### Harnoor Kaur and Varun Kalia

#### Credit Authorship Contribution Statement

HK: Investigation, Resources, data curation, Writing -original draft.

VK: Conceptualization, Methodology, Formal analysis, Writing - review & editing, Visualization, Supervision.

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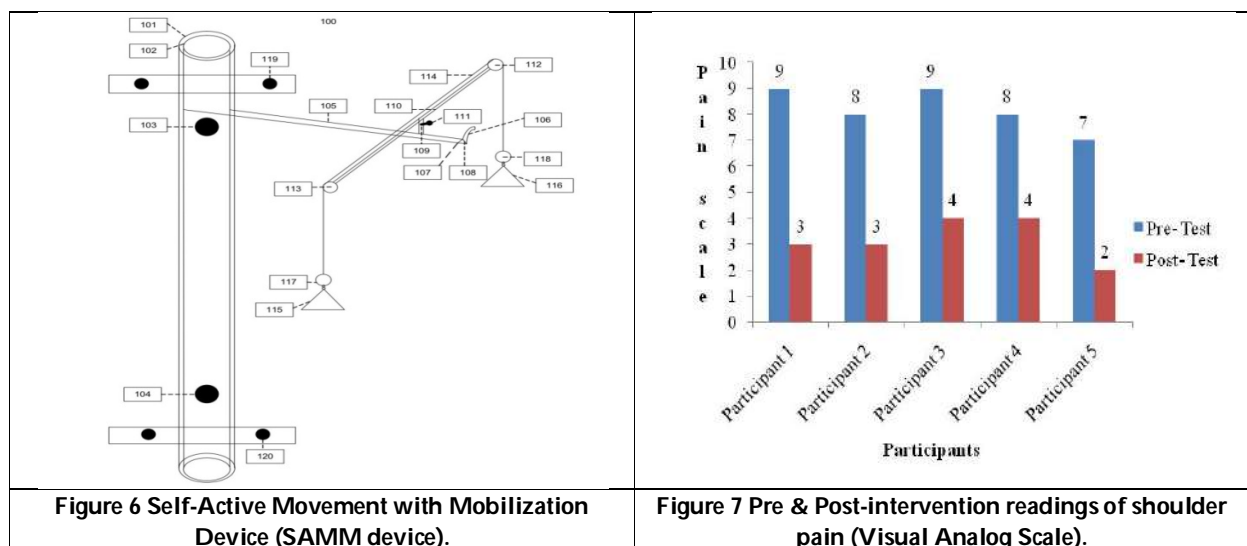
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**Table 14 Demographic characteristics of study participants.**

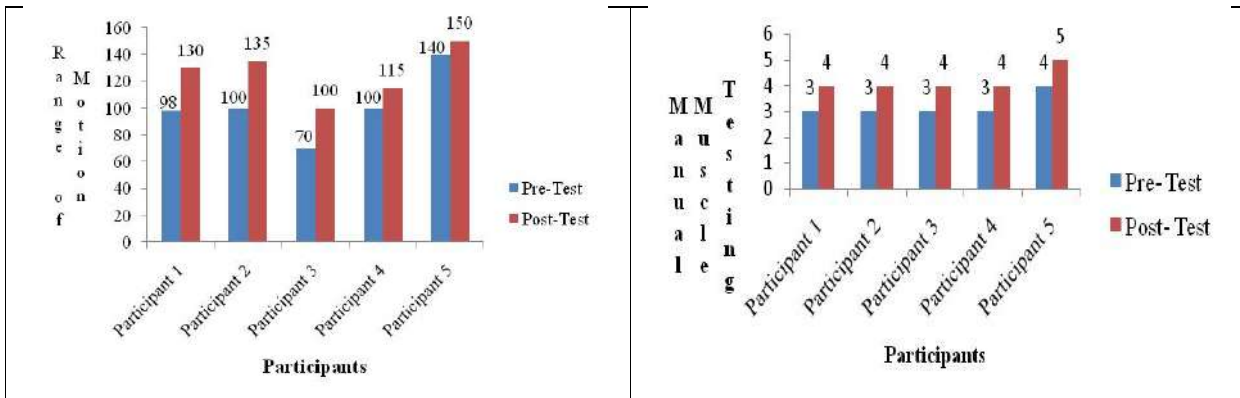
Measures	Participant-1	Participant-2	Participant-3	Participant-4	Participant-5
Gender	Male	Female	Male	Female	Female
Age (Year)	45	43	48	43	49
Height (Feet)	5.7	5.3	5.9	5.4	5.1
Weight (Kg)	76	68	87	63	71
BMI (kg/m <sup>2</sup> )	26.24	26.56	28.32	23.84	29.58

Note. Kg- Kilogram, BMI- Body Mass Index, Kg/m<sup>2</sup>- Kilogram per meter square.

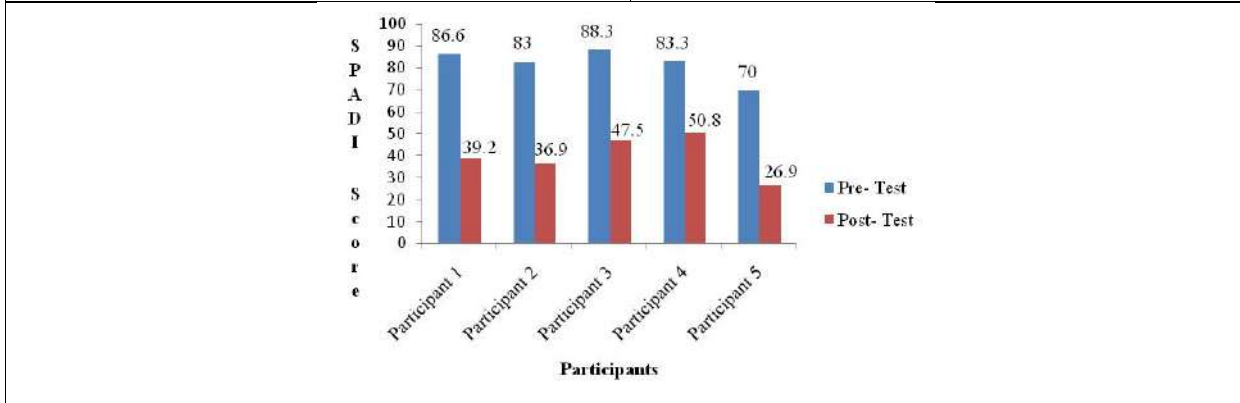




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**Figure 8 Pre & Post-intervention readings of shoulder range of motion (Universal goniometer).**      **Figure 9 Pre & Post-intervention readings of shoulder muscle strength (Manual muscle testing).**



**Figure 10 Pre & Post-intervention readings of Shoulder Pain and Disability Index.**





## Animal- Vehicle Collision Near Girnar Wildlife Sanctuary: Junagadh - Bilkha Highway, Gujarat, India

Agnikumar H. Vyas<sup>1\*</sup>, Pratik A. Siddhapara<sup>2</sup>, Megha R. Chovatia<sup>3</sup>, Pradip D. Kachhiya<sup>4</sup>, Nikunj R. Dand<sup>5</sup> and Sanjay K. Teraiya<sup>6</sup>

<sup>1</sup>Ph.D Scholar, Department of Zoology, MVM Science College, Saurashtra University, Rajkot, Gujarat, India.

<sup>2</sup>Gallery Guide, Regional Science Center, Bhavnagar, Gujarat, India

<sup>3</sup>Assistant Professor, Department of Life Sciences Dr. Subhash University, Junagadh, Gujarat, India.

<sup>4</sup>HoD, Department of Life Sciences, Dr. Subhash University, Junagadh, Gujarat, India

<sup>5</sup>M.Sc., Zoology, Department of Life Sciences, Dr. Subhash University, Junagadh, Gujarat, India.

<sup>6</sup>Associate Professor, Department of Zoology, MVM Science College, Saurashtra University, Rajkot, Gujarat, India.

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### \*Address for Correspondence

Agnikumar H. Vyas  
Ph.D Scholar,  
Department of Zoology,  
MVM Science College,  
Saurashtra University,  
Rajkot, Gujarat, India.



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### ABSTRACT

Animals are biological significant as they provide priceless services to the ecosystems, nowadays some of them are endangered organisms in the world. They often affected by killing on road by vehicles. Highways passing through national reserves/wildlife sanctuaries have adverse impact upon wild animals. Eventually they prefer the open area for basking and hunting then try to cross the roads; ultimately, they might be killed by vehicular activities on roads. Number of specimens was found killed abruptly in the morning or early morning in the monsoon season and cold days. The present survey was conducted to estimate the road kills on the State Highway GJSH30 passing nearer to Gir and Girnar corridor and adjoining areas of Junagadh, Gujrat, India during a period of year. The study was carried out from June 2020 to May 2021. During 2020-21, 8 amphibians, 22 reptiles, 9 birds, and 12 mammal's species have reported dead due to vehicle collisions. According to vegetation, the overall road kill was found in nearer areas from dry deciduous teak forest. Conservation and management implications are essential to prevent and protect the animals from road kill.

**Keywords:** Girnar Wildlife Sanctuary, Sanctuary, Roadkill, Tetrapoda, Collision





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## INTRODUCTION

Vertebrates play a vital role in the natural environs and are integral to the food chain. They are successful hunters as well as ambush predators. Globally many species are affected by anthropogenic habitat destruction; buildings and the spreading of roads are the major threat for many vertebrates (Bhandarkar and Paliwal, 2021). Human development and encroachments activities continue to threaten the wildlife by fragmenting their habitat (Selvan *et al.*, 2011). In many ways, road traffic affects the adjacent environment and damage adjoining flora and fauna (Forman and Alexander, 1998). Roads are the barrier for many wild animals. The increasing traffic on roads can cause a decline or turn down the vertebrate population. The herpeto fauna is rich in species diversity and population which is indicated by road kill mortality. Animals are come out for food-finding, reproduction, and territory search and due to vehicular migrations killed on roads (Langen, *et al.* 2007). Vehicle-animal collisions affect common animals as well as threatened animals (Solanki *et al.*, 2017). On the road avian fauna like flycatchers, sparrow, mynas, bee-eater, lapwings, swifts, and cattle egrets are seen to eat insects from the cow dung and human food waste (Solanki *et al.*, 2017). Millions of animals killed by road traffic every year, posing a critical threat to the population of many species (Rytwinski *et al.* 2016). More directly, roads can cause the mortality of animals as a result of collisions with the vehicles that travel on them. (Kioko J. *et al.* 2015). Junagadh district lies near Girnar hills in the western Indian state of Gujarat. The city area is about 160 km<sup>2</sup> and the population is around 3,20,000 (2011). Girnar forests were once part of a major forest ecosystem comprising of Gir and Girnar. Gradually the urbanization and economic activities caused by major agricultural enlargement and industrial development. These two convert Girnar Wildlife Sanctuary into an isolated compact patch of the forested habitat of 17,878.871 (178.8 Km<sup>2</sup>) (Source: <https://forests.gujarat.gov.in/girnar-wildlife-sanctuary.htm>).

## METHODOLOGY

The study was carried out from June 2020 to May 2021 on a 25 km road segment of a state highway, which runs near the Protected Forest in between Gir and Girnar corridor, Junagadh, Gujarat India. Many of the patches of the roadside include human habitations of villages, agricultural land, and protected forest area. The habitat of Junagadh is mostly dominated by large vegetation. The spatial and temporal distribution of water limits presence of reptiles and amphibians, with higher activity patterns during the wet than the dry season. Subsequent studies will be undertaken to cover both wet & dry season to allow seasonal comparison. We categorized activity patterns of species as either diurnal or nocturnal base on kingdom and branch. The status of kill was classified into two category, such as fresh (killed within the last 24 hour), and old (killed more than 24 hours) based on the condition of the tissue skin texture (soft/hard) and blood condition.

### Data Collection

#### Driving Survey Road Mortality Data Collection

The study was carried out from June 2020 to May 2021. Surveys were conducted while driving at speeds between 30 km/h to 40 km/h. On road sections with more than one lane, surveyors drove in the right-most lane. There were two people in the vehicle: the driver and a data collector and both were responsible for looking for mortalities along the road. When mortality was spotted, the vehicle stopped on the side of the road at the closest and safest location. The data collector then exited the vehicle wearing safety gear (a reflective safety vest and a hard hat) and walked to the road mortality (Litvingston T. 2019). The mortality was documented with GPS position. The lowest possible taxonomic classification and position on the road were documented for every mortality. Some mortalities could not be identified and due to condition of the carcass. Surveys were conducted at least once per week (Litvingston T. 2019). Monthly four to five visits have been taken using bike or cycle on the selected road of Junagadh- Bilkha Highway. Generally, early morning and evening or night driving methods are used to notify the kills of vertebrates on the road. The vertebrate animals kill seen was noted, verified, photographed, and removed from the road to





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evade multiple counts. For the identification of road kills, we used field guides (Menon, 2003; Grimmat *et al.*, 1998; Daniels, 2002). During this survey, we have not preserved any animals.

## RESULT AND DISCUSSION

The Junagadh-Bilkha Road is a 25km state highway, was monitored once or twice a week for one year from June 2020 to May 2021. Mainly four classes namely Amphibia, Reptilia, Aves, and Mammalia were taken into account as they exhibit a considerable volume of road kill. In class, Amphibia total of 8 animals was killed on the road which was 15.68% of the total road kill. They belong to one Order (Anura) and two families respectively Dicroglossidae (*Hoplobatrachus tigerinus*, *Sphaerotheca breviceps*) and Ranidae (*Euphyctis cyanophyctis*, *Rana temporaria*). In the class Reptiles total 22 was killed due to vehicular migration which was 43.13% of the total roadkill (Figure 2). They belong to one Order (Squamata) and 6 families respectively Viperidae (Russell's Viper), Elapidae (Cobra), Boidae (Sand Boa), Colubridae (Banded Racer, Trinket, Buff Striped Keelback, and Black Rat Snake), Varanidae (Monitor Lizard), and Agamidae (Calotes). In class Aves total 9 birds was killed by vehicles and they are belonged from five Orders (Passeriformes, Coraciiformes, Columbiformes, Charadriiformes, Pelecaniformes) and seven families Pycnonotidae (Red-whiskered Bulbul), Cisticolidae (Ashy Prinia), Muscicapidae (Magpie Robin), Alcedinidae (White Throated Kingfisher), Columbidae (The Rock Pigeon), Charadriidae (Red-wattled Lapwing) and Ardeidae (Great Egret). Total 12 animals were killed on road of class Mammals and they belong to two Order (Rodentia, Carnivora) and six families Muridae (Rat), Sciuridae (Indian Palm Squirrel), Herpestidae (Indian Grey Mongoose), Viverridae (Small Indian Civet), Canidae (Indian Pariah Dog) and Felidae (Domestic Cat, Rusty Spotted Cat). The world's Smallest Cat is died due to animal collision. Most of the animals were killed near the closed bushland (Figure 3).

## CONCLUSION

In all season's animal get victim of road accident but particularly more in monsoon. As they show their great diversity and abundance in monsoon. The study illustrates that among the all-classes reptiles were killed more in road in a year of study period. After then mammals were also killed more comparative to other class. As per above result in summer season least animals were killed from all class. This study was carried out because all tetrapodan animals are most important for the society. They are maintain the ecosystems and are bio indicators of the nature and seasonal changes. There were many reasons for presence of animals on road but the reasons behind collisions were lacking of awareness of animal importance and violation of traffic rule regarding vehicle speed. Collision of reptiles can be avoided by making tunnels in roads, while big animal collision can be prevented by using Road side animal detection system (RADS) (Solanki *et al*; 2017). Speed breakers on road may help in protection of wildlife habitat in forest range can minimize the road killing of all types of animals(Bhandarkar and Paliwal;2021).

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**Table 1: Classification of Roadkill Animals**

Phylum	Class	Order	Family	Scientific Name	Common Name
Chordata	Amphibia	Anura	Dicroglossidae	<i>Hoplobatrachus tigerinus</i>	Bullfrog
				<i>Sphaerotheca breviceps</i>	Indian burrowing frog
			Ranidae	<i>Euphyctis cyanophyctis</i>	Indian skipper frog
				<i>Rana temporaria</i>	Common frog
	Reptiles	Squamata	Viperidae	<i>Daboia russelii</i>	Russell's Viper
			Elapidae	<i>Naja naja</i>	Cobra
			Boidae	<i>Gongylophis conicus</i>	Sand Boa
			Colubridae	<i>Argyrogena fasciolata</i>	Banded Racer
				<i>Coelognathus helena</i>	Trinket
				<i>Amphiesma stolum</i>	Buff Striped Keelback
				<i>Pantherophis obsoletus</i>	Black Rat Snake
Varanidae	<i>Varanus komodoensis</i>	Monitor Lizard			





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			Agamidae	<i>Calotes versicolor</i>	Calotes
			Elapidae	<i>Bungarus caeruleus</i>	Common Krait
			Pycnonotidae	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul
	Aves	Passeriformes	Cisticolidae	<i>Prinia socialis</i>	Ashy Prinia
			Muscicapidae	<i>Copsychus saularis</i>	Magpie Robin
			Coraciiformes	Alcedinidae	<i>Halcyon smyrnensis</i>
		Columbiformes	Columbidae	<i>Columba livia</i>	The Rock Pigeon
		Charadriiformes	Charadriidae	<i>Vanellus indicus</i>	Red-wattled Lapwing
		Pelecaniformes	Ardeidae	<i>Ardea alba</i>	Great Egret
		Mammals	Rodentia	Muridae	<i>Rattus rattus</i>
	Sciuridae			<i>Funambulus palmarum</i>	Indian Palm Squirrel
	Carnivora		Herpestidae	<i>Herpestes edwardsii</i>	Indian Grey Mongoose
			Viverridae	<i>Civetta indica</i>	Small Indian Civet
			Canidae	<i>Canis lupus familiaris</i>	Indian Pariah Dog
			Felidae	<i>Felis catus</i>	Domestic Cat
<i>Prionailurus rubiginosus</i>	Rusty Spotted Cat				

**Table 2: List of Roadkill Animals with GPS Location and Frequency**

Sr. No.	Common Name	Scientific Name	Number of Roadkills	GPS Location	IUCN Category
1	Bullfrog	<i>Hoplobatrachus tigerinus</i>	2	N21°29'8.91" E70°28'1.46" N21°29'6.74"N E70°28'1.50"	LC
2	Indian skipper frog	<i>Euphyctis cyanophyctis</i>	1	N21°29'7.51" E70°28'1.55"	LC
3	Indian burrowing frog	<i>Sphaerotheca breviceps</i>	3	N21°29'4.40" E70°28'1.67" N21°29'4.38" E70°28'1.61" N21°27'56.10" E70°28'31.20"	LC
4	Common frog	<i>Rana temporaria</i>	2	N21°27.909' E070°28.551' N21°28'4.50" E70°28'25.84"	LC
5	Russell's Viper	<i>Daboia russelii</i>	3	N21°28.105' E070°28.392' N21°27'48.59" E70°28'38.69" N21°27'4.31" E70°29'15.92"	LC
6	Cobra	<i>Naja naja</i>	2	N21°28.694' E070°28.116' N21°26'36.38" E70°29'51.11"	LC
7	Banded Racer	<i>Argyrogena fasciolata</i>	1	N21°27.312' E070°29.088'	NE
8	Sand Boa	<i>Gongylophis conicus</i>	3	N21°26.312' E070°30.692' N21°26'13.32" E70°30'27.12" N21°25'30.98" E70°31'7.93"	NT
9	Trinket	<i>Coelognathus helena</i>	2	N21°26.501' E070°30.021' N21°27'13.08" E70°29'9.40"	NE
10	Buff Striped Keelback	<i>Amphiesma stolatum</i>	7	N21°28.694' E070°28.116' N21°25'35.75" E70°31'33.46" N21°25'38.32" E70°31'48.65" N21°25'50.00" E70°32'54.49" N21°25'58.89" E70°33'55.78"	NE

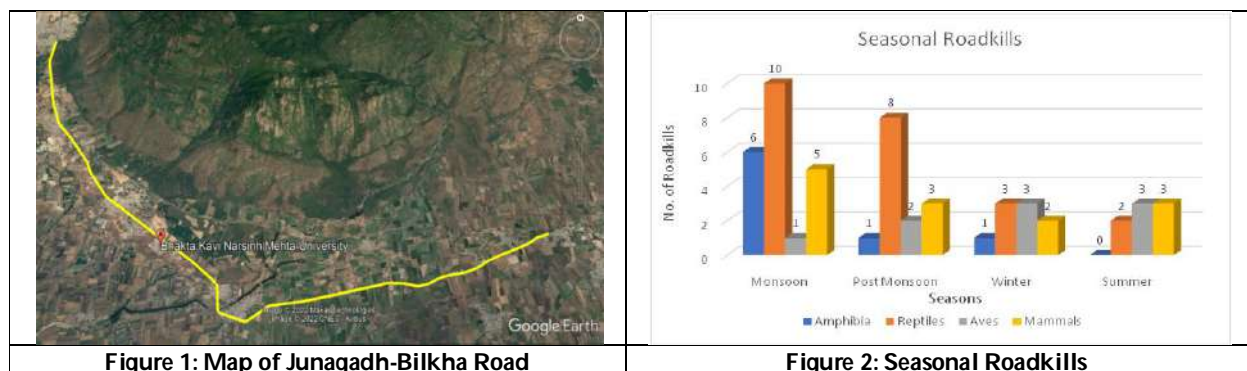




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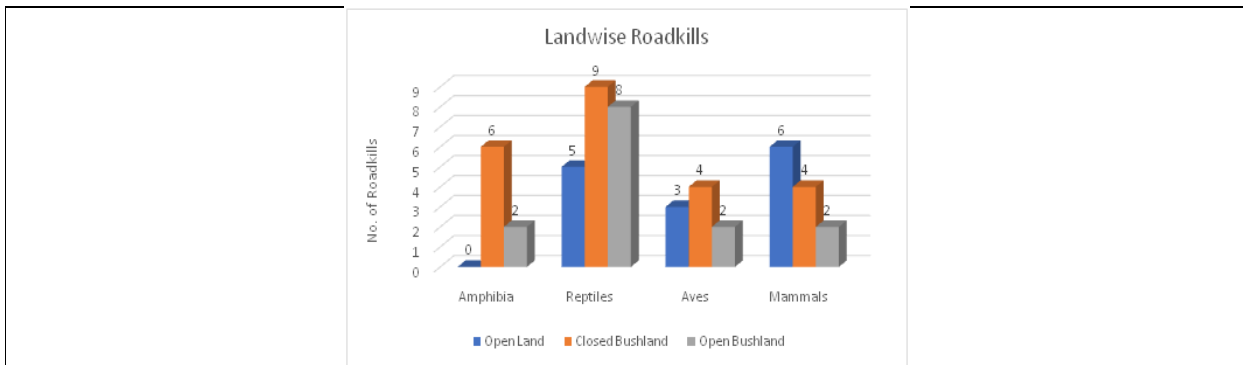
				N21°26'23.50" E70°34'56.51" N21°28'44.85" E70°28'8.08"	
11	Black Rat Snake	<i>Pantherophis obsoletus</i>	1	N21°28.492' E070°28.240'	LC
12	Common Krait	<i>Bungarus caeruleus</i>	1	N21°28.009' E070°28.47'	LC
13	Monitor Lizard	<i>Varanus komodoensis</i>	2	N21°26'26.94" E70°31'38.96" N21°29'3.05" E70°28'1.72"	EN
14	Calotes	<i>Calotes versicolor</i>	1	N21°27.312' E070°29.088'	LC
15	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	2	N21°26.554' E070°29.949' N21°28'12.08" E70°28'22.97"	LC
16	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	1	N21°28.312' E070°28.208'	LC
17	The Rock Pigeon	<i>Columba livia</i>	1	N21°27.312' E070°29.088'	LC
18	Ashy Prinia	<i>Prinia socialis</i>	1	N21°26'25.59" E70°31'43.61"	LC
19	Red-wattled Lapwing	<i>Vanellus indicus</i>	2	N21°27.951' E070°28.508' N21°28'56.21" E70°28'3.57"	LC
20	Magpie Robin	<i>Copsychus saularis</i>	1	N21°27.579' E070°29.869'	LC
21	Great Egret	<i>Ardea alba</i>	1	N21°27.139' E070°29.2'13	LC
22	Rat	<i>Rattus rattus</i>	2	N21°25.995' E070°30.791' N21°26'29.95" E70°30'0.88"	LC
23	Indian Palm Squirrel	<i>Funambulus palmarum</i>	3	N21°28.155' E070°28.392 N21°26'52.62" E70°29'26.57" N21°26'4.37" E70°30'40.61"	LC
24	Indian Grey Mongoose	<i>Herpestes edwardsii</i>	1	N21°27.390' E070°29.039'	LC
25	Domestic Cat	<i>Felis catus</i>	2	N21°28.009' E070°28.47' N21°25'29.80" E70°31'11.66"	NE
26	Indian Pariah Dog	<i>Canis lupus familiaris</i>	3	N21°28.410' E070°28.272' N21°25'27.74" E70°31'18.88" N21°26'25.79" E70°35'2.29"	NE
27	Small Indian Civet	<i>Civetta indica</i>	1	N21°26'51.98" E70°30'10.40"	LC
28	Rusty Spotted Cat	<i>Prionailurus rubiginosus</i>	1	N21°27.312' E070°29.088'	NT

(Here LC: Least Concern, NE: Not Evaluated, EN: Endangered, NT: Near Threatend)(GPS Locations: Retrieved on Google Earth 25May, 2021)














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**Figure 3:Landwise Roadkill**













**Plates**

		
1. <i>Hoplobatrachus tigerinus</i>	2. <i>Euphyctis cyanophyctis</i>	3. <i>Sphaerotheca breviceps</i>
		
4. <i>Rana temporaria</i>	5. Russell's Viper	6. Cobra
		
7. Banded Racer	8. Sand Boa	9. Trinket





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10. Buff Striped Keelback	11. Black Rat Snake	12. Common Krait
		
13. Monitor Lizard	14. Calotes	15. Red-whiskered Bulbul
		
16. White Throated Kingfisher	17. The Rock Pigeon	18. Ashy Prinia
		
19. Red-wattled Lapwing	20. Magpie Robin	21. Great Egret





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22. Rat	23. Indian Palm Squirrel	24. Indian Grey Mongoose
		
25. Domestic Cat	26. Indian Pariah Dog	27. Small Indian Civet
		
28. Rusty Spotted Cat		







## Sustainability through Green Supply Chain Management Practices – An Initiative towards SDG 2030

Seranmadevi R<sup>1\*</sup> and Kevin Thomas<sup>2</sup>

<sup>1</sup>Associate Professor, Department of Professional Studies, School of Commerce, Finance and Accountancy, CHRIST (Deemed to be University), Bangalore, Karnataka, India.

<sup>2</sup>Final Year Student of B.Com Professional, Department of Professional Studies, School of Commerce, Finance and Accountancy, CHRIST (Deemed to be University), Bangalore, Karnataka, India

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### \*Address for Correspondence

#### Seranmadevi R

Associate Professor,  
Department of Professional Studies,  
School of Commerce, Finance and Accountancy,  
CHRIST (Deemed to be University),  
Bangalore, Karnataka, India.



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### ABSTRACT

Green Supply Chain Management is rapidly emerging as an innovative means of integrating sustainability and environmental concerns into business processes. While the concept is still in its infancy in India, considering the country's efforts to reach SDG 2030, the need of the hour is for industries to adopt the practices and accelerate their transition to attain sustainable development. The purpose of the paper is to explore the impact that the implementation of Green Supply Chain Management can have on the various factors of an organization, with a specific focus on India. The research conducted is descriptive in nature and a non-probability sampling design has been adopted, under which area sampling study was made in the state of Karnataka to include as many as 250 respondents, working in a variety of industries. The data is administered by employing Structured Questionnaire having focused on different segment of questions connected to Green SCM practices and its implications on the scalability and sustainability. The statistical design employed to develop the model on Green SCM practices is Structural Equation Model through IBM AMOS v.21. Technology diffusion in industrial operations are evidenced in many cases, that will ultimately result in Green SCM practices under logistics and supply chain management. This paper also deliberates and adds credibility towards the implications of Green SCM to upgrade and elevate companies' performance.

**Keywords:** Green SCM, SDG 2030, Scalability, Sustainability, Technology Diffusion





## INTRODUCTION

### Introduction to Green Supply Chain Management

The increasing significance given to environmental sustainability and protection has fuelled the search for innovative practices that corporate entities can adopt to contribute to safeguarding the environment. Green supply chain management is one such practice of the modern era. It involves adopting measures with regard to a company's supply chain that attempts to reduce the overall emissions that the company produces. This involves selecting suppliers in a prudent manner, transporting material and storing inventory in the most efficient manner, etc. For a developing country like India, such practices can make an impact on the country's ability to contribute to the betterment of the environment. SDG 2030, announced in September 2015, focused on ensuring sustainable development throughout the world. India's efforts at achieving the goals set by the United Nations will definitely be aided by the adoption of practices like Green SCM.

## REVIEW OF LITERATURE

There is an increasing necessity, in the modern era, for organizations to attempt to achieve a balance between economic and environmental pressures. (Semana, Noor & Zakuan, Norhayati & Jusoh, Ahmad & Arif, & Mohd., 2012). Green Supply Chain practices have become an important part of managerial decisions and (Semana, Noor & Zakuan, Norhayati & Jusoh, Ahmad & Arif, & Mohd., 2012) identified 6 key green supply management decisions, a few of them being green manufacturing and packaging, environmental participation and green suppliers. In a general perspective, both environmental and cost performance are said to improve when firms adopt GSCM practices. The benefits are seen to be manifold when there is a wider implementation of the practice in a way that considers even non-traditional actors as components of the supply chain. (Cousins, Lawson, Petersen, & Fugate, 2019)

Companies that implement Green SCM practices, by ensuring the optimum selection of suppliers who are committed to the cause of the environment are generally able to see the benefits of green innovation as well. This also had the potential to improve the performance of the firm. (Novitasari & Agustia, 2021) Research conducted in the construction industry in Indonesia also pointed out the importance of the appropriate selection of suppliers with an emphasis being laid on suppliers having ISO 14001 certifications. (Wiguna, Rachmawati, Rohman, & Setyaning, 2021). Another important aspect to be considered while measuring the impact of Green SCM is the visibility and traceability of multi-tier supply chains as well as the mechanisms that are used to reach the level of sub-suppliers. (Tuni, Rentizelas, & Duffy, 2018)

In order to extract the maximum benefit from their sustainability activities, it is of utmost importance that managers focus on improving both their monitoring and collaboration activities. (Cousins, Lawson, Petersen, & Fugate, 2019) Studies have also identified that the implementation of Green Supply Chain Management is a more arduous task in developing countries than in their developed counterparts. However, adopting the practices often tends to show an overall reduction in emissions. (Semana, Noor & Zakuan, Norhayati & Jusoh, Ahmad & Arif, & Mohd., 2012) (Khan, Zhang, & Nathaniel, 2020), their research further added to the theorization, confirming that long-term and sustainable logistics policies, that are environmentally friendly, are absolutely necessary to encourage green products that would be helpful in reducing the harmful effects of carbon dioxide and emissions. The study also pointed out that within the selected target market the inflow of FDI, renewal energy, and Carbon dioxide emission have a measurable positive impact on green supply chain operations.

### Statement of the Problem

Research is essential to analyze the importance of Green Supply Chain Management to level up the focus on evaluating the firms' performance in terms of agility, productivity, longevity, and sustainability. Today's world





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revolves around technology and digital platform and the concept of supply chain management has also not deviated from that. The extensive utilization of digital cum technology platforms in supply chain management has helped in reducing carbon emissions and other forms of environmental destruction. The adoption of technology has led to an improvement in the internal performance of the firm through elevated productivity and has also contributed to the betterment of the external environment.

**Research Questions**

The following are the research questions pertaining to the application of Green SCM practices in the firms and connected to the current study,

- Do Green Supply Chain Management practices help in improving the productivity of the firm?
- Do Green SCM practices elevate the performance of firms based on scalability in operations and agility?
- How do Green SCM practices help firms in contributing to the external environment in terms of achieving sustainability goals?

**Scope of the Study**

The study will focus upon,

- The green supply chain practices adopted in the firm, the ways of implementation of digital cum technological platform in designing and improving supply chain operations.
- The study further focuses on the importance of green supply chain practices in redesigning a firm’s internal and external environment toward the path of sustainability.

**Research Gap**

**Conceptual Gap** - Research so far has focused on analysing the impact of the implementation of Green SCM practices in a general way, and the importance of taking the right decisions at each step of the supply chain management process was not pointed out with respect to firms’ scalability and sustainability.

**Contextual Gap** – A gap in research was observed in the lack of literature revolving around the impact that the implementation of Green SCM practices would have on specific factors in the Indian context, especially in the Karnataka region.

**Methodological Gap** – In this research, the Structural Model design is adopted. The method was not widely discussed by many of the existing research literature while analysing Green SCM practices and its applications.

**Research Objectives**

There are two major research objectives assumed for this study, they are,

- To measure the importance of each element of Green SCM Practices
- To identify the impact of Green SCM practices on firms’ scalability and sustainability

**Conceptual Framework**



Source: Researchers Model



**Seranmadevi and Kevin Thomas****Independent and Dependent Variables****Independent Variables**

- Firms' nature of Business
- Industry Type
- Volume of operations
- Supply chain Practices
- Length of Existence of Business
- 

**Dependent Variables**

- Scalability
- Sustainability

**Mediation Variable**

- Technology Diffusion in Supply Chain Practices
- 

**Research Hypothesis**

H0: Digital Transformation in Supply chain practices does not significantly vary with the nature of business, agility, volume, and type of industry

H0: Technology Diffusion does not change the effect of Supply chain Practices

H0: Green Supply Chain Practices do not contribute to building scalability in operations

H0: Green Supply Chain Practices do not contribute to the sustainability of business performance

**RESEARCH METHODOLOGY**

**Research Design** – It is proposed to adopt the descriptive research design, to describe the actual and present business scenario after the adoption of Green Supply chain practices into the business operations. It will further be underlining the way in which the Green SCM practices are addressing problems and contributing towards enhanced scalability and sustainability.

**Sampling Design** – The sampling frame for the present study consists of 250 respondents, that belong to various industries in Karnataka. The study is more inclusive in nature and generalizes the application of Green SCM practices and its effect in the firms' performance towards the achievement of scalability and sustainability at large. Purposive sampling technique under non probability sampling design was adopted to collect the responses.

**Data Design** – The data required for the study is observed through both primary and secondary sources of information. The primary data is collected through a structured questionnaire consisting of four parts, well-constructed with statements measured through a Likert Five Point scale stating 5 – Strongly Agree to 1- Strongly Disagree. The first part tries to understand the significance of the adoption of various Green SCM Practices in the firm. The second part discusses the effect of Green SCM practices on the improved performance of the firms and its scalability. The third part focuses on the sustainability attainment of the firm through the adoption of Green SCM Practices. Finally, the fourth part of the questionnaire concentrates on the firm's general business scenario, which is imparting the application of technology into supply chain practices.

**Statistical Design** - The statistical design proposed for the study to explore the mean difference in the application of technology in Supply chain practices based on the nature and volume of business, the age of the organization, and industry type, it is proposed to use MANOVA. To build the model explaining the impact of Green SCM practices through the adoption of technology to attain the Scalability and Sustainability of the business, it uses the Structural Equation Modelling technique, with the help of statistical software SPSS V.26 and IBM AMOS V.21.



**Seranmadevi and Kevin Thomas****Research Boundary**

The following are the boundaries and limitations of the research conducted

- The Geographical Research boundary for the current study is limited to the state of Karnataka in India only.
- The respondent size is 250 and subject to bias.
- Green SCM practices vary with respect to the type of business and nature of the industry.
- The study is delimited to the scalability and sustainability of business operations

**ANALYSIS AND DISCUSSION**

Supply Chain Management includes various activities starting from procuring material from the suppliers to delivering the promised products to the hands of the customer. It deals with various procedural activities in executing these transactions in a seamless way. The supply chain management activities include purchasing or procurement of materials, transporting the materials and finished goods at different destinations, manufacturing, and processing the materials, storing and warehousing the raw materials, and finished products, packaging, and cross-docking the products. Along with this efforts are made at improving the total efficiency and effectiveness of operations through waste reduction and cost control quality management policy.

The diffusion of technology into supply chain management practices has enhanced the quality of discharge of work in all the ways and means of its applications. It ensures speedy recovery, rapid delivery, quality process, optimum storage, and economy cum efficacy in operations, and the same was tested by Confirmatory Factor Analysis and by constructing a path diagram using the structural equation model with the help of IBM AMOS V.21. The impact of technology in supply chain practices and its influence on the internal expedients through increased scalability in business operations and external commitment is evidenced through sustainability in operations.

To construct the model for the impact of supply chain practices on the scalability and sustainability of the operations of the company based on the "Technology Transformation" in supply chain practices resulting in Green Supply Chain Management, a total of twelve variables were used, among them, three variables are observed and endogenous variables i.e. Technology, Scalability, and Sustainability; six variables are observed and exogenous variables, i.e. Transportation, Manufacturing, Packaging, Purchasing, Waste Reduction, and Warehousing; three are unobserved and exogenous variables to represent the error content of this model.

The result of the standardized and unstandardized estimate value presents the inter-correlation value of variables admitted in the model. The p-value is generated and tested for the significance of the correlation present between the variables. Based on the table, it was evidenced that Technology is having a significant influence on Transportation, Packaging, Purchasing, and Waste Reduction operations at a 95 percent confidence level, but with manufacturing and warehousing it has influence to the maximum of 90 percent confidence level. Based on the level of influence of Technology on the supply chain practices, it was ordered in such as way that, the variable which has a high influence is waste reduction, followed by Purchasing, Transportation, Packaging, and Manufacturing, and the least influencing variable is Warehousing. The level of influence was based on the sample survey of industries.

The factor technology has significantly contributed to determining the scalability of the operations of the business the extent of 89.5 percent and towards sustainability, it is recorded as 85.1 percent influence. From the standard estimates value, it was proved that Technology is the stronger influencing factor on supply chain practices, and it further significantly contributes to the widespread operations of the company in attaining its scalability and sustainability. Almost all factors of Green Supply chain management have a significant effect on the other factors, amongst them, a higher relation was found between Manufacturing to Packaging, Packaging to Transportation, and Packaging to Transportation. There exists a high level of co-variance among these factors when compared to all the



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other factors of the model and it was proved that all the variables including defining the green supply chain management practices have statistical significance at a 99 percent confidence level.

The factor score loading table reveals the factor loading or regression weight of each outcome variable admitted in the study. Through the supply chain practices the transformation technology has 76.7 percent importance, and the technology transformed supply chain management practices, often referred to as Green Supply Chain Practices have influenced the Sustainability to 72.4 percent and Scalability at the rate of 80 percent in attainment. The structural equation model is an outcome of the confirmatory factor analysis, the goodness of fit indices is ensuring the appropriateness of the model and the structure of best fit. Based on the confirmatory factor analysis statistics, the required fitness indices such as GFI, AGFI, CFI, and TLI are more than the standard norms of 0.90. the Root Mean Error and the Root Mean Square Approximation Error (RMSEA) values are also considerably low as it is mentioned in the acceptable form, it indicates the significance of the model and gives a great height of recognition to the model as Good Fit.

The structural equation model and the path analysis are further used to test the hypothesis for the model. The hypothesis is developed to indicate the significant influence of Technology on the scalability and sustainability of the nature of the business. The test statistics proved that Technology in Supply Chain practices has a 72.4 percent influence on scalability, and on sustainability at 80 percent. The significance of the statistical result was attained at a 99 percent confidence level and it is proved through the structural model.

**Practical Implications**

Technology has widespread applications and performs an inevitable role in designing and executing supply chain practices. Technology-equipped supply chain management practices will empower employees, customers, management, business partners, and the whole external world with immersive experiences and it also enhances the company to scale up their activities and production operations and improvise the concentration towards the attainment of sustainability goals at large. All the stakeholders benefit from Green Supply Chain Practices, since it leads to superiority in productivity, profitability, efficiency, quality, and optimum utility of the available resources to reach the sustainability in future.

**CONCLUSION**

Diffusion of technology into supply chain practices have had a measurable impact on the scalability and sustainability of business operations. The importance of various factors including that of purchasing, warehousing, transportation, manufacturing, packaging and waste Reduction on the overall process has also been studied. The research further points out the importance of companies taking the initiative to improve their supply chain practices by adopting more technological changes and gaining from the inevitable benefits that the decision would provide. Initiatives like this would not only help the company, but also the country in achieving its environmental objectives by helping in the reduction of emissions overall. Efforts like these are essential to achieve the SDG 2030 goals, especially in the Indian context where the concept of Green Supply Chain Management is still in its nascent stage. Further research could be conducted in this area, pointing out the impact that Green Supply Chain practices would have on other aspects of business operations as well as other practices that companies could adopt to further improve their operations.

**Scope for Further Study**

The study conducted focuses on the impact of Green Supply Chain Management on sustainability in a general manner. Further studies can try to understand the impact of adoption of such practices on the 17 Sustainable Development Goals (SDGs) portrayed by the United Nations which is achievable by 2030. Scalability and Sustainability were analysed within this study, further study in the area can focus on other factors such as adaptability, extensibility, etc.





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**Table. 1 Estimate value of Path Analysis**

Variables			Unstd. Estimate	S.E.	Standard. Estimate	C.R.	P
Technology	←	Transportation	.194	.082	.185	2.365	.018
Technology	←	Manufacturing	.181	.094	.156	1.923	.055
Technology	←	Packaging	.192	.085	.174	2.266	.023
Technology	←	Warehousing	.126	.087	.103	1.446	.148
Technology	←	Purchasing	.229	.093	.187	2.468	.014
Technology	←	Waste_Reduction	.272	.092	.228	2.963	.003
Scalability	←	Technology	.650	.033	.895	19.910	<.001
Sustainability	←	Technology	.581	.036	.851	16.130	<.001

**Table 2 - Covariance Estimates of Path Analysis**

Supply Chain Practices			Unstd. Estimate	S.E.	Std. Estimate	C.R.	P
Purchasing	<-->	Waste_Reduction	.838	.156	.640	5.366	<.001
Transportation	<-->	Waste_Reduction	.999	.183	.657	5.461	<.001
Manufacturing	<-->	Waste_Reduction	.958	.168	.697	5.689	<.001
Waste_Reduction	<-->	Warehousing	.825	.155	.633	5.320	<.001
Packaging	<-->	Waste_Reduction	.962	.175	.662	5.491	<.001
Packaging	<-->	Warehousing	.851	.166	.602	5.133	<.001
Manufacturing	<-->	Packaging	1.019	.182	.683	5.614	<.001
Transportation	<-->	Packaging	1.129	.201	.684	5.619	<.001
Packaging	<-->	Purchasing	.928	.170	.654	5.445	<.001
Manufacturing	<-->	Warehousing	.826	.158	.618	5.230	<.001
Transportation	<-->	Manufacturing	1.075	.190	.689	5.644	<.001
Manufacturing	<-->	Purchasing	.921	.164	.686	5.630	<.001





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Supply Chain Practices			Unstd. Estimate	S.E.	Std. Estimate	C.R.	P
Purchasing	<-->	Warehousing	.809	.152	.636	5.337	<.001
Transportation	<-->	Purchasing	.965	.178	.650	5.423	<.001
Transportation	<-->	Warehousing	.943	.176	.637	5.347	<.001

**Table 3 – Factor Score Loading of the Exogenous Variables**

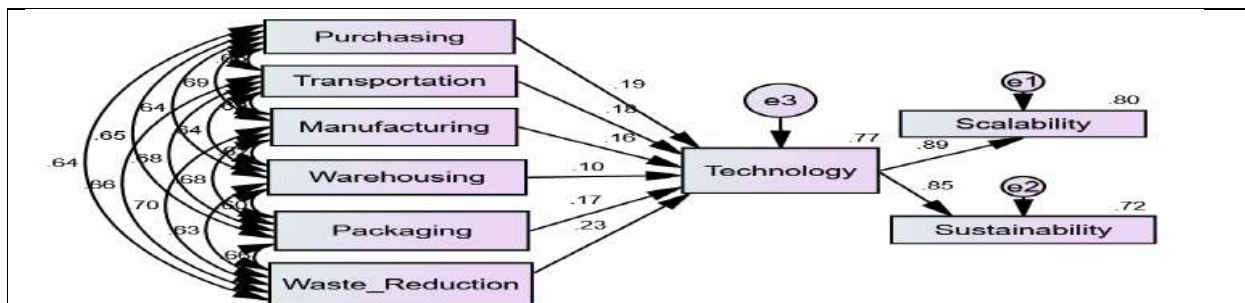
Variables	Estimate
Technology	.767
Sustainability	.724
Scalability	.800

**Table 4 – Results of Confirmatory Factor Analysis**

Parameters	Standard Statistics	Test Statistics
CMIN		23.568
DF		13
P		0.035
CMIN/DF		1.813
GFI	>0.9	.952
AGFI	>0.9	.934
TLI	>0.9	.964
CFI	>0.9	.987
RMR	<.08	.034
RMSEA	<.08	.071

**Table 5 Hypothesis Testing for Structural Equation Modelling**

Variable 1		Variable 2	Hypothesis	R2	P Value	Result
Technology	→	Scalability	Technology in SCM does not greatly influence the Scalability of Operations	.724	<.001	Significant
Technology	→	Sustainability	Technology in SCM does not greatly influence the Sustainability of the business	.800	<.001	Significant



**Figure 1 – Structured Equation Model for Green Supply Chain Management influences on Scalability and Sustainability operations of the business (based on Standardized Estimates value)**







## A Study on the Effect of Experience of Management Styles on Indus Automation, Coimbatore

Malarkodi K<sup>1\*</sup>, Ajai Kanna K<sup>2</sup> and Keerthi Vasani S<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Management Studies, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

<sup>2</sup>II MBA, Department of Management Studies, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

Received: 23 Mar 2023

Revised: 16 Apr 2023

Accepted: 31 May 2023

### \*Address for Correspondence

**Malarkodi K,**

Assistant Professor,

Department of Management Studies,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E. Mail: malarmkce@gmail.com



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### ABSTRACT

This study aims to look into how emotional intelligence (EI) affects leadership effectiveness. The study's foundation is a comprehensive review of the literature on leadership and emotional intelligence. The study examines the various facets of emotional intelligence and how they relate to effective leadership, including self-awareness, self-regulation, motivation, empathy, and social skills. Additionally, the study investigates the relationship between emotional intelligence and a number of leadership ideologies, such as transformational, transactional, and servant leadership. The results of the study show that leaders are more likely to achieve organizational goals if they have high levels of emotional intelligence. Leadership effectiveness is significantly impacted by emotional intelligence. Future leadership research proposals and implications are discussed in the paper's conclusion.

**Keywords:** Emotional intelligence (EI), leadership style, motivation, empathy, self regulation.

### INTRODUCTION

This study aims to investigate how leadership is influenced by emotional intelligence. It specifically looks at how emotional intelligence affects the leadership skills of teamwork, communication, and decision-making. We'll also discuss how to boost your emotional intelligence to become a better leader. Emotional intelligence (EI) is the capacity to recognize, comprehend, and regulate both your own and other people's emotions. A high level of emotional intelligence is necessary for effective leadership in addition to technical knowledge and comprehension.



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Organizations now recognize the value of having leaders who can create positive work environments, motivate teams, and support them as they strive to achieve common objectives. The importance of research on the connection between leadership and leadership is growing.

This study looked at the connection between emotional intelligence and effective leadership. Analyze the effects of emotional intelligence on leadership behavior, decision-making, communication, and conflict resolution. The study also looks at how emotional intelligence affects organizational success, employee happiness, and retention. Our understanding of the importance of emotional intelligence in leadership and how it influences organizational performance is aided by the study's findings. This study will be beneficial to academics, HR experts, and business executives who are interested in raising organizational performance and strengthening leadership effectiveness.

**Objective**

- To find a link between emotional intelligence and leadership effectiveness.
- To identify the specific emotional intelligence competencies most relevant to effective leadership.
- It is investigated to what extent emotional intelligence can be developed and trained, and whether this development increases the effectiveness of management.
- To Lead a Team or Lead Change, which explores the role of emotional intelligence in specific leadership situations.

**LITERATURE REVIEW**

Emotional intelligence (EI) is an increasingly important concept in leadership. A leader with a high level of her EI is more effective in her role, able to navigate complex social situations, and better able to manage herself and her team members' emotions. It is suggested. The literature review aims to examine current research on the impact of emotional intelligence on leadership. One of his seminal works in the field of emotional intelligence is Daniel Goleman's book Emotional Intelligence. Goleman argues that emotional intelligence is a more important indicator of success in life than his IQ, and is especially important for leaders. He points out that the leaders with high levels of emotional intelligence are able to inspire and motivate team members, build trust and relationships, and manage conflict effectively.

Research supports Goleman's claims. For example, in a study of 117 managers, Cherniss and Goleman (1998) found that people with higher emotional intelligence were more effective in their roles as measured by various performance indicators. Another study by Wong and Law (2002) found that emotional intelligence was positively correlated with transformational leadership, a leadership style that emphasizes inspiration, intellectual stimulation, and personal consideration. Other studies have examined that the specific components of emotional intelligence that are most important for leadership. For example, Boyatzis, Goleman, and Rhee (2000), in a study of 162 managers, found that the most effective leaders were those who exhibited high levels of self-awareness, self-regulation, empathy, and interpersonal skills.

Research also shows that the emotional intelligence has a significant impact on leadership effectiveness. A study by Boyatzis *et al.* (2000) found that leaders with high emotional intelligence motivate and inspire their teams more effectively than leaders with low emotional intelligence. They were also adept at managing conflicts and building relationships with team members. Another study by Wong and Law (2002) found that emotional intelligence was positively correlated with leadership effectiveness as measured by the Leadership Performance sub-assessment. Specifically, leaders with high emotional intelligence were seen as more transformative, charismatic, and effective than those with low scores. Additionally, research shows that emotional intelligence is especially important for leaders in stressful environments. A study by Cherniss (2001) found that leaders with high emotional intelligence manage stress better and remain effective under pressure.



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## RESEARCH METHODOLOGY

The research used in the project is Empirical method of research. The study used both primary as well as secondary data. The primary data was collected from the labor of Indus Automation. The study was conducted with the help of field survey technique among 120 employees in Indus automation at Coimbatore. The respondents were selected by simple random sampling. Well-structured questionnaires were prepared and circulated among selected respondents.

### Method Of Data Collection

There are two types of data collection. They are

#### Primary Data

- Primary data Primary data refer to the the pure and the fresh data which are collected for the first time.
- The primary data was collected from the response of the employee using questionnaire for this study.

#### Secondary Data

- Secondary data a refers to the data which are already collected by some researchers in the past an disavailable inpublished or unpublished form.
- The secondary data for this study has been obtained from international journals and company websites.

### Sample Size

The sample size for the present study is 120

### Tools Used

- Mean Analysis

### Analysis and Interpretation

#### Data Analysis

#### Demographic Statistics

#### Interpretation

Table 1 shows that, most of the people are 26-30 years old, most of the people are male, most of the people are Single, most of the people have income level 8001-10000 and most of the people are 1-2 year experienced.

#### Descriptive Statistics

#### Interpretation

Table 2 most of the people Strongly disagree that they have good working environment, most of the people Neutral and Disagree about the have encouraging career mobility, most of the people have Neutral about Aligning organizational and employee goals and most of the people are neutral about corrective measures.

### Findings

Most people disagree that they have a good work environment, most people are neutral and disagree about job mobility, most people are neutral about aligning organizational and employee goals, and most people are neutral about corrective action.





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## SUGGESTIONS AND CONCLUSION

Organizations should provide emotional intelligence training to their managers to improve their ability to understand and manage emotions. This allows managers to build stronger relationships, communicate more effectively and create a positive work environment. Organizations should consider emotional intelligence as an important factor in hiring and promoting managers. It gives managers the skills they need to create a positive and productive work environment. Organizations must continuously assess the emotional intelligence skills of their leaders to identify areas for improvement and provide appropriate training. Emotional intelligence is positively correlated with effective leadership. Research results show that emotional intelligence is positively correlated with effective leadership. Leaders with high emotional intelligence are better able to handle difficult situations, communicate effectively and build strong relationships with their team members. Research also shows that emotional intelligence can be developed through practice and practice. Therefore, organizations should invest in emotional intelligence training to improve their managers' ability to lead effectively. Emotional intelligence is an important factor in hiring and promotion. This study shows that emotional intelligence is a key factor in hiring and promoting managers. Organizations should consider emotional intelligence in their decision-making to select the best leaders.

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**Table 1 Demographic Profile**

Demographic Profile	Categories	Number	Percentage (%)
Age	20-25years	23	23
	26-30years	29	29
	31-35years	23	23
	Above 35years	25	25
Gender	Male	55	55
	Female	45	45
Marital Status	Single	53	53
	Married	47	47
Income Level	Below 8000	27	27
	8001-10000	28	28
	10001-12000	20	20
	Above 12001	25	25
Experience	Less than 1 year	19	19
	1-2 years	41	41





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	2-5years	23	23
	Above5 years	17	17

Source: Primary data

**Table 2. Descriptive Analysis**

Descriptive Profile	Categories	Number	Percentage (%)
Work Environment	Strongly Agree	17	17
	Agree	10	10
	Neutral	22	22
	Disagree	24	24
	Strongly Disagree	27	27
Encouraging career mobility	Strongly Agree	23	23
	Agree	16	16
	Neutral	22	22
	Disagree	22	22
	Strongly Disagree	12	12
Aligning organizational and employee goals	Strongly Agree	18	18
	Agree	18	18
	Neutral	26	26
	Disagree	21	21
	Strongly Disagree	17	17
Corrective measures	Strongly Agree	22	22
	Agree	18	18
	Neutral	20	20
	Disagree	21	21
	Strongly Disagree	19	19

Source: Primary data





## A Study on the Safety Practices Adopted At Padmavahini Transformers Private Limited

Sriram S<sup>1\*</sup> and C.Suganya<sup>2</sup>

<sup>1</sup>MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of MBA, M.Kumarasamy College of Engineering, Karur, , Tamil Nadu, India.

Received: 25 Mar 2023

Revised: 15 Apr 2023

Accepted: 31 May 2023

### \*Address for Correspondence

**Sriram S**

MBA Student,

M. Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E. Mail: pravinsuresh1503@gmail.com



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### ABSTRACT

The purpose of this study is to examine the safety practices implemented at Padmavahini Transformers Private Limited. This paper focuses on the safety measures adopted by the company to ensure the protection of its employees and the prevention of accidents in the work place. The study analyses the company's safety policies, procedures, training programs, and safety culture. The study also reviews the safety records and accident statistics of the company. The findings of this study highlight the importance of safety practices in the workplace and suggest areas for improvement to enhance safety measures at Padmavahini Transformers Private Limited. The study concludes that the company's safety practices are effective, and continuous efforts should be made to maintain a safe and healthy work environment.

**Keywords:** Safety Practices, Padmavahini Transformers Private Limited, Workplace Safety, Accident Prevention, Safety culture

### INTRODUCTION

Ensuring safety in the workplace is essential for any organization to maintain a healthy work environment and promote employee well-being. Workplace safety practices are particularly critical in industries such as manufacturing, where employees work with heavy machinery and equipment. The transformer industry is one such industry where safety measures are of utmost importance. Padmavahini Transformers Private Limited is a leading transformer manufacturing company that provides a range of transformers for various applications. The company is committed to ensuring the safety of its employees and has adopted safety practices to prevent accidents and promote a safe work culture.



**Sriram and Suganya****Objectives of the Study****Primary Objective**

To study about the safety measures with reference to Padmavahini Transformers Pvt Ltd

**Secondary Objectives**

- I am interested in hearing the thoughts of my fellow workers on the topic of workplace safety.
- Finding out what factors contribute to workplace mishaps.
- Determine how happy people are with current safety procedures.
- To propose workable solutions for bolstering the security of the company's staff.

**Need of the Study**

- The study's primary purpose is to evaluate the efficiency of the safety procedures in place at Padmavahini Transformers pvt.ltd.
- So that everyone who works for the company can live comfortably.
- Discussing the hazards that employees must contend with every day on the job and coming up with solutions to those problems is the point of this section.
- To identify and analyse all potential sources that are harmful to workers through an evaluation of all equipment, machinery, work space, and work processes.

**Scope the Study**

- To Understand the Awareness of Safety Health, among the employees provided by the organization.
- To analyse the occupational health hazards among the workers.

**Limitations**

Padmavahini Transformers pvt ltd. personnel are the only people surveyed. Only the company's internal safety procedures are examined in the report.

**REVIEW OF LITERATURE**

Safety Goal Quantification for Stockholm's Underground Compressed Natural Gas Bus Terminal by Johan Lundin, First Safety Journal (2019), In this study, we suggest quantifying this safety goal in terms of risk acceptance criteria that take into account both personal and societal factors. This study's methodology relied on an exhaustive inventory of risk acceptance criteria used in other sorts of facilities and activities across the United States and abroad. The technique also accounts for the fact that individuals' risk perceptions influence their willingness to take risks. Accident analysis and prevention (2015), Grigore M.Havameanu, "A systematic evaluation of the literature on safety methods to prevent railway suicides and trespassing accidents," Keeping people from taking their own lives or causing accidents by trespassing on railroad property is a major topic of this analysis. This study seeks to address the question, "What methods are available to prevent railway suicide and trespass, and what is the evidence for their effectiveness?" The content analysis uncovered 19 primary categories of preventative strategies, including over 100 individual interventions. We found that there are 16 general categories of measures taken to prevent suicide and trespassing on railways, and 3 kinds of suicide prevention strategies. Safety science (2014), Lori Mooren, "Safety management for heavy vehicle transport," We also evaluated studies of safety management methods, safety culture, and injury risk assessment in non-OHS transportation settings that were said to have a direct impact on crash and/or injury outcomes. Safety training, management commitment, scheduling or travel planning, organisation size or freight type, worker participation, incentives, and safety or return to work policies were all operational and management factors related with lower collision and injury risk. "The Impact of Transportation Infrastructure on Bicycle Injuries and Crashes," by Conor CO Reynolds, M Anne Harris, Peter A Cripton, and Meghan Winters (2009), Cycling may be an effective way to get in shape. Improving public health requires an understanding of how to make bicycling safer. We looked at research on how better bicycle infrastructure may make streets safer for cyclists.



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Research on injuries, injury severity, and accidents, among other safety-related outcomes, was considered. According to available data, the existence of cycling facilities (such as on-road bike routes, on-road marked bike lanes, and off-road bike pathways) is correlated with the lowest risk, while the presence of sidewalks and multi-use qualities is correlated with the highest risk. Additional characteristics that appear to promote cyclist safety are street illumination, paved surfaces, and low-angled hills. Measuring Patient Safety in Developing and Emerging Countries, by K.B. Carpenter, BMJ, 2010. (2010), Patient safety research in underdeveloped and emerging nations has been rare and shallow. Safe patient care in emerging and developing countries can be measured and monitored if foundational safe patient practises have been established, integrated into routine health services delivery, and patient expectations have been established.

**RESEARCH METHODOLOGY****Research Design**

Descriptive research using a well-structured questionnaire was used for this study's design.

**Method of Collection**

Primary and secondary data are used in the data collection process.

**Sampling Size**

The study has a 115-person sample size.

**Sampling Unit**

The sampling unit of the study is employees of Padmavahini Transformers Pvt. Ltd.

**Sampling Method**

The Sampling Method Used in the study simple random sampling method.

**Tools for Data Analysis**

- Chi-Square Test
- ANOVA

**Data Analysis****Chi-Square Test****Hypothesis Statement**

**H0:** There is no significance relationship between age and employee safety.

**H1:** There is significance relationship between age and employee safety.

**Inference**

From the above table the calculated Pearson Chi-Square significance value is .000, the significance value is below than the 0.05(5% level of significance). Hence H0 is rejected. H1 is accepted. Therefore, it is inferred that there is a significance relationship between age and employee passing in safety quiz.

**Inference**

From the above table the calculated Pearson Chi-Square significance value is .000, the significance value is below than the 0.05(5% level of significance). Hence H0 is rejected. H1 is accepted. Therefore, it is inferred that there is a significance relationship between age and employee encouragement in reporting.





**Sriram and Suganya****Inference**

From the above table the calculated Pearson Chi-Square significance value is .000, the significance value is below than the 0.05(5% level of significance). Hence H0 is rejected. H1 is accepted. Therefore, it is inferred that there is a significance relationship between age and promoting safety in the workplace.

**ANOVA****Hypothesis Statement**

**H0:** There is no significance relationship between age and employee safety.

**H1:** There is significance relationship between age and employee safety.

**Inference**

From the above table the calculated significance value is .000, that significance value is below than the 0.05(5%level of significance). Hence H0 is rejected. H1 is accepted. Therefore, it is inferred that there is a significance relationship between age and safety training.

**Inference**

From the above table the calculated significance value is .000, that significance value is below than the 0.05(5%level of significance). Hence H0 is rejected. H1 is accepted. Therefore, it is inferred that there is a significance relationship between age and safety training.

**Findings, Suggestions and Conclusion****Findings**

From the above analysis, the majority 68.7% of the respondents age are below 25, the majority 98.3% of the respondents are male, the majority 48.7%of the respondents qualifications are diploma, the majority 57.4% of the respondents salary are below 20000, the majority 82.6% of the respondents are married, the majority 58.3% of the respondents are working in distribution department.

**Suggestions**

- Conduct a survey among employees to assess their perceptions of safety practices.
- Identify gaps.
- Evaluate The Effectiveness Of Current Safety Practices.
- Analyze accident reports.
- Evaluate The Training Programs Offered to employees on safety practices.
- Assess Their Effectiveness in reducing in reducing the number of accidents and injuries.

**CONCLUSION**

In conclusion, safety practices adopted in the manufacturing industry are critical for ensuring the well-being of employees and reducing the likelihood of accidents and injuries in the workplace. Through a review of the literature, it is evident that there are various safety practices that can be implemented to promote a safe working environment, including risk assessment, employee training, and hazard identification. However, there's still room for improvement, and further research is needed to identify the most effective safety practices and strategies for implementation.

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**Table1: Age\*Are employees required to pass safety equipment before being allowed to operate equipment?**

Particulars	Value	df	Asymptotic Significance(2-sided)
Pearson Chi-Square	43.176 <sup>a</sup>	6	.000
Likelihood Ratio	51.951	6	.000
Linear-by-Linear Association	13.370	1	.000
N of Valid Cases	115		

**Table 2 : Age\*Are Employees Encouraged To Report Safety Concerns?**

Particulars	Value	df	A symptotic Significance(2-sided)
Pearson Chi-Square	67.993 <sup>a</sup>	9	.000
Likelihood Ratio	75.690	9	.000
Linear-by-Linear Association	12.994	1	.000
N of Valid Cases	115		

**Table 3 .Age\* Does Management Activity Promote Safety In The Workplace?**

Particulars	Value	df	Asymptotic Significance(2-sided)
Pearson Chi-Square	33.300 <sup>a</sup>	9	.000
Likelihood Ratio	45.155	9	.000
Linear-by-Linear Association	16.879	1	.000
N of Valid Cases	115		

**Table 4. Age\*Is Protective Equipment(e.g..gloves, hardhats, safety glasses)provided and used as needed?**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.061	3	3.354	7.008	.000





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Within Groups	53.121	111	.479		
Total	63.183	114			

**Table 3 Age\*Is There Ongoing Safety Training For employees?**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	26.726	3	8.909	20.629	.000
Within Groups	47.935	111	.432		
Total	74.661	114			





## Colour Psychology in Branding

Seranmadevi R<sup>1\*</sup> and Rejoice Thomas<sup>2</sup>

<sup>1</sup>Associate Professor, Department of Professional Studies, School of Commerce, Finance and Accountancy, CHRIST (Deemed to be University), Bangalore, Karnataka, India

<sup>2</sup>Assistant Professor, Department of Professional Studies, School of Commerce, Finance and Accountancy, CHRIST (Deemed to be University), Bangalore, Karnataka, India

Received: 24 Mar 2023

Revised: 19 Apr 2023

Accepted: 31 May 2023

### \*Address for Correspondence

**Seranmadevi R**

Associate Professor,  
Department of Professional Studies,  
School of Commerce, Finance and Accountancy,  
CHRIST (Deemed to be University),  
Bangalore, Karnataka, India



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### ABSTRACT

Colour psychology is observed as the branch of the psychology of how various colours influence human behaviour and decisions. Colour is too subjective to be unvaryingly transferred to diverse emotions. Based on personal experiences, preferences, upbringings, cultural differences, and environment ambiguous the effect of definite colours on human beings. By using colour in logos, signage, packaging, and advertising, many brands can stimulate and impulse consumers to buy or prefer their product or service over their competitive companies' products. In advertising and marketing, colour psychology is utilized to elicit emotional responses. Different colours may directly influence the buyers to weigh a brand in different ways that are not quite obvious, and concrete hues can influence hunger. In this paper, it is concentrated to develop the regression model based on four independent variables awareness, attractiveness, assortment, and marketing mix components on the product preference of the customers, by applying 150 respondents residing in the Chennai region at Tamil nadu in the southern part of India, the analysis was made through SPSS V.25 and concluded that other than assortment, all the three variables are considerably influencing the product preference of the customers based on colour psychology.

**Keywords:** Attraction, Awareness, Assortment, Branding, Colour, Marketing Mix, Psychology





**Seranmadevi and Rejoice Thomas**

**INTRODUCTION**

Colour is referred to as the universal identity of corporates. Colour is having a significant influence on the minds of customers and it is playing an inevitable role in evoking the emotions of customers at the point of purchase. The choice of colour of a company is purely determined based on the vision and mission of the company. It should narrate the features of the company and presents the image of the company in the minds of the consumers. Colour plays a critical role in developing a holistic and integrated brand program as just not only it is instinctual but meaningful too. While opting for the colours for designing the brand, corporate should avoid vibrant and bright colours, because it irritates the consumers at large. To improve the visibility of the long-distance event, using high-contrast colours are suggested, normally the corporate do not go around the complimentary colours when going with combinations. Hence, the colours should reflect the personality, appropriateness, and the kind of emotions that a brand tries to portray to the world. The brand’s personality perfectly is mapped with the colours through image and feeling which will persuade the consumers to a greater extent at the point of purchase. Despite spending a lot of time and money on the selection of appropriate colours to exhibit the quality and perseverance of the brand among the consumers, it is possible to attract customers through psychological effects.

**Brands by Colour**



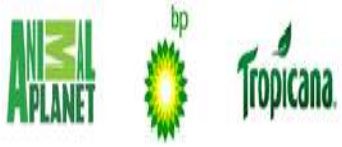







**Colour Psychology attached with Brand**

Colour	Features	Meaning	Brand
Red	Triggersare energetic, powerful, and passionate. It can also be seen as aggressive, provocative, and attention-grabbing Love, Excitement, Strength, Energy	An intense colour, often associated with energy and passion, frequently used to facilitate quick decision-making	
Pink	lively and full of excitement, Compassion, Assertive, Nurturing, Possibilities, and parity, while lighter pinks are romantic	It deals with Illusion, reverie, childhood, tenderness, courtesy, eroticism, and sweet charm.	
Orange	fun, cheery, and appeals effectively to children, confidence, Success, Bravery, Creative, Friendly	A stimulating and cheerful colour which is most frequently associated with human adventure, fabulous fun and admirable risk-taking	





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Green	nature and health, peace, Quality, growth, luck, generosity, jealousy, prosperity, wealth, and greed	The natural and restful colour of this is used to evoke feelings of well-being	
Blue	Trust, Peace, Loyalty, positivity, security, Tranquillity and serenity	A colour emphasises feelings of expertise and constant stability, connected with depth and tranquillity basically masculine colour.	
Purple	royalty, Wealth, Noble, Power, Whimsy, Ambitious, sophistication, opulence, luxury	A regal colour, associated with creativity, can be used to create a calming feeling	
White / Grey	pure and elicits feelings of cleanliness, Honest, Hopeful, innocence, purity, and crispness	The pure colour of this is used to evoke feelings of cleanliness and simplicity	
Yellow	happiness, calmness, relaxation, enjoyment, and tivity, Opportunity, Optimism, Clarity, Energetic, Warmth	A warm colour, evoking pleasant feelings	
Brown	Dependable, Rugged, Practical, Natural, Comfort	It is the colour associated with Cozy, stable, comfortable, bitter, warm, ordinary and rustic.	
Black	Authoritative, Classic, Luxury, Powerful, Bold	A powerful, seductive colour, often associated with sophistication	
Multi-colour	Powerful, All in One, Natural Choice, Potentiality and Vibrant	A multi-colour progressive brand encompassing several colours in its logo seems to be a natural choicewith a greater global reach.	

The individual perception and choice of the brand are basically associated with its visual perception and it plays a very important role in the choice of the brand while taking a purchase decision. When the colour attracts the eye, there is psychological immigration goes on which directly senses the colour either assumed to be eye-hurting or to be comforting. These colours, when observed, get backs their sweet memories and thoughts cum past experiences from their inner memories for every individual. Sometimes, the colours may lead towards a place of one relating to pastries or some individual. This obviously induces the person to either step forth or step backwards, which will register a remarkable change in the company. Colours are just a reflection, but it plays an immense role in an individual's life.





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**Spectators / Audience**

Colour psychology will have a strong influence and is directly connected to the different feelings and emotions of every individual. While selecting the corporate colour, every company thus, keeping the target audience in its mind, as it will make assist the company to create a distinctive competitive advantage over all the other competitors in the industry. To flourish and have an immense reputation in the market, it is inevitable to have a strong grip on the audience.

**Brand’s Personality**

The usage of colours will evoke the personality of the company, and it is solely based on the colour, ambience, and significant aroma of the distinctive place. The brown colour used by the café shop impulses a person to have and sip the coffee sold on Café Coffee Day. Not only the colour but also the pleasant aroma of afresh coffee beans. Thus, the colour of the brand sounds a lot, it pulls the customers to the physical or virtual store.

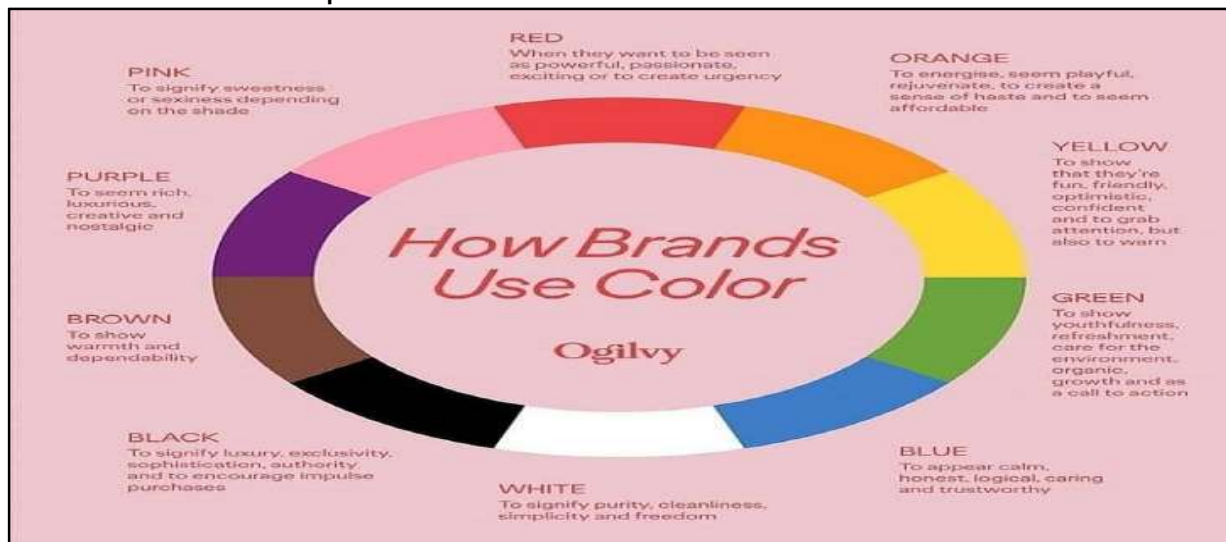
**Gender Colour Bias**

The myth of most girls liked pink and most boys liked blue was abandoned by proper research. It is no pink is to girls and blue is to boys, every colour has its own supporters and haters. But generally observed cases are, the companies which are producing the product to the female genders are particularly concentrated in pink and other related colours for their company.

**Distinguish Brand Using Colours**

Colours which are used by the company to distinguish their products from their competitor’s products are very crucial and it dominates the influence of purchasing decision-making of the customers.

**Gives out the Field of Your Expectation**



**Statement of the Problem**

The human minds are conditioned to respond to colour. Through colours, corporates are tried to stir emotions and tell a story to the consumers, irrespective of the products and services they have been offered. Colours are inextricably connected with brands, they instantly convey their messages, without the need for words and it is recognized as a symbol of pride, shapes and designs which further enables the consumers to recall quickly.

**Research Objectives**



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The following are the research questions and objectives posed for this research,

- To study the demographic profile of the respondents
- To study the awareness level of consumers towards colour psychology in product preference
- To analyze the association of colours and their preference for products
- To evaluate the impact of colour on the marketing mix of the products in customers attraction

**Research Hypothesis**

The following are the hypothesis framed to prove through this research,

H0: Demographic profiles do not influence the colour psychology

Ha: Demographic profiles do influence the colour psychology

H0: The awareness level of consumers does not reflect on the colour preference

Ha: The awareness level of consumers does reflect on the colour preference

H0: Colours do not significantly influence the preference for products

Ha: Colours do significantly influence the preference for products

H0: Colours do not significantly vary in customers attraction based on components of the marketing mix

Ha: Colours do significantly vary in customers attraction based on components of the marketing mix

**REVIEW OF LITERATURE**

Sevinc, *et al* (2014) aims to determine the psychological belongings of colours on individuals, by using the students' union complex on a university campus, since this building has richness in colour variances. The survey-based research method was adopted to collect the responses from an even range of undergraduate and postgraduate students, comprising both international and local students through structured questionnaires, which have been collected and analyzed to find out the effects of different colours on the students. This study would provide to understand more towards colours and how they influence our feelings, hence stimulating better decisions and increasing the appropriate use of spaces when choosing different colours for distinguished spaces to match the ultimate purpose of the study.

Nurlelawati, *et al* (2012) reviewed the factors like assessment method, type of setting and colours, and instruments. Secondly, it discusses the extent to which colours or coloured environments impact working performances; developing positive or negative perceptions of the environment resulting in certain behaviour cum tasks given, and quite obviously influencing incredible emotions and moods. Lastly, this study resulted in the potential scientific measure to finding the impact of colour effects on human behaviour. Even more, Aoki *et al.* (2011) were also found to use the ever-green neuroimaging techniques in their physiology examination.

As per the arguments of Kuehni (2003), Colors are emotionally bonded and bundled psychological experiences which explain reductively with strong neurological processes and it insists upon the linking propositions that attempt to develop an incredible link between in-depth subjective experiences and objectively measured data related to physical measures of reflectance or spectral power or neural responses. According to the statement of Court is (2004), Color is fundamental to sight, identification, perceptions, interpretation, and senses moreover few colours evoke psychological responses through signals such as relaxation, energy, warmth, purity, danger, and death. Colour psychology works as when light strikes or disturbs the eye, each colour wavelength does so slightly differently. Based on the level of reflection, Red colour is deserved the longest wavelength, requires a high level of adjustment to look at it and therefore appears to be closer than it is, while green colour requires no further adjustment, and is therefore relaxing as highlighted by Angela Wright (1998).

Both brain and body changes are studied by Tsunetsugu *et al.* (2005), they vibrantly displayed an increment in pulse rate after generating stimuli to various environments demonstrating a sympathetic nervous system in which the theme is at provocation stage. In terms of brain level investigation, they diagnosed an increase of rCBF in the left





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frontal area presumed indicating the subject was registering the greater effect by the defined stimuli. In contrast, Jin et al. (2005) attempted to show body responses with decreased regular activity in the parasympathetic nervous system from lower heart rate, respiratory rate, and blood pressure and after adjustment of factors and stimuli instigated to the soothing state of both mind and body.

**Research Gap**

Colour psychology was assumed by several pioneers all around the world in different dimensions. The exclusive study concentrated to describe the characteristics and features of the respondents regarding their preference for products based on colour psychology. The research gap is identified as, a methodology gap found in the application of colour psychology in the product preference by the customers based on their awareness, assortments, and attraction towards the product choice. The geographical gap is filled by conducting the research exclusively in the Chennai region, the southern part of India. The contextual gap is identified by applying the four different independent variables to measure the preference of a product based on colour psychology.

**Research Methodology**

It is the method of executing the research or the master plan for the present study, contains the following block,

**Research Design**

Descriptive research design is applied in this research in the toaster the respondents' psychological approach towards the product preference based on their choice of colours. The influence of colours in the choice of products concerning marketing mix elements like product packaging, differential pricing based on colours, physical distribution based on colours differentiating through domestic and international identity, and the promotional mix design based on the colour contrast.

**Sampling Design**

Non-probability sampling design was applied in to study because of the non-availability of a definite population set, the sample was arrived at by using the convenience sampling technique, based on the convenience of the respondents. The sample frame consists of the respondents living in the Chennai region of Tamilnadu, the southern part of India. The final sample size included for the current study is 150, who are regularly buying the products from retail stores and have colour psychology in the preference of the product procurement.

**Data Design**

The study requires both types of data viz., primary and secondary data, primary data for the current study were observed using a structured questionnaire circulated among the respondents through a mail survey, and the secondary data are obtained through authenticated websites.

**Statistical Design**

The statistical design for the study is observed based on the nature of the data and the expectation of the results. To conclude preference of products based on colour psychology, the awareness level, the attraction level of the product to consumers and the assortment collection on various components of the marketing mix are studied through Multiple Linear Regression. The data obtained through the questionnaire was coded, edited, and tabulated using SPSS V.25 and the statistical calculation was also applied and the final model was built.





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#### Conceptual Framework



Source: Researcher's Creative model

#### Data Analysis

The preference for the product based on the influence of colour psychology among the selected respondents is analyzed through the combinations of a few independent variables on a dependent variable using multiple linear regression. The independent variables assumed for the study are the Awareness level of the customers, Attraction of customers based on colours, the influence of colours on different assortments, components of marketing mix varied by colours and the only dependent variable for the study is the reference of the product by the customer based on the colours.

The above table indicates the range of independent variables assumed for the current study are entered into the study to measure the preference of products by the customers based on the colour's psychology. It was observed from the Preference for Product based on colour psychology - Model Summary table that, the R square value for the constructed model with the defined set of variables is .907 and the adjusted R square value for the same model is .905, it is assumed that the regression model describes 90.5% explanation to the preference of products by the customers based on colour psychology. The ANOVA table built under the regression analysis depicts the statistical significance of the model constructed using the set of independent variables such as Awareness, Attraction, Assortments and Marketing mix components deferred with colours on the preference of products by the customers based on colour psychology.

From the regression coefficient table, it is observed that four independent variables are significantly influencing the assumed dependent variable preference for the products based on colour psychology. The following regression equation exhibits the individual weightage level of influence of each independent variable on the assumed dependent variable preference for the products,

$$\text{Preference of Products} = .693 + (.289) \text{ Awareness} + (.305) \text{ Attraction} + (.043) \text{ Assortment} + (.247) \text{ Marketing Mix components}$$

It was crystal clear that Attraction of product through various colour components have more influence on the preference of products (30.5%), followed by Awareness of colour psychology among the customers (28.9%), marketing mix components also have a significant influence on the product preference (24.7%) and the assortment is the least variable influencing the product preference (4.3%). Other than Assortment, the rest of the components are significantly influencing the product preference of the customers.

#### Practical Implications

The study reveals the customer choice and preference of products based on colour psychology. Colour is a simple but very much vital strategy, that corporates used to distinguish their products at almost all levels of their marketing mix components. The product differentiation is evidenced through colour variation in the product packaging and product offerings, it is further be used to differentiate their product from that of their competitor's product in the same industry. The colours play a very significant role in positioning in the minds of customers as well.





## CONCLUSION

It was concluded from the study that most of the companies under consumable goods and textile cum cosmetics have concentrated more on colour psychology because it has direct implications on product preference. The corporate identified the most preferred colours and premium colours to distinguish the product from other category products of their own and from that of the competitors. The colours like purple, pink, golden yellow, black and white are a few colours which have been priced often higher than the other products colours. The place mix also significantly influences the offering of products at domestic cum foreign land. Few premium colours are exclusively designed and offered only to foreign lands and few other colours are designed to fill the domestic competition. The promotion mix also has a high influence based on colour psychology, the corporate even concentrate more on colour psychology in preferring their colours to define their brands and positioning them in terms of colour psychology.

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**Table 1 –Preference for Products based on Colour Psychology - Variables Entered/Removed**

Model	Variables Entered	Variables Removed	Method
1	Marketing Mix components, Attraction, Assortment, Awareness	.	Enter

- a. Dependent Variable: Preference for products
- b. All requested variables entered.

**Table 2 –Preference for Product based on colour psychology - Model Summary**

Model	R	R Square	Adjusted Square	R	Std. The error in the Estimate
1	.952 <sup>a</sup>	.907	.905		.373

- a. Predictors: (Constant), Marketing Mix components, Attraction, Assortment, Awareness

**Table 3 - Preference for Product based on colour psychology - ANOVA**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	265.446	4	66.361	476.642	.000 <sup>b</sup>
	Residual	27.149	195	.139		
	Total	292.595	199			

- a. Dependent Variable: Preference for products
- b. Predictors: (Constant), Marketing Mix components, Attraction, Assortment, Awareness

**Table 4 – Preference for Product based on colour psychology - Regression Coefficients**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.693	.085		8.173	.000
	Awareness	.289	.071	.316	4.061	.000
	Attraction	.305	.045	.353	6.827	.000
	Assortment	.043	.057	.049	.755	.451
	Marketing Mix components	.247	.051	.273	4.864	.000

- a. Dependent Variable: Preference for products





## A Study on HRM Functions and Its Effectiveness towards SP Filling Machining Products India Pvt Ltd at Coimbatore

Ragul.T<sup>1\*</sup> and C.Suganya<sup>2</sup>

<sup>1</sup>MBA Student, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of MBA, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

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### \*Address for Correspondence

**Ragul.T**

MBA Student,

M.Kumarasamy College of Engineering,

Karur, Tamil Nadu, India.

E. Mail: ragulreigns28@gmail.com



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### ABSTRACT

The company's prestigious clientele are very pleased with the global standard and brand, helping the company achieve a prominent position in the commercial centre. Harley retains the workforces who are the dearly loved ones of his representatives at a rate of 98 percent. Significant challenges, such as competition from lower estimated competitors and entry into foreign markets, arose after its tremendous success. The purpose of this study is to shed light on how HRM operates and how successful it is in bringing about change in organisations. Data is collected via voluntary responses. The findings reveal the work done, allowing us to compare our organisation to others of a similar calibre and to identify the efficient steps that can be taken to strengthen our HRM function capabilities and lay the groundwork for future endeavours. The moderate work framework and human asset formative policies are also being provided. In this research, we examine how the globalisation of the Sp filled machining goods sector has affected the development of its human assets in the deals group. A evaluation of HRM processes can help a company save money and resources.

**Keywords:** Human Resource Management Function, Sp filling machining products.

### INTRODUCTION

One of the most important parts of every business is its human resources department. The function's responsibility is to maximise the productivity of a company by making the most of its available human resources. Numerous earlier studies have demonstrated that strategic HR management can have a significant impact on business results. In particular, modern understandings of strategic human resources management group together those organisational





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strategies that can simultaneously increase individual productivity and the organization's overall effectiveness. Strategic human resource development is tied to problem-solving and leadership within the larger corporate context.

Human resources, or HR, is the department in charge of managing an organization's employees. In this capacity, you'll be responsible for a wide range of tasks, such as filling open positions in the business, conducting interviews, selecting candidates, conducting background checks, conducting drug tests, conducting performance reviews, and handling employee complaints and misconduct (Cania, 2014). Human resource management is generally assumed, using these procedures, to be current on organizational behaviour and to have the power to shape the culture of an organisation. Because of its centrality to the HRM function, HRM is widely recognised as an essential factor in influencing the behaviour of employees and the quality of their output inside an organisation. The efficiency of the time unit function is a major factor in the workplace's overall output, largely due to the employees' level of discipline. When human resource management isn't doing its job properly, the company has a harder time getting things done. Human resource management tasks are intrinsically linked to all other options. Even if the achievement approach is in place, for instance, if the job assignment doesn't take into account the essential competencies of every member of the organisation, the function may not make the most of all the available competencies.

#### SP Filling machineing Products India Private Limited

SP Automation and Packaging Machine, which has been in business since 2003, is well-known for its reliable service of industrial machines. Our VF Machine Service, Filling Machine Service, and Sealing Machine Service are all backed by years of experience in the industry, giving our clients the peace of mind they need to maintain their credibility, market presence, and competitive edge. We are able to maintain constant contact thanks to our well-developed network infrastructure. Businesses can enhance their quality system with our help and either keep up with or even surpass their customers' expectations. Our customer-centric strategies have helped us achieve a prominent position in the industry.

#### Need of the Study

The purpose of the research was to investigate the impact of HRM duties on business success and record the findings. The study's other goals were to influence future research in this field and give actionable data that the company could use to improve its human resource management and so increase its chances of success.

#### Problem Statement

The staffing practices and methodologies observed in the use of automobile packing manufacturing are intended to attract and retain professionals and intentionally meet existing economic conditions. The association defines a stable HRM Function lengthy aspect of possible systems to achieve the goals of utilizing human assets to an appropriate extent. There has been a major change in staffing strategies and practices to capitalize on the existing reputation of automobile packing manufacturing organizations. Numerous HR exams have been conducted across a number of organizations. There is no academic investigation done to decide the human resource exams in automobile corporations In Coimbatore. The aim of the exam is to check the Human Assets in SP filling machineing Companies in Coimbatore. From now on, this observational research is coordinated closer to SP filling machineing products give groups with the recognition of human resources practices and its results that trigger thinking in brains and discover solutions to face future problems.

#### Objectives Of the Study

- To observe the Human Resource Management function of the SP filling machineing product in Coimbatore.
- To find out the recruitment, training practices in the Packing machine.
- To recognize the important Issues with the contemporary training regime
- To deliver a few guidelines of improving HRM Function in the SP filling machineing product system.
- To study the Proper assessment of human resources Functions needs in future.
- To study the Human Resource Requirements and Analyze Current Workforce
- To realizing organizational Goals. To determine the future skill requirements of the organization





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### Scope of the Study

The look at is huge and systematic. The information gathered from the records has been created to a conclusion. The purpose of the satisfaction facilities absolutely around human asset rehearses within the chose SP filling machineing product industry. The method of the have a look at has been made with the angle at the representatives of packing machine enterprise located in Coimbatore city

### Limitations of the Study

1. In wearing out this Study, the researcher got here across a few difficulties, like pattern respondents aren't so large. It have to be performed greater sampling.
2. At the time of wearing out the research, maximum of the respondents had been wearing out their ordinary jobs, and as a result, finding time to fill within the questionnaires is hard.
3. It referred to as for consistent verbal exchange among the researcher and the establishments to find the right healthy in phrases of time, bearing in mind gathering data from all the respondents.

## REVIEW OF LITERATURE

**Steve Kahl and Fernaando Suarez (2010)** of their evaluation paper "A idea of HRM Function in Packing machine product industries", has all over that during several product-oriented industries, offerings have become gradually essential. The filling machine business universal generates an oversized portion of its profits from distinctive product-related service activities like insurance and maintenance. The authors argued that regardless of the ostensible significance of services, there's no longer ample idea to assist researchers or practitioners justify the situations underneath that offerings rely in product industries. The typical read that emerges from the offerings literature is that services generally tend to turn out to be essential for generating corporations as soon as their industries reach a mature level. Asha Nagendra *et al.*, (2014)The authors emphasised the SP filling machine product system in HR planning and development in medium to big firms in their study of HR executives' efficacy and understanding of technological phenomena in the workplace. Human resources managers are aware that they may reduce costs and increase productivity by using information technology to improve HR planning. For the sake of record-keeping and strategic decision-making, it is important that technology operations be implemented if they would offer strategic value and competitive advantage. Human resources professionals are confident that supervisors can get the information they need to foster their teams' growth and success. In some cases, this is a vital subsystem for preventing errors in procedure or paperwork. The organization's business operations need to be in sync with the applicable machine product system.

(Kessler, Purcell, 2018)Human resource professionals have defined innovative HR practises as the adoption and deployment of any untested idea, method, or technique for managing or influencing employee output with the goal of enhancing the organization's bottom line. Human resource innovations that boost productivity and help keep the best workers on board. One of the most visible examples of cutting-edge HR strategies, job satisfaction encourages workers to feel good about themselves and their work, which pays dividends in the form of loyalty to the company. When a firm takes measures to improve workers' lives, those workers are more likely to respond favourably in kind by adopting the company's values and culture. A person's level of commitment can be defined as "the intensity of his or her identification with a group or cause."

Budhraj and Sharma (2020) studied the reasons of strain among vehicle employees. The information for the take a look at was collected from Packing machine merchandise. Its undertook a research have a look at with an goal to cowl most of the ideas of human resource improvement (HRD) like recruitment, choice manner, placement, training, merchandising, wage income and financial incentives, switch, deputation, industrial relation, and political interference within the packing machine organizations. The demanding situations confronted with the aid of Human useful resource manager in context of recent financial situation. This paper emphasized that these demanding





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situations must severely taken filling machine of. Main assignment is the shortage of skilled manpower. This paper tested the function of human useful resource branch to address the hassle. It became the responsibility of HR branch to layout a likely filling machineer course to retain talent. It changed into counseled that HR manager ought to be geared up to address the demanding situations, but the role of different stakeholders need to also be blanketed in an effort to make certain healthful survival of the Packing machine organisation.

(Cross and Daniel, 2021). Human resource management, or HRM, is the process through which an organisation acquires, trains, and retains qualified workers to accomplish its objectives. Human resource management, or HRM, entails the process of planning, organising, directing, and controlling the acquisition, development, compensation, integration, maintenance, and separation of human resources to achieve the goals of the organisation, its employees, and society as a whole. Human resource management, or HRM, is the process by which a company creates and implements a strategy for its human resources, or HR team, to support the organization's business strategy. These go beyond the conventional understanding of personnel management by placing greater emphasis on the management of components of the employment relationship such as salary, evaluation, hiring, firing, and reward systems. This highlights the significance of HR practises to the development of the business. While many businesses, both large and small, do not completely integrate these HR practises into a strategic HR plan, larger businesses are more likely to have all of the components of an HRM system.

## RESEARCH METHODOLOGY

### Introduction

The steps that are often taken by a researcher when examining an issue and the reasoning behind them are what make up a researcher's methodology.

### Research Design

Research designs are plans for gathering and analysing data that try to strike a balance between efficiency and relevance to the study's stated goals. The studies used a descriptive research strategy. In order to understand how consumers will react, the researcher must describe the current state of affairs. Descriptive research is used because of this. Only the past and the present can be reported via descriptive research.

### Method of Collection

It has two types

1. Primary data
2. Secondary data

### Sampling

#### Population

The term "population" is used to describe all of the individual participants in the study.

#### Sample Size

Consumers' thoughts and expectations served as the sole basis for the research. A total of 120 participants were used in the study's sample.

#### Sample design

Convenience sampling techniques were used for the study.

#### Tools Used

The commonly used statistical tools for analysis of collected data are:

- Simple Percentage analysis
- Chi-square Analysis





**Ragul and Suganya****Data Analysis****Descriptive Statistics**

Percentage analysis is a straightforward statistical tool that measures the proportion of a sample population that answers a questionnaire. It is one of the simplest types of analysis that may be used to understand the results of a study. From the above table it was found that major of the respondents are Male (60.0%) & they are under the age group of between 36-50 (43.3%) & 85% of the respondents are married persons and they are Completed under graduate (43.3%) & the persons have 6-10 years of experience (35.3%) and their Salary is between Less than Rs. 10000 per month (38.3%).

**Chi-Square Test**

**Table 1:** Age and skills selection process

**Null Hypothesis**

H<sub>0</sub>: There is no significance relationship between Age of the respondents and Skills and qualification of selection process.

**Alternative Hypothesis**

H<sub>1</sub>: There is a significance relationship between Age of the respondents and Skills and qualification of selection process.

**Interpretation**

The significant value (1.80) is > greater than the P value (0.000). Hence null hypothesis is accepted so there is no significant relationship Age of the respondents and Skills and qualification of selection process.

**Chi Square Test**

**Table 2:** Age and effective recruitment selection

**Null Hypothesis**

H<sub>0</sub>: There is no significance relationship between Age of the respondents and Effective recruitment selection the right candidates.

**Alternative Hypothesis**

H<sub>1</sub>: There is a significance relationship between Age of the respondents and Effective recruitment selection the right candidates.

**Interpretation**

The significant value (2.00) is > greater than the P value (0.000). Hence null hypothesis is accepted so there is no significant relationship Age of the respondents and Recruitment and selection method of job position.

**Correlation**

The table shows that the relationship between Qualification and Satisfied the performance evaluation process.

**Interpretation**

This is a positive correlation. There are relationships between Qualification and Satisfied the performance evaluation process.





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#### Findings, Suggestion and Conclusion

##### Suggestion

- The impact of human resource management on the bottom line. To get over this restriction, a multi-level behavioural approach that emphasises people's ability to act as mediators could be put into place.
- Despite its widespread adoption, this framework has not yet been extended to describe how employees' actions are formed in response to HRM initiatives.
- Human resource management that has a positive effect on workers' actions can be highly efficient. Increasing HRM effectiveness through the effective application of HRM policies and practises is another topic that can be explored in multilevel studies of the topic. However, there is limited consensus on how to really put this into practise.

## CONCLUSION

The studies paper analysis concludes that, the power system management is not able to attract the first-rate to be had skills no matter the reality that that is a zone that gives appropriate income and benefits packages, has highly based training & improvement programs, has numerous organizations with top agency reputation and, most importantly, with gigantic possibilities for a significant career. The power system management automobile industry desires to exhibit those opportunities and create attention most of the younger talent pool. SP machinery Industry businesses as well as huge corporations inside the zone want to satisfaction on creating a tremendous logo photo for the enterprise with the intention to appeal to clean talent. Further, companies have to satisfaction on converting the satisfaction environment via better human aid practices, soft skill training, decreasing hierarchical boundaries and growing career development maps for the employees. Experienced HR managers from other zone ought to be inducted to incorporate nice practices from different sectors. The scope of the in addition study is in how the generation of HRM function may be tailored and broadened to the measure of different types of intellectual belongings.

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**Table 1. Demographic variables**

Demographic variables		Frequency	Percent
Age	Below 35 years	44	36.7
	36-50 years	52	43.3
	Above 50 years	24	20.0
	<b>Total</b>	<b>120</b>	<b>100.0</b>
Gender	Male	72	60.0
	Female	48	40.0
	<b>Total</b>	<b>120</b>	<b>100.0</b>
Marital Status	Married	102	85.0
	Un married	18	15.0





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	<b>Total</b>	<b>120</b>	<b>100</b>
<b>Educational Qualification</b>	Matric	21	17.5
	Under Graduate	52	43.3
	Post graduate	13	10.8
	Others	34	28.3
	<b>Total</b>	<b>120</b>	<b>100</b>
<b>Experience</b>	Less than 5 years	39	32.5
	6-10 years	43	35.8
	11-15 years	17	14.2
	16-20 years	10	8.3
	More than 20 years	11	9.2
	<b>Total</b>	<b>120</b>	<b>100</b>
<b>Monthly Income</b>	Less than Rs. 10,000	46	38.3
	Rs. 10,001-20,000	30	25.0
	Rs. 20,001-30,000	19	15.8
	Rs. 30,001-50000	12	10.0
	More than Rs. 50000	13	10.8
	<b>Total</b>	<b>120</b>	<b>100</b>

**Table 2. Case Processing Summary**

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Skills and qualification of selection process	120	100.0%	0	.0%	120	100.0%

**Table 3. Chi-Square Tests**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.947E2 <sup>a</sup>	8	.000
Likelihood Ratio	199.726	8	.000
Linear-by-Linear Association	98.249	1	.000
N of Valid Cases	120		

**Table 4: Age and effective recruitment selection**

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Effective recruitment selection the right candidates	120	100.0%	0	.0%	120	100.0%





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	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.152E2 <sup>a</sup>	8	.000
Likelihood Ratio	219.592	8	.000
Linear-by-Linear Association	102.088	1	.000
N of Valid Cases	120		

		Qualification	Satisfied the performance Evaluation process
Qualification	Pearson Correlation	1	.879**
	Sig. (2-tailed)		.000
	N	120	120
Satisfied the performance evaluation process	Pearson Correlation	.879**	1
	Sig. (2-tailed)	.000	
	N	120	120

\*\* . Correlation is significant at the 0.01 level (2-tailed).





## A Study on the Role of Artificial Intelligence in Human Resource Management

Vidya.N<sup>1\*</sup> and M.Gurusamy<sup>2</sup>

<sup>1</sup>Assistant Professor, M.A.HRM Department, SDNB Vaishnav College for Women, Shanthi Nagar, Chrompet, Chennai – 600 044, Tamil Nadu, India.

<sup>2</sup>Professor and Chairperson – Marketing and Entrepreneurship, Adarsh Institute of Management and Information Technology, Chamarajpet, Bengaluru-560018, Karnataka, India.

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### \*Address for Correspondence

#### Vidya.N

Assistant Professor,  
M.A.HRM Department,  
SDNB Vaishnav College for Women,  
Shanthi Nagar, Chrompet,  
Chennai – 600 044, Tamil Nadu, India.  
E.Mail: vidya.00005@gmail.com



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### ABSTRACT

The merging of Human Resource Management practices and AI has strengthened HR managers to analyze and forecast toward better decisions in the corporate era. The Main objective of HR managers is to recruit and retain highly qualified candidates for the long term. The blending of AI and Human resource management has significantly impacted in recent years. AI has the power to modify the entire functions of HR in a better way. This paper will discuss how AI can transform the entire organization and its work culture. The literature review is a real example of how HR Managers make decisions regarding Recruitment, Selection, Performance Management, Compensation Management, etc.

**Keywords:** Compensation Management, Human Resource Management, Performance Management, Recruitment, Selection.

### INTRODUCTION

AI is the recreation of the Human Intelligence process through machines. It focuses on creating machines to perform the functions usually required for human intelligence to complete. These operations include recognizing speech, making decisions, and understanding the database management system. AI has the following applications for deciding on organizations they are image recognition and decision-making systems.

AI is playing a vital role in the field of HR; they are as follows:





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Recruitment, Training, Performance Management, employee motivations, compensation management, etc.

#### Why is AI important to HRM?

AI is an essential tool to transform the day-to-day life of every organization's decision-making. Also, it plays a vital role in new strategy applications and competitors' operations as the HR department has to perform the essential functions of collection of data in terms of employee profiles, performance, data on star performers and low performers, the history of salary and promotion, the demographic data training retention and absenteeism details.

AI has to perform the measurement function of collecting continuous data and comparing such data. Various analytical methods are used, such as descriptive, predictive, and prescriptive. These analyses are beneficial in performing the following functions as

1. Automated recruitment
2. Suitable training program for different employees
3. Automated Performance Management to identify employees' working levels and determine their training needs.
4. Algorithm based model has to be applied to different employees to understand ROI (return on investment)
5. Workforce analysis, Talent Management.

#### Objectives of the Study

- To study the concept of AI and HRM
- To examine the challenges and implementation of AI in HRM.
- To assess the ways and means of how AI tools help perform HRM functions.

#### Concept and Blending Mode Of Artificial Intelligence And Human Resource Management Functions

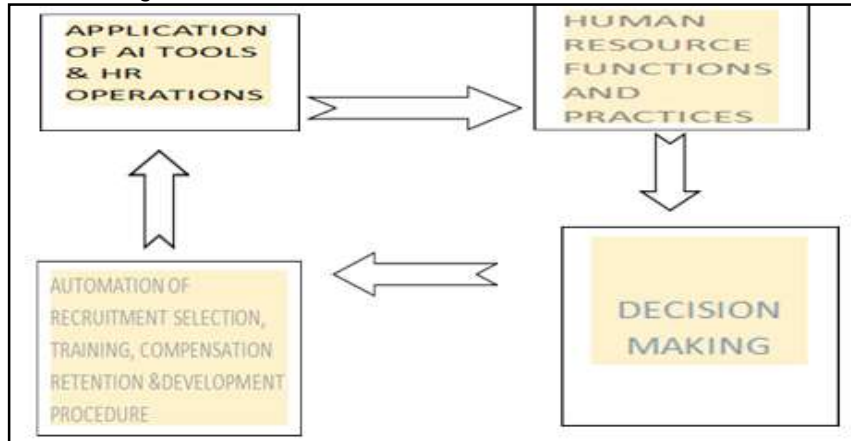
HR operation	Application of Artificial Intelligence in Human Resource Management and Predictive analysis
<b>Recruitment</b> – Scrutinising the application	Securing qualified smart candidates
<b>Selection</b> –choosing the right man for the right job	AI tool to select the correct type of candidate in lesser time
<b>Orientation program</b> – Inducting an employee into the organization	Application of proper technology to introduce policies and practices.
<b>Training Methods</b>	Advanced AI and machine learning techniques to identify & suit the various levels of employees.
<b>Performance management</b> –Evaluating the performance of the employees – star performer and moderate performer	Adopting suitable AI techniques to improve performance by making alterations in the process management
<b>Adopting promotion strategy</b> – Analysing the candidate – whom to give promotion	Writing proper algorithms to select the best candidate for the new roles
<b>Retention Strategy</b>	AI-powered chat bots to retain and maintain the employee for the long term
<b>Compensation Management</b>	Installation of suitable software to analyze and calculate the employee benefits & incentives (financial and non-financial )based on performance





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#### The Blending Mode of AI and HRM



## LITERATURE REVIEW

In his article, Mohammad Hossein Zarei and AminehGhorbani (2021) explained the scope and uses of AI IN HRM and the problems associated with implementing AI in HRM. He also emphasized the ethical aspects of AI and bias in implementing AI tools and applications. "Artificial Intelligence in Human Resource Management: Theory and Practice" by Davide Aloini, Gianluca Danese, and Marco Romano (2019), in his article, explains the theoretical and practical application and usage of AI in HRM. He also emphasized database management and privacy towards implementing AI in HRM.

"The impact of artificial intelligence on human resource management" (2018) by Robert M. Verburg and Paul G. Frijters. In his article, he discussed both pros and cons of AI In HRM. Also, he discussed that if it is not adequately tested and implemented, it will lead to bias and displacement of employees' hierarchical positions. "Artificial intelligence and human resource management: a systematic literature review" by Carvalho *et al.* (2021). In his article, he concluded that AI could be implemented to automate many HRM functions and to improve decision-making.

(Otilia & Lucia,2009) In his article, he discussed the importance and evidence of its supportive factors. (Shauna 2017) explained the changing concept of human resource management and highlighted the functions of human resource managers. Furthermore, this article also explains the future challenges of future HR Managers.

## RESEARCH METHODOLOGY

This study is based on the descriptive research method in this paper, secondary data collection methods were used, and the sources of data collection were research articles, books, websites, and other published articles.

### Recent Trends in Human Resource Management and Challenges in Implementing AI

Modernization of the workforce with the help of AI in HRM would improve the efficiency and sustainability of the organization. Now we will discuss the challenges in implementing AI as follows:

#### Recruitment

AI-driven software is used to identify the best talent and remove bias in job descriptions. Once the candidates clear initial screening, AI software can administer skills and aptitude tests to rank the candidates. Chat bots are also deployed to communicate directly during recruitment.





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#### Orientation

Nowadays, as the number of employees keeps on increasing day by day, instead of using traditional onboard methods, AI-based chat bots are used to reduce the burden of HR managers through automation of functions such as receipt and delivery of documents, company policies, information about employees log in, permissions, installation HRM app, etc.

1. It is an essential function for HR managers to keep employees engaged for a long time and balanced workforce, employees are available only on screen, and they would like to disconnect themselves. AI-based communication and collaboration tools are introduced to motivate interpersonal connections, natural time environments, and virtual office experiences.
2. AI Based health monitoring tools are introduced to identify employees' illnesses and provide valuable suggestions to improve employees' welfare.
3. It is essential on the part of HR managers to update themselves with the latest technology, and they should be confident in the ROI. AI-based software is essential nowadays to update themselves and reduce the organization's cost and efficiency.

#### Supportive AI Tools in the HR Industry

##### Robotic Process Automation

Grading and screening of candidates' Resumes

Comparing resumes to specific job criteria

Choosing the best candidate from the large no of candidates/applicants

Alerting applicants scheduling interviews - sometimes reject them

Procedures are simplified through AI in HR - Decision making made accessible in the recruitment process.

##### AI Cloud-Based Technology

Accessibility is one of the positive aspects of cloud-based technology.

Predictive analytics is one of the best methods to analyze the candidate's carrier options from across the firm; it is also helpful to identify the trends in employee data and to reward, develop, and retain talent. Examples of cloud-based systems are mobile apps.

1. Best AI tools in HRM

#### SKILLATE

It is used to extract information from resumes and to recruit intelligent candidates by creating job descriptions.

- ❖ Automation of job description assistance
- ❖ Automation of interview scheduler
- ❖ Presently, the following companies are using as follows:

OLA, MAHINDRA, BYJUS, BIG BASKET, SONY, GROFERS, RAPIDO.

#### ENTELO

ENTELO performs the following functions.

It helps recruiters collect information on candidates from various grouping such as gender, rays, and veteran status.

It removes obstacles and delays in the screening of resumes.

The following companies are using the ENTILO software.

NETFLIX, NEWYORK TIMES, GOLDMAN SACHS.

#### TALENTURE

TALENTURE performs the following services:

Selecting the candidate who is using job websites, Social media websites, email, and others.

Nowadays, thousands of business use such software. Following customers are using this tool

GENEXT, CORPORATE SERVICES, JOB EXCEL, VENPA STAFFING SERVICES.







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It covers candidate screening, candidate searching, and other HR recruitment process.

#### **HARVER**

It helps the companies to automate and streamline the recruitment process - to assess the candidate, and to match the right man for the right job based on the skill set and experience of the candidate by using machine learning algorithms. It is used to identify the candidate's strengths and weaknesses. It reduces the time and resources to administer the recruitment process. Accuracy and efficiency are possible through the installation of AI tools.

#### **TURBO HIRE**

It is a collaborative, data-driven, and intelligent recruitment process tool. It is beneficial in terms of cloud-to-customer communication, and it also protects consumer data. It reduces the time. It is advantageous when employing more than 50,000 candidates. It is also used to reduce expenses. Its customers are as follows: ICICI BANK, WAKEFIT, CLEAR TAX, & ACCEL PARTNERS.

#### **LOXO**

It is beneficial for applicant tracking. The following are the customers such as AMAZON, WORLD WIDE TECHNOLOGY, KENSINGTON INTERNATIONAL, AND SIGNA. It can contain data from more than 550 million persons.

#### **HIREVIEW**

It is used to find the best applicants and to reduce bias. It also reduces the screening procedure time and provides structured interview guidelines. Avoiding inconsistent interview procedures is all the functioning performed by HIREVIEW.

#### **TELLA**

The main essential features are to assist during the automation of HR procedures. PAYPAL uses such software.

## **SUGGESTIONS AND CONCLUSION**

Artificial intelligence (AI) has the ways and means to transform many areas of human resource management (HRM): recruitment, Performance management, employee engagement, and training and development. With the support of AI tools in HRM, more organizations are facilitated with the perfect and systematic business solutions that can be attained. Most of the HR functions, such as recruitment automation, performance management, training, and employee development, are being facilitated by AI. Though AI can perform efficiently, human resource managers must monitor its implementations. HR managers must be adequately trained to perform the functions without any obstacles. Before implementing AI in HRM, where it can be best fitted and has to be correctly analyzed, and priorities also has to be established. HR managers also should have clarity before implementing the AI tools concerning the features of HRM. Proper care should be established in the database management systems because data rely on decision-making accuracy. Careful planning and execution are also crucial during implementation.

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## Histopathological Changes in Gills and Muscles of *Cirrhinus mrigala* Fingerlings Exposed to Copper Sulfate

Viji Margaret I<sup>1\*</sup>, Anushiya Selvam T<sup>2</sup>, Kavitha Bharathi<sup>3</sup> and Kombiah P<sup>4</sup>

<sup>1</sup>Assistant Professor and Head, PG Department of Zoology, Sarah Tucker College (Autonomous), Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India

<sup>2</sup>Assistant Professor, PG Department of Zoology, Sarah Tucker College (Autonomous), Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India

<sup>3</sup>Assistant Professor, PG and Research Department of Zoology, Poompuhar College (Autonomous), Melaiyur - 609 107, Mayiladuthurai Dt. Tamil Nadu, India.

<sup>4</sup>Assistant Professor, Department of Zoology, Pasumpon Muthuramalinga Thevar College, Affiliated to Madurai Kamaraj University, Madurai Melaneelidanallur, Tenkasi – 627953, Tamil Nadu, India

Received: 15 Nov 2022

Revised: 28 Feb 2023

Accepted: 04 May 2023

### \*Address for Correspondence

#### Viji Margaret I

Assistant Professor and Head,  
PG Department of Zoology,  
Sarah Tucker College (Autonomous),  
Affiliated to Manonmaniam Sundaranar University, Tirunelveli,  
Tamil Nadu, India.  
E. Mail: vijisino@gmail.com



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### ABSTRACT

Freshwater ecosystems are essential contributors to the diversity and productivity of the biosphere. Recently, it has brought increasing concerns about potential adverse ecological health effects resulting from the production, use and disposal of numerous chemicals that offer improvement in industry, agriculture, medical treatment and even household conveniences. The pollution of the aquatic environment by heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms. The toxic effect of Copper sulfate on the histology of the gills and muscles of *Cirrhinus mrigala* fingerlings was studied. The fingerlings were exposed for 10 days to a 10% sub lethal concentration of 96 h LC50 of copper sulfate (10 ppm). Behavioural changes when exposed to a lethal concentration of Copper sulfate showed increased opercular movement, increased surface behavior, loss of equilibrium, change in body colour and irregular swimming activity. The gills showed hyperplasia of secondary lamellar epithelium, fusion of secondary lamellae and clavate lamellae, necrosis and degeneration of epithelium in gills; muscle it showed edema, mild lymphocyte infiltration, vacuolar degeneration in muscle bundles and atrophy of muscle bundles.

**Keywords:** Heavy metal, copper sulfate, *Cirrhinus mrigala*, histology, gill and muscle.





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## INTRODUCTION

Aquatic ecosystems are important components of the global environment. Aquatic water bodies are most often polluted with various potentially hazardous substances [1]. Rapid industrialization coupled with geochemical alterations poses a major threat to environmental pollution of air, soil and water. With both organic and inorganic is a matter of great concern. However, the non-degradable persistent trace metals are the most pressing problems of the present day. Usually, many toxic compounds affect organisms in nature at the same time, each of them having a specific effect on physical and chemical processes that influence an organism's condition and reactions. Copper has a more toxic effect on many different organs in fish and mollusks. Metals can either increase or decrease hepatic enzyme activities and can lead to histopathological hepatic changes, depending on the metal concentration, fish species, and length of exposure period [2]. Toxicants produce pathological changes in fish such as necrosis in the liver, tubular damage of kidney and gill lamellar abnormalities [3], [4]. Therefore, histopathological studies are necessary for the description and evaluation of potential lesions in aquatic animals exposed to various infections and toxicants in aquaculture. The present study was focused on assessing the acute toxicity and its effect on the histology of gills and muscle tissue of *Cirrhinus mrigala* treated with copper as copper sulfate, as a component of industrial waste.

## METHODOLOGY

### Fish Collection and Maintenance

The fish, *Cirrhinus mrigala* fingerlings, with an average length of 4-7cm and weight of 3.25g – 5g were procured from local fish markets in Tirunelveli District. They were carefully transferred through oxygenated polythene bags. They were acclimatized to laboratory conditions for two weeks prior to exposure to Copper sulfate. Physico-chemical characteristics such as pH, salinity, ammonia, temperature, dissolved oxygen were checked and results were recorded. Fishes were maintained in plastic containers (capacity 20 liters) at a stocking density of ten fishes in each container.

### Experimental Design

Laboratory acclimated *Cirrhinus mrigala* were recruited for the study and divided into 2 groups of 10 fishes each. The first group was kept as unexposed control. The second group was exposed to sub-lethal concentrations of 10ppm Copper sulfate. Water in the containers was changed on alternate days without disturbing the test organisms and fed regularly with the artificial diet. Behavioural and symptomatic morphological changes were monitored in the experimental fishes throughout the period of the study. For histopathological studies, fish were treated with Copper sulfate and various steps (fixation, washing, dehydration, clearing, infiltration, embedding, sectioning, staining) were followed for this study. Gills and muscles were removed for histological studies.

### Physical and Chemical Characteristics of the Water

Histopathological changes of the gills and muscle of *Cirrhinus mrigala* as an indicator of water quality (biological method), were related to physical and chemical parameters measured. Results of physical and chemical characteristics of water are presented in Plate 1.

## RESULTS AND DISCUSSIONS

The elevated levels in physiochemical properties observed in pollution as the source of alteration in water quality. The negative impact of different sources of pollutants discharged into this drain was further confirmed by the highest values in all physiochemical parameters with a concomitant decrease in dissolved oxygen. Histopathology is an important component of several measures of fish health and histopathological markers have been recommended



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for field application, more often as a generalized, nonspecific response to severe stressful stimuli [5], [6]. Various alterations were observed in the gills and muscle tissues of *C. mrigala* treated with a lethal concentration of Copper sulfate for 96hours might be due to the toxic stress developed by copper.

### Gills

In the present study, in control fish, gill filaments were seen: primary lamellae and secondary lamellae were lined along both sides of the gill filament (Figure 1-2). The surface of the control gill lamellae was covered with epithelial cells running parallel along the surface (Figure 3). This epithelium is considered by different cell types, including pavement (epithelial) and mucous cells. However, during acute and sub-lethal treatment of Copper sulfate, the fish *C. mrigala* shows histological alterations such as hyperplasia of the epithelial cells, hemorrhages with rupture of the lamellar epithelium and lifting of the lamellar epithelium (Figure 4-6). Similar observations were reported by Krishnani *et al.*[7] gill epithelial necrosis in *Latescalcarifer* exposed to copper. The infused secondary lamellae were thinner compared to their controls. During acute treatment, the hyperplasia was more severe, resulting in the fusion of some secondary lamellae. Further, alterations such as hypertrophy of epithelial cells, lamellar aneurysms and lamellar disorganization were also observed. In a few regions, disintegration and fusion of primary lamella were observed. Similar results have also been observed by Skidmore [8] in rainbow trout when exposed to Zinc sulfate. Fig. 1 showed histological observations on gills of control *C. mrigala* fingerlings showed the normal architecture of gill filaments such as primary gill lamellae (SGL), secondary gill lamellae (PGL) with mucus cells lying scattered on both sides. Fig. 2-3 explained a section through the gill of the control *C. mrigala* showing normal primary and secondary lamellae. The secondary gill lamellae are highly vascularised (V) and surrounded by a thin layer of epithelial cells (LE). Figure 4 represents the photomicrograph showing a section through the gills of *C. mrigala* treated with 10ppm of Copper sulfate for 24hours indicates fusion of secondary lamellae (FSL) and degeneration of epithelium (DE). Figure 5 showed a section on the gill tissue of treated fish showed hypoplasia of esoinophylic cells (HE). Figure 6 Photomicrograph showing a section through the gill tissue of the treated fish indicates gill filaments sloughed (GS).

### Muscle

In the present study, the muscle control group of *C. mrigala* showed normal structure of muscle bundles and muscle fibers (Figure 7-9). In treated muscle, edema and mild lymphocyte infiltration, vacuolar degeneration in muscle bundles and atrophy of muscle bundles were observed. Edema between muscle bundles and splitting of muscle fibers were observed (Figure 10-12). Similar observations were reported by Nagarajan and Suresh [9] in the muscle tissue of the fish *C. mrigala* with increasing concentrations of Sago effluent.

Figure 7-8 explains the photomicrograph of the muscle of the control fish *C.mrigala* showing normal structure of muscle bundles (MB). Fig. 9 showed the muscles of fingerlings (control) showed the normal arrangements of muscle fibers (MF) and muscle bundles (MB). Figure 10 express the copper sulfate treated with *C. mrigala* fingerlings showed many deformities such as degenerated muscle fibers (DMF), gradual infiltration of macrophages (M), muscular necrosis (N) and fragmentation of muscle fibers (FMF). Figure 11 showed a section of the muscle tissue of treated fish showed degeneration of muscle fibers (DMF), edema (E), splitting of muscle fibers (S), necrosis (N) and vacuolar degeneration in muscle bundles (V). Figure 12 explains the photomicrograph of the muscle section of *C. mrigala* fish treated with 10ppm of Copper sulphate showing vacuolar degeneration in muscle bundles (DMB).

## CONCLUSION

Heavy metal pollution in developing and developed countries has resulted in heavy metal pollution in the environment. The result indicates that heavy metal pollution definitely affects the aquatic life of freshwater fish. It can be conclusively deduced from this study that fish are highly affected by heavy metals in a polluted environment. Since virtually all metals investigated were found in higher concentrations, the government should impose laws that





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will ensure that industries make use of standard waste treatment plants for the treatment of their waste before it is discharged into water bodies.

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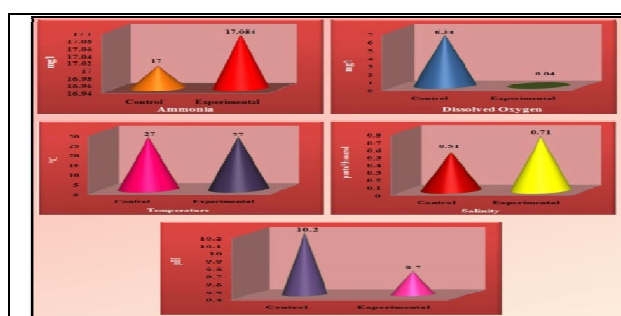


Plate: 1. Analysis of physical and chemical parameters of water quality.

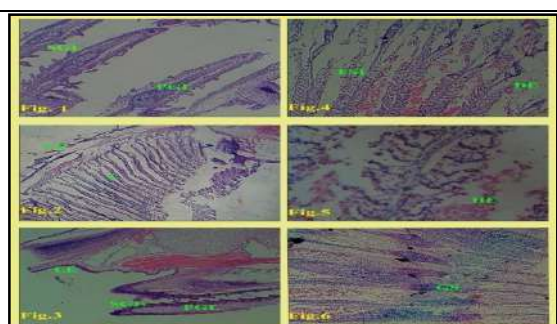


Plate: 2 Photomicrograph of the section of gill filament *Cirrhinus mrigala* fingerlings treated with a sublethal concentration of Copper sulfate.





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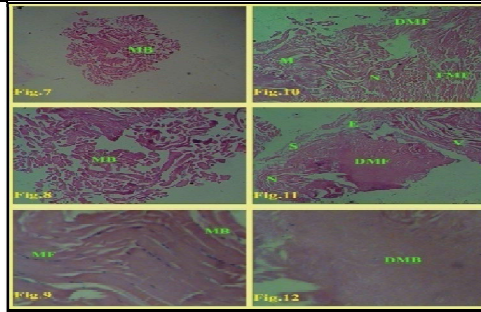


Plate: 3 Photomicrograph of the section of muscle tissue *Cirrhinus mrigala* fingerlings treated with a sublethal concentration of Copper sulfate.





## Optimization of Transportation and Game Theory Problem using Modi and Bi-Criteria Method

Sunil D Bagde<sup>1\*</sup> and Pallavi Y Gajbhiye<sup>2</sup>

<sup>1</sup>Assistant Professor, Post Graduate Teaching Department of Mathematics, Gondwana University, Gadchiroli-442605, Maharashtra, India

<sup>2</sup>Research Scholar, Post Graduate Teaching Department of Mathematics Gondwana University, Gadchiroli- 442605, Maharashtra, India

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### \*Address for Correspondence

**Sunil D. Bagde**

Assistant Professor,

Post Graduate Teaching Department of Mathematics,

Gondwana University,

Gadchiroli-442605, Maharashtra, India.

E.Mail: sunilkumarbagde@rediffmail.com



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### ABSTRACT

Linear Programming is the method used for solving the complex problems and it is the simplest method for performing optimization. The linear optimization problem is carried out through simplified assumptions for obtaining optimum results. The transportation problem and game theory problem are the examples of linear programming which tries to identify the optimal solution using simplest method. The transportation problem identifies the optimal solution for transportation through allocation of resources from the source to various destinations by considering minimum expenditure. The main scope of the study is cost minimization of transportation problem and game theory problem and the collected data is solved using MODI method and Bi-Criteria method. The proposed optimization methods are compared with the existing methods for minimization of cost in transportation problem from source city to destination cities using MODI method in petroleum refineries, textile mill industry and food industry. Bi-Criteria method of Game theory problem for decision making in International Economy market.

**Keywords:** Transportation problem, Game Theory problem, Optimization, MODI method, Bi-Criteria Method

### INTRODUCTION

A strong transportation infrastructure is essential for the country's long-term economic prosperity and is a major driver of regional and global integration. An efficient transportation system stimulates the economy and increases its

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resilience. A reliable transportation system is necessary for rapid expansion. There is no automatic flow of commodities and services from the point of supply to the point of demand. These goods and services must be transported from the point of supply to the place of need. The three most important supply-chain conditions that a traditional transportation system must fulfil are that the goods be delivered on time, in excellent condition, and at a reasonable price. This concept can be broken down into a number of doable tasks, and their successful accomplishment will guarantee the prompt and efficient distribution of humanitarian aid. Moving items safely from a factory or other source to recipients is necessary when doing so. There are numerous problems involved in transporting items via the various routes (Gogi., 2022).

The formulation and solution of transportation problems as linear programming problems, which are connected to daily activities in our real lives and mostly deal with logistics, is one of the most significant applications of linear programming in operations research. The goal of this study is to present a novel approach to problem resolution that maximizes some objective function. This novel method was developed by including a crucial stage in the process for locating the initial solution. Miniaturization is an efficient way to handle both balanced and unbalanced problems since it involves simple application and comprehension requirements and yields outcomes that are either optimal or very close to the optimal solution. The results obtained by the new technique are generally superior to those of the three traditional methods, North-West corner method, least cost method, and Vogel's Approximation Method. In addition, the new strategy differs from the other three methods in terms of how quickly and easily the stages can be implemented (Zabiba *et al.*, 2023).

Transportation problem includes the commodity distribution from different type of source cities to different types of destination cities. The transportation problem ensures that the demand requirements are completely satisfied in the destination according to the available resources from the source city with minimum cost. Many modes of transportations that includes water, rail, roadways and Airways are there. Even though, road transport are mostly used and it is considered as the favourite choice by the industries due to low cost, flexibility and response time. Even though, it is more dangerous for transporting petroleum products and it is the greatest contribution for emission of greenhouse gas effect, emission of CO<sub>2</sub>. Transportation model extends with different areas operation for control of product inventory and maintenance of equipment recognition of parallels among the elements after transportation model and problem (Iheonu&Inyama., 2016).

In dynamic multicriteria games with asymmetric participants, a novel way to building cooperative behavior is described. Game theory and multi-objective optimization are coupled to find cooperative and non-cooperative equilibria. Using the bargaining solution, a multicriteria Nash equilibrium is built. A compromise strategy is used to create a multicriteria cooperative equilibrium that ensures the fulfilment of the rationality prerequisites. For dynamic multi-criteria games, the idea of dynamic stability is embraced, and a method for time-consistent payment distribution is proposed. This is a dynamic bi-criteria bioresource management problem with several discount variables. Players' tactics and rewards are determined by their cooperative and anti-cooperative actions (Rettieva., 2022).

The transportation problem is considered as the subclass of linear programming problem where the objective the study includes various quantities of single homogeneous commodity of transport which initially stored in various source cities and it is transported to different cities of destination like the way involving total transport cost. The transportation cost is considered to be a biggest problem of industries which should be minimised through optimization techniques for transportation problem which provides minimum cost than that of existing transportation problems. The objective of the transportation problem determines the number of products to be transported from the origin city to destination city. The transportation problem applied in three types of industries like petroleum refineries, textile mill factory and food product industries. The optimization method like MODI method for solving the complex problem in simplex method. Game theory problems attempts for decision making in the situations of international economy market with two or more intelligent options and the rational options are



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involved under the conditions for cooperation and conflicts. The optimization technique used for game theory problems in international economy market include Bi-criteria method.

**Research Problem**

The optimization of transportation problem has the objective for minimising the cost and it should be encountered in petroleum refineries textile mill factory and food product industries.

**Research Objectives**

The research objectives are discussed below;

- The existing methods of transportation and game theory problems are studied
- Optimization methods like Modi method for transportation problem and bike criteria method for game theory problem is developed
- Transportation problem and game theory problems are solved by the new methods for getting optimum result

**LITERATURE REVIEW**

Karagul & Sahin., (2020) the key issues in the subject of optimization is the transportation problem. It has to do with figuring out the lowest-cost transportation strategy for getting goods from a particular number of sources to a specific number of demand points. In the literature, various approaches to resolving this issue have been discussed. Typically, these techniques are created for an initial solution or an ideal answer. A innovative approach to identifying the first fix for the transportation issue is put forth in this paper. Twenty-four test problems were used to compare this novel approach, known as the Karagul-Sahin Approximation Method, with six initial solution approaches from the literature. With impressive calculation times, the proposed method has, when compared to other methods, found the best initial solution to 17 of these issues. In summary, the solutions produced by the suggested method are just as accurate as Vogel's approach and just as quick as the Northwest Corner Method.

Thanoon., (2022) for the purpose of analyzing challenges associated with the transportation of goods from industrial locations to retail outlets, operations research commonly uses the transportation issue as an optimization technique. One potential goal of the TP is to reduce the cost of transportation as well as time spent traveling long distances. Such problems can be resolved methodically. To do this, we identify the Initial Basic Feasible Solution to the issue. The Least Cost technique, and the North-West Corner strategy are the commonly used methods for calculating the IBFS. More strategies to deal with these issues have been put up recently. In this article, a novel approach to the transportation issue is presented, and its effectiveness is contrasted with that of previously proposed ones.

Vora & Kulkarni., (2019) they frame the finite block length communication problem with a jammer as a zero-sum competition among the decoder-encoder team and jammer, with both parties permitted to use locally randomized communication tactics. The game's minimax value corresponds for channel coding of joint source over an Arbitrarily variable Channel, which is known to admit a strong converse in the context of channel coding. Since the challenge facing the communication side is non-convex, a minimax theorem does not necessarily need to hold for this game.

Biggar & Shames., (2023) they define the games that have a response graph in common with a potential or zero-sum game, respectively, and show the duality between these sets. This enables us to comprehend how these properties affect the response graph. It is demonstrated that all two-player games feature response graphs for Matching Pennies and Coordination, with every non-iteratively dominated strategy participating in a subgame with these graph structures. It follows that any game that has a response graph that contains both a zero-sum game and a prospective game must be solved by dominance. Finally, we use some bigger games to show off our findings.





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### Research Gap

According to the literature studies, more studies done on existing models of transportation and game theory models. Limited studies are done in optimization techniques for transportation problems and Game theory problems.

## METHODOLOGY

### North-West Corner Method

The technique used for determining the initial feasible solution for transportation problem is referred as North West corner rule. The strategy uses the North West corner since the fundamental variables chosen from every left corner in each problem. This technique is used to figure out a workable solution to a transportation issue. In this procedure, the top left corner, also known as the Northwest corner, is typically where the fundamental variables are picked. To get at this workable answer, the actions below are taken (Pasaribu., 2019). 1. Finding and choosing the cell in the transportation table's upper left corner is the first step. It will be necessary to distribute as many units as feasible to this cell. The units must match the minimum available criteria for both supply and demand. 2. The numbers for supply and demand must then be modified in the designated rows and columns. Only if the supply for the first row has run out will the first cell in the second row be reached. In a similar manner, if there is sufficient demand for the first cell, we will go on to the next cell in the second column. 3. If the demand for any of the allotted cells is greater than the supply, the next allocation can be made in either the following row or column. This process is repeated until all of the total quantity available has been successfully allocated to the necessary cells. To demonstrate how the four aforementioned techniques operate, the following example will be utilized throughout the remainder of the paper.

### Least Cost Method

The Least Cost Method is an additional method for finding the main useful response to the transportation issue. The cell with the lowest expense is where the allotment cycle begins for this situation. To have the lowest transportation costs, the cheaper cells are liked over the greater expense cells. The supply and demand should be equal, and if the supply is higher than the demand, a fake source is added to the table, with the demand set at the difference between the two, and the cost is left at zero. Similar to the above, if the demand exceeds the supply, a dummy origin or destination is added to the table, with a supply equal to the discrepancy between the quantities demanded and supplied and a cost of 0. Choosing fundamental variables is typically done as the unit cost of transportation when the least cost approach is employed to compute a basic workable solution in a transportation problem.

### Maximin Minimax Principle

1. Maximin Criteria: The player who wants to maximize his winnings makes a list of the minimum gains he expects from each strategy, then chooses the one that maximizes these minimum gains.

2. Minimax Criterion A: The minimising player specifies the highest loss he can sustain from each strategy, then chooses the one that causes him to suffer the least loss out of these maximum losses.

As An Example, Imagine a two-player, zero-sum game with the pure strategies A1 A2 & A3 for player A and B1 & B2 for player B. The payoff is as follows. Assume that player A enters the game knowing full well that B will choose the specific counter strategy that will minimize A's payout regardless of the strategy he chooses. If A chooses strategy A1, then B will choose B2 so that A can achieve the lowest gain. Similarly, if A picks A2, B will follow A2's lead and use B2's technique. A would naturally want to maximize his maximum gain, which is only the largest of all possible row minima. This is also known as "maximin approach." Similar to how A will reduce his minimum loss, B will employ the "minimax strategy."

We see that the maximum if row minima and minimum of column maxima are equivalent in the example above.

In equation,

$$\text{Maxi [Min]} = \text{Mini [Max]} \quad (1)$$





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#### Dominance Property

Problems involving pure strategy and mixed strategy can both be solved using the dominance method. In pure strategy, the solution is found on its own, however in mixed strategy, it can be applied to help in issue simplification. Dominance principle. According to the Principle of Dominance, if one player's plan outperforms another player's strategy under all circumstances, the latter strategy should be disregarded because it will have no bearing on the outcome (Gold & Colman., 2020). From the perspective of the gainer, if one approach generates greater gain than another, the first strategy takes precedence over the second and can be completely disregarded. Similarly, from the perspective of the loser, if one method results in less loss overall than another, the second can be disregarded. So, the player's goal determines whether a strategy is superior or inferior. The inferior strategies can be eliminated since each player must choose his or her best approach. In other words, unsuccessful rows and columns can be removed from the game matrix, and the reduced matrix only keeps the effective rows and columns.

The following general guidelines should be followed when eliminating inefficient rows and columns.

1. Player A won't ever choose the  $i^{\text{th}}$  strategy if all the components of one row, let's say the  $i^{\text{th}}$  row, of a payoff matrix are smaller than or equal to () the corresponding elements of the other row, let's say the  $j^{\text{th}}$  row. Then remove the fifth row.

$$E_{ij} - [R_{ith}] \leq E_{ij} \left( \begin{matrix} R_{ith} \\ Row \end{matrix} \right) \text{ Delete } R_{ith} \text{ rows} \quad (2)$$

2. If all of a column's elements, such as column j, are more than or equal to the corresponding elements of any other column, such as column it, then column j is dominant over column it.

Next, remove the fifth column.

$$E_{ij} (C_i) \geq E_{ij} (C_j) \quad (3)$$

Delete =  $C_i$  th

#### Modified Distribution Method (MODI Method) or UV Method

With this approach, a number of actions must be taken in order to get the best result. They consist of:

1. Using one of the first three techniques

Select a fundamental, workable solution as a starting point. The next step is to calculate the dual variables,  $g_q$  and  $h_p$ , using the formula  $g_q + h_p = eqp$ . This will make it easier to calculate the opportunity cost using the formula  $iqp = eqp - (g_q + h_p)$ . The remaining solution will be the best one if the opportunity costs for all unoccupied cells are either zero or positive. However, if any of the vacant cells has a negative opportunity cost, the resulting solution cannot be regarded as the best one, allowing for further transportation cost savings (Hussein & Shiker., 2023).

2. As a result, the cell that is not occupied but has the least negative opportunity cost will be chosen to be a part of the next-to-be-calculated solution.

3. Then, for the selected unoccupied cell, a closed loop is drawn, and the corner points are given positive and negative signs, respectively. The cell being evaluated typically receives the good sign.

4. The maximum number of units that can be carried to the empty cell being assessed must then be established. So, the units that will be delivered to the entering cell will be represented by the smallest number with a minus position on the closed loop. This is the amount that must be deducted from all negative cells and added to all positive cells on the closed loop's corner points in order to make an empty cell into one that is occupied. It will be necessary to carry out this process multiple times before finding the best answer.

It was suggested to use the floating-point method to locate the best answer to a transportation issue with additional restrictions. The proposed method was superior to the simplex method and inverse matrix method in terms of usability and effectiveness. However, the best method, which aims to have  $(m + n) - 1$  allotted entries, is not always practical. The dual matrix approach was also put out, which is far more computationally efficient than the simplex method and can be used with both balanced and unbalanced TP. As path-tracing is not necessary, this method takes into account the transportation model's dual rather than its primal, which solves the issue of degeneracy in solutions. Nevertheless, the method requires a  $(m + n) \times (m + n)$  matrix, which is both cumbersome and unfavourable.





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#### Bi-Criteria Method

A well-known analysis technique in operation research is the multiple criteria for decision making process sometimes it can be referred as "Multiple Criteria Decision Analysis". Since it was first used in the 1960s, numerous academics have developed cutting-edge models based on it. And it continues to be a very effective tool for analysing industrial issues. Many MCDM applications are used in big businesses and organizations. The game theory Models are used in ecology and economy for understanding the opponent's strategy (Rettieva., 2020). This makes sense because we frequently consider the payoffs for both players, and how one person does affect our decision. In general, the weights given to the qualities should not be negative and should equal one. Nonetheless, there are also situations particularly when players are competing against one another where a negative weight may be put on an opponent's reward, making whatever the opponent wins feel like a loss. It is possible to label this behaviour as "selfish" or "anti-social." That might occur in actual games, and it might be able to help us resolve some contradictions.

#### Data Collection

The present research study includes effective data collection in this work related to transportation problems of petroleum refineries textile mill factory and food product industries and game theory problems of international economic market. The book concentrates on development of optimization model for transportation problem such as MODI method, the stepping stone method and UV method. The optimization model developed for game theory problem includes include Nash equilibrium and bi-criteria method for the cost-effective method. The study intends to optimize the model for data distribution BBC in the above discussed applications as the linear transportation problem as well as to minimize the transportation cost by determining the schedule for minimum cost distribution of the products from three different types of industries to various destinations. The saved cost can we utilize to the actualisation of other projects of the organization with respect to corporate social responsibility. The research study concentrates on the transportation of products of petroleum refineries, textile mill factory and food product industries. The data study after present study gathered during the period of 6 months. The assumptions are made as given below;

- ❖ The transportation cost of product unit is  $C_{ij}$  is independent to the number of product units dispatched  $x_{ij}$ .
- ❖ In in the round-trip container trucks almost carry the maximum loads.
- ❖ The direct shipment is allowed between the destination and source cities.
- ❖ Container truck contains the same level of load capacities and other technical conditions.
- ❖ Linear model should be assumed
- ❖ The production cost should be uniform in the industry

Data collected from three types of industries are collected for the formation of transportation table.

#### Analysis and Findings

The optimization method like MODI method or UV method and Stepping stone method is used in the research study for obtaining the research objective of minimal transportation cost in different applications for transportation of products from source cities to satisfy the demand of consumers in various cities of India. The data from data collection was solved to get the final iteration in petroleum refineries transportation problem with minimal cost, which is represented after the iterations. The quantities of the products to ship over each route are indicated by the values for the choice variables This optimal method MODI method saves the business over the existing methods method in transportation costs each day as it chooses the nearest speed path over the closed path method used in stepping stone method. The number of used iterations performed includes 2 rows and 4 columns is  $m + n - 1 = 2 + 4 - 1 = 5$

The solution is therefore not degenerate either.

1. Constraint 1 is accompanied by a positive slack variable. As a result, the constraint is not legally binding and does not prevent the point from changing in any way. Little tweaks to the right side do not change the best solution because we have not used all of our resources optimise solution may not depend upon the constraints. This can alternatively be interpreted as meaning that there is an infinitely large permitted increase because the price associated with the constraint one is zero.





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The objective value will not change whether the constraint is increased or decreased by a unit. All other restrictions are legally binding and come with the corresponding shadow charges.

2. Dual price or shadow price We can see from the figures that an increase of one unit in constraint 4 rise in the objective value.

3. Decreased cost or opportunity cost: It tends to be seen from our outcomes that the diminished expenses for the non-fundamental factors are positive, demonstrating that they are not qualified to enter the premise as an expansion in the factors will cause an expansion in its goal capability coefficient, and since we are taking care of a minimization issue, we won't build the amount of the factors to try not to pay something else for transportation. In like manner, since there is no fundamental variable with an ideal worth of nothing and a relating decreased cost worth of zero too, we don't have an alternate ideal arrangement.

1)  $m + n - 1 = 2 + 4 - 1 = 5$

2)  $C_{ij} = U_i + V_j$

3) Find  $U_i$  and  $V_j$

4)  $d_{ij} = C_{ij} - U_i - V_j$

5) Optimal Solution was found using positive values of demand and supply using MODI or UV method.

#### Bi-Criteria Method

It can turn out that the weight is negative when we solve the issues. When the weight is negative, you are no longer increasing your opponent's payout but rather decreasing it. For instance, if the payoff for player A and player b is (5,2) and  $w_b = (-0.4, 0.6)$ , we set player A's payoff as a negative objective and apply the equation  $(-5) * |-0.4| + 2 * |0.6| = -0.8$  instead of  $5 *$  to calculate the weighted sum model as a new payoff directly  $(-0.4) + 2 * 0.6 = -0.8$ . The lack of a clear definition for the negative weight is the basis for this.

Hence, the weights allocated to each player's reward should, technically speaking, satisfy the following equation:

$$|x_1| + |y_2| + \dots + |y_n| = 1,$$

$n$  = number of players

Here, the equation can be reduced to  $|x_1| + |y_2| = 1$ . since in this thesis, we only talk about two-player games. And for this reason, in our thesis, we refer to bi-criteria rather than multi-criteria. The example that follows may help to further explain this technique.

#### Findings

- ❖ The total minimal cost value obtained after the last iteration in MODI method for transportation problem in petroleum refineries is ₹ 18850.
- ❖ The total minimal cost value obtained after the last iteration in MODI method for transportation problem in textile mill industry is ₹ 65800.
- ❖ The total minimal cost value obtained after the last iteration in MODI method for transportation problem in food industry were ₹ 52350.

The transportation problem approach we employed in this study assists in solving the majority of real-world transportation problems with multiple objectives and a range of imprecise and exact parameters using an interactive decision-making process. In order to solve multi-objective transportation issues with erratic cost, demand, and supply, this work will provide an interactive possibilistic linear programming problem technique. This technique simultaneously maximizes the chance of obtaining lower total costs and minimizes the risk of obtaining higher total costs while minimizing the most probable value of the uncertain total costs.

## CONCLUSION

Transportation problems plays a significant role in many industries and the transportation cost is considered as the key element for total cost structure in all the business. The irreplaceable infrastructure is transportation structure that depends on the social and economic development. Based upon the results and the findings of our research study, mathematical theories are applied for operations for transportation problems which is helpful for administration as





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well as production areas. The proposed transportation model employed in three different industries that assist them greatly for the efficient transportation plans among the sources and different destination cities in India by minimizing the total transportation cost by choosing the fastest path for optimal solution. Game theory is an area of applied mathematics that examines the rational elements' strategic behaviour. In other words, game theory is a set of analytical techniques that may be utilized to solve interactional and decision-making issues in the best possible way. The best member of an existing collection is chosen for a particular purpose in mathematics and computer science. To reduce expenses or increase revenue, several optimization techniques have been applied. From a specific vantage point, it is possible to claim that game theory is actually a form of optimization. The combined application of game theory and optimization methods has been examined in this study, and a new classification for studies that have been done in this field is offered.

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**Table 1 Minima and Maxima of row and column**

		Player M		Minima (Row)
		M <sub>1</sub>	M <sub>2</sub>	
Player L	L <sub>1</sub>	6	4	4
	L <sub>2</sub>	9	2	2
	L <sub>3</sub>	8	6	Maximin * 6
Maxima (Column)		9	Minimax * 6	
		Since Minimax = Maximin		
V = 6				





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**Table 2. Optimum result in Petroleum Refineries-MODI Method**

Origin	Destination					Supply
	City	Bengaluru	Chennai	Delhi	Ernakulam	
Hyderabad	235 10	220 45	75 30	60 20	105	
Mumbai	70 45	80	65	50	45	
<b>Demand</b>	55	45	30	20	150	

Total Minimal Cost = 235 x 10 + 220 x 45 + 75 x 30 + 60 x 20 + 70 x 45 = ₹ 18850

**Table 3. Optimum result in Textile Mill Factory-MODI Method**

Origin	Destination					Supply
	City	Bengaluru	Chennai	Delhi	Ernakulam	
Mumbai	500	380 55	210 25	340 15	95	
Gujarat	420 65	630	230	290 25	90	
<b>Demand</b>	65	55	25	40	185	

Total Minimal Cost = 380 x 55 + 210 x 25 + 340 x 15 + 420 x 65 + 290 x 25

**Total Minimal Cost = ₹ 65800**

**Table 4. Optimum result in Food Industry-MODI Method**

Origin	Destination					Supply
	City	Bengaluru	Chennai	Delhi	Ernakulam	
Hyderabad	580 30	600	190 15	320 25	70	
Mumbai	490 10	480 40	220	280	50	
<b>Demand</b>	40	40	15	25	120	

Total Minimal Cost = 580 x 30 + 190 x 15 + 320 x 25 + 490 x 10 + 480 x 40 = ₹ 52350







## High Frequency in *in vitro* Plant Regeneration through Nodal Explants of *Cassia auriculata* L. - a High Valued Therapeutic Plant

S. Jeevitha<sup>1</sup> and R. Anandan<sup>2\*</sup>

<sup>1</sup>Ph.D Research Scholar, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608002, Tamil Nadu, India.

<sup>2</sup>Assistant Professor (Biotechnology), Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608002, Tamil Nadu, India.

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### \*Address for Correspondence

#### R. Anandan

Assistant Professor (Biotechnology)  
Department of Genetics and Plant Breeding  
Faculty of Agriculture, Annamalai University  
Annamalai Nagar-608002  
Tamil Nadu, India.  
E. Mail: bioanandan@gmail.com



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### ABSTRACT

*Cassia auriculata* L., is a highly valued therapeutic shrub, widely used in Homeopathy, Ayurveda, Unani, and Siddha system of traditional medicine. An efficient, reproducible micropropagation protocol was accomplished using node explant of 30- d -old axenic seedling. *In vitro* response of nodal explants of *C.auriculata* was studied with different concentration as well as combinations of basal Murashige and Skoog (MS) media fortified with synthetic auxin and cytokinin. The differential response of single explants to different combination and concentration of auxin and cytokinin revealed that the shoot induction response was higher at a quantitative ratio of 1:2 (auxin:cytokinin). Maximum adventitious shoot induction and proliferation was achieved on MS medium fortified with 6-benzylaminopurine (BAP) and indole-3-acetic acid (IAA) at 1.0 mg/l and 0.5 mg/l, respectively. The number of average shoots per explants as well as mean shoot length was higher at this dose. Effects of different strength of MS supplemented either with indole-3-butyric acid (IBA) or  $\alpha$ -naphtheleneacetic acid (NAA) on rooting of adventitious shoots. Treatment with full strength of MS in addition to IBA at 1.0 mg/l registered higher rooting percentage coupled with a greater number of root formation and higher length of root per shoot. This maiden enquiry in *in vitro* response of *C. auriculata* brought out that BAP in blend with IAA for better shoot induction and full strength of MS (full MS) contains IBA for better root induction. The micropropagated plants had been transferred to pot mixture and effectively acclimatized in greenhouse



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with 70% survival rate. Thus, the demonstrated protocol could be subjected to germplasm conservation, large scale production at industrial level, and genetic engineering studies.

**Keywords:** *Cassia*; Nodal segments; Micropropagation; Acclimatization; Organogenesis

## INTRODUCTION

Tanner's senna (*Cassia auriculata* L. synonymously *Senna auriculata* L.) is an evergreen shrub belongs to Fabaceae family. It's a drought tolerant and widely cultivated in dry regions of India and Srilanka [1-2]. This has been extensively utilized in Indian traditional medicinal system such as Siddha, Ayurveda, Unani and Homeopathy. In ayurvedic, the leaves, flowers, barks, roots and immature fruits were mixed together to prepare an herbal tea known as avarai panchanga chooranam. A vast survey of literatures has confirmed the therapeutic potential of *C. auriculata* to cure rheumatism, liver disease, diabetes, urinary tract disorders, constipation, jaundice, ulcer, leprosy, skin and conjunctivitis [3-4-5]. The pharmacological properties exerted by senna includes nephroprotective, hepatoprotective, anti-inflammatory, anti-cancer, anti-bacterial, anti-microbial, and hyperlipidemic actives [6-7-8-9-10-11-12]. The various phytochemical ingredients present in *C. auriculata* are alkaloids, tannins, flavonoids, terpenoids, sugar saponins, phenols, quinines, proteins and steroids [13-14]. Several constrains which abruptly restrict the natural propagation of this plant at large scale includes indiscriminate reaping by folk medical experts, frequent grazing of cattle and livestock's, short term seed viability and poor germination frequency. Further, therapeutic plants are exported at enormous level due to its wide spectrum of phytochemical and pharmacological properties. Thus its increasing demands at commercial scale could not meet out with natural propagation through seeds. Therefore, micropropagation is a potential technique for mass propagation at commercial scale and conservation of medicinal plant species. Only few attempts have been made regarding the *in vitro* regeneration of different *Cassia* species; *C. angustifolia* [15], *C. siamea*[16] and *C. sophera* [17]. Thus, the current study demonstrates an earliest report on optimization of micropropagation protocol of *C. auriculata* using seedling node as explants.

## MATERIALS AND METHODS

### Explant Preparation

Matured, fresh, plumpy and dry pods were collected from M.R. Palayam village, Trichy district, Tamil Nadu, India. Seeds were extracted from pods, cleanse thoroughly using flowing tap water for 10 min to take off all dust particles and immediately treated with fungicide (2 % w/v) for 5–10 min in order to prevent fungal contamination. After that, the seeds were surface sterilized in a laminar air flow chamber with ethanol (70%) for 1 min and then 0.1% mercuric chloride (HgCl<sub>2</sub>) for 2 minutes. To eliminate any traces of the disinfectants, the sterilized seeds were washed four to five times with ddH<sub>2</sub>O. They were then incubated in hormone free MS (Murashige and Skoog) medium. The nodal explants were cut off from 45-d-old axenic seedling to carry out micropropagation studies in *C. auriculata*.

### Media Preparation and Culture Conditions

In all experiments, MS medium comprising of 0.8% (W/V) of agar and 3% (W/V) sucrose was used. 1N NaOH and 1N HCl was used to adjust the pH of 5.8 – 6.0. The culture media were autoclaved at 121°C at 1.06 kg cm<sup>-2</sup> pressure for 20 min. For adventitious shoot regeneration and rootings, cultures were incubated at 24±2°C and alternating photoperiods of 16 h of 50µmol m<sup>-2</sup>s<sup>-1</sup> of light provided by cool white fluorescent tube (40W, Phillips, India) and 8 h of darkness and at 50-65% relative humidity. All the chemicals and hormones were obtained from Hi-media, India and glassware was obtained from Borosil, India.



**Jeevitha and Anandan****Shoot Induction and Proliferation**

The nodal segments cultured on MS medium supplemented with 6-benzylaminopurine (BAP), indole-3-acetic acid (IAA) and kinetin at different concentration (0.5, 0.1, 0.2 and 0.3) and different combinations for shoot induction and proliferation. The cultures were maintained for 8 weeks by sub culturing it in same media once in two 2 weeks. Data regarding regeneration response, average number of shoots / explant and shoot length were recorded after 8 weeks. Qualitatively, the plantlets were divided into two groups: normal shoots with leaves and aberrant shoots with stunted growth. The experiment was carried out three times using a total of 20 explants for each treatment. The formula for regeneration response was given below: Regeneration response (%) = (Number of explants showing shoot regeneration / total number of explants cultured) × 100.

**Adventitious Root Initiation**

The *in vitro* regenerated shoots (4-6 cm) were transferred to rooting induction media comprising of half strength MS (half MS), full MS, full MS +  $\alpha$ - naphthaleneacetic acid (NAA) 0.5 mg/l, full MS + NAA (1.0 mg/l), full MS + indole-3-butyric acid (IBA) 0.5 mg/l, and full MS + IBA (1.0 mg/l) for root formation. After root initiation, sub-culturing was carried out on fresh medium after 2 weeks and was maintained up to 4 weeks. Then the average root numbers per propagule, average root length, and percentage of rooting were noted after 6 weeks of culturing. About 10 shoot were subjected to each treatment and the experiment was replicated three times.

**Hardening and Acclimatization**

The regenerated plants with normal shoot and roots were choice of selection for hardening. Such plant was gently removed from the medium and root was rinsed completely using running tap water to take off every adhered material. They were then transferred to sterilized paper cups consisting of sterilized sand, red soil and FYM in the ratio of 1:1:1 for plantlet hardening in greenhouse. In order to assure high humidity, the plantlets were enclosed with polythene bags, and holes were made for gaseous exchange. Then the plantlets had been given watering every three days. The survival rates of plantlets were calculated after 4 weeks at greenhouse conditions.

**Statistical Analysis**

Completely randomized design (CRD) was followed for all the experiments. Collected data were statistically analyzed using one way analysis variance (ANOVA) by adapting SPSS 10, software package. DNRT was used to assess the significance differences within treatment means at 5% probability. The result data were expressed as mean  $\pm$  standard error (SE).

**RESULT****Direct Shoot Organogenesis**

The nodal explants from 45 days old seedlings were cultured on MS media supplemented with various dosages of BAP, IAA and kinetin for induction of adventitious shoots and proliferation (Figure 1-a). Explants induced adventitious shoots after two weeks of culturing. According to the current study, without the presences of distinct intermediate callus phase, well-defined shoot could visible after six weeks of inoculation. The effectiveness of BAP alone recorded the highest regeneration response ( $52.28 \pm 1.4$ ) at the level of 1.0 mg/l (Figure 1b). Among the different growth regulators tested, BAP (1.0 mg/l) combined with IAA (0.5 mg/l) has found to be efficient for higher frequency ( $83.33 \pm 4.0$  %) of shoot induction with  $22.0 \pm 0.2$  mean number of shoots (Figure 1-c). Kinetin has induced maximum regeneration response of  $45.43 \pm 1.6$  % with  $3.0 \pm 0.6$  mean number of shoots and average shoot length of  $1.6 \pm 0.1$  cm at the concentration of 0.5mg/l from nodal segments (Figure 1-d). But, compared to BAP along with IAA, Kinetin had registered a lower shoot regeneration response (Table 1). However, proliferated and elongated shoots were obtained only after eight weeks of inoculation (Figure 1-e-g).



**Jeevitha and Anandan****Rooting of Regenerated Shoots**

*In vitro* regenerated shoots were transferred to a rooting medium comprise of either half MS or full MS with different concentrations of NAA and IBA. Four weeks after inoculation, root induction was found from the cut end portion of shoots (Table 2). However, numerous elongated roots were noticed after six weeks on the same culture media composition. The highest response of root induction ( $64.38 \pm 2.6$  %) and highest number of regenerated roots per shoot ( $8.7 \pm 0.4$ ) was archived from full-MS fortified with 1.0 mg/l IBA followed by effective rooting response ( $44.44 \pm 1.8$  %) with  $6.0 \pm 0.5$  roots per shoot was recorded with full MS + 0.5 mg/l IBA with a mean root length of  $1.0 \pm 0.05$ cm (Figure 1-h). MS fortified with NAA had minimal effect for root formation than IBA. All the other treatments exhibited lower root formation and delayed root initiation.

**DISCUSSION**

*In vitro* culture techniques provide an alternate way for the synthesis of phytochemicals which are employed in pharmaceutical sector for drugs production and producing secondary metabolites for medical consequence. Current-day pharmaceuticals are typically based on plant-derived metabolites, with new products being discovered constantly. Tissue culturing of medicinal plants is widely used to produce active compounds for herbal and pharmaceutical industries. Conservation of genetic material of many threatened medicinal plants also involves culturing techniques. Explant is material used as initial source of tissue culture. Tissue culture success mainly depends on the age, types and position of explants because not all plant cells have the same ability to express totipotency. In this technique have the more potential but the explant selection is critical for successful multiplication, which may entail adjusting culture medium conditions and balancing elements governing *in vitro* morphogenesis [18]. Initially, successful multiplication of shoots derived from nodal explants of *C. auriculata* was inoculated on MS medium supplemented with BAP and IAA for shoot initiation and proliferation. An earlier report revealed that BAP and IAA were induced higher regeneration frequency, shoot numbers and shoot length from *in vitro* clonal propagation studies in *C. sophera* [17] and *C. absus* [19]. BAP influences shoot organogenesis in *Adhatoda beddomei* [20]. The effects of BAP concentrations on shoot induction and multiplication, among the various BAP hormone concentrations used for multiple shoot formation, 0.9 mg/l BAP fortified MS medium produced the effective response, with an average of  $6.5 \pm 0.3$ cm shoots/explant and an average of  $2.9 \pm 1.6$ cm leaves/explants. BAP was proven to be more effective than kinetin for shoot multiplication. The result of BAP was among the different concentration (0.5, 1.0, 2.0 and 3.0 mg/l) were used for multiple shoot formation the best response was found on MS with 1.0 mg/l. BAP. Higher frequency of proliferated shoots was achieved in nodal explants cultured on MS media comprised with cytokinin than in media supplemented with cytokinin and auxin. Among the various concentration of BAP and IAA tested, IAA at 0.5 mg/l and BAP at 1.0 mg/l was found to be efficient for higher frequency ( $83.33 \pm 4.0$  %) of shoot induction followed by BAP (0.5 mg/l) and IAA 0.5 mg/l ( $75.45 \pm 2.5$  %). The ratio between auxin (IAA) and cytokinin (BAP) was 1:2 which resulted in higher percentage of shoot regeneration in *C. auriculata* under controlled condition. Where as in the absence of auxin but with cytokinin in the form of kinetin promoted shoot differentiation up to an enhanced level of 45.43%. Kinetin at 0.5 mg/l, induced  $45.43 \pm 1.6$  % of regeneration from nodal segments. It was established to be MS with kinetin at 0.5 mg/l produced a superior result. The maximum percentage of shoot regeneration was 41.69% when auxin was combined with kinetin. After two weeks of incubation in *Plumbago zeylanicain*, BAP and NAA supplied MS showed multiple shoots had raised form nodal explant [21]. Similar results were reported by [22] in *Baccopa moniera*. The virtual concentrations of cytokinins and auxins are frequently required for morphogenesis. Auxin in addition to cytokinin may promote shoot proliferation in some species. Organogenesis was possible in several plants by transferring cells to high cytokinin to low auxin media. Auxin's involvement in the medium, in blend with cytokinin, for shoot proliferation has previously been documented in many cases [23-24-25-26-27-28-29]. The ratio of auxin to cytokinin was 1:1. The result amply indicated that the shoot regeneration response was higher when auxin and cytokinin ratio was 1:2. Gbadamosi and Shaibu, 2013 [30] suggested that shoot elongation had been noted after 14 weeks, which exhibits an there were remarkable differences ( $P < 0.05$ ) in all seedling conditions, the greatest number of shoots per plantlet ( $4.0 \pm 00.00$ ) was obtained in MS media containing BAP (0.05 mg/l) + NAA (0.01 mg/l), BAP (0.075 mg/l) + NAA (0.01 mg/l), achieving



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a height of  $4.05 \pm 0.46$  cm and  $3.50 \pm 0.22$  nodes per Sprouted shoot. Hence, the BAP + IAA concentration of 1.0 mg/l + 1.00 mg/l produce higher number of shoots ( $6.80 \pm 0.748$ ) and shoot length per explants ( $3.58 \pm 0.490$  cm) per explants in *C. alata* (L.); followed by BAP 1.0 mg/l was observed as the superior response in *C. alata* [31]. BAP 1.0 mg/l in MS medium produces the best shooting ( $7.20 \pm 0.750$ ) and has the highest elongated shoots ( $4.60 \pm 1.020$ ).

Here, we examined the physiological and genetic determinants of root growth from developmental roots, are classified according to their three main categories namely primary, nodal and lateral roots and also various types of rooting media to be used for cassia species rooting are important aspects to consider. With different kinds of media used such as NAA and IBA and their combination, the most suitable media for rooting must be standardized. The roots were strong, thick, and well-developed secondary branches. IBA has been shown to be superior to other auxins in root formation in various plant species such as *Cunila origaloides* [32], *Clitoria ternatea* [33] and *C. siamea* [16], *Gerbera Jamesonii* [34], *Pterocarpus marsupium* [35], *Oxystelma esculentum* [36]. The response of IBA on rooting from *in vitro* raised shoots of *C. angustifolia* in MS medium supplementing with activated charcoal 1%, followed by four weeks cultured plant to hormone free half MS medium, indicated that IBA  $1\mu\text{M}$  was maximum frequency of root formation (52%), number of roots ( $3.6 \pm 0.29$ ), and root length ( $3.9 \pm 0.40$ ) resulted in the highest of rooting frequency 52%, root length ( $3.9 \pm 0.40$ ), and root number ( $3.6 \pm 0.29$ ) in MS medium supplanted with  $60\mu\text{M}$  IBA [15]. Anandha Prabhakaran *et al.*, 2018 [31] observed that on MS medium with BAP (1.0 mg/l) level, the optimum number and shoots per explant were achieved, and the proliferation of roots occurred in the blends of IAA (1.0mg/l) and BAP (1.0mg/l). On MS medium treated with IAA root initiation was shown to be established. For acclimatizing, the *in vitro* propagated well rooted *C. alata* was transferred to the greenhouse successfully. Regenerated shoots were rooted in half MS medium with  $0.98\mu\text{M}$  IBA with proper handling techniques. Plantlets of *Clitoria ternatea* were effectively acclimatized and grown in soil and they morphologically resembled the maternal plant in appearance [37]. It is perceived that full strength of MS supplemented with IBA at higher concentration induced more rooting percentage coupled with more number of roots per adventitious shoot. The average length of root was also higher at this dose. Thus, the superiority of IBA in inducing roots and its elongation was well evidenced. IBA was more potent than NAA in inducing root characteristics of *C. auriculata*. The root formation was observed within one week in MS media supplemented with IAA (1.0 mg/l) and IBA (1.0 mg/l). The plant attained the greatest number of roots ( $7.00 \pm 0.98$ ) and root length ( $5.21 \pm 0.58$ ) in the MS supplied with 1.0 mg/l IAA and 1.0 mg/l IBA with a total number of roots ( $5.81 \pm 0.61$ ) and root length ( $6.99 \pm 0.89\text{cm}$ ). The effects of IAA and IBA on root induction were investigated and accompanied within 7 days root formations were observed in MS media supplemented with 1.0 mg/l IAA and 1.0 mg/l IBA. The most roots ( $7.00 \pm 0.98$ ) were found among them [21]. Highest rooting (63.93%), primary root number per shoot (4.74) and maximum longest primary roots (34.67 mm) were observed with IBA (2.0 mg/l). When the come across rooting percentage and root number, IBA had shown significant results than NAA was observed in *Jasminum nudiflorum*. In the while, days of root initiation was observed as low (22.00) with 2.0mg/l NAA. The effective survival of rooted micro shoots (89.67%) was achieved with IBA (2.0 mg/l) under *ex vitro* condition [38]. The IBA stimulating and positive effect on root initiation was reported in *Adhatoda vasica* [39]. The micro propagated plants had been transferred to pot mixture and effectively acclimatized in greenhouse with 70% survival rate. Successful hardening was achieved by *Lychnophora pinaster* [40], *Alpinia galanga* [41], *Scutellaria bornmuelleri* [42], *Nanorrhinum ramosissimum* [43].

**CONCLUSION**

The projected micropropagation protocol was the first report in *C. auriculata* exhibiting the highest adventitious shoot and root regeneration frequency. This protocol can be utilized for large scale multiplication at industrial level. In the mean while, it is also used for germplasm conservation. These plant parts could serve as a valuable source for various biochemical characterizations of active compounds and which would possibly increase the local medical/experts to actively involved in folk and modern medical health care and also in this protocol is useful for industrial propagation of the species in order to produce secondary metabolites. The pharmacological bases for the



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disorders such as nephroprotective, anti-cancer, hepatoprotective, hyperlipidemic, anti-inflammatory, anti-microbial, anti-bacterial, actives and drug production to cure the disorders.

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**Table 1 Effect of different levels of BAP, Kinetin with IAA on adventitious shoot regeneration from nodal segments of *Cassia auriculata***

Phytohormones (mg/l)			Regeneration response (%)	Mean no. of shoots/explants	Mean shoot length (cm)	Morphogenic response
BAP	Kinetin	IAA				
0.0	0.0	0.0	0.0 ± 0.0q	0.0 ± 0.0i	0.0 ± 0.0j	–
0.5	-	-	35.45 ± 1.2hi	3.0 ± 0.5f	1.5 ± 0.1ef	+
1.0			42.28 ± 1.4fg	5.0 ± 0.2e	1.4 ± 0.2fg	+
2.0	-	-	25.43 ± 1.2l	3.0 ± 0.1f	1.4 ± 0.1fg	+
3.0	-	-	22.00 ± 1.3n	3.0 ± 0.3f	1.0 ± 0.1d	+
0.5	-	0.5	75.45 ± 2.5b	28.0 ± 0.2a	2.8 ± 0.1b	++
1.0	-	0.5	83.33 ± 4.0a	22.0 ± 0.2b	4.0 ± 0.1a	++
2.0	-	0.5	65.74 ± 1.3c	12.0 ± 0.2c	2.5 ± 0.1c	+
3.0	-	0.5	57.87 ± 1.2d	10.0 ± 0.2d	2.0 ± 0.1d	+
-	0.5	-	45.43 ± 1.6e	3.0 ± 0.6f	1.6 ± 0.1e	+
-	1.0	-	36.35 ± 1.5h	2.0 ± 0.5g	1.5 ± 0.1ef	+
-	2.0	-	27.38 ± 1.3k	2.0 ± 0.5g	1.5 ± 0.1ef	+
-	3.0	-	16.44 ± 1.2o	1.2 ± 0.1h	1.5 ± 0.1ef	+
	0.5	0.5	41.69 ± 1.0g	5.0 ± 0.4e	2.0 ± 0.1d	+
	1.0	0.5	34.26 ± 1.5ij	3.0 ± 0.2f	2.0 ± 0.2d	+
	2.0	0.5	24.33 ± 1.3lm	2.0 ± 0.1g	1.0 ± 0.1h	+
	3.0	0.5	14.25 ± 0.4p	2.0 ± 0.1g	0.9 ± 0.0i	+

Means having the same letter in columns are not significantly different by Duncan's multiple range test ( $P < 0.05$ ). Each data represent mean ± SE of three independent experiments

**Table 2 Effect of different levels of MS, NAA and IBA on rooting of adventitious shoots of *C. auriculata***

Culture medium	Rooting (%)	Mean no. of roots/shoot	Average root length (cm)
Half MS	10.40 ± 0.5f	1.0 ± 0.7d	0.50 ± 0.03 f
Full MS	14.25 ± 0.6e	1.0 ± 0.6d	0.98 ± 0.05d
Full MS+NAA (0.5 mg/l)	26.62 ± 1.2d	3.0 ± 0.1c	1.20 ± 0.07b
Full MS+ NAA (1.0 mg/l)	35.50 ± 1.6c	3.0 ± 0.1c	0.70 ± 0.04e
Full MS+IBA (0.5 mg/l)	44.44 ± 1.8b	6.0 ± 0.5b	1.00 ± 0.05c
Full MS+IBA (1.0 mg/L)	64.38 ± 2.6a	8.7 ± 0.4a	6.50 ± 0.5a

Values followed by the same letter are not significantly different at  $P < 0.05$  according to Duncan's multiple range tests. Each data represent mean ± SE of three independent experiments







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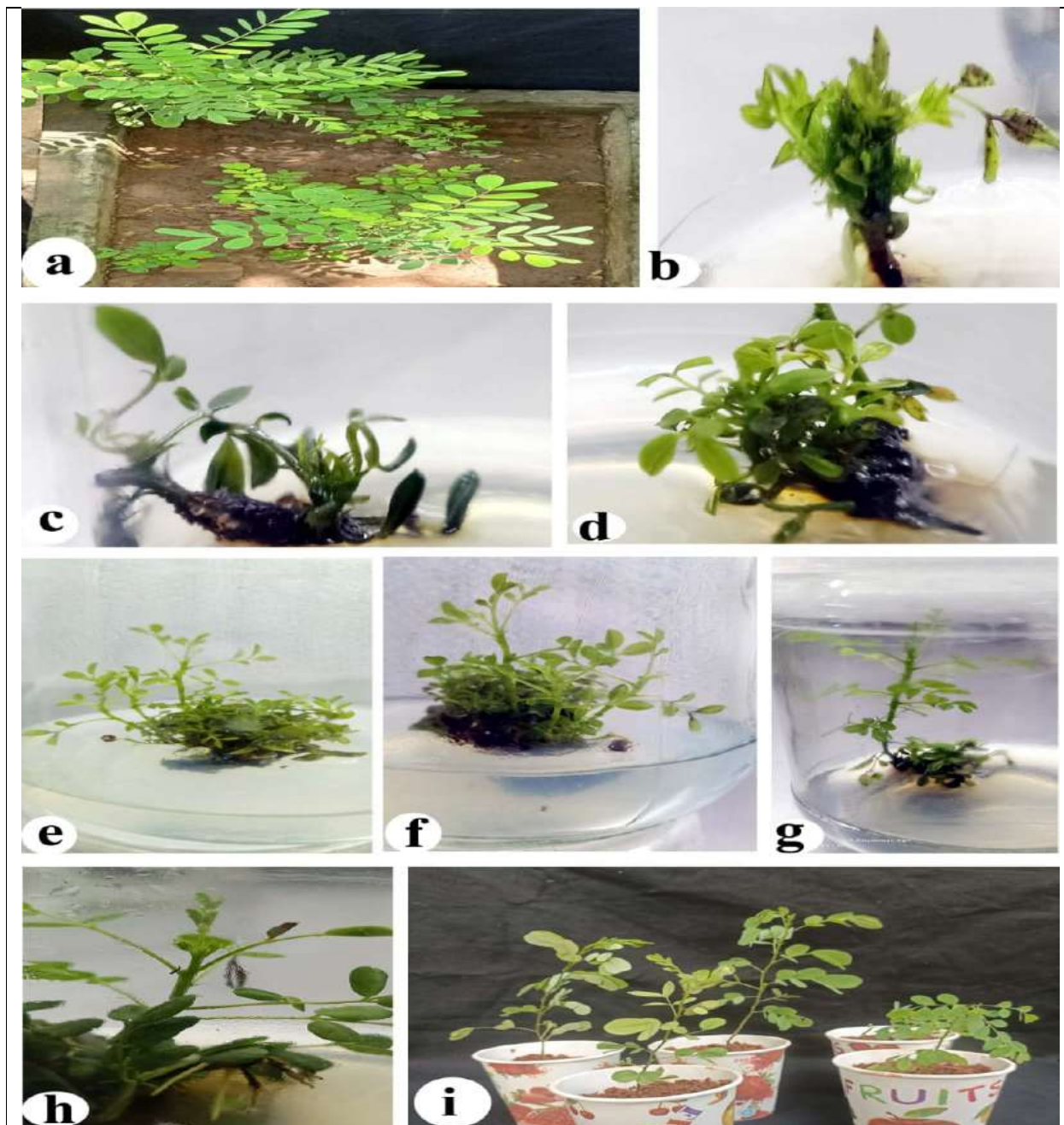


Figure 1. *In vitro* shoot regeneration and plant acclimatization in *C. auriculata*. Stock plants established in pot culture (a), shoot initiation from node on MS with BAP (1.0 mg/l) and MS with BAP (1.0 mg/l) and IAA (0.5 mg/l) after 2 weeks (b) & (c), shoot proliferation on MS with BAP (1.0 mg/l) and IAA (0.5 mg/l) after 4 weeks (d) and 6 weeks (e & f), well developed elongated shoots after 8 weeks (g), Rooting of shoots on MS using IBA (1.0 mg/l) after four weeks (h), Somatic plants acclimatized in pot mixture (i). Scale bars (a=1cm, b-g =0.5cm, h & i= 1 cm).





## Verification of K-Anonymity Model using Mapreduce for Big Data Privacy-Preserving in D2D Communication

Shelly Bhardwaj<sup>1\*</sup>, Abhishek Kumar Mishra<sup>2</sup>, and Rahul Kumar Mishra<sup>3</sup>

<sup>1</sup>Research Scholar, Department of Computer Science and Engineering, IFTM University, Moradabad, Uttar Pradesh, India.

<sup>2</sup>Associate Professor, Department of Computer Science and Engineering, IFTM University Moradabad, Uttar Pradesh, India

<sup>3</sup>Professor (Director), School of Computer Science and Applications, IFTM University Moradabad, Uttar Pradesh, India

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### \*Address for Correspondence

#### Shelly Bhardwaj

Research Scholar,  
Department of Computer Science and Engineering,  
IFTM University, Moradabad,  
Uttar Pradesh, India.

E. Mail: shellybhardwaj29@gmail.com



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### ABSTRACT

Due to the extraordinary advantages of quick transmission as well as the reaction on data delivery, including its variety of applications, device-to-device (D2D) communication has attracted a lot of research interest as a distinctive and exciting innovation for 5G communications networks throughout the world. Big data analytics offers new advantages but also poses a significant barrier to D2D communications since the data frequently contains sensitive personal or corporate information that is vulnerable to leaking. Today's climate has almost made privacy protection a must for D2D services, yet technology advancements have left a substantial research gap. By implementing the (k)-anonymity model using Map Reduce, the authors developed a novel method for ensuring privacy in huge data in D2D communication. In this approach, enormous D2D datasets are handled via the (k)-anonymity paradigm, and various massive datasets are categorised and grouped using Map Reduce. The findings of this experiment and analysis demonstrate that this recommended prototype is more durable and workable than earlier approaches in terms of huge data secrecy, lowest data or information losses, and less computation time.

**Keywords:** Big Data, Data Security, D2D Communication, K- anonymity, Privacy Preserving.





## INTRODUCTION

Modern communication devices and cutting-edge technology are drastically altering people's lives all around the world. These modern technology, such as cell phones, computers, and tablets, are assisting people in a variety of ways, including texting and calling, exchanging image files, and many other things. With the aid of the internet, individuals share this kind of massive amounts of data on a daily basis [1], [2]. A potential approach for 5G cellular networks is device-to-device (D2D) communications. D2D communications have been shown to improve network performance in terms of spectrum efficiency, power dissipation, cellular coverage, and communication capacity and latency. The amount of data and traffic generated by mobile networks has increased significantly in recent years due to the improvement in the quality and availability of multimedia services. To transfer interesting files locally, users choose to use wireless short-range D2D connection.

According to recent studies based on their social and mobile behaviours, users prefer to communicate content offline via D2D communication. On the other hand, earlier studies on the subject have relied on small-scale data analysis and the development of algorithms for particular user groups. Given the rapid growth of mobile users and devices, D2D technology should be able to adapt to the transmission of enormous amounts of data to a large number of users. This paper introduces a (k)-anonymous D2D big data privacy-preserving architecture based on Map Reduce to provide speedy sharing, high accuracy on deliveries, efficient and intelligent distribution, and right content promotion to a large number of users. Big data technology presents new opportunities for sharing D2D communication capabilities, but it also presents challenges for the conventional data analysis of mobile user groups. The dimensionality, heterogeneity, and complexity of the data worsen the security and privacy problems associated with D2D communication. Big D2D data frequently includes a user's or an event's private information. Private user information may be leaked as a result of the mining, analysis, and processing of D2D big data. There are a large number of sensing nodes in D2D communication systems that continuously convey a large amount of data about citizens, organisations, and national infrastructures, much of which contains sensitive information. If they are not sufficiently protected throughout data mining, analysis, and processing, these sensitive data may be disclosed.

The next phase of cellular technology, which will include wireless telecommunication infrastructure, will have cutting-edge innovations like D2D telecommunications. Datasets used in D2D telephony must be protected in order to head off damaging attacks. Meanwhile, encrypted D2D transmissions between portable phones continue to be difficult. In this paper, researchers describe a technique for controlling D2D data accessibility through the use of an attribute-rooted encryption strategy to ensure the privacy of large datasets during the communication process. A General-Trust grade provided by central networking, anLocal-Trust degree determined by a device, or perhaps both in real-time, might be used to accomplish this new concept.

## LITERATURE REVIEW

In [3], U. N. Kar *et al.* conducted a review on D2D communication within a mobile cellular networking environment. D2D telecommunication, which offers much-reduced delay for consumer interaction, is anticipated to serve a large part in emerging cellular infrastructures. Either licensed or unlicensed bandwidth could be used by this novel concept. It represents a fresh improvement on the established wireless telecommunication concept. Nevertheless, despite its advantages, there are several economic but also technological problems that must be overcome before it is integrated into the wireless environment. The basic traits of D2D telecommunication are covered throughout this article, along with its use contexts, framework, and technological aspects, including current investigation fields. The usage of D2D within cellular networking has indeed been examined across several researches. For instance, to lower the same expenses of ground controlling headquarters resulting from the requirement of organizing cars throughout vast numbers as coding peddlers, the researchers of [4] suggested a machine-learning-rooted coding dissemination system. This method chooses cars with a greater covering ratio as well as dependability as coding distributors. Through suggesting a process orchestration as well as datasets aggregation architecture which may provide solutions for organizing the datasets including merging data packages. Liu *et al.* minimized the operation reply



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latency as well as duplication of datasets in [5]. In [6], B. Yang *et al.* discussed an automated repairing scheme for D2D telecommunication routing in real-time. For improving the secrecy along with the communication quality effective maintenance of the cellular network is very essential. Owing to increased client activity, communication datasets easily cross the buffer's edge, decreasing the amount of protected dataset information. The issue of inadequate telecommunication secrecy is caused by the fact that previous restoration techniques primarily focus on the features of covering dataset information, neglecting the influence of networking infrastructure data transfer latency as well as packet failure throughout estimation. However, this approach is inefficient in the case of larger datasets translation on the limited bandwidth channels owing to the constant increment in the number of consumers all around the world. Many adaptations to the k-anonymity model have been developed since Sweeney *et al.* [7] first presented it to solve its flaws. For instance, [8] suggests t-closeness and [8] suggests l-diversity, both of which defend against inference-based attacks. None of the models that have been suggested take into account combining different anonymization processes.

Zhaohao *et al.* [9] explained about Privacy and security in the big data age have drawn significant attention in academia and industry. This article examines privacy and security in the big data paradigm by proposing a model for privacy and security in the big data age and classification of big data-driven privacy and security. It extends the big data body of knowledge, highlights important research topics, and identifies critical gaps through statistical analysis of big data and its impacts on privacy and security based on literature data published from 1916 to 2016. It also presents state-of-the-art privacy and security based on the analysis of SCOPUS data from 2012 to 2016. The result shows that privacy and security face new challenges and require new policies, technologies, and tools for protecting privacy in the big data paradigm. The proposed approach might facilitate the research and development of privacy and security, and big data-driven privacy and security in terms of technology, governance, and policy development. In [10], Jordi Domingo-Ferrer *et al.* explained the challenges raised by big data in privacy-preserving data management. First, we examine the conflicts raised by big data concerning preexisting concepts of private data management, such as consent, purpose limitation, transparency, and individual rights of access, rectification, and erasure. Anonymization appears as the best tool to mitigate such conflicts, and it is best implemented by adhering to a privacy model with precise privacy guarantees. For this reason, we evaluate how well the two main privacy models used in anonymization (k-anonymity and  $\epsilon$ -differential privacy) meet the requirements of big data, namely composability, low computational cost, and linkability. Shuai Li *et al.* [11], discussed about the Internet of things (IoT) has become a significant part of our daily life. Composed of millions of intelligent devices, IoT can interconnect people with the physical world. With the development of IoT technology, the amount of data generated by sensors or devices is increasing dramatically. IoT-based big data has become a very active research area. One of the key issues in IoT-based big data is ensuring the utility of data while preserving privacy. In this paper, we deal with the protection of big data privacy in the data storage phase and propose a searchable encryption scheme satisfying personalized privacy needs. Our proposed scheme works for all file types including text, audio, image, video, etc., and meets different privacy needs of different individuals at the expense of high storage costs. We also show that our proposed scheme satisfies index In distinguish ability and trapdoor In distinguish ability.

In [12], A. Ozhelvaci *et al.* discussed another article on handover secrecy as well as D2D telecommunication within the 5G (5th Generation) HetNets. Technical specifications for these currently being developed coming-generation cellular communication technologies are set by the 3GPP (Third-Generations and Partnership-Project (3GPP)). This is indeed known as 5G cordless cellular networking, which has emerged as the model for bringing not just answers to the growing need for vast amounts of dataset transmission but also enormously linked objects, for example, the IoT (Internet-of-things) and many other additional activities. Additionally, 5G is anticipated to provide the quickest, best dependable networking connection to accommodate vast dataset traffic as well as terminals that are heavily linked with minimal delay as well as excellent capacity. However, this approach contains numerous limitations namely the more computational complexity. In [13], X. Chen *et al.* discussed the investigation growth scheme on the big datasets secrecy technique. A big dataset has a tremendous impact on folks' life as a fresh but dynamic area of financial growth, a creative accelerator of societal growth, as well as a smart instrument for defining country competence. Increased adoption of big dataset uses is, nevertheless, being hampered more and more by big data protection due to



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increased societal knowledge of the worth of dataset and the rapid growth of big dataset platforms. A single big data privacy paradigm has not yet been developed, but as big dataset technologies as well as architecture continue to advance, academics continue to have divergent views on that fundamental concept as well as essential elements of big dataset security.

In [14], Yi Liu *et al.* explained the rapid development of 5G networks, big data, and IoT, data in many environments is often continuously and dynamically generated with high growth rates, just like a stream. Thus, we call it a big data stream, which plays an increasingly important role in all walks of life. However, how to verify its authenticity becomes a challenge when this big data stream is in an untrusted environment such as a cloud platform, for it faces the problems just like delay-sensitive, unpredictable data size and privacy leaks caused by third-party audits. To solve these problems, we propose a new authenticate data structure named privacy-preserving adaptive trapdoor hash authentication tree (P-ATHAT) by introducing trapdoor hash and BLS signature to the Merkle hash tree. The P-ATHAT scheme realizes real-time verification of the data stream and can dynamically expand its structure as the data stream arrives. These characteristics not only shorten the authentication path but also solve the single point failure problem of the conventional authentication trees and enhance the robustness of the scheme. Moreover, we construct a homomorphic verification scheme above the tree structure to solve the privacy leakage problem in the third-party audit. Finally, security analysis and detailed experimental evaluation are performed on the proposed scheme, both results demonstrate that it is desirable for big data stream authentication and privacy-preserving in practical application. The authors of [15] make a suggestion on how to combine differential privacy and k-anonymity in a single data release. The authors suggest selecting a sample at random from the initial dataset and processing this sample to achieve k-anonymity before publication in order to add a stochastic component to k-anonymity (a deterministic system). Differential privacy can also be achieved thanks to the uncertainty introduced by randomly choosing users to be included in the disclosed (yet anonymized) dataset. If the information for each person contained in the release cannot be discerned from at least k-1 other individuals whose information appears in the release, the release is said to have the k-anonymity [16, 17] property. A database, in the context of k-anonymization problems, is a table with n rows and m columns, where each row of the table represents a record related to a specific person from a population and the columns of the table serve as the data.

A novel set of k-anonymity rules with roots in clustering for secrecy maintenance was the subject of research by S. Ni *et al.* [18] K-anonymity is a practical idea that may be used in a variety of ways to protect privacy while disclosing information. They favour local generalisation because it results in less data loss. Nevertheless, these techniques struggle to work well when dealing with enormous amounts of data since they take a lot of time. To address these issues, the research offers a different swarm K-anonymity technique that is likewise multiplexing optimised. Our results demonstrate that such methodology performs best in terms of data loss as well as speed when compared to conventional strategies and Incognito methods. Another adaptive k-Anonymity strategy was investigated by K. Arava *et al.* [19] for the confidentiality of cloud datasets. Cloud services require a high level of information security for information exchange. Some consumers find it challenging to use contemporary technological platforms for encrypted communication in business healthcare applications. Although k-anonymity and "data analysis employing data mining technologies" were important, extensive research has been done on encrypted datasets of sensitive data. The term "k-anonymity" in the context of vulnerable data protection refers to delicate private information that has been released and could, therefore, be linked to the identification of the k-1 and other users. To achieve k-anonymity, clustering techniques are used. Yet, it is challenging to identify the right seeding numbers for capturing relevant data that can be anonymous at the same time to reduce data loss. The research employs the flexible k-anonymity strategy and adheres to a thorough methodology for seeding the selection of how to group all the data. With the goal of reducing data loss as well as runtime, early work is compared and assessed.



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## METHODOLOGY

### Design

The term "5G" refers to the fifth generation of cellular networking, which mainly utilises device-to-device (D2D) communication. Once the communication channel has been established, datasets can be transferred directly without the use of intermediary devices. This can improve spectrum use, reduce the demand for data on the telecommunication platform's network architecture, and significantly enhance internet bandwidth. D2D communication was developed with the purpose of broadcasting important or interesting info to numerous other phone devices as well as requesting nearby peers for desired material. Throughout this procedure, a sizable amount of varied data is gathered. The possibilities, including the research value of looking through and using such huge, intricate databases, are vast. Threats to privacy are a major factor in D2D communication. The several stages of the life-cycle of huge datasets are depicted in Fig. 1, including dataset generation, storage, and processing. The framework for massive datasets and a threat prototype for D2D (Device to Device) communication for privacy preservation are shown in Fig. 2.

### Instrument

The verification and secrecy assessment of the suggested scheme is done by utilizing Hadoop, which is indeed a Map Reduce-rooted software paradigm. The entire testing procedure of the proposed scheme is done by utilizing the described system structure: AMD Ryzen 7, 64-bit operating system, SSD (Solid State Drive) 512 GB and integrated with the 16 GB RAM. Map Reduce is indeed a pragmatic and faster software paradigm as well as a programming prototypical utilized for processing gigantic datasets. This Map Reduce package functions within two diverse stages such as Map as well as Reduce. The overall mapping jobs deal with the breaking as well as mapping of entire datasets while reducing the jobs shuffle as well as minimization of the entire data for effective segregation of a large amount of the datasets.

### Data Collection

In this part, the researchers provided motivational examples of how to apply the proposed strategy. The major goal of the author is to increase secrecy in massive datasets D2D communication contexts, particularly since handling enormous amounts of data becomes more complicated and challenging in the present era. Below is a description of the whole implementation as well as the verification scenario. Table 1 illustrates the sources of the datasets as well as the outcomes of the mapper. As a result, a viable privacy-preserving architecture for D2D multimedia applications with massive data is necessary. Table 2 illustrates the grouping of the outcome data of Table 1 as likeness class.

### Data Analysis

Equivalence class (EC) and information are divided into a number of dataset block segments by Map Reduce, which iterates the subsequent steps concurrently. When  $q$  increases, the projected sample size decreases until all data is attributed to the same EC. It's important to keep in mind that each EC can only have a fixed number of  $q$  parameters throughout this scenario. These ECs are included in master files, along with newly produced ECs to which all Map Reduce tasks are allocated. Every EC in the approach is included in this global document, and the drivers add any newly created EC to the end iterations. Each cycle's mapper, combiners, and reducer each serve a different purpose.

## RESULT AND DISCUSSION

The experiment was carried out using Hadoop, a software framework that implements Map Reduce, and the characteristics of the data transmission of the algorithms studied were examined by looking at the validity of data. This experiment uses two datasets, Poker Hand Datasets. The poker hand dataset consisted of 11 numeric attributes, with the odd and even QI having ranges of 1-4 and 1-13, respectively, and the SA being variable classes. The dataset was divided into tiny blocks using the pre-processed Map Reduce. Synthetic Datasets Using these two pieces of data, a synthetic dataset [10] was created. One had 10 million data records totalling 1.4 GB in size, whereas the other had





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10 million records totalling 14 GB. A collection of data had 10 clusters with a random mean and bias, 15 dimensions, and 15 clusters. Each dimension in the mapper was scaled to 5 M100 M, and datasets of 10 M and 100 M were split into 70 copies and 300 fragments, respectively. The cut was made using the midpoint value and the longest side of the bounding rectangle, which were both set to  $q/2$ .

## CONCLUSION

For categorising and organising the huge data datasets, the authors use distributed Map Reduce, which increased computer efficiency and cut down on calculation times. We used the (k)-anonymity prototype for the secrecy framework to defend ourselves against various adversaries around the world. Results of the recommended paradigm show that this framework is more effective in terms of D2D communication secrecy for large volume datasets. The study and experimentation results show that this proposed prototype is more practical and robust than the existing techniques in terms of huge data secrecy, lowest data or information losses, and fastest computing times.

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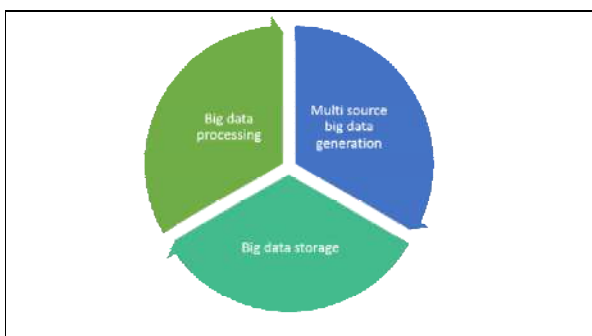
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**Table 1 illustrates the sources of the datasets as well as the outcomes of the mapper.**

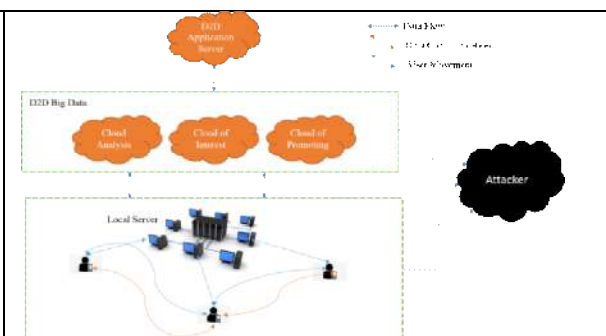
S. No.	Source of the data	Outcome of the mapper	
1	[1:5][8:9]	1, {S <sub>1</sub> , 1}, 1	11, {S <sub>1</sub> , 1}, 1
2	[1:5][8:9]	1, {S <sub>1</sub> , 1}, 1	10, {S <sub>3</sub> , 1}, 1
3	[1:5][8:9]	6, {S <sub>1</sub> , 1}, 1	13, {S <sub>1</sub> , 1}, 1
4	[1:5][8:9]	6, {S <sub>3</sub> , 1}, 1	11, {S <sub>1</sub> , 1}, 1
5	[1:5][8:9]	4, {S <sub>2</sub> , 1}, 1	10, {S <sub>2</sub> , 1}, 1

**Table 2 Illustrates the grouping of the outcome data of Table 1 as likeness class.**

Quasi #1	Quasi #2	Sensitive
1	11	S <sub>1</sub>
1	10	S <sub>3</sub>
6	13	S <sub>1</sub>
6	11	S <sub>1</sub>
4	10	S <sub>2</sub>



**Fig. 1 illustrates the diverse phases of the life-cycle of the big datasets, for instance, generation of the datasets, storage as well as processing.**



**Fig. 2 Illustrates the big datasets framework as well as threat prototypical for the D2D (Device to Device) communication for privacy-preserving.**







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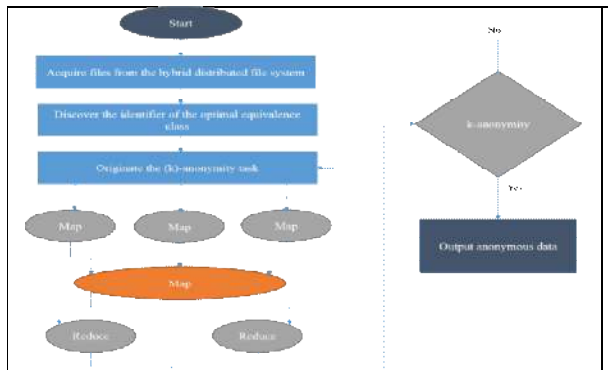


Fig. 3. Illustrates the suggested (k)-anonymity set of the rules-based framework using MapReduce.

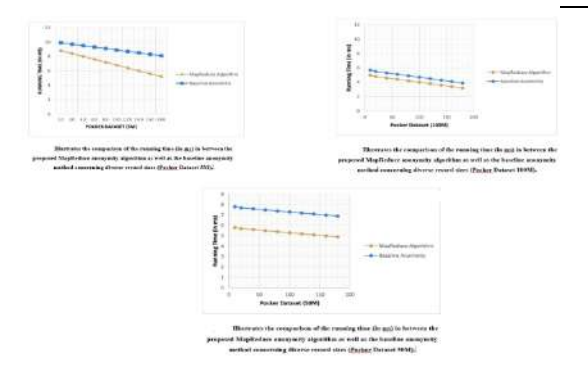


Fig. 4. Illustrates the comparison of the running time (in ms) in between the proposed MapReduce anonymity algorithm as well as the baseline anonymity method concerning diverse record sizes (Pocker Dataset 5M, 50M and 100M)

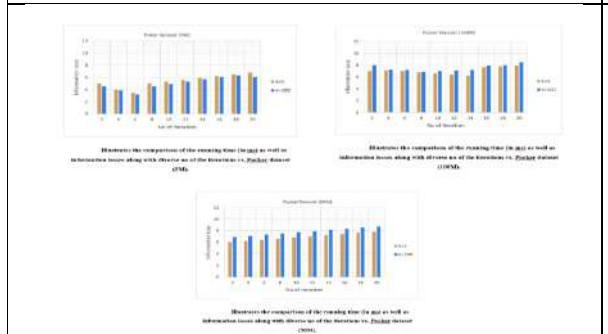


Fig. 5 Illustrates the comparison of the running time (in ms) as well as information losses along with diverse no of the iterations vs. Pocker dataset (5M, 50M and 100M).

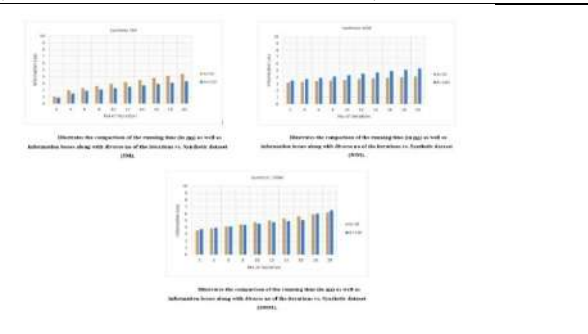


Fig. 6 Illustrates the comparison of the running time (in ms) as well as information losses along with diverse no of the iterations vs. Synthetic dataset (5M, 50M and 100M).





## A Study on the Solid Relationship between Entrepreneurial Passion and Business Performance among MSME Units in Kollam District

Gayathri.H<sup>1\*</sup> and Thriveni Kumari<sup>2</sup>

<sup>1</sup>Research Scholar, School of Management, Presidency University, Bengaluru, Karnataka, India.

<sup>2</sup>Associate Professor, Presidency University, Bengaluru, Karnataka, India.

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### \*Address for Correspondence

**Gayathri.H**

Research Scholar,  
School of Management,  
Presidency University,  
Bengaluru, Karnataka, India.  
E. Mail: gayathripadma26@gmail.com



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### ABSTRACT

Entrepreneurial success is the main aim of all MSME business units and it is clearly the strong positive emotion of an entrepreneur while doing the business. The research seeks to explore how entrepreneurial passion affects performance of selected MSME units in registered as Manufacturing and Service units at Kollam district in Kerala. The research aims to find the positive significant relation between entrepreneurial passion and the performance of business considering the main types of entrepreneurial passion such as passion for invention, passion for founding and passion for development. The outcomes of entrepreneurial passion are considered here as financial stability, market position and good social network. The study considered newly registered MSME units in Kollam district of Kerala during the time period 2017 to 2020. The structured questionnaires were supplied among 300 entrepreneurs. The study will analyse the data using descriptive statistics and regression analysis. The study's conclusions will be beneficial for the entrepreneurs in the region as it will provide them with valuable insights into how their passion can contribute to the success of their business.

**Keywords:** Entrepreneurial passion, MSME units, Business performance, Domains of passion, Kerala

### INTRODUCTION

Passion is the fire inside us which leads us to success. Passion is a driving force for motivating a person and being success in his business. Passion has been examined extensively across disciplines and domains, including entrepreneurship, as a key factor in triggering or driving human action.



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Entrepreneurial passion is increasingly being recognized as a vital element in deciding the formation of entrepreneurial intentions among entrepreneurs (Biraglia and Kadile, 2017), The persistence and commitment level of entrepreneurs at the beginning stages of their start up business (Breugst *et al.*, 2012) and the occurrence of inventions and radical innovations among entrepreneurs (Strese *et al.*, 2014) addressing the development of entrepreneurial enthusiasm is a very conflicting task. In theory, entrepreneurial passion methods are single sided giving more emphasis on the outcomes. This might be due to the immaturity and lack of legitimacy of the entrepreneurial passion notion, which need pioneering researchers demonstrating its influence and relevance so as to raise its legality (Cardon *et al.*, 2012). In order to improve entrepreneurship theory, the theoretical frame requires a thorough knowledge of entrepreneurial passion's genesis. In practice, concentrating on the after effects of entrepreneurial passion rather than its origin inhibits our capacity to assist entrepreneurs and related people in developing entrepreneurial passion and reaping the benefits of understanding that it matters.

Most of the studies on passion concentrates on entrepreneur's passion in connection to the business units (Baum & Locke, 2004; Chen *et al.*, 2009) and the after effects that are behavioural (Murnieks *et al.*, 2011) and do not have any direct focus on success of the enterprise(Murnieks *et al.*, 2011; Vallerand *et al.*, 2007).Even studies that looked at the correlation between passion and performance did so indirectly by looking at the effect of passion on business success as a moderating factor to other antecedent factors (De Clercq, Castaer, & Belausteguigoitia, 2011) or considering as an antecedent confounding variable to other variables that explain its after effects (De Clercq, Castaer, & Belausteguigoitia, 2011). As a result, this study looked at the link between entrepreneurial passion domains (enthusiasm for developing, inventing and starting), as described by Cordon et al. (2013). This is because, in the process of cultivating entrepreneurial enthusiasm, particularly among entrepreneurs, the love for developing new things and starting new organizations seems to matter more and is more urgent (Fitzsimmons & Douglas, 2011).

The socio economic growth of India is depending mostly on the MSME (Micro, Small, and Medium Enterprises sector, as the contribution of these units towards GDP is the valid proof. The level of exports by these MSME units shows an increasing trend which also helps in increasing the attainment of GDP. By the growing trend of these manufacturing as well as service sector industries registered under MSME act, the economic, infrastructural and social development of rural and urban areas has been increasing massively. The quality of life of people in these rural sector also improved by getting new jobs and societal development. Micro, Small and Medium Enterprises are classified as Manufacturing Enterprises and Service Enterprises under Micro, Small and Medium Enterprises Development (MSMED) Act, 2006. Later, as per Annual report of MSME 2020-21, these categories have been removed for getting equal importance to all business units and removed the classification according to the investments in plant and machinery.

Through business innovations and the support of various programs of Central and State government under MSME acts vast development has been witnessed in entrepreneurial contribution towards development. Currently MSMEs are expanding the level of business to international level through proper exporting channels. They are capable of satisfying the local as well as international requirements. The statistical report at current prices from 2018-19 to 2020-21 provided by the Central Statistics Office (CSO) proves the contribution of these business units towards the country's Gross Value Added (GVA) and Gross Domestic Product (GDP). Out of the all India contribution from MSME units, the share of Kerala is 5.62% according to the MSME survey and Quick results of 4<sup>th</sup> Census. It shows an increasing tend when compared to the previous results. The government of Kerala introduces various schemes for the development various categories such as of SC, ST, Women, Handicapped separately in contributing their innovative business ideas towards the welfare of the state and society through self-development and sustainability. The registration of MSME units has been fully monitored by the online application Udyog Adhaar from September 2015. The District Industries Centre stopped the service of filling the registration form after the implementation of the application. Handicraft, Bamboo industry, Coir industry, Rubber industry, Cashew industry, Beedi industry are common industries focused by entrepreneurs in Kerala. Most of the business related units and commercial enterprises over Kerala are based their business on Coastal regions like Trivandrum, Kollam, Ernakulam, Alappuzha etc. Udyog Adhaar Memorandum filled by business units during the end of March 2018 was more than 55000 and



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the number has been increasing year by year. Comparatively the number of manufacturing units is larger than service sector units in Kerala under MSME sector. There are lots of Financial inclusion schemes under the central and state government financial programmes aiming the funding of MSME units for their upliftment and foundation of new units. Kerala is having high literacy rate and facing the issue of unemployment at the same time. So young talents are in wait for a good opening in various companies. Later, to solve this issue of unemployment the Government of Kerala is taking active measures through District Industries Centres, Self-employment schemes etc. Out of 633.88 estimated number of MSMEs, 324.88 lakh MSMEs (51.25%) are in rural area and 309 lakh MSMEs (48.75%) are in the urban areas as per the MSME annual report of 2020-21. MSME sector can contribute towards the State economy by expanding the level of exports by implementing proper quality control mechanisms while production. There is a research gap that there is limited research on the subject in the area. Most of the investigation done on the subject was on other parts of the country, with no studies focusing on the Kollam district. Furthermore, there is a lack of exploration in the causal link between entrepreneurial enthusiasm on passion and performance and its outcomes in the MSMEs in the region.

**Theoretical and Conceptual Frame Work**

Expectancy theory (Vroom, 1964), Porter and Lawler's model (1968) of intrinsic and extrinsic motivation, Positive affect maintenance (Isen, 2020) are studies and various models and theories explaining intrinsic motivation and its positive effect. Entrepreneurial Passion is the strongest internal urge of a business man or entrepreneur towards an activity that he/she like, and feels important to contribute their valuable time and energy (Vallerand *et al.*, 2003). Obsession for work includes an affective (love for work) and internalization component (work is internalized into person's identity) Self-determination theory (Deci & Ryan, 2000). The internalization component can be autonomous or controlled in nature. It helps to create two splits of work passion: harmonious (autonomous internalization) and obsessive (controlled internalization). Entrepreneurial passion encircles two sections: (a) intense positive feelings and (b) focusing of the role to one's self-identity. The common entrepreneurial roles consist of developing products, launching a new business, and invention.

**Objectives of the Study**

- To understand the level of entrepreneurial passion among the industrialists in MSMEs of Kollam District in Kerala.
- To identify the components affecting entrepreneurial passion which impacts on performance of MSMEs.
- To analyze the significant correlation between entrepreneurial passion and performance of MSMEs.

**METHODOLOGY AND DATA ANALYSIS**

The sample for the study has been collected from the official database of District Industries Centre, Government of Kerala (last edited on December 2022). Out of the total population of 2827 newly registered MSME units in between 2017 to 2020, after considering 95% confidence level at 5% margin of error the sample is selected as 300. Validated structured questionnaires were used for data collection. SPSS software has been used for data analysis. Cronbach's alpha is used for testing reliability. The Cronbach's alpha efficient value normally ranges between 0 to 1. Cronbach's alpha has a tolerance level of 0.70. According to the researchers, any Cronbach's alpha value above 0.7 indicates good dependability and is sufficient to move forward with the final study. The Cronbach's alpha values shown in Table 1 demonstrate the high reliability of all the constructions. The factors have been rotated using the Varimax method to make them simpler to analyze and interpret. 300 entrepreneurs were included in the sample for the exploratory factor analysis. To confirm that the data matrix contains enough correlations to support the use of factor analysis. Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) tests of sampling adequacy were applied to guarantee the same. There are enough correlations between the variables, as per the statistically significant Bartlett's test of sphericity results ( $p < .05$ ). The value was determined to be .926, demonstrating meritorious sampling adequacy.





## CONCLUSION

Entrepreneurial performance in MSMEs is significantly and favourably impacted by entrepreneurial enthusiasm. The output of the study that Entrepreneurial passion is having a positive relation to entrepreneurial success and performance. If an entrepreneur is having a good sort of entrepreneurial passion the business can achieve good financial stability, market position and can create good social network. Through proper motivational and training facilities by the authorities, the level of passion among entrepreneurs will definitely increase which keeps their business in achieving heights. The result of the study will help the authorities as well as the academic community as it will provide them with more evidence on the importance of entrepreneurial passion in the success of MSMEs.

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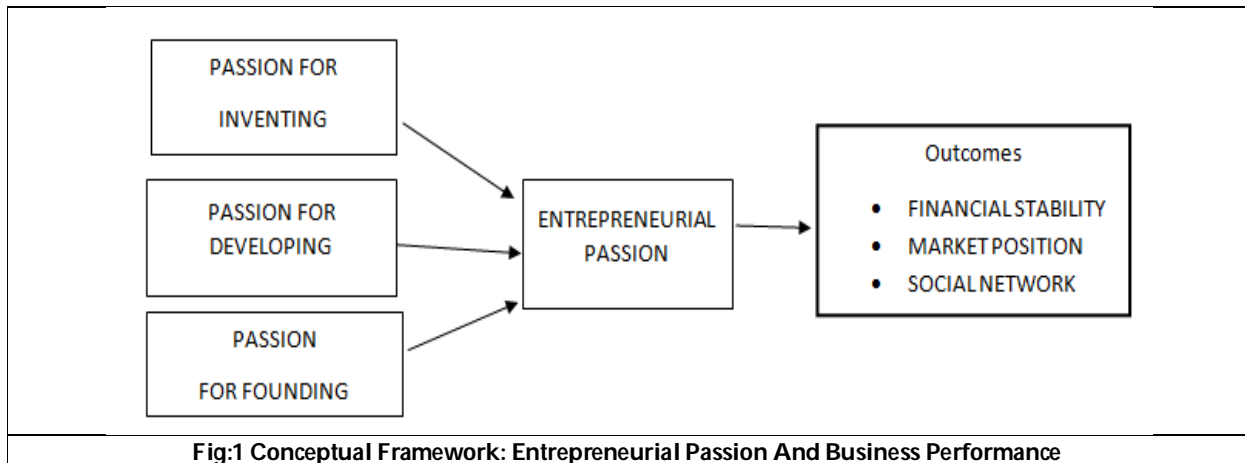
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**Table 1: Reliability Analysis Results**

Construct	N	No. of statements	Cronbach's Alpha
Passion for Developing	300	5	0.83
Passion for founding	300	5	0.81
Passion for Inventing	300	5	0.79
Financial stability	300	5	0.88
Market position	300	5	0.78
Good social network	300	5	0.82

**Table 2: KMO and Bartlett's Test**

KMO value	.926
Measurement value of Sampling Adequacy	
Approximate $\chi^2$ value	24226.260
Bartlett's Test of Df	1780
Sphericity Sig.	.000





## Optimization and Characterization of SNP synthesised from Endophyte rhizopus Sps fungi Isolated from *Abutilon indicum* (L.) Sweet

Deepalakshmi Durairaj<sup>1,2\*</sup>, Ruth Daniel<sup>1</sup>, J. Sebastin Raj<sup>3</sup>, Krishnasamy Gobalan<sup>3</sup> and Vithya Dharmaraj<sup>4</sup>

<sup>1</sup>Research Scholar, P.G and Research Department of Biotechnology, Jamal Mohamed College (Autonomous), Affiliated to Bharathidasan University, Thiruchirappalli-620020, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Microbiology, Sri Sarada Niketan college of Science for Women, Karur-5, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, P.G and Research Department of Biotechnology, Jamal Mohamed College (Autonomous), Affiliated to Bharathidasan University, Thiruchirappalli-620020, Tamil Nadu, India.

<sup>4</sup>Assistant Professor, P.G and Research Department of Biotechnology, Dhanalakshmi Srinivasan College of Arts and Science for Women (Autonomous), Affiliated to Bharathidasan University, Perambalur - 621212, Tamil Nadu, India.

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### \*Address for Correspondence

#### Deepalakshmi Durairaj

Research Scholar,  
P.G and Research Department of Biotechnology,  
Jamal Mohamed College (Autonomous),  
Affiliated to Bharathidasan University,  
Thiruchirappalli-620020, Tamil Nadu, India.  
E. Mail: deepamayflower88@gmail.com



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### ABSTRACT

The activity of expansion of constant and biodegradable metallic nanoparticles are a major step in the field of nanotechnology. To attain this utility of natural sources like biotic systems becomes crucial. In this present inspection, silver nanoparticles were synthesised extracellularly from endophyte *Rhizopus delemere* fungi. Ag particle Synthesis was Optimized, and it was confirmed by colour variation after noticeable time using UV-Visible spectrum peaks at 447 nm. And the Particle size distribution and Zeta potentiality results showed the synthesised SNP were constant nano compounds which gives an upright value. Whereas metabolite coating of Ag nanoparticle was characterized by FTIR. Which explores silver molecules were covered such as O-H, N=C=S, C=C, C=O, CO-O-CO, C-Br capping agents while used in fungal filtered nanoparticle solution and their morphology tested by SEM analysis. The size ranges from 10-50nm. The X-RD study shows two theta range values are 38.0824, 45.7077, 67.0407, 78.1871 and 78.4575. The peaks of synthesized Ag nanoparticles are cubic structure and crystalline pattern. This eco-friendly system of natural Ag nanoparticle production can be applied potentially in numerous products







that directly met the human being similar to cosmetics, foods and consumer goods, besides medical applications.

**Keywords:** Silver nitrate, *Rhizopus delemer*, Endophytic fungi, Characterization, biological synthesis

## INTRODUCTION

Presently, there is an expanding need to grow an environmentally benign nanoparticle synthesis process that does not use any virulent chemicals in the synthesis. An essential aspect of nanotechnology which has a significant challenge in the development of metal nanoparticle synthesis. Nanoparticles considered with a size of up to 100 nm measurement display completely new or improved properties as compared to the larger particles of the bulk material with specific characteristics, such as size, distribution and morphology [1]. Nanoparticles of great metals, such as gold, silver, and platinum, are broadly applied in products that straitly come in contact with the human body, such as shampoos, detergent, soaps, shoes, cosmetic products, and toothpaste besides medical and pharmaceutical applications. Mainly in the form of silver and gold nanoparticles used in very competent part of medicine. Various application-oriented researches are ongoing in gene delivery techniques [2], cancer treatment[3], antimicrobial infection[4], cardio vascular disease, antidiabetic and neurological disorder[5], using this nanoparticle. Biotic methods for ore nanoparticle synthesis using micro-organisms, enzymes and plants or plant extracts have been implied as possible eco-friendly alternatives to chemical and physical methods [6]. Applying plants for nanoparticle synthesis can be more gain over other biological processes because it removes the complicated process of keeping up cell cultures and can also be suitably scaled up for mass nanoparticle synthesis [7]. The demonstration of gold and silver nanoparticle synthesis within live alfalfa plants from solid media [8,9]. Biosynthesis of SNP by plants, such as *Abutilon indicum* [10], *Atrocarpus altilis* [11], *Plantago indicus* [12], *Azadiracta indica* [13], *Jasmiun officinal* [14], *Abelmoschus esculentus* [15], *Salvia spinosa* [16], *Pterocarpus indicus* [17] have also been reported, thus extracellular nanoparticle synthesis using plant leaf extracts rather than whole plants would be more economical owing to easier downstream processing. A review of the literature revealed that the synthesis of nanoparticles using endophytic fungi has been unexplored, which attracted our interest in the present investigation. Herein, an environmental-friendly method for the aqueous synthesis and stabilization of silver nanoparticles by the reduction of aqueous  $\text{AgNO}_3$  ions using the fungal broth of *Rhizopus delemer* (Mucaraceae) reported. Interestingly, this is the first report about the synthesis of highly stable silver nanoparticles using *Rhizopus delemer* endophytic fungi.

## MATERIALS AND METHODS

### Plant Sample

*Abutilon indicum* (L.) Sweet. (Malvaceae) plant was collected from the Gandhigramam Village in Southern part of Karur District, Tamil Nadu, India and immediately transported to the laboratory for analysis. The plant was identified and authenticated by the Director of Rapinet Herbarium, St. Joseph College, Trichy, Tamilnadu India.

### Isolation and Identification of Endophytic Fungi

Selected healthy leaves were washed with tap water to remove unwanted particles. The explant leaves were dipped in ethanol (70%) for 20 secs, immersed in (0.52%) sodium hypochlorite for 30 secs, washed with sterile water 3 times at 1 min systematic intervals and then air-dried the sample in What man no:1 paper, make this explant leaves portion into bore 6mm using one sterile whole forcible and transferred into PDA plates with added to Streptomycin (250 mg/ltr) to keep away the bacterial growth. Keep the plates at room temperature for 2 weeks for incubation and noted the fungal growth at 3-4 days. Make an appearance of mycelia from the end of explant were subculture in newly prepared PDA plates (Water 1000ml, potato (sliced washed and peeled) 300g, glucose 20g, and agar 20 g) and acquired pure cultures. Endophytic fungi were pointed out based on macro and micro morphological characteristics added to colony diameter, texture, colour, dimensions and morphology of hyphae, and reproductive structures.





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### Molecular Confirmation of the Fungal Isolate

Isolation of fungal DNA is done by the Standard salting out methods. 0.24 g of agarose powder was soaked in 30 ml of 1x TAE buffer and heated until it makes a clear solution. At approximately 50°C it was retained to cool down. Then additionally 1.5 µl of ethidium bromide and mixed well in the solution. Kept at room temperature for ½ hours for solidification as it was poured into gel casting plate with an already adjusted gel comb. The gel was soaked in 1X TAE buffer in the electrophoresis tank. 3µl of DNA with 3µl of gel loading dye was loaded in the wells using micropipettes. It was run at 70 V for 15 to 20 min, orange colour DNA bands were observed in the UV transilluminator. PCR Thermal cycler (Gene AMP PCR 9700, Applied Biosystem, USA). Big Dye Terminator v3.1 cycle sequencing kit on ABI 3730xl genetic analyser was used. ITS1 and ITS 4 Primer approximately taken in 700bp of ITS region, further undergoing to aligner software Mega 7. More than 100 bases aligned in blast n and used clustal W analysis for multiple sequence alignment. The evolutionary history was inferred by using the Maximum Likelihood method based on the Kimura 2-parameter model. The bootstrap consensus tree inferred from 1000 replicates is taken to represent the evolutionary history of the taxa analysed. Branches corresponding to partitions reproduced in less than 50% bootstrap replicates are collapsed. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) are shown next to the branches. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbour-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach and then selecting the topology with superior log likelihood value. The analysis involved 11 nucleotide sequences. Codon positions included were 1<sup>st</sup>+2<sup>nd</sup>+3<sup>rd</sup>+Noncoding. All positions containing gaps and missing data were eliminated. There was a total of 568 positions in the final dataset. Evolutionary analyses were conducted in MEGA7.

### Optimization and Synthesis of Silver Nanoparticles

1mM silver nitrate was prepared in a 100ml standard flask. 2.5ml of the fungal extract sample is added to 50ml of 1mM silver nitrate with continuous and constant stirring which react at an ambient condition and Ag get reduced into Ag<sup>+</sup> ion. Without any contamination the stock solution in different concentration (25µl, 50µl, 75µl, 100µl ) are mixed with 1mM and 3mM of silver nitrate solution separately. The colour change was observed for the reaction mixture from transparent white to dark brown indicates the formation of silver nitrate. The presence of reduction of Ag<sup>+</sup> ion was confirmed overtime by the UV-Spectral analysis.

### Characterization of Silver Nanoparticles

The optical properties of silver nanoparticles were characterized using UV-Visible spectrophotometer. Silver nitrate was added to the fungal extract, UV was taken after 24hours of addition. The absorbance was recorded between 350-500nm. The functional group of the synthesized silver nanoparticles was studied using FT-IR spectrometer. Using KBr pellet method dried powder sample was characterized in the range between 4000-400cm<sup>-1</sup>. Crystalline nature and grain size of synthesized silver nanoparticles was characterized using X-ray diffraction spectroscopy. The size and morphology of synthesized silver nanoparticles were evaluated using SEM analysis. SEM image confirmed the development of silver nanoparticles. The zeta potential was measured by using Zeta Sizer (Malvern Instruments) having zeta cells, polycarbonate cell with gold-plated electrodes and using water as medium for sample preparation. Zeta potential determines the surface potential of silver nanoparticles, and it is essential for the characterization of stability of nanoparticles. The stability of nanoparticles is measured when the values of zeta potential ranged from higher than +30 mV to lower than -30 Mv.

## RESULTS

### Isolation and Identification of Endophytic Fungi

A total of 4-6 fungal endophytes were isolated and assessed from the leaf pieces of the plant *A. indicum* in this study. Based on the dominance, one isolate (D4) was valued for further study. In Figure 1 represents the isolate D4 was possibly identified as *Rhizopus* sp. depends on cultural and morphological characteristics such as colony shape, texture, colour and morphology.



**Deepalakshmi Durairaj et al.,****Molecular Confirmation of the Fungal Isolate**

The fungal isolate was further confirmed by molecular study, the amplified ITS (5.8S and large subunit rDNA) products were sequenced using ABI 3730 automated sequencer. The obtained contigs sequence has the length of 700 bp and was deposited in GenBank (Accession number: LC514308.1).

**ITS of UICC 26 Fungal Isolate in FASTA Format**

The Phylogenetic tree of *Rhizopus delemer* fungi LC514308. confirms the species identification of endophytic fungi isolated from *Abutilon indicum* plant. Among various *Rhizopus* species, our blast search results show 98% *Rhizopus delemer*. This is the unfamiliar mutant fungal strain. Whereas the result of LC514308.1 *Rhizopus delemer* fungi UICC 26 gene was the identified name of fungi from tree results, Ribosomal subunit was internal terminus sequence 1 - 5.8 S rRNA subunit and internal terminus sequence 2 -28 S rRNA partial and complete sequences.

**Sanger Seq Chromatogram Data File Data****Forward Sequence**

```
GGGCTACTGCAGACGACATTATTTATAGTTCGCCCCCCTTACCGGTTGGTTCCTCTGGGGTAATTGATTGCT  
TCTACACTGTGAAAATTTGGCAGACACACAGACTGGGCATGGGTATACCTATCTGGGGTTTGATCCCTGC  
CCCTCCTGGTTGCAGACCACCCTTCATAATAAACCTATAAATTCCTTTATTATTTAATTTAATAAAAAACTAC  
TTTTAAGAATGGATCTCTTGGTTCTCCCATCAATAAAGAACCAAGCAA
```

**Reverse Sequence**

```
CCAACCTTTGTAAAGTTTGTCTATATCTACTTAACTTTTTATAACTGAATTTCTAGGTTTATTATGAAG  
GGTGCTCCTGAAACCAGGAGTGGCATCGATCAAACCCAGATAGGTCTACCCATGACCAGTCTGAGTCTCTC  
AGCCAAATTTTCACAGTGTAGAAGCAATCACTTACCCAGAGGAAACCCTAAGGTAAGGCGCTTTAACATA  
ATTAATGATCCTTCCGCAGGTTACCTACGGAAACCTTGTTACGACTTTAACATCACAAA
```

The BLASTn analysis of assembled contigs ITS sequence showed 98 % homology with the fungi species *Rhizopus delemer* small subunit ribosomal RNA gene. In Figure 2 represents the phylogenetic analysis (NJmethod) of the sequence closely matched with the sequence of *Rhizopus delemer*. Hence, the isolate D4 was confirmed as *Rhizopus delemer*.

**Synthesis of Silver Nanoparticle**

In Figure3 represents the synthesis of silver nanoparticle using the extract of endophytic fungal *Rhizopus delemer*. The light-yellow color of the reaction solution containing 1 mM and 3 mM AgNO<sub>3</sub> and fungal filtrate. The Color change of the reaction solution from light yellow to dark brown indicating the formation of AgNPs.

**UV-Vis Spectroscopy**

UV-visible spectroscopy is an important technique to characterize the morphology and stability of nanoparticles. Figure 3 shows the shaping of silver nanoparticles by the cell-free filtrate was noticed with a change of colour from colourless to dark brown which is the characteristic of silver nanoparticles formation due to the stimulation of surface plasmon vibrations in silver nanoparticles. It is well familiar that the optical properties of the metal nanoparticles strongly influence their size and shape. According to the Mie theory, the small silver nanoparticles exhibit only one surface plasmon resonance (SPR) absorption band, and it was confirmed. Figure4 shows UV-Vis spectra of the aqueous silver nitrate to silver ion reduction. In the case of silver ion reduction, the bands corresponding to the SPR occurred at 447 nm. The solution was extremely stable without any clumps for 12 hours after reaction.

**FTIR Spectrum Band Values**

The FTIR analysis revealed the strong bands at 3,331, 1, 637, 597, 659, 557, 414, and 437 cm<sup>-1</sup> shown inFigure 5along with other weak bands. The band at 1, 637 cm<sup>-1</sup> corresponds to of N=C=S stretching vibration of aliphatic alkenes. The band at 659 cm<sup>-1</sup> belongs to the weaker aliphatic C=C compound. The band obtained at 557 cm<sup>-1</sup> corresponds to





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C=O carbon mono oxide group one arising due to carbonyl stretch in proteins. Both bands at 414 and 597  $\text{cm}^{-1}$  can be assigned as primary amines and carbon stretch. The intense broad band absorbance at 3331.07  $\text{cm}^{-1}$  is the characteristic of the hydroxyl functional group in alcohol and phenol compounds. The band at 437  $\text{cm}^{-1}$  is a very weak band corresponding to the CO-O-CO group. This indicates that silver nanoparticles synthesized using *R.delemer* fungal extract are enclosed by some proteins and secondary metabolites, such as alkaloids having functional groups of hydroxyl, amines, alcohols, phenol and carboxylic acids.

### XRD Analysis

The X-ray diffraction pattern (XRD) silver nanoparticles synthesized using fungal *R.delemer* are shown in Figure 6. In this several Bragg reflections with 2 theta values of 38.08°, 45.70°, 67.04°, 78.18°, 78.45° which corresponds to the (111), (200), (220), and (311) sets of lattice planes are noticed which are indexed to the face-centred cubic structures for silver. The broadening of Bragg's peaks indicates the formation of nanoparticles. A few intense additional and yet unassigned peaks were also noticed in the vicinity of quantified peaks of silver (38.36, 44.44, 64.44, and 77.24). The XRD pattern thus clearly illustrates that the silver nanoparticle synthesized by the extracellular method is crystalline.

### Particles Size Distribution and Zeta Potential Activity

The particle size distribution, Polydispersity index and average size of synthesised *Rhizopus delemer* extract silver nanoparticles were analysed by a particle size analyser. In figure 7 shows the average particle size diameter of synthesised *Rhizopus delemer* extract silver nanoparticle is 376.4 nm with a polydispersity index of 0.072. From the results of PDI and PSD values, it is found that produced nanoparticles were monodispersed in nature. The Zeta potentiality of Ag nanoparticles was helped to determine the stability of synthesised particles in that particular sample. In figure 8 shows our synthesised *Rhizopus delemer* extract silver nanoparticles have zeta potential value -15.6 mV found to be peak area of 100% intensity. This value indicates that synthesised *Rhizopus delemer* extract silver nanoparticles have stabilized compounds.

### SEM Analysis

In Figure 9 shows SEM images of the silver nano granules having spherical morphology with traces of clumps. The size of nanoparticle range is found to be between 10 to 50 nm.

## DISCUSSION

Huge level and stable myco-biosynthesis of AgNps it is important to optimize the physical and cultural parameters. Several experiments were undergone to Concern the rate of synthesis and stability of AgNps [18]. Environmental conditions mostly adjust the growth and metabolism of fungi. Culturing parameters have been the critical components, directly affecting the yield and the cost effective. Optimization of physical parameters will not only advantageous to upright the growth but also induce the product yield [19]. The growth conditions, such as substrate concentration, pH, temperature, and inoculum size, which directly monitor the rate of enzyme activity which catalyst the synthesis of AgNps.

The use of silver nanoparticles in numerous fields is craving the capacity to synthesize particles with properties such as chemical composition, shape, size, and monodispersed. Further, the particles should be chemically balanced without undergoing deterioration such as partial oxidation or undesired sintering. Currently, there are enormous physical and chemical methods to obtain metallic nanoparticles that are kept by the material scientists[20]. Still, the evolution of simple and eco-friendly (green technology) synthetic pathway would help in encouraging further importance in the synthesis and application of metallic nanoparticles. In this regard, *R.delemer* proves to be an important biological component in the right direction for extracellular biosynthesis of stable silver nanoparticles.

It was observed that the reduction of the  $\text{AgNO}_3$  ions during exposure to *R.delemer* fungal culture may be easily followed by UV-vis spectroscopy. It has been well established that SPR of metallic silver nanoparticles exhibit dark



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brown colour and gives rise to an absorption band at 410-450 nm [21]. The fact that the silver nanoparticles peak remained close to 447nm even after 12 h of incubation indicates that the particles were well dispersed in the solution, and there was not much aggregation. The rate of synthesis to silver nanoparticles conversion reached 100 % in reaction at room temperatures.

The FTIR spectrums of the hydroxyl groups (OH) are enormous in polysaccharides of the fungal cell wall [22] and its presence in the reductive process was confirmed by FTIR analysis of the biomass thereafter silver recovery. Fungal pigments, such as rubropunctamine and monascorubramine, a kind of red pigment rich in hydroxyl groups, could also have acted in the silver reduction. Red pigments have reductive properties and are released to solution by circulation. These elements could have acted as capping agents and also stop the mass up of nanoparticles in solution, take part of a relevant role in its extracellular synthesis and forming [23].

The particle size of Ag NPs was found to be of different range. The morphology of the particles formed consists of a mixture of silver nano prisms and spheres with FCC (111) structure of Silver. The XRD pattern thus clearly illustrates that the silver nanoparticle synthesized by the extracellular synthesis method are crystalline in nature. These sharp peaks might have resulted from some secondary metabolite compounds or proteins in the nanoparticle during the synthesis. The presence of these exterior peaks, which are a lot did not alter the Bragg reflection peaks dedicated to silver, indicating that their presence could also be controlled for the stabilized silver nanoparticles. The XRD pattern thus clearly illustrates that the silver nanoparticle synthesized by the extracellular method is crystalline. SEM image of synthesized Ag NPs shows the spherical nature and silver nanoparticles with very good disparity using endophyte *Cladosporium sp* [24]. Whereas in *Rhizopus sps* fungi synthesised np up to ranges at 5-30nm coated with active secondary metabolite [25].

The particles are not highly monodispersed but seem to be assembled, spherical and uniform this could be due to the presence of some bio-organic compounds in the fungal extract that seems to act as a ligand which effectively stabilizes the formation of silver nanoparticles. The conformation of unmixed metallic nanoparticles and bimetallic nanoparticles by reduction of the metal ions is possibly facilitated by reducing sugars and/or terpenoids present in the neem leaf broth [7]. The presence of extracellular polysaccharides compound in leaf extract of *Pterocarpus indicus* [17], which ease the sustaining of nanoparticles. This study will therefore lead to the development of an easy bioprocess for the synthesis of silver nanoparticles and opens up a new possibility of very conveniently synthesizing Ag nanoparticles using different types of natural products which will be helpful in biomedical applications.

## CONCLUSION

In this paper we describe a chemistry approach which is an eco-friendly method for the synthesis of Ag nanoparticles by the reduction of aqueous  $\text{AgNO}_3$  ions using *R.delemer* fungal broth. An important potential gain of the reported method of synthesis nanoparticles using fungal broth is that they are entirely strong in solution, and this is a very important lead over other biological methods currently in work. Although the primary aim of this research has *Rhizopus delemer* synthesised np, have upright value in characterization or not, so these results also open up the chance for subsequent effort involving other applications with proteins or other biologically important molecules. Surely, mixed-monolayer of obtained Agnanoparticle were a breath-taking platform for future.

## ACKNOWLEDGEMENT

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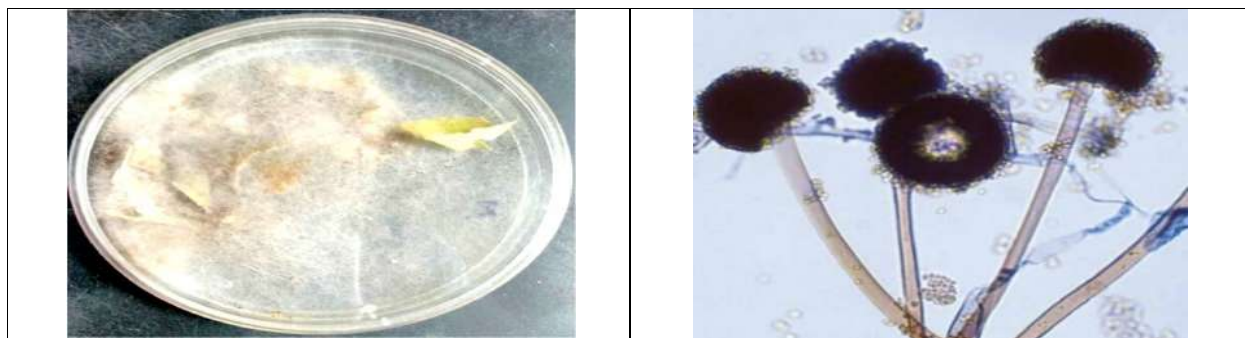
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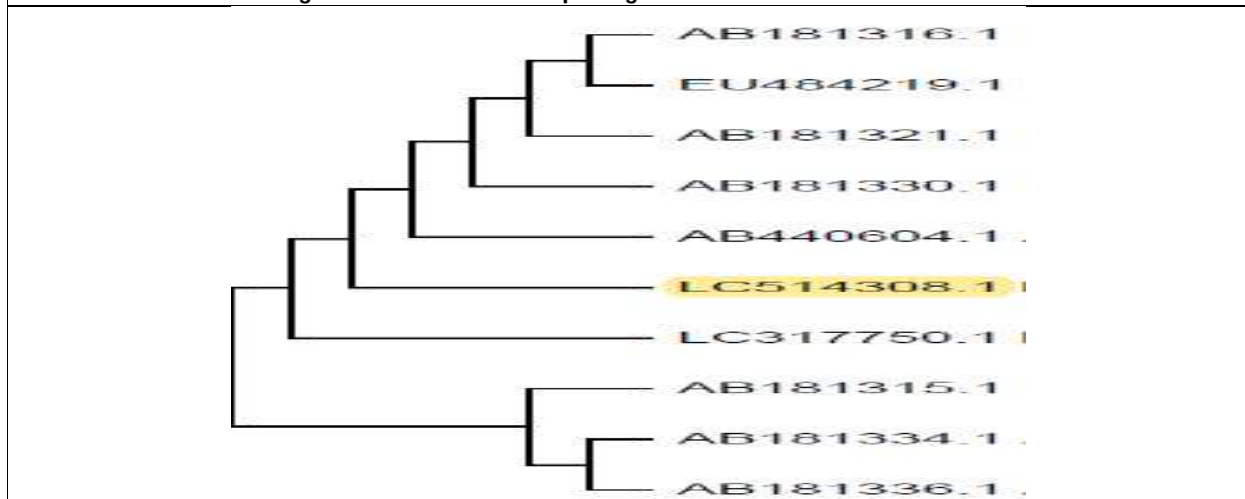


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**Figure 1. Cultural and Morphological Characters of the Isolate D4**



**Figure 2. Phylogenetic Tree of ITS of D4 Constructed by NJ Method**





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Figure 3. Optimization and Synthesis of silver Nanoparticle from fungi *Rhizopus delemere*

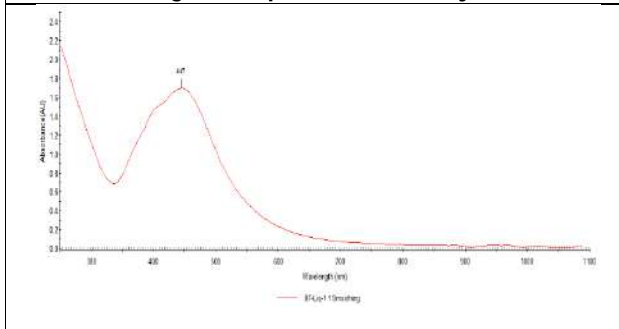


Figure 4 UV- Vis spectrum recorded for silver nanoparticles formed using fungi *Rhizopus delemere*

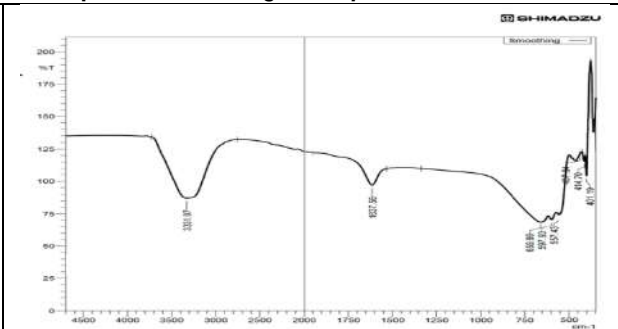


Figure 5. FTIR spectra of silver nanoparticles synthesized using fungi *Rhizopus delemere*

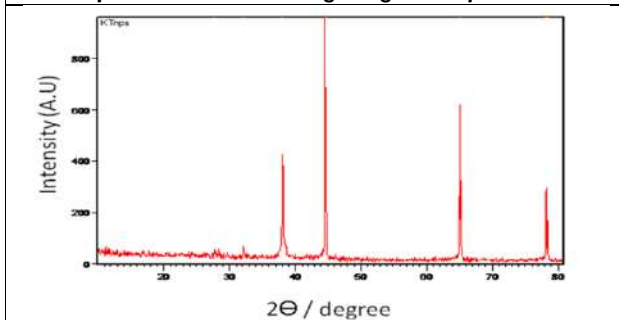


Figure 6. X-ray diffraction pattern of silver nanoparticles using fungi *Rhizopus delemere*

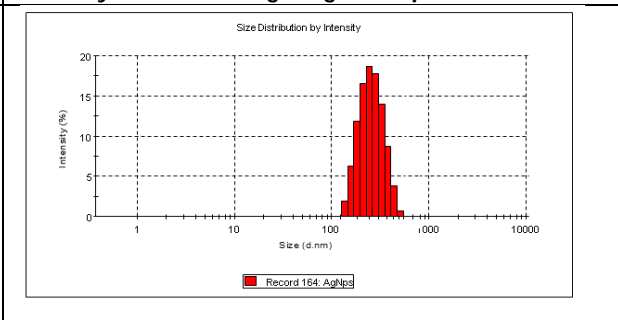


Figure 7. Particle size distribution pattern of silver nanoparticles using fungi *Rhizopus delemere*

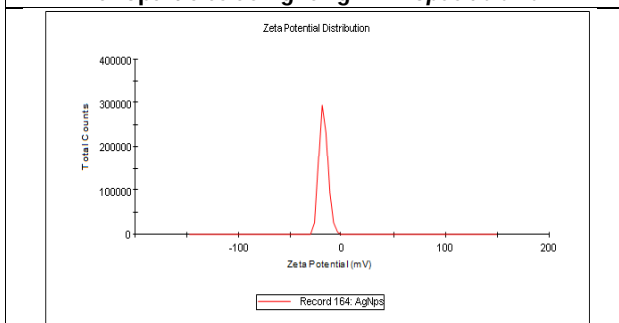


Figure 8. Zeta potential activity of silver nanoparticles using fungi *Rhizopus delemere*

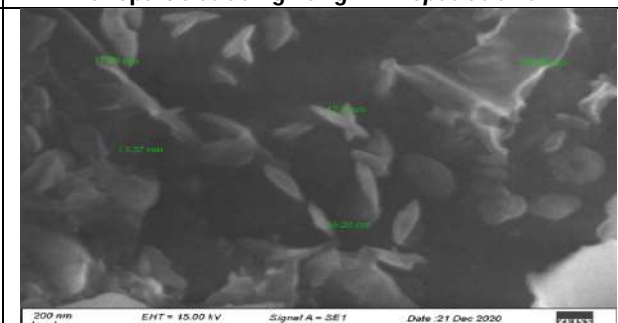


Figure 9. SEM images of the SNP using fungi *Rhizopus delemere*







## Studies on Growth Parameter in Different Strains of *B. mori* exposed to Temperature

E. M. Jeena<sup>1</sup>, J.P Jespa<sup>2</sup> and M. Thilsath Fatima Quraiza<sup>3\*</sup>

<sup>1</sup>Ph.D. Research Scholar, Reg. No. 19123092192018, Department of Zoology, Muslim Arts College, Thiruvithancode, Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India.

<sup>2</sup>Ph.D. Research Scholar, Reg. No.11779, Department of Zoology, Holy Cross College, Nagercoil, Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, Department of Zoology, Muslim Arts College, Thiruvithancode, Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India.

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### \*Address for Correspondence

#### M. Thilsath Fatima Quraiza

Assistant Professor,  
Department of Zoology,  
Muslim Arts College, Thiruvithancode,  
Affiliated to Manonmaniam Sundaranar University,  
Tirunelveli, Tamil Nadu, India.



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### ABSTRACT

In present-day scenario varying global climate appears to be one of the major interruption in the growth of silkworms. Various climatic factors such as temperature, humidity, precipitation, light, air etc. influences on the developmental process, any alteration in the ratio of these climatic factors might lead to sarcastic effect. Theaim of this study was to investigate the growth parameters in different strains of *B.mori* when exposed to different temperature. Observations on the different growth parameters of silkworm, *B.mori* were taken. The three different strains of 4<sup>th</sup> instar larvae, was exposed to 22°C, 25°C, 29°C and the effects of temperature on the larval index, larval survivability of 5<sup>th</sup> instar *B. mori*, were investigated. This study evaluated the effect of different temperature on growth and development of fifth instar silkworm larva. The highest larval weight was recorded of 1516 ± 133.20, 1567± 103.39 and 1600±107.33 respectively under the temperature 25°C. The maximum larval duration of 8.16 ± 0.75, 8.19±0.58 and 9.01±0.83 respectively was recorded at 29°C.The results of the present study indicated that the growth rate is significantly increased in the strain CSR<sub>2</sub> at 25°C temperature. Every physiological activity has an optimum temperature. As the temperature rises the rate of reaction increases until the maximum limitbut with the further increase in temperature the rate of reaction decreases. This study is important from academic as well as economic point of view.

**Keywords:** *B. mori*, CSR<sub>2</sub>, PM, Temperature, Growth index.





## INTRODUCTION

Most insects can adapt to daily environmental temperature fluctuations [1]. Fluctuation in environmental conditions is maintained by retaining the internal temperature and water content, but it has a limit of tolerance [2]. Majority of the economically vital genetic traits of silkworms are qualitative in nature and that phenotypic expression is incredibly influenced by natural factors such as temperature, light, humidity and nutrition [3]. Silkworm varies with impertinent climatic factors. The requisite of management of temperature for sustainable silk production depends on the environmental conditions day to day and season to season. As silkworms are poikilothermic animals, temperature will have a direct impact on various biological activities. The main factor that affects the physiology of insects is the humidity and temperature [4].

The temperature has a direct relationship with the growth of silkworms; wide variation of temperature is harmful to the growth of silkworm. Low temperature is always lighter than high temperature with reference to productivity of silkworm and larval duration for different instars [5]. The impact of different seasons such as rainy, summer and winter on cocoon and grain age traits of prevalent bivoltine races of India were considered and concluded that temperature and humidity influence all characters of these races [6]. The development and growth of the silkworm larvae is greatly influenced by the temperature during rearing. All biological processes including the rates of biochemical and physiological reactions [7] is also influenced by high temperature. Due to this the quality and quantity of cocoon crops get affected ultimately. Hence this study was aimed to investigate the growth parameters in different strains of *B.mori* when exposed to different temperature. The three different strains of 4<sup>th</sup> instar larvae, was exposed to 22°C, 25°C, 29°C and the effects of temperature on the larval index, larval survivability of 5<sup>th</sup> instar *B. mori*, were investigated.

## MATERIALS AND METHODS

Disease Free Layings (DFLs) of *Bmori* (3 strains) were obtained from the State Government Sericulture Centre at Thenkasi and were incubated at 27° C in ant proof racks at 70-80% humidity. Since the experiments required constant maintenance of the test species, silkworms were reared within the laboratory in harmony with the procedure implemented by standard methods [8]. The present study has been aimed at investigating growth parameters of the silkworm, when exposed at three different temperatures. The fourth instar larvae were selected randomly and grouped into three batches for experiments. Control was also setup. Each group are replicated 5 times. Each group consisting of 50 larvae. The experimental groups were maintained at a temperature of 22°C, 25 °C and 29°C respectively. The growth parameters of silkworm were recorded. Hence this study was conducted to determine the effect of variation in temperature on larvae of *B. mori*. Larval duration, larval weight and larval index were calculated using appropriate methods. The growth indices such as larval, pupal and adult indices [9] were calculated. All the data were analyzed statistically by ANOVA [10].

## RESULTS AND DISCUSSION

The development and growth of the silkworm larvae is greatly influenced by temperature. The purpose of this study is to obtain recent data to get an idea of performing different trials of experiment on various larval stages of silkworm *B.mori* under various temperatures. Rise in temperature increases different physiological activities and with a fall in temperature, the physiological functions are decreased. Results shows that the larval duration was very low when the *B. mori* larvae exposed to 25°C in PM×CSR<sub>2</sub>. The present investigation indicates that growth rate is significantly increased under the temperature 25°C whereas larval weight was recorded maximum of 1516± 133.20, 1567± 103.39 and 1600±107.33 respectively at the temperature of 25°C. During silkworm rearing especially in late instars if the temperature increases, it accelerates larval growth and shortens the larval period [11]. Meanwhile, at low temperature, the growth is slow with prolonged larval period. The maximum larval duration of 8.16 ± 0.75,



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8.19±0.58 and 9.01±0.83 respectively was recorded at 29°C. The optimum temperature for normal growth of silkworms is between 20°C and 28°C and the desirable temperature for maximum productivity ranges from 23°C to 28°C [12]. Two-way ANOVA results indicated significant difference between the temperature and larval duration, temperature and larval weight respectively Table 1.1 and 1.2).

Temperature above 30°C has a direct impact on the health of the silkworm. In case if the temperature is below 20°C all the physiological activities are retarded, particularly in early instars; as a result, silkworms become too weak and susceptible to various diseases [13]. The temperature necessities during the I, II and III instars are high and the silkworms feed actively, grow very vigorously, and lead to maximum growth rate [14]. Such vigorous silkworms can withstand better even at adverse conditions in later instars. Generally high temperature accelerates the growth rate leading to poor cocoon quality. Mishra [15] pointed out that as the temperature raise the rate of reaction increases until the maximum limit. But with the further increase in temperature the rate of reaction decreases.

## CONCLUSION

The development and growth of silkworm is enormously influenced by natural conditions. The mulberry silkworm is very fragile, highly sensitive to environmental variations and unable to persist extreme natural fluctuation in temperature. This study attempts to highlight the favorable and optimal environmental conditions for the growth of silkworms in order to provide sufficient knowledge about more efficient practices of silk worm rearing. These practices facilitate the farmers to provide better care to silk worm during sericulture to improve the quality and quantity of the product. This study concluded that there are significant differences among the strains at different temperature.

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**Table 1. Effect of temperature on larval index of fifth instar *B.mori* exposed at IV instar**

Races	Parameter Treatment	Larval duration (days)	Larval weight (mg)	Larval Weight Index
PM ♂ × PM ♀	Control	7.14 ± 0.85	1406 ± 92.16	
	22°C	8.12 ± 0.63 (13.72)	1390 ± 80.71 (-1.152)	0.98
	25 °C	6.23 ± 0.41 (12.74)	1516 ± 133.20 (7.92)	1.07
	29°C	8.16 ± 0.75 (14.28)	1278 ± 83.34 (-9.21)	0.90
PM ♂ × CSR <sub>2</sub> ♀	Control	7.15 ± 0.59	1453 ± 91.39	
	22°C	8.01 ± 0.77 (12.02)	1475 ± 119.27 (1.496)	1.01
	25 °C	6.20 ± 0.41 (-13.28)	1567 ± 103.39 (7.752)	1.07
	29 °C	8.19 ± 0.58 (14.54)	1327 ± 85.38 (-8.568)	0.91
CSR <sub>2</sub> ♂ × PM ♀	Control	7.21 ± 0.67	1497 ± 88.56	
	22°C	8.20 ± 0.80 (13.73)	1306 ± 95.07 (-12.60)	0.87
	25 °C	6.10 ± 0.47 (-15.39)	1600 ± 107.33 (6.79)	1.06
	29 °C	9.01 ± 0.83 (24.96)	1290 ± 72.38 (-13.66)	0.86

N=50 Percent deviation over control values in parentheses

**Table 1. Effect of temperature on larval duration of fifth instar *B.mori* exposed at IV instar**

Source of Variation	SS	df	MS	F	P-value	F crit
Races	6.713033	2	3.356517	30.34368	0.031904	19
Exposure	0.138017	1	0.138017	1.247702	0.380177	18.51282
Error	0.221233	2	0.110617			
Total	7.072283	5				





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**Table 1.2. Effect of temperature on larval weight of fifth instar *B.mori* exposed at IV instar**

Source of Variation	SS	df	MS	F	P-value	F crit
Races	16132	2	8066	1.21099	0.452286	19
Exposure	37288.17	1	37288.17	5.598263	0.14164	18.51282
Error	13321.33	2	6660.667			
Total	66741.5	5				

**Table 2. Effect of temperature on growth parameters of fifth instar *B.mori* exposed at IV instar**

Races	Parameter Treatment	Initial weight	Final weight	Growth Index	Larval Survivability
PM♂ × PM♀	Control	347.06 ± 21.63	1406 ± 90.25	3.05	80
	22°C	398.01 ± 17.23 (14.673)	1390 ± 85.77	2.49	76
	25 °C	439.26 ± 25.06 (26.55)	1516 ± 106.80	2.45	82
	29°C	320.66 ± 20.11 (-7.603)	1278 ± 95.70	2.98	80
PM♂ × CSR <sub>2</sub> ♀	Control	360.14 ± 28.06	1453 ± 97.60	3.03	74
	22°C	395.86 ± 30.07 (2.740)	1475 ± 106.29	2.72	70
	25 °C	452.15 ± 35.68 (25.48)	1567 ± 82.70	2.46	80
	29 °C	359.33 ± 32.27 (-0.224)	1327 ± 98.90	2.69	88
CSR <sub>2</sub> ♂ × PM♀	Control	386.07 ± 30.60	1497 ± 113.40	2.87	76
	22°C	390.72 ± 28.04 (1.204)	1306 ± 77.14	2.34	78
	25 °C	497.25 ± 38.75 (26.79)	1600 ± 137.06	2.21	84
	29 °C	375.68 ± 31.53 (-2.69)	1290 ± 90.33	2.43	86

N=50 Percent deviation over control values in parentheses

**Table 2.1. Effect of temperature on Larval Survivability of fifth instar *B.mori* exposed at IV instar**

Source of Variation	SS	df	MS	F	P-value	F crit
Races	172	2	86	6.789474	0.128378	19
Exposure	16.66667	1	16.66667	1.315789	0.370059	18.51282
Error	25.33333	2	12.66667			
Total	214	5				





## Nanotechnology-based Strategies for the Treatment of Diabetic Retinopathy

Pyda Venkata Harsha Vardhan<sup>1</sup>, Shubhashitha H M<sup>1</sup>, Asha Spandana K M<sup>1\*</sup> and Haripriya G<sup>2</sup>

<sup>1</sup>Industrial Pharmacy, Department of Pharmaceutics, JSS College of Pharmacy, JSS Academy of Higher Education and Research, Sri Shivarathreeshwara Nagar, Mysuru-570015, Karnataka, India

<sup>2</sup>Department of Pharmacognosy, JSS College of Pharmacy, JSS Academy of Higher Education and Research, Sri Shivarathreeshwara Nagar, Mysuru-570015, Karnataka, India

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### \*Address for Correspondence

**Asha Spandana K M**

Industrial Pharmacy,  
Department of Pharmaceutics,  
JSS College of Pharmacy,  
JSS Academy of Higher Education and Research,  
Sri Shivarathreeshwara Nagar,  
Mysuru-570015, Karnataka, India.  
E. Mail: asha@jssuni.edu.in



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### ABSTRACT

Diabetic Retinopathy [DR] is a consequence of diabetes mellitus that is linked to damage to the retinal blood vessels, along with the interdependent vascular, neuronal, glial, and immunological cells which ultimately results in vision loss and lowers the patient's quality of life. Treatment and management of DR is a difficult task because of the anatomy and physiology of barriers in the eye. Over the past decade, treatments for the vision-threatening consequences of proliferative diabetic retinopathy [PDR] and diabetic macular edema [DME] have advanced significantly. The use of nanoparticles has potentially been beneficial for the treatment of DR due to its non-invasiveness, cost-effectiveness, and capacity to target the medicine to the retina through the ocular pathway, nanoparticle-based formulations have proved successful in pre-clinical investigations. We emphasize the pathophysiology of DR, treatments, problems with traditional therapy, risk factors associated and current advancements in nanotechnology-based treatments for DR in this study.

**Keywords:** Diabetic Retinopathy, Chronic Diabetes, Nanotechnology, pharmacotherapy.





## INTRODUCTION

Diabetes, is a chronic disorders that is the ninth greatest cause of death globally [1,2] Hyperglycemia or hypoglycemia, which occurs when pancreas cells fail to secrete insulin or when the body is unable to use the insulin that is produced [3,4]. The vast majority of cases of diabetes can be divided into two categories: Type 1 diabetes, which is caused by inadequate insulin secretion and high risk, and Type 2 diabetes, which is caused by both insulin resistance and inadequate insulin secretion [5]. Diabetes affects the blood, muscles, liver, and adipose tissue because of a high glucose level. As a result of the effects on different tissues and organs, macrovascular complications like heart disease, stroke, and arterial problems emerge, damage to the visual system [diabetic retinopathy], kidney[nephropathy], and nerves[neuropathy] are among other complications [7]. Schröder *et al.*, 1991 studied the effect of monocytes and granulocytes occlusion on retinal microvasculature in streptozotocin [STZ]-induced diabetic mice and confirmed leukostasis as a crucial mechanism in the early stages of DR. As early as three days after diabetes was induced in rats, increased leukocyte adherence was found in the retinal vasculature. Diabetic rats have been found to have higher levels of the b2-integrins CD11a, CD11b, and CD18 as well as increased leukocyte adhesion. [9,10]. Additionally, it has been shown that chemokines, which regulate the leukocytes' attraction and activity, play a vital role in the pathogenesis of DR. "A science, engineering, and technology performed at the nanoscale special phenomena permit novel applications in a wide variety of domains, from medical, engineering, and electronics to chemistry, physics, and biology," is the definition of nanotechnology [12]. Modern drug research also incorporates nanotechnology, which helps to address the barrier issue that is present in conventional treatment. Nanocarriers can be used to deliver drugs while minimizing or avoiding their side effects. They also possess the property of sustained release, which can lengthen the duration of drug action, increase the stability of the drug. These outcomes encourage the formulation of drug delivery system that are simple, convenient, and has low-dose with few adverse effects. Nano based drug delivery system have a small volume and a high drug-loading capacity. Despite their ease of blood vessel penetration, they do not harm vascular endothelial cells [13,14]. The majority of conventional dosage forms exhibit side effects, toxicity, a lower therapeutic index, enzymatic & chemical degradation, and are poorly soluble in water, [15,16]. Using nanomedicines, these concerns can be addressed [30,31].

### Diabetic Retinopathy [DR] the Concept and Pathophysiology

Diabetic retinopathy [DR] is the most common microvascular complication of diabetes and one of the main causes of blindness worldwide. Long-term exposure to diabetes mellitus activates a number of interconnected metabolic pathways that are involved in the pathophysiology of the DR [18]. Oxidative stress is thought to be the common mechanism that connects all the routes because it results from the overproduction of superoxide in mitochondria due to hyperglycemia. Activation of protein kinase C, excessive activation of the plasma kallikrein-kinin pathway, and accumulation of advanced glycation end products are the main mechanisms involved. There is also an increase in glucose flow through the polyol and hexosamine pathways. Multiple early clinical characteristics of the DR, including as thicker basement membrane, pericyte apoptosis, and mitochondrial dysfunction leading to Blood Retinal Barrier disruption, are caused by oxidative stress. Leucocytosis and retinal thickening are both brought on by blood retinal barrier disruption resulting in WBC adherence to the endothelial cells that lines to blood vessels, which affects capillary blockage and vascular leakage. Additionally, endothelial injury and pericyte loss result in capillary blockage and local ischemia, which activates the hypoxia-inducible factor [HIF-1]. Along with other angiogenic factors [Ang-1, Ang-2 and activated HIF-1] enhances the expression of vascular endothelial growth factor [VEGF], which in turn causes vascular permeability [25]. The production of delicate and permeable blood vessels that are conducive to vitreous bleeding is known as neovascularization, which is caused by the upregulation of pro-angiogenic factors [VEGF, Ang-1, Ang-2, and platelet derived growth factor]. Repeated episodes of such bleeding causes fibrovascular scarring and gliosis, which contraction leads to the sight-threatening outcomes PDR [proliferative diabetic retinopathy] and DME [diabetic macular edema]. Pictorially represented in figure 2





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**Risk Factors for Diabetic Retinopathy**

**Diabetes Duration** Type 2 diabetes primarily affects older people [21] who have had the disease for a long time and can develop retinopathy. About 90% of adults over the age of 50 years have an increased chance of developing retinopathy with increasing prevalence [22]. A mild or moderate form of retinopathy might occur after living with type I diabetics for more than ten years. In type II diabetics who have had the condition for 10 years, 67% have not used insulin, whereas 79% have done so [23].

**Blood Sugar Level** Raised glycated hemoglobin levels alpha which suggests elevated glucose levels, are associated with a higher risk of retinopathy in diabetics [24].

**High Blood Pressure** Patients who have high blood pressure and high blood sugar levels are at an increased risk of developing hypertensive retinopathy [25]. The current treatments, of DR primarily consist of surgical: [laser treatment, scatter or photocoagulation, vitrectomy surgery], Glycemic control, hyperlipidemia control, and blood pressure are all treated systemically

**Treatment of Diabetic Retinopathy**

The goal of primary prevention is to stop or delay the onset of DR in people with diabetes who do not yet show signs of the condition. In order to stop DR from progressing to vision-threatening phases, secondary prevention is used on people with early-stage DR. With VTDR, tertiary prevention is used to stop blindness, restore vision, and enhance the quality of life for patients who have visual deficits.

**Various Strategies Are Used For Primary Prevention, Including**

Alterations of lifestyle and behavior before the onset of diabetes or DR screening for the early detection of DR. Self-management of diabetes and hypertension. pharmacological treatments to better manage blood pressure and glucose levels [38].

**Secondary Preventative Strategies Include**

Implementation of recommendations and policy appropriate to each country's health care system for the management of DR across all countries. DR screening and monitoring for early DR to VTDR progression. pharmacological treatments to better manage blood pressure and glucose levels [83].

**Tertiary Prevention Includes**

Vitrectomy for people with more advanced DR. Anti-VEGF medication for PDR and DME. Laser photocoagulation for PDR. Visual rehabilitation for those with DR blindness to improve quality of life. These are illustrated in figure 3 While Steroids are utilized for cataracts and glaucoma, anti-VEGF is beneficial for retinal neovascularization for PDR that has similar visual acuity to PRP [Figure: 4]. Similar to this, vitrectomy with or without internal membrane, or element, results in thickening. Vitreoretinal surgery is used to minimize fibrous attachment that may fluctuate the retina & cause loss of vision [29] [30]. Even though the thickness is typically reduced after vitrectomy, the outcomes are less predictable because 40–50% of patients do not respond to anti-VEGF medication, and 20–30% of patients have a reduction in vision loss [31]. For both PDR and DME, non-invasive, non-destructive, and long-term treatment options are necessary [Figure 4]. [32].

**Nano technological approaches for the treatment of diabetic Retinopathy**

Nanomedicine is significant for diagnosis and cutting-edge methods of therapeutic drug delivery to the eyes, particularly in the case of posterior ocular disease. Nowadays nanotechnology is gaining the interest of researchers for treating the various ocular disorders because of its smaller size and multiple functions. Nanoparticle [NP] has shown better and controllable physicochemical properties [34, 35] hence delivers the drug to the specific site by overcoming the barriers [retinal or BBB] and also provides a superior solution to the solubility and bioavailability issues of many poorly soluble therapeutic medications [36]. These drug delivery system provides longer circulation time, target-specific binding and drug delivery, which results in the reduced dose and side effects. They also possess

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the property of sustained release, and protection against harsh environmental conditions, which makes drug storage becomes easier [36].

**Polymeric Nanoparticles**

polymeric nanoparticles also known as colloidal particles and are made of biodegradable polymer. The drug is dissolved or dispersed in a liquid core [oil or water] before being enclosed by a polymeric membrane to form a nanocapsule. The formulation of nanospheres involves encapsulating drugs in a polymeric matrix[11]. The usage of poly[lactic-co-glycolic acid] [PLGA] has become particularly popular for the delivery of ophthalmic drugs using polymeric nanoparticles [NPs] because of its biocompatibility and extensive range of degradation, non-immunogenicity, non-toxicity, and rate. Polymers are generally categorized into three different groups [natural, synthetic, biodegradable, and non-degradable], for formulating polymer-based NPs. Polymers are biodegradable in the presence of suitable environment because they are biocompatible and degrade slowly. In earlier studies, a variety of polymer-material conjugates were formulated using poly[d, l-lactoscolide N-[2-Hydroxypropyl]methyl acrylamide [HPMA], dextran, and PEG. In earlier studies, it was found that hyaluronic acid targets the retinal pigment epithelium cells [RPE] and the CD44 receptor to regulate effective blood sugar levels in diabetic control mice. Subsequently, GLUT1-coated hyaluronic acid nanocarriers were inserted into the mice retina in the sub-retinal region [38]. Polycaprolactone [PCL] and PF68 steroid exhibit trapping for tannic acid or hydrophobic substances to inhibit interaction with the eye tissues during a prolonged therapy carried out and monitored in the blood-retinal barrier [BRB] [39]. Due to Polymeric nanoparticles compatibility and biodegradable qualities, several drugs loaded with poly-lactic glycol acid [PLGA] have recently attracted interest in the ocular route. Anti-VEGF monoclonal antibody bevacizumab is given for therapy up to 500mg block angiogenesis.[40,41]. Bevacizumab-loaded PLGA-dextran microspheres that use chitosan nanoparticles to improve mucoadhesive property in drug delivery exhibit long-lasting action and maintain drug bioactivity over a 5 day period [43,44]. Similar to this, when delivered intravenously via Chitosan-PLGA NPs, arginylglycylaspartic acid [RGD] showed that the target delivery to retinal neurovascular lesions reduced VEGF expression and stopped subretinal fibrosis [46].

**Inorganic Nanoparticles**

Inorganic nanoparticles [NPs] are often utilised in the treatment of diabetes because of their exceptional biocompatibility and low toxicity in tissue or organs. This enables efficient drug/therapeutic target delivery. Silicate nanoparticles were found to reduce retinal angiogenesis and restrict microvasculature while having no adverse effects on angiogenesis [23,24,47]. Similar to this, the Gold NPs [AuNP] show that VEGF effectively suppresses endothelial cell proliferation while lowering neovascularization. Gold nanoparticles safety is further assured by the fact that they do not affect the function of microvascular endothelial cells or cause retinal toxicity [48,49]. Particles of titanium dioxide [TiO<sub>2</sub>] have been discovered to effectively suppress angiogenesis without endangering the retina. Animal models also use nanoparticles or other particles given intravenously to halt neovascularization [49,50].The somatostatin analogue octreotide functionalized magnetic NPs [Oct-MNPs] has an anti-angiogenic effect and inhibits the growth of blood vessels, which up to 100 times enhances bioactivity [51]. However, the clinical uses of inorganic Nanocarriers are now restricted due to the occurrence of some side effects, and clinical trials for the same are still investigated.

**Polymeric Dendrimers**

Dendrimers are nano-based formulations with high bifurcation, well-organized high branches, and layered architecture that allow for a variety of adaptable chemical modifications. This dendrimer nanotechnology studies a unique, promising class of nanoscale carriers for therapeutic drugs and imaging reagents by combining passive and active targeting techniques. The intrinsic physicochemical properties of dendrimers and drugs based on dendritic structures, such as the hydrophilicity of the unit molecules, particle size, surface charge, and modification, can be modified to significantly alter their biological fate. Sugar, nucleotides, and amino acids are used to create a number of the dendrimer's arms, which extend from its central region [53]. Dendrimers have a diameter of 2 to 10 nm on the nanometer scale. Researchers evaluated various poly [amidoamine] [PAMAM] dendrimer series for controlled ocular drug delivery. Dendrimers are used in ophthalmology for genetic testing, medication delivery, gene delivery,



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antioxidant delivery, peptide delivery, and biomedical imaging, according to a number of studies [54]. The covalent bonds between the drug and the dendrimer are broken by the appropriate enzymes, and the physical environment, including pH and temperature. These are only a few of the mechanisms used to transport drugs through dendrimers [8]. For intravenous or intravitreal drug delivery, Kambhampati *et al.* effectively developed a formulation based on dendrimers to target retinal macrophages and microglia. Following ischemia/reperfusion [I/R] injury, dendrimer treatment in an *in vivo* model, these delivery systems were able to produce equivalent retinal biodistribution profiles. Target exclusively Iba-1+ active macrophages and/or microglia, and hold for not more than 21 days. Use of polymeric dendrimers increases the bioavailability of drugs which have been administered with desired structures and made off-target approach quite fast [93]. Additionally, the approval from healthy tissues and off-target organs were detected rather quickly, indicating that the negative effects of an increase in the bioavailability of drugs that have been delivered to the desired structures.

Hongkwan Cho *et al.* studied the dendrimer-based targeted therapy by using a mouse [oxygen-induced retinopathy] OIR model of ischemia-induced pathologic retinal neovascularization. This model served as a delivery platform for the combination of triamcinolone and hydroxyl polyamidoamine [PAMAM] [D-TA]. Dendrimer-conjugated TA [D-TA] demonstrated exceptionally precise targeting of active microglia in disease-induced OIR retina without localization in other cell types in the diseased retina or microglia in the healthy, perfused retina. Regarding the preservation of neuroretinal and visual function, the inhibition of retinal inflammatory cytokines, microglial activation, and pathologic retinal neovascularization, D-TA significantly outperformed free TA at the same dose [10]. The activation of T cells by nanocarriers has a stronger effect on the treatment and diagnosis of many diseases than any other polymeric material composed of biocompatible polymers [55].

Ludewig *et al.* has reported autoimmune diseases like insulin-dependent diabetes mellitus [IDDM] can result from autoreactive T cell activation. In transgenic mice expressing the lymphocytic choriomeningitis virus glycoprotein under the control of the rat insulin promoter, the role of dendritic cells [DC], the most potent professional antigen-presenting cells, in the onset and maintenance of IDDM was examined [56]. Due to the chemical nature of polycations, cationic macromolecules, particularly cationic dendrimers, have been reported to cause toxicity [57]. Dendrimer oligonucleotide-1 and plasmid DNA enable more efficient downregulation of VEGF expression in human retinal pigment epithelium cells [58-60].

**Lipid-Based Nanoparticles**

Lipid-based nanoparticles, including liposomes, nanostructured lipid carriers [NLCs], solid lipid nanoparticles [SLNs], and nanoemulsions, can deliver both hydrophobic and hydrophilic drugs for extended periods of time with little toxicity, improved pharmacokinetic properties. [61]. To increase the bioavailability of triamcinolone acetate, for instance, SLNs consisting of biodegradable and biocompatible lipids are successful at avoiding the retinal bio-barrier. SLN is a potential method for administering eye medications [62]. Similar to this, palmitoylethanolamide NLCs formulations pass blood-retinal barrier, decreases inflammation brought on by hyperglycemia in diabetic rats [63]. As an effective antiangiogenic, triamcinolone acetate NLCs were first reported in 2010 [64], and in 2012, mangiferin NLCs were shown to promote drug activity with antioxidant and anti-inflammatory effects [40]. Myrecitin-encapsulated SLNs boost antioxidant capabilities in hyperglycemic patients [66]. Additionally, the prolonged drug release profile of ciprofloxacin was observed by using lipid-based formulations [67], whereas studies on gene delivery with itraconazole reveal less adverse effects and reduced angiogenesis in the corneas of rats [68,69]. Injecting ranibizumab DPPC-DPPG liposomes with the luciferase gene into the ocular tissue rabbit eye led to a better transfection efficiency and a medication with a more effective sustained release profile [around 52.7%] [70,71,72]. Bevacizumab liposomes were used to treat rat eyes with minocycline-encapsulated therapy because they had a higher bioavailability and possible therapeutic effect [72]. A Nano carrier system exhibits an increasing anti-inflammatory effect during the course of prolonged circulation [73]. These lipid-based formulations have a powerful anti-inflammatory impact and have less adverse effects. In a recent study, loteprednol etabonate [an ester-based corticosteroid formulation] was made into gel and injected into rabbit eyes to alleviate ocular inflammation following cataract surgery [75].



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### Challenges and Perspective

Further research is required to better understand the therapeutic delivery options for ocular targeting based on nanotechnology. pre-clinical evidence, *in vitro* experimental data analysis, is needed in rat or rabbit modal for in vivo correlation of the human eye. More investigation of potential use of nanocarrier for its therapeutic delivery into ocular system need to studied. Delivery of nanotechnology products will have more considerable benefits along with traditional therapy may help in reducing toxicity [91,92].

### CONCLUSION

DR is an eye disorder that negatively affects a patient's quality of life and raises their risk of going blind. The studies included in this review article, discuss on the numerous Nano drug delivery techniques for the treatment of DR. Additionally, they get around a lot of problems that come up when employing bioactive substances that have a reduced potential for treating diabetic retinopathy. The primary metabolic processes that DR affects are reviewed, along with potential pharmaceutical tactics. This review contains of Numerous research which have been published using different kinds of nanocarriers, like polymers and lipids, to enhance the bioavailability and ocular penetration of medicinal drugs. Additionally, the nanobased drug delivery system is adaptable for a combination treatment, by reducing the frequency of injections and invasive procedures while enabling continuous drug release.

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Abbreviation	
DR	Diabetic Retinopathy
DME	Diabetic Macular Edema
PDR	Proliferation Diabetic Retinopathy
DME	Diabetic Macular Adema
PRP	Pan Retinal Photocoagulation
ETDRS	Early Diabetic Retinopathy Study
NPs	Nanoparticles
AuNP	Gold NPs
TiO <sub>2</sub>	Titanium Dioxide
Oct-MNPs	Octreotide Functionalized Magnetic Nps
PCL	Polycaprolactone
PLGA	Poly Lactic Glycol Acid
SLNs	Solid Lipid Nanoparticles
NLCs	Nanostructured Lipid Carriers
PEA	Palmitoylethanolamide
IDDM	Insulin-Dependent Diabetes Mellitus
DC	Dendritic Cells
RGD	Arginylglycylaspartic acid
BRB	blood retinal barrier

**Table 1: various Nanocarrier systems used in the treatment of DR**

Type of nanoparticle	Major Component	Drug[s]	Key findings	Ref no.
Gold nanoparticle	-	-	VEGF-induced autophosphorylation of VEGFR-2 is suppressed, which prevents ERK1/2 activation. There is no proof that the retina is toxic, and the vitality of the retinal microvascular endothelial cells is unaffected.	28
Silver Nanoparticles	leaf extract of Mulberry	-	AgNPs produced from environmentally friendly mulberry leaf extract show a positive therapeutic effect on DR.	94, 95
PLGA-NPs	glycolic acid, Lactic acid	Other protein/enzyme medicines, such as bevacizumab	PLGA is a substance that can safely carry drugs to the retina. Albumin allows the protein to be shielded by PLGA nanoparticles, against accumulating and inaction.	38
cationic nanoemulsion	--	Hydrophilic/ protein-based drugs	Through the period of time, mucus adhesion to the retina was improved and drug retention in the eyeball was increased by electrostatic interaction with the human eye mucosa.	77
Solid lipid nanoparticles	Stearic acid, castor oil	Triamcinolone acetone	Through electrostatic contact with the human eye mucosa and the high biocompatibility of physiological lipids, the duration of medication retention in the eyeball was extended.	78
SiO <sub>2</sub> -CeCl <sub>3</sub> nanoparticles	-	-	Rapidly forming crystalline protein and reduced silica-cerium [III] chloride [CeCl <sub>3</sub> ] conjugates prevent advanced glycation end products [AGEs] while lowering cellular reactive oxygen species and oxidative stress.	79

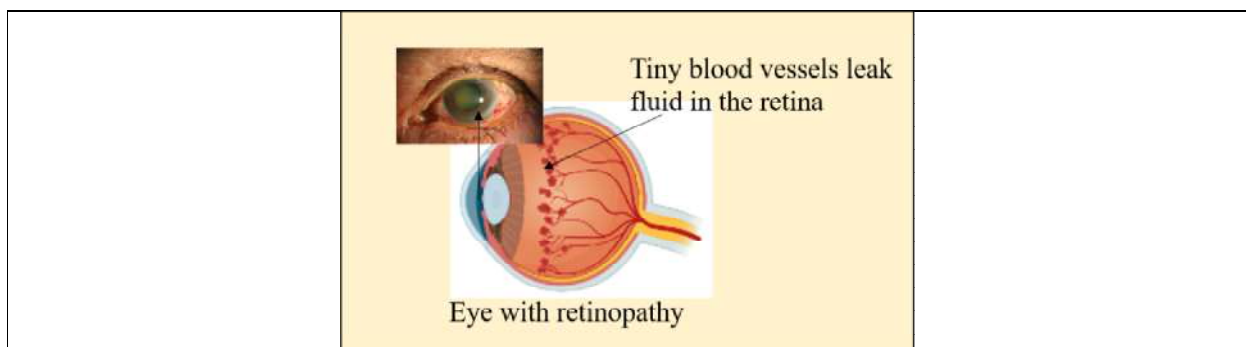




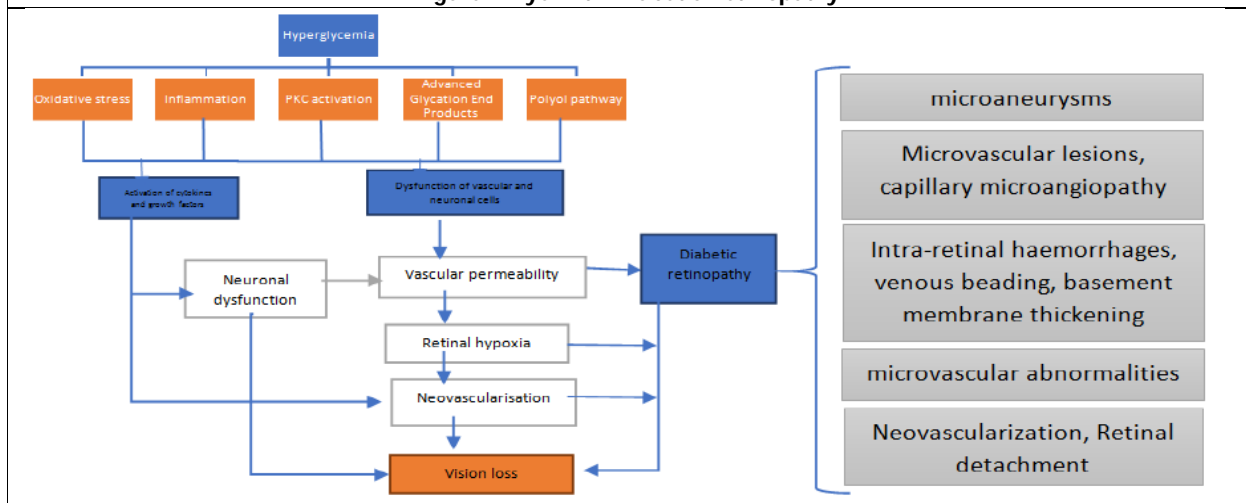


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Magnetic nanoparticles	Iron oxide, ferric oxide	Octreotide	When combined with octreotide, MNP has little effect on the anti-angiogenesis and anti-apoptosis properties of octreotide and exhibits little to no cytotoxicity to human retinal cells. MNP is initially present on the RPE, then spread throughout the entire retina.	51
Chitosan-based nanoparticles	-	Bevacizumab	Bevacizumab has a long half-life in the retina and can prevent retinal neovascularization, which is brought on by nanoparticles made of chitosan.	43



**Figure 1: Eye with Diabetic Retinopathy**

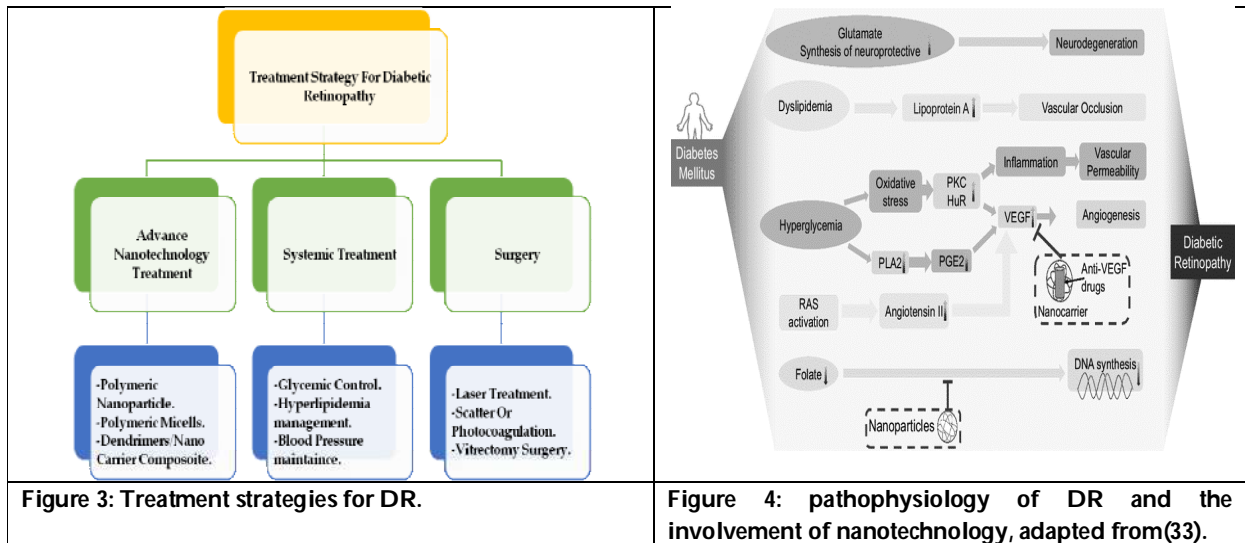


**Figure 2: Flowchart showing the main contributing factors to the development of DR and the symptoms that emerge at different phases of the disease.**

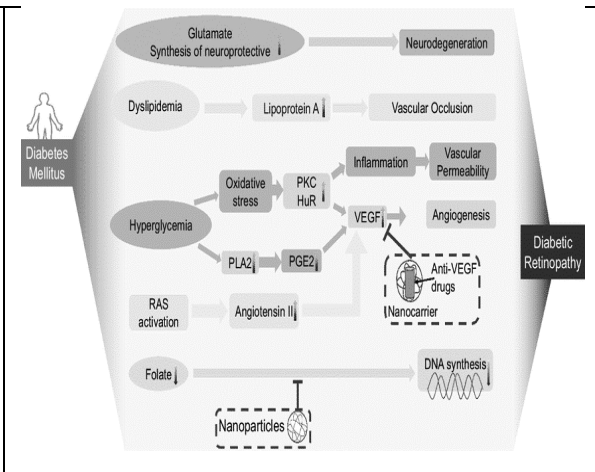




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**Figure 3: Treatment strategies for DR.**



**Figure 4: pathophysiology of DR and the involvement of nanotechnology, adapted from(33).**





## An Advance DTC-SVM Scheme for A 3-Phase Induction Motor used A Ts Fuzzy Controller

Sony Verma<sup>1\*</sup>, Anil Kumar<sup>2</sup> and A.K. Gupta<sup>3</sup>

<sup>1</sup>Ph.D Scholar, IFTM ,Moradabad , Uttar Pradesh, India.

<sup>2</sup>HoD, EE Department, IFTM, Moradabad , Uttar Pradesh, India.

<sup>3</sup>Professor, IET, MJPRU, Bareilly, Uttar Pradesh, India.

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### \*Address for Correspondence

**Sony Verma**

Ph.D Scholar,

IFTM ,Moradabad,

Uttar Pradesh, India.

E. Mail: 07ee49sony@gmail.com



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### ABSTRACT

In this paper, a Fuzzy Takagi-Sugeno Controller (TSF) for the Space Vector Modulation direct torque Control process is developed. a pair of Proportional Integrator controllers are employed the reference voltage vector is produced for the stator in traditional DTC-SVM design. This type of advance controller is proposed to replace PI controllers, both, in order to enhance the shortcoming of this kind of DTC-SVM method. The suggested controller determines the stator voltage vector's reference quadrature components. Using trapezoidal and triangle membership functions, the law foundation regarding the potential controller is established in relation to both the electromagnetic torque and stator flux errors. Using this technique which is SVM, consistent frequency of switching and less shifts in torque are achieved. The suggested TSF controller's DTC-SVM performance is examined in relation to a number of final result indicators, including settling time, torque ripple, and rising time, while taking various running circumstances into account. The software based results demonstrated the suggested method's ability to provide quick torque response and little torque ripple.

**Keywords:** 3-phase Induction Motor, Direct torque Controller, SVM, Takagi-Sugeno Controllers, Fuzzy Controllers.

### INTRODUCTION

Due to it delivers a quick without the dynamic torque response need of current variable device, direct torque control has been a famous technology for 3-phase Induction Motor drives in recent years. [1] [2], However, there are currently several additional DTC alternatives [3] [4]. In general, the correct mathematical model of the process to be

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managed is not necessary for the usage of fuzzy systems. Instead, it builds its control rule foundation on the expertise and experience of the individuals engaged. Fuzzy logic is effective for controlling motors; for instance, in [5], The Fuzzy Logic Controller is employed in [6] to not consistence parameters. In this instance, the stator and rotor flux ripples are significantly diminished. The fuzzy PI speed controller in [7] responds more quickly across a wider range of motor speeds. It has also been designed and implemented in [8] [9] [10] [11] to use self-tuning and self-organizing controllers, among other types of adaptive FLC. The simulation findings demonstrated that the suggested TSF controller for the DTC-SVM scheme performed well when evaluated under various operating situations in terms of parameter. The suggested TSF controller is discussed in depth in section IV, mentioning several design elements, while part III the suggested control system's topology. The simulation/software results of the TSF controller are shown in Section 5th, and the final analysis is provided in Section 6th.

**II. Direct Torque Control Principles**  
**3-Phase Induction Motor Dynamical Equations**

the dynamically formulated equation of 3-φ IM in a static frame work of reference may be expressed mathematically in the following way [18]:

$$\vec{u}_s = R_s \vec{i}_s + \frac{d\vec{\varphi}_s}{dt} \tag{1}$$

$$0 = R_r \vec{i}_r + \frac{d\vec{\varphi}_r}{dt} - j\omega_r \vec{\varphi}_r \tag{2}$$

$$\vec{\varphi}_s = L_s \vec{i}_s + L_m \vec{i}_r \tag{3}$$

$$\vec{\varphi}_r = L_r \vec{i}_r + L_m \vec{i}_s \tag{4}$$

Where  $\vec{\varphi}_s$  and  $\vec{\varphi}_r$  are the stator and rotor flux space vectors, respectively;  $\vec{u}_s$  is the stator voltage space vector;  $\vec{i}_s$  and  $\vec{i}_r$  are the stator and rotor current space vectors; and  $r$  is the rotor  $L_s$ ,  $L_r$ , and  $L_m$  are the stator, rotor, and mutual inductances, respectively.  $R_s$  and  $R_r$  are the stator and rotor resistances, respectively.

The vectorial cross-product of the flux space vectors; shows electromagnetic torque

$$t_e = \frac{3}{2} P \frac{L_m}{L_r L_s \sigma} \vec{\varphi}_r \times \vec{\varphi}_s \tag{5}$$

$$t_e = \frac{3}{2} P \frac{L_m}{L_r L_s \sigma} |\vec{\varphi}_r| |\vec{\varphi}_s| \sin(\gamma) \tag{6}$$

Where The various pole pairs  $P$ ,  $= 1 - L_m^2 / (L_s L_r)$  is the dispersion factor, and  $\gamma$  is the flux space load angle between the stator and the rotor vectors.

**Direct Torque Control**

Should the sample duration is brief sufficient, the motor will be forced to accept stator voltage space vector while maintaining the flux of the stator at its reference value. Since the flux of rotor fluctuates less than the stator flux, it will eventually become constant. By swiftly adjusting the required direction's angle, the electromagnetic torque (6) may be altered. If the proper stator voltage is used, this angle may simply be altered spatial vector.

Let's assume that it would be possible to ignore the stator phase ohmic decrease in (1).

Therefore  $\frac{d\vec{\varphi}_s}{dt} = \vec{u}_s$ . When the voltage space vector is applied for a brief period of time  $\Delta t$ , it has ;

$$\Delta \vec{\varphi}_s \approx \vec{u}_s \cdot \Delta t \tag{7}$$

**The Suggested DTC-SVM Method**

This suggested DTC-SVM technique is shown in Figure 1. This scheme simply requires sensing the Two phases and the DC Link of the induction motor's  $I_s$  (stator current), which accepts the emt error ( $E_T$ ) and the stator flux error ( $E_{\varphi_s}$ ) as inputs.





**Calculation for Stator Voltage**

The three inverter switches' states (Sa, Sb, and Sc) and the DC link voltage "Vdc", of the two level inverter are used in the stator voltage calculation. The voltage vector of stator, designated as  $\vec{u}_s$ , is established as follows:

$$\vec{u}_s = \frac{2}{3} \left[ (S_a - \frac{S_b+S_c}{2}) + j \frac{\sqrt{3}}{2} (S_b - S_c) \right] V_{dc} \tag{8}$$

**Electromagnetic Torque and Stator Flux Estimation**

Due to the calculation:

$$\vec{\varphi}_s = \int (\vec{u}_s - R_s \vec{i}_s) dt \tag{9}$$

The emf, which varies with stator resistance at low speeds, is a challenge for this sort of calculation. To address this challenge, the flux estimation is improved using the current model as in [20]. The rotor flux stood for:

$$\vec{\varphi}_{rdq} = \frac{L_m}{1+sT_r} \vec{i}_{sdq} - j \frac{(\omega_{gr}-\omega_r)T_r}{1+sT_r} \vec{\varphi}_{rdq} \tag{10}$$

Where  $T_r = L_r/R_r$  the time constant of the rotor. By using this expression in place of the original and setting  $r_q = 0$  in equation (10), it is:

$$\vec{\varphi}_{rd} = \frac{L_m}{1+sT_r} \vec{i}_{sd} \tag{11}$$

The stator flux in the current model is shown as:

$$\vec{\varphi}_s = \frac{L_m}{L_r} \vec{\varphi}_r + \frac{L_s L_r - L_m^2}{L_r} \vec{i}_s \tag{12}$$

Where  $\vec{\varphi}_r$  is the rotor flow in the equation estimated (11). Equation (1) serves as the foundation for the voltage model, is given by:

$$\vec{\varphi}_s = \frac{1}{s} (\vec{v}_s - R_s \vec{i}_s - \vec{U}_{comp}) \tag{13}$$

The voltage model is modified using the PI controller in order to rectify the mistakes caused by the stator resistance measurement and pure integration..

$$\vec{U}_{comp} = (K_p + K_i \frac{1}{s}) (\vec{\varphi}_s - \vec{\varphi}_s) \tag{14}$$

The  $K_p$  and  $K_i$  coefficient are computed using the recommendation formulated in [20]. rotational flux  $\vec{\varphi}_r$  in the calculation of the stationary reference frame is:

$$\vec{\varphi}_r = \frac{L_r}{L_m} \vec{\varphi}_s - \frac{L_s L_r - L_m^2}{L_m} \vec{i}_s A = \pi r^2 \tag{15}$$

As opposed to that, the electromagnetic torque is computed when equations (13) and (15) are substituted in (5).

**SIMULATION RESULTS**

The simulations were carried out using the MATLAB simulation package, which contains Simulink block sets and the fuzzy logic toolbox. The PWM inverter's switching frequency was set to 10 kHz, the coefficients were 90 and 2, and the flux with reference of stator was 0.46 Wb. We conducted a variety of tests to evaluate both the effectiveness of the proposed control mechanism and the closed-loop stability of the overall system. Figure 9 shows the behaviour of the rotor angular speed  $r$ , the electromagnetic torque, and the phase of a stator current waveform when a step shift in the reference speed from 0.5 pu to -0.5 pu is applied. There was limited torque to 3/2 times the anticipated rated torque, and the stator current's sinusoidal waveforms demonstrated that this control method also permitted effective current control since it is a component of the algorithm control suggested in this paper. The DTC-SVM approach using TSF controller that is proposed performed admirably in every test, according to the results.





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## CONCLUSION

It is proposed to replace both PI controllers with the fuzzy Takagi-Sugeno controller to address the drawbacks of the C- DTC-SVM approach. The suggested controller determine the quadrature parameter of the in the stator flux reference frame, the stator voltage vector. In this paper we use membership function of trapezoidal and triangle type. Numerous operational scenarios have been simulated. The results of the simulation shows the recommended DTC-SVM system with this type of controller selected satisfactory result parameters as expected. In several operational scenarios, it demonstrated quick torque response and minimal torque ripple at different circumstances, incorporating abrupt changes in speed reference when no load is applied and step variations in the motor load.

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**Table.1 Dimensions of Induction Motors [21]**

Nominalvoltage(V)	220 VOLT/60HERTZ
NominalPower(HP)	3
NominalTorque(Nm)	11.8
NominalSpeed(rad/s)	179
$R_s, R_r(\Omega)$	0.435,0.816
$L_l s(H)$	0.002
$L_l r(H)$	0.002
$L_m(H)$	0.0693
$J(K m^2)$	0.089
$g$	
P(PAIR OF POLES)	2

► TABLE I			
$E_{\psi_m} / E_{\tau}$	N	ZE	P
N	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$
ZE	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$
P	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$	$u_{ds}^* = aF_e + bT_e$ $u_{qs}^* = -bF_e + aT_e$





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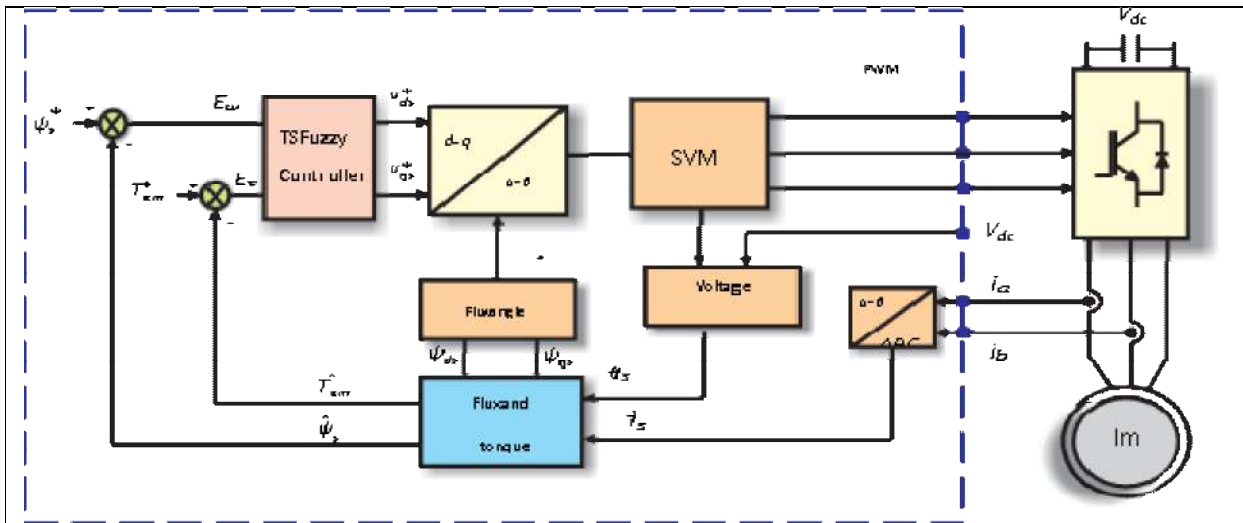


Fig.1. In the DTC with SVM approaches, the Takagi-Sugeno fuzzy controller

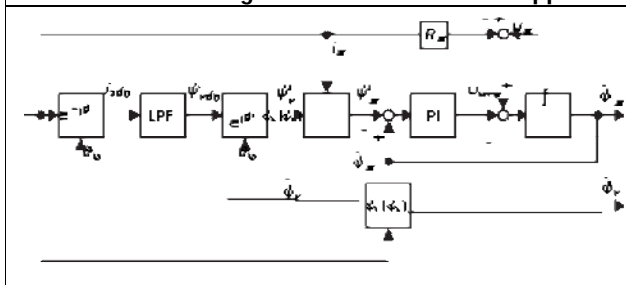


Fig.2. Estimator of rotor and stator flux

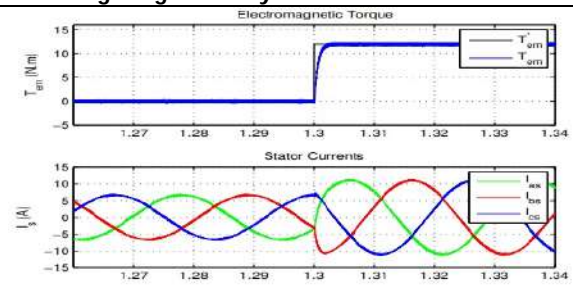


Fig.3. Response of the stator current and magnetic torque when the load torque profile is applied at 50% of the rated speed

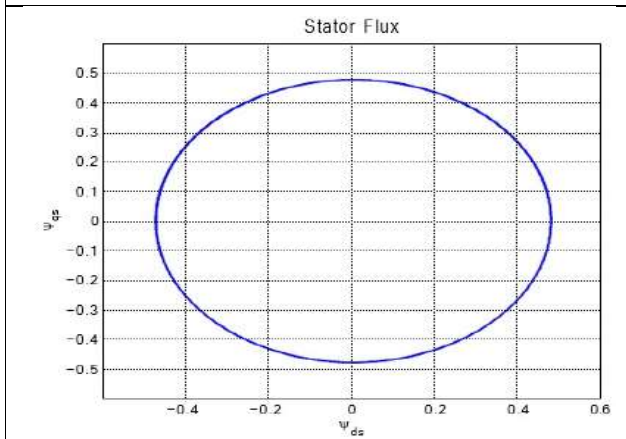


Fig. 4. Space of the Quadrature Stator Flux Components

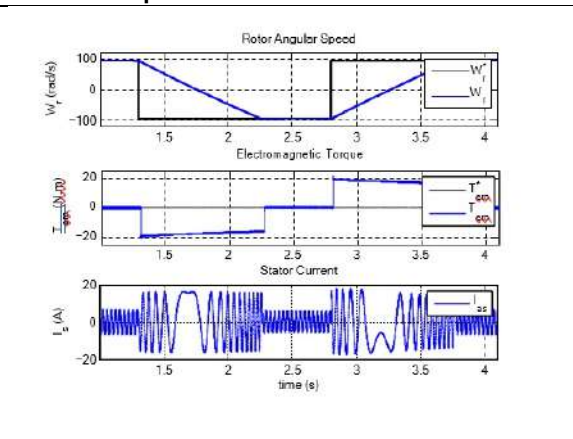


Fig.5. When the no-load abrupt change in speed reference was applied at 50% of rated speed, the rotor's angular speed, electromagnetic torque, and phase of the stator current were all changed.







## Evaluation of Bioactive Phytocompounds from *Cecropia peltata* L. against BRCA Proteins by *In silico* Approach

Ruth Daniel<sup>1</sup>, Joseph Sebastin Raj<sup>2\*</sup>, Abdullah Ansari<sup>3</sup>, Baskaran Maheswaran<sup>4</sup> and Vithya Dharmaraj<sup>5</sup>

<sup>1</sup>Research Scholar, P.G and Research Department of Biotechnology, Jamal Mohamed College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli-620020, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Biotechnology, Jamal Mohammed College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli-620020, Tamil Nadu, India.

<sup>3</sup>Department of Biology, Faculty of Natural Sciences, University of Guyana, South America.

<sup>4</sup>PG Department of Biotechnology, Ayya Nadar Janaki Ammal College (Autonomous), Sivakasi, Affiliated to Madurai Kamaraj University, Madurai, Tamil Nadu, India.

<sup>5</sup>P.G and Research Department of Biotechnology, Dhanalakshmi Srinivasan College of Arts and Science for Women (Autonomous), Perambalur, Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

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### \*Address for Correspondence

**Joseph Sebastin Raj**

Assistant Professor,

Department of Biotechnology,

Jamal Mohammed College (Autonomous),

Affiliated to Bharathidasan University, Tiruchirappalli-620020,

Tamil Nadu, India.

E. Mail: jsebastinraj@gmail.com



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### ABSTRACT

Researcher's interest in BRCA1 has stirred up by the widely known target of estrogen receptor alpha. Due to their significant scaffolding, phytoconstituents have a significant role in anticancer activities and may be more effective than synthesized medications while having fewer negative side effects. The goal of the current investigation is to find novel, less harmful anticancer medicines from dietary and natural components. The current study has focused on molecular computational analysis to identify the potential compounds from *Cecropia peltata* L., which can block the mutated gene (BRCA1) responsible for the breast cancer. This is due to the lack of reliable and potential drugs to treat the life-threatening breast cancer. The carcinogenic protein was evaluated against seven different phytochemicals. From protein data bank (PDB), the 3D crystal structure of the protein was retrieved and the protein binding sites of the test compounds were determined. Auto Dock 4.2.6 molecular docking techniques was employed to evaluate the energy of targeted binding and anticipate the characteristics of bioactive phytocompounds from natural products. Our findings showed that among seven chemicals, 1-Propene, 2-(2-

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methylPhenyl)-1-Phenyl, (Z) was shown to be effective in destroying the protein (BRCA1) responsible for breast cancer.

**Keywords:** *Cecropia peltata*, BRCA1, GC-MS

## INTRODUCTION

There are several factors which play a role in cancer but more common one being mutation. The most common "high penetrance" gene mutations are those in the BRCA1, BRCA2, and PALB-2 genes, which significantly increase the risk of developing breast cancer. The available potent treatments for breast cancer have negative side effects and are ineffective in individuals. Therefore one has to turn to other source of treatment which are long standing and cost effective. In times past plants have proven time and time again the value and the potential exhibited by the plant if it has a medicinal property. In recent times ethanobotany has played a vital role in plant research purposes in terms of finding cure for several diseases which has increased drastically due to antibiotic resistance in the world. Plant have secondary metabolites which are found naturally in the plant and are responsible for the defense as well as protecting the plant from various diseases. From survey conducted it has been reported that in this world about 80% of the population use traditional medicines for primary health cure (Kumar and Raja Kumar 2016). Medicinal plants contain a plethora of bioactive compounds which makes them a sort after product for the development of drugs. The results of the benefits are from a combinations of the secondary metabolites within the plant which makes it having similar properties of the usual synthetic drugs available on the market (George et al., 2019). *Cecropia peltata* has been introduced to Africa, Asia, and the Pacific. Its range extends from southern Mexico to Central America to northern South America, Guyana, Trinidad & Tobago, and Jamaica. GC-MS is a technique which is used in the identification of organic volatile compounds (Kumari et al., 2019). *Cecropia peltata* is commonly known as "trumpet tree" classified in the plant family Urticaceae and is commonly used for the treatment of respiratory diseases (Costa et al., 2011), anti-inflammatory (Lans 2006), antimicrobial effects (Daga et al., 2020), Hypertension (Lans 2006), diabetes (Rivera-Mondragón et al., 2021). Hence, the present study was carried out to investigate the bioactive compounds of *Cecropia peltata* leaves using the GC-MS and constituents using molecular docking studies.

## MATERIALS AND METHODS

### Collection of Plant Materials

The plant leaves were collected from the Soesdyke –Linden Highway (6.450819337890005, 58.23684632828325 6.4497699267788855, -58.2371571057697) in the month of November, 2019. The plant was identified and confirmed by Ms. Kaslyn Collins, Scientific Officer, from the Centre for the Study of Biological Diversity. The plant leaves were cleaned, washed and was subjected to shade dry.

### Extract Preparation

The healthy plant leaves were collected from the natural habitats and it was washed with running tap water then it was left for air-drying under shade dry then it was then ground to a coarse powder. The leaves were treated with two different solvents namely Ethanol and Ethyl acetate in a Soxhlet apparatus. The extract was then refrigerated for further analysis.

### GC-MS Analysis

A GC clarus 500 Perkin Elmer system with an AOC-20I auto sampler, a gas chromatograph, and a mass spectrophotometer was used for the GC-MAS analysis. Using the National Institute of Standard and Technology (NIST) database, which contains more than 62,000 patterns, the mass spectrum of the GC-MAS was interpreted. It was compared to the spectra of the known component that was already present in the NIST collection. The components of the test materials' names, molecular weights, and structures were identified.



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### Retrieval of Receptor Proteins

Breast Cancer gene 1 (BRCA1), a well-known target for breast cancer treatment, was employed as the target protein in this computational analysis. The three-dimensional (3D) structures of as receptor proteins (PDB ID: 3PXB) with 2.6 Å resolution were obtained in .pdb format from the RCSB Protein Data Bank (<https://www.rcsb.org/>).

### Modification of Receptor Protein

The atomic coordinates of the protein receptor (3PXB) were separated and its geometry was optimized using Tripos SYBYL 7.3(Tripos Associates, St. Louis, MO, USA). Kollman unified charges, Polar hydrogen atoms, and solvent parameters were applied to the protein for docking with AutoDock using the pmol2q script. This script changes the protein template's .pdb file format to a .pdbqs file format that is compatible with AutoDock4.2.6.

### Binding Site Prediction

A structural and active site analysis of BRCA1 was performed utilizing the computed atlas of surface topography of proteins (CASTp) (<http://sts.bioe.uic.edu/castp/index.html?1yca>).

### Analysis of Drug Likelihood Property

Lipinski's rule of five was followed to ensure good access to drugs. It functions as a virtual filter for the selected database, which has a violation of about 0 and 1 was considered for this investigation. According to Lipinski's criterion, pharmaceuticals have typically been active molecules having a molecular mass should be less than 500 Da, no more than 5 hydrogen bond donors, no more than 10 hydrogen bond acceptors, and partition coefficient log P less than 5 and should Not more than 1 rule can be violated (Lipinski *et al.*, 2012). SwissADME (<http://www.swissadme.ch/>), an online web-based platform that assesses the pharmacological accuracy of the drug candidates, was employed for the initial screening.

### Preparation of Ligand Molecules

The 3D structures of seven compounds named Bicyclo-[2.2.1] heptan-2-ol, 2-(2-cyclopenten-1-yl) - (CID: 573923), Phenol (CID: 996), Diazene,dimethyl;1-oxide(Azoxy methane) (CID: 33184), 2,7-Dimethyl-2-3-dihydrofuro[2,3-C]Pyridine (CID: 590969), Octanoic acid, 2-methyl-methylester (CID: 5519895), 1-Propene,2-(2-methylPhenyl)-1-Phenyl, (Z) (CID: 5375332), and N-isopropyl-3-Phenyl Propanamide (CID: 541823) were retrieved from the chemical database of PubChem (<https://pubchem.ncbi.nlm.nih.gov/>).

### Molecular Docking

Molecular docking study was carried out in five independent runs for each ligand using the AutoDock 4.2 tool (the Scripps Research Institute, La Jolla, CA, USA). The grid dimension space was as follows: x-centering: 46.327, y-centering: 32.329, and z-centering: 39.677. The results were analyzed in order to determine the lowest binding energy and the inhibition constant of the interactions.

### Visualization of Protein-Ligand Complexes

Using the Discovery Studio Visualizer 20.1 Programme, the protein-ligand complexes were visualized. The polar and hydrophobic interactions between ligand and target were characterized using this programme, 2D and 3D illustrations of such interactions were made. The docked poses that resulted were determined based on their binding energy scores, ligand efficiency, and intermolecular H-bonds.

## RESULTS AND DISCUSSION

Plant metabolites are better prospects for drugs because they exhibit greater "drug-likeness and biological activity than fully synthesized molecules"(George *et al.*, 2019).Breast cancer is a significant public health concern despite the development of medical technology and substantial study, getting the utmost priority in the field of medicine (Mehta *et al.*, 2019; Pashayan *et al.*, 2020). Finding possible breast cancer inhibitors using a variety of computational



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approaches is the primary goal of this work. The investigation of different phytochemicals against a BRCA1 proteins considered to be potential therapeutic targets and involved in the progression of breast cancer was attempted.

### Results of GC-MS

Twenty chemicals were clearly present in the investigations on the active principles in the leaves of plant *Cecropia peltata* in Ethyl acetate extract by GC-MS. The active principles and their duration of retention (RT). Table 1 lists the Chemical structure, molecular weight (MW), and concentration (peak area %) structure and activity. Figure 2 depicts the GC-MS chromatogram for the seven (7) identified chemical peaks. The results revealed that 1-Propene,2-(2-methylPhenyl)-1-Phenyl was found as the major component in the Ethyl acetate extract., minor compounds such as Diazene,dimethyl;1-oxide(Azoxy methane). In the Ethanolic extract 4C,8A- had the highest retention time of 38.525 and an area % of 0.21. whereas Bicyclo[2.2.1]heptan-2-ol,2-(2-cyclopenten-1-yl)- ad the lowest retention time of 5.941 and an area % of 0.28. 2, 7-Dimethyl-2-3-dihydrofuro[2,3-C]Pyridineand Hexanedioicacid were found common in both Ethyl acetate extract and Ethanolicextract.

A study conducted by Othman et al., (2015) showed that the hexane extract of *Jatropha curcas* root plant exhibited the presence of hexadecanoic acid methyl ester, octadecanoic acid methyl ester and octadecanoic acid which was responsible for anti-inflammatory. The initial findings showed that *Cecropia peltata* leaf of the ethyl acetate (EtOAc) extract was more effective against BrAC -1 than the ethanol extract. As a result, the extract underwent additional purification, and GC-MS. The isolated plant compounds were analyzed for drug -like qualities of the plant. The highest retention time chemical compound and Cyclohexasiloxane, dodecamethyl (8.95) as the lowest retention time chemical compound. The GC-MS chromatogram of Ethylacetate and Ethanoic extract of *Cecropia peltata* leaf showed prominent peaks representing the presence of a total 25 phytochemical constituents Table 1.

### Drug Likeness and Toxicity Prediction

As we know ADME is critical in determining how a substance's potential impact on a biological system could be described in the context of cellular biology and biochemistry. In order to cut costs and maximize lead compounds, the drug discovery and development pipeline has increasingly relied on in vitro testing and in silico predictions. Before beginning in vivo testing and clinical trials, test systems such as lipophilicity, solubility, and plasma stability act as surrogates and help evaluate a compound's pharmacological properties (Krüger et al., 2020). In order to assess the anti-breast cancer activity of furanocoumarins 1, Lipinski's rule of five was applied to determine the drug-likeness property. In this ADME study before approaching in vivo studies due to the positive results, the following compounds in Table 2 were found to be adhering to the Lipinski's rule of five. The selected 7 compounds obey the rule and thus used for the purpose of drug production.

### Protein Structure Retrieval

3D Structure of BRCA1 (3PXB) was downloaded from PDB.

### Prediction of Binding Sites of the Receptor Protein

According to maximum pocket area and pocket volume binding pockets of a receptor protein were calculated by CastP server and selected for docking studies (Table 3). These pockets contains TRP27, GLU29, ALA31, HIS38, ASN39, ILE40, LEU41, ILE52, LYS53, SER128, TRP139, ASN141, GLY142, GLU144, VAL145, GLN160, ASN191, GLU193 and VAL197 for 3PXB.

### Selection of Ligands

The molecules examined in this study were obtained from a wide variety of classes of phytochemicals, including alkaloids, flavonoids, etc. As cancer-related enzyme inhibitors, some of the compounds have already been reported in various findings. The 25 phytochemicals that have already been found as anti-cancer substances were evaluated in the current study. Primarily, pharmacokinetic properties were studied, and Lipinski's rule of five was taken into account for the evaluation of the drug-likeness of molecules. Out of all the selected 25 phytochemicals, 13 molecules were satisfied with the Lipinski rule and were subjected to further analysis.



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### Molecular Docking

The protein-ligand binding process is suggested to be in an equilibrium state by the Gibbs free energy (kcal/mol). The extrapolation of ligand (inhibitor) conformation and orientation within a targeted binding site is a component of the docking process. The most common docking programme, AutoDock, made it easier to predict selected compounds might interact with BRCA1. The promising pose from the docking simulations was retained for a real study of the intermolecular interactions since it had a greater binding energy, ligand efficiency, and intermolecular H-bonds. From Figure 3, molecular interactions of the target protein (3PXB) with the selected ligands were depicted. In this investigation, the results of molecular docking showed that BRCA1 target protein tends to bind to the selected ligands (Bicyclo-[2.2.1] heptan-2-ol, 2-(2-cyclopenten-1-yl), Phenol, Diazene, dimethyl;1-oxide (Azoxy methane), 2,7-Dimethyl-2-3-dihydrofuro[2,3-C]Pyridine, Octanoic acid, 2-methyl-methylester, and N-isopropyl-3-Phenyl Propanamide) with the lowest binding energy of -5.7, -4.8, -3.7, -6.3, -5.2, and 7 kcal/mol, respectively (Table 5). Also, the compound 1-Propene, 2-(2-methylPhenyl)-1-Phenyl, (Z) was bound to the 3PXB target protein with the lowest binding energy of -7.2 kcal/mol.

As a result from the Molecular Docking study the prediction of these selected drug compounds will serve the public for breast cancer treatment. The found ligands exhibit good pharmacokinetic characteristics and satisfy the prerequisite of Lipinski's rule. The development of vaccines against this breast cancer illness has been the target of much investigation by a number of researchers, but these efforts have not yet proved effective (Bulcha et al., 2021; Quemener et al., 2022). There is a need to design novel approaches to fight against this cancer target. By using plants to develop a drug through this way which offers lots of advantages like higher expression, easier distribution, lower production cost, and better safety as there are no human or animal pathogen that increases the biosafety aspect (Baxendale et al., 2015; Chen et al., 2019; Zhang et al., 2022). The main conclusions of this study demonstrate that various phytochemicals may be able to block the different genes of breast cancer. Some phytochemicals that can be regarded as better lead molecules include 1-Propene, 2-(2-methylPhenyl)-1-Phenyl, (Z). Additionally, more analogues of these prospective compounds can be developed using pharmacophore modelling and drug development. In vitro and *in vivo* experiments can be performed to validate the *in silico* research. If the results are consistent with our findings, further chemical synthesis of the phytochemicals can be done.

### CONCLUSION

There is an urgent need to find an effective cure for breast cancer given the tragedies that the disease has been responsible for decades. In order to address this problem, 13 lead compounds were identified after 25 phytochemicals were screened using pharmacokinetic parameters in our study. Further, these 13 molecules were docked against BRCA1, resulting in the top 7 potential binders. Furthermore, toxicity and bioavailability analysis of these top 7 molecules revealed that the phytochemical were found to be safe and non-toxic. As a result, these compounds can be regarded as effective against the target proteins. In addition to identifying promising hits for potential lead optimization in the development of breast cancer treatments, we think the data will help with the development of conventional medicine-based therapy techniques. Molecular dynamics simulations of the protein model and experimental research on animals may help to further demonstrate the validity of these studies, providing the possibility of the development of potent personalized treatments for breast cancer.

### Conflicts of Interests

The authors declare that they have no conflict of interest. It has not been published elsewhere. That it has not been simultaneously submitted for publication elsewhere. All authors agree to the submission to the journal.

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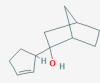

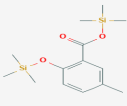


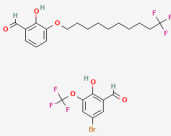




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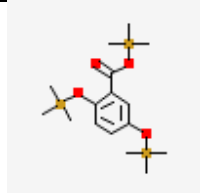
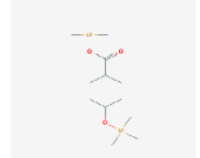
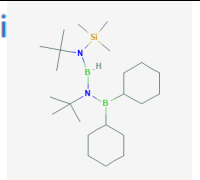
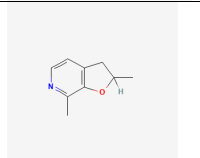
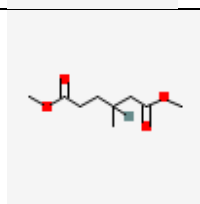
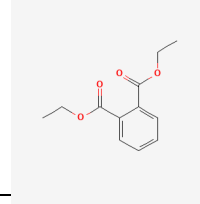
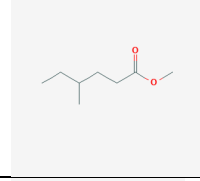
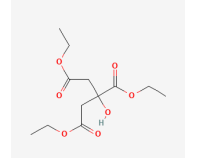
**Table 1: Bioactive compounds of *Cecropia peltata* leaf extract identified by GCMS**

S. No	Compound Name	Retention Time	Area %	Molecular Formula	Structure	Molecular weight g/mol
1	bicyclo[2.2.1]heptan-2-ol,2-(2-cyclopenten-1-yl)-	5.941	0.28	$C_{12}H_{18}O$		178.27
2	silanol,dimethyl	6.026	0.19	$C_2H_7OSi$		75.16
3	trimethylsilylesterof5-methyl-2-trimethylsilyloxy-benzoicacid	6.46	1.06	$C_{14}H_{24}O_3Si_2$		296.51
4	2-cyclopenten-1-one,4-methylene	6.5	0.33	$C_9H_{12}O$		136.19
5	3-(2,2-dimethoxyethyl)-1,1,5,5-tetramethoxy-3-pentanol	6.676	0.37	$C_{13}H_{28}O$		200.36
6	benzaldehyde,2-hydroxy	7.98	2.63	$C_{25}H_{27}BrF_6O_6$		617.4





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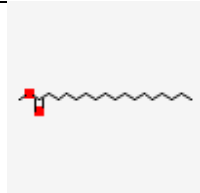
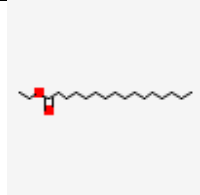
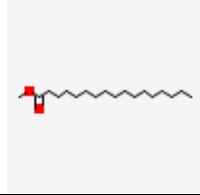

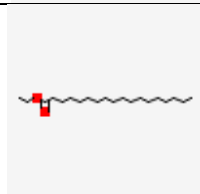
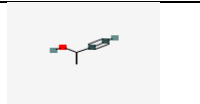
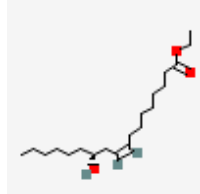
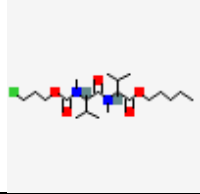
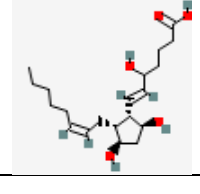
7	benzoic acid, 2,5-bis(trimethylsilyloxy)-, trimethylsilyl ester	10.052	1.61	$C_{16}H_{30}O_4Si_3$		370.66
8	di(15)n-thiourea 2,3,4,4-tetrapropyl-1-(trimethylsilyl)-1-(trimethylsilyloxy)-1,3	10.498	0.21	$C_{13}H_{28}O_3Si_2$		288.53
9	diaza-2,4-diborabutane	13.99	0.71	$C_{23}H_{50}B_2N_2Si$		404.4
10	furo[2,3-c]pyridine, 2,3-dihydro-2,7-dimethyl-	19.93	0.4	$C_9H_{11}NO$		149.19
11	hexanedioic acid, 3-methyl-, dimethyl ester	19.968	0.19	$C_9H_{16}O_4$		188.22
12	1,2-benzenedicarboxylic acid, diethyl ester	20.027	1.92	$C_{12}H_{14}O_4$		222.24
13	hexanoic acid, 4-methyl-, methyl ester	20.135	0.19	$C_8H_{16}O_2$		144.21
14	1,2,3-propanetricarboxylic acid, 2-hydroxy-, triethyl ester	21.282	61.1	$C_{12}H_{20}O_7$		276.28







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15	heptadecanoicacid, methylester	26.102	3.28	$C_{18}H_{36}O_2$		284.5
16	hexadecanoicacid, ethylester	27.211	6.73	$C_{18}H_{36}O_2$		284.5
17	heptadecanoicacid,methylester	29.293	4.18	$C_{18}H_{36}O_2$		284.5
18	1,6-octadien-3-ol,7-methyl-3-(trifluoromethyl	29.893	0.2	$C_{12}H_{20}O_2$		196.29
19	octadecanoicacid,ethylester	30.295	1	$C_{20}H_{40}O_2$		312.5
20	3-butyn-2-ol	31.695	0.33	$C_4H_6O$		70.09
21	9-octadecenoicacid,12-hydroxy-,ethylester,[r-(z)]- dl-valyl-dl-valine,n,n'-dimethyl-n'-(3-chloropropoxycarbonyl)-,pentyl ester	32.617	3.13	$C_{20}H_{38}O_3$		432.6
22	4b.alpha.,4c.beta.,5.alpha.,8.alpha.,8a.beta.,8b.alpha.)-2,4b,5,8,8b,11-hexamethyl-6,7-diphenyl-4,4b,5,8,8b,9-hexahydro	38.27	0.18	$C_{21}H_{39}ClN_2O_5$		435.0
23	Isoprostane F2alpha-I	38.525	0.21	$C_{23}H_{30}O_3$		354.5





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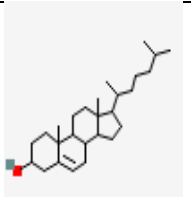
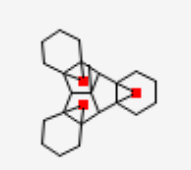
24	3.alpha.-methylcholest-5-en-3-beta.ohnitrite (4b.alpha.,4c.beta.,5.alpha.,8.alpha.,8a.beta.,8b.alpha.)-2,4b,5,8,8b,11-hexamethyl-6,7-diphenyl-4,4b,5,8,8b,9-hexahydro--	38.462	0.19	$C_{27}H_{46}O$		386.7
25	Melengesterol	38.525	0.21	$C_{23}H_{30}O_3$		354.5

Table 2: Pharmacological properties of selected ligands

Name of the compound	Molecular weight (g/mol)	H acceptor	H donor	Log P	Log S	Solubility	GI	BBB	Cyt p	Results of Lipinski rule
Bicyclo-[2.2.1]heptan-2-ol, 2-(2-cyclopenten-1-yl)	178.27	1	1	2.56	2.39	S	High	Yes	No	0 violation
Phenol	136	1	0	2.12	1.63	VS	High	Yes	No	0 violation
Diazene,dimethyl;1-oxide(Azoxy methane)	435	5	0	4.06	-4.6	MS	High	Yes	No	0 violation
2,7-Dimethyl-2-3-dihydrofuro[2,3-C]Pyridine	149	2	0	1.82	2.23	S	High	Yes	Yes	0 violation
Octanoic acid, 2-methyl-methylester	75	1	1	2	0.61	VS	High	No	No	0 violation
1-Propene,2-(2-methylPhenyl)-1-Phenyl, (Z)	208	0	0	4.63	4.82	MS	Low	No	No	1 violation
N-isopropyl-3-Phenyl Propanamide	191	1	1	2.32	2.25	S	High	Yes	No	0 violation

Table 3: Protein and its binding pocket information

PDB ID	Length (aa)	Resolution (Å)	Pocket area (Å <sup>2</sup> )	Pocket volume (Å <sup>3</sup> )
3PXB	352	2.40	402.746	296.781

Table 4: Molecular docking scores of selected ligands participating in hydrogen bonding and other interactions with BRCA1 receptor protein

S.No	Ligands	Docking Score	h-BOND Interactions	Distance
1	Bicyclo-[2.2.1]heptan-2-ol, 2-(2-cyclopenten-1-yl)	-5.7	ASP855 N-H...O	2.77
2	Phenol	-4.8	LEU777 N-H...O MET766 N-H...O	4.95 4.62
3	Diazene,dimethyl;1-oxide(Azoxy methane)	-3.7	CYS775 N-H...O	3.52

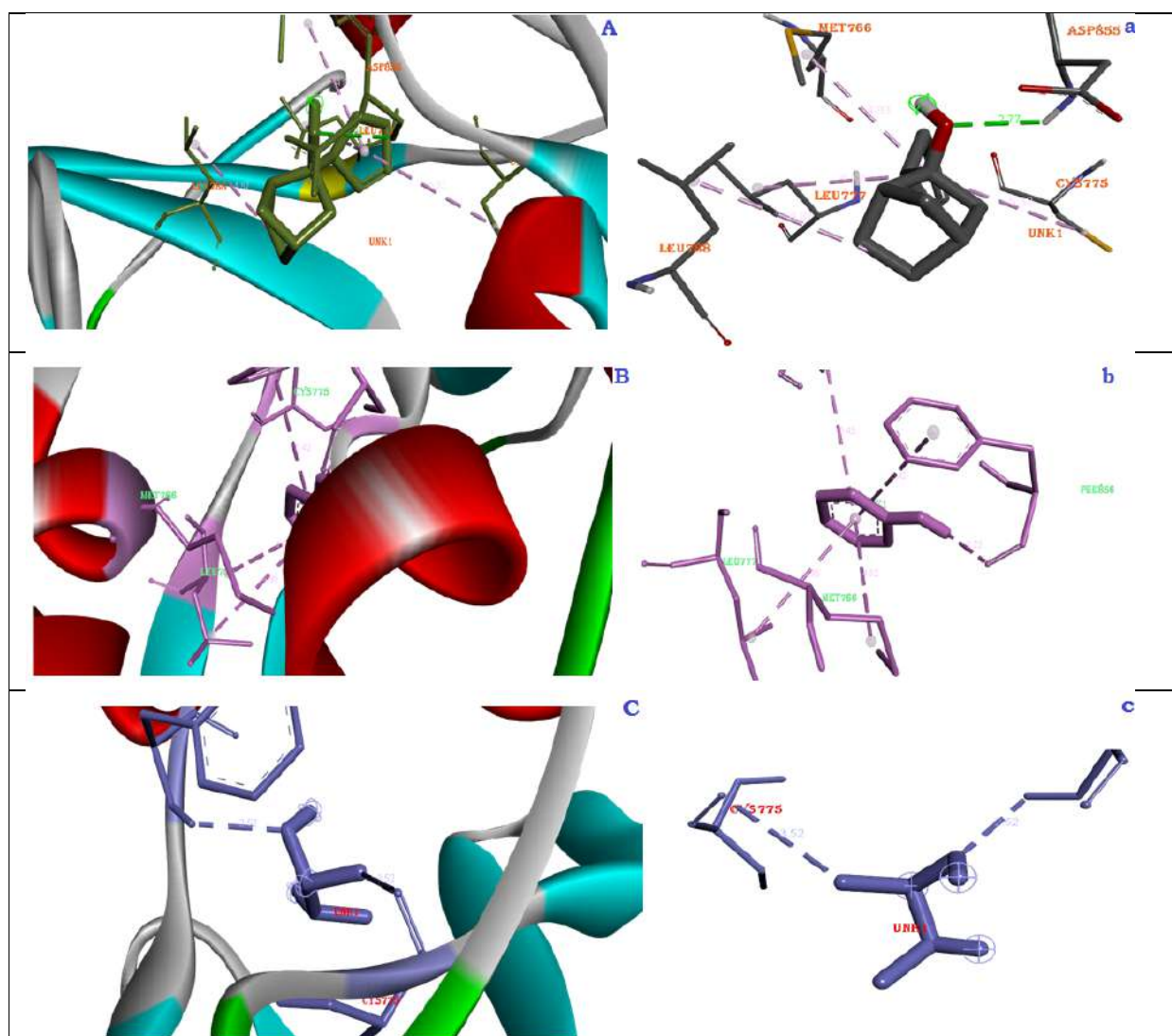




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4	2,7-Dimethyl-2-3-dihydrofuro[2,3-C]Pyridine	-6.3	LEU792 NH...O CYS775 N-H...O	4.25 2.60
5	Octanoic acid, 2-methyl-methylester	-5.2	LEU789 NH...O PHE712 N-H...O LYS714 N-H...O GLY729 N-H...O	4.87 4.24 4.39 2.84
6	1-Propene,2-(2-methylPhenyl)-1-Phenyl	<b>-7.2</b>	LEU789 N-H...O PHE712 N-H...O LYS714 N-H...O	3.68 4.37 2.75
7	N-isopropyl-3-Phenyl Propanamide	-7	LYS714 N-H...O	4.78

\*Number in bold is the lowest amount of binding energy value





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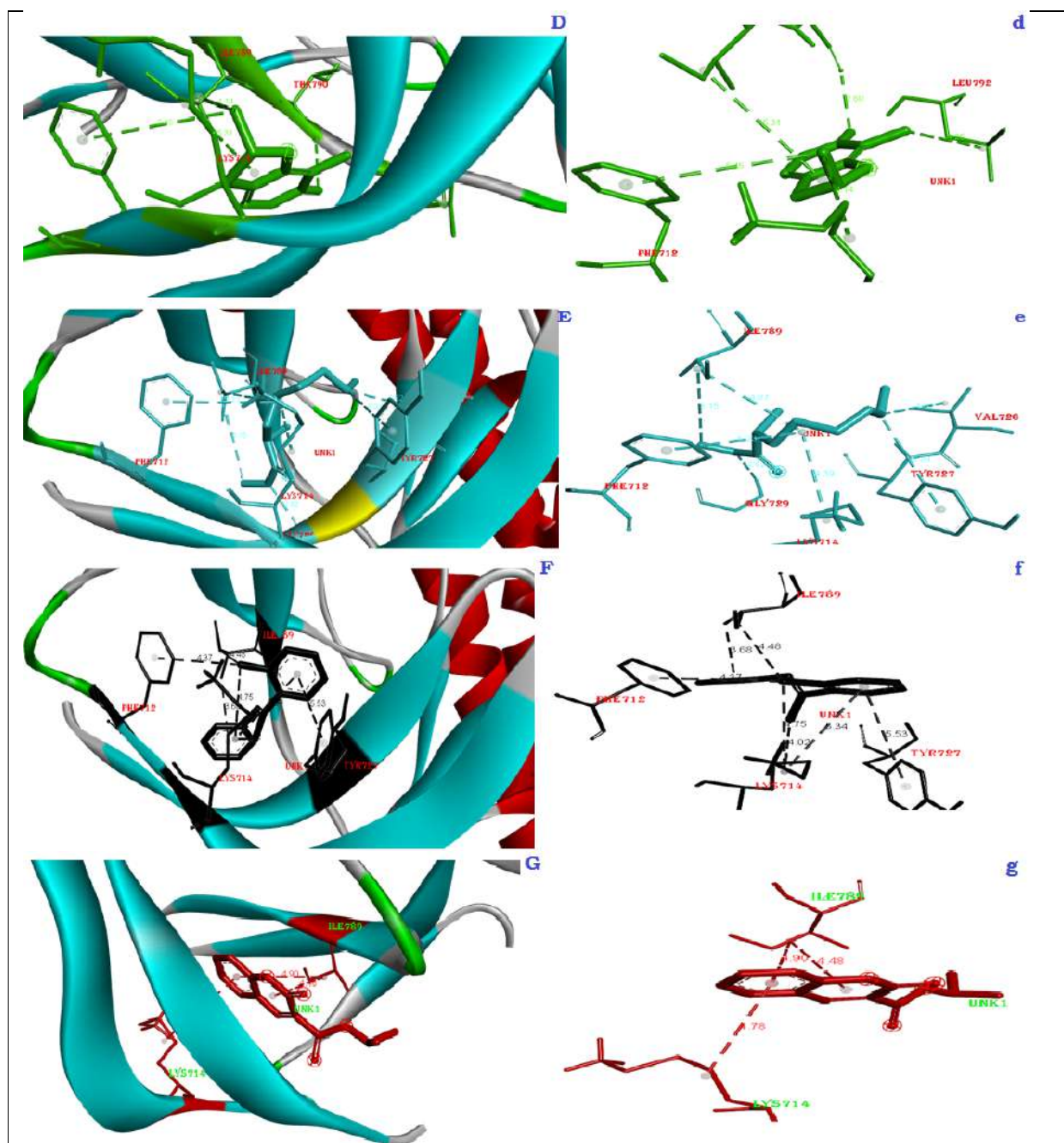


Figure 1. The 3D and 2D graphical representations of the best binding mode and interacting residues of the Bicyclo-[2.2.1] heptan-2-ol 2-(2-cyclopenten-1-yl) with 1XKK (A, a), Phenol with 1XKK (B, b), Diazene, dimethyl; 1-oxide (Azoxy methane) with 1XKK (C, c), 2,7-Dimethyl-2,3-dihydrofuro[2,3-C]Pyridine with 1XKK (D, d), Octanoic acid, 2-methyl-methylester with 1XKK (E, e), 1-Propene, 2-(2-methylPhenyl)-1-Phenyl, (Z) with 1XKK (F, f) and N-isopropyl-3-Phenyl Propanamide with 1XKK (G, g).





## One-Step Synthesized Copper Oxide Nanoparticles and Evaluation of Photocatalytic and Antibacterial Activities

R.Muraleedharan<sup>1\*</sup>, B.Saravanan<sup>2</sup>, J.Ramajothi<sup>3</sup>, D.Balakrishnan<sup>1</sup> and M.Marimuthu<sup>4</sup>

<sup>1</sup>Assistant Professor in Physics, Department of Science and Humanities, Sri Ramakrishna College of Engineering, Perambalur, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Physics, Marudupandiyar College, Thanjavur, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, Department of Physics, Anna University, Chennai, Tamil Nadu, India.

<sup>4</sup>Principal, Department of Mechanical Engineering, Sri Ramakrishna College of Engineering, Perambalur, Tamil Nadu, India.

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### \*Address for Correspondence

#### R.Muraleedharan

Assistant Professor in Physics,  
Department of Science and Humanities,  
Sri Ramakrishna College of Engineering,  
Perambalur, Tamil Nadu, India.  
E. Mail : muraleedharan0@gmail.com



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### ABSTRACT

Copper oxide nanoparticles are produced using the stems of *Cissus quadrangularis*. Powder XRD was used to determine the crystallinity of copper oxide nanoparticles produced using leaves. It is feasible to analysis the optical properties of copper oxide nanoparticles made by a *Cissus quadrangularis* extract using UV-Vis spectral measurements. It was feasible to confirm the surface topology of the synthesized compound using SEM examination. CuONPs' elemental presence is verified by EDX analysis. The photo catalytic and antibacterial activities of CuONPs derived from *Cissus quadrangularis* stem extract were examined.

**Keywords:** Copper oxide, Powder XRD, EDX, Photo catalytic.

### INTRODUCTION

Medicinal plants have been playing an essential role in the development of human culture [1-3]. As a source of medicine, medicinal plants have always been at forefront virtually all cultures of civilizations [4-5]. Medicinal plants are regarded as rich resources of traditional medicines and from these plants many of the modern medicines are produced [6-8]. Most of the important drugs of the past 50 years, which have revolutionized modern medicinal practice, have been isolated/derivatives from plants. These chemical ingredients exhibit therapeutic properties of plant and animal drugs [9-11]. The WHO endorses and promotes the addition of herbal drugs in national health care

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programs because they are easily accessible at a price within the reach of a common man and are time tested and thus considered to be much safer than the modern synthetic drugs [12- 14].

## EXPERIMENTAL METHODS

### Plant Extract of *Cissus quadrangularis* Stems

The phytochemical characters of the *Cissus quadrangularis* stems were investigated and represented in table. 1 and fig. 1. The qualitative phytochemical analysis of *Leucasasperaleaves* was found to contain tannin, saponins, flavonoids, terpenoids, triterpenoids, anthraquinone, polyphenol, glycosides and coumarins were present in aqueous extract while steroids and alkaloids were absent.

### Synthesis of Copper oxide Nanoparticles

In this work, a study on the phytosynthesis of copper oxide nanoparticles by the aqueous stem extract of *Cissus quadrangularis* was carried out. During the visual observation, copper acetate and leaf extract stirred magnetically revealed the green mixture after 10 min. We demonstrated the efficiency of *Cissus quadrangularis* stem extract in the rapid synthesis of copper oxide nanoparticles with a variety of fascinating morphologies due to its diverse groups of phytochemicals such as phenolics, flavonoids, polyphenols, tannin, anthraquinones, terpenoids, and saponin. Nanotechnology is a broad interdisciplinary area of research, development, and industrial activity that has grown very rapidly all over the world for the past decade. It plays a vital role in the technology of the new millennium. Nanomaterials may provide solutions to technological and environmental challenges in the areas of solar energy conversion, catalysis, medicine, and water treatment [8]. The presence of copper oxide nanoparticles was confirmed in this study by a change in colour from bluish green to dark green (Fig. 2).

<b>Copper acetate</b>	=	<b>Copper acetate without <i>Cissus quadrangularis</i> extract.</b>
<b>CuO NPs</b>	=	<b>CuO NPs with <i>Cissus quadrangularis</i> extract after the processing (Green colour)</b>

## RESULT AND DISCUSSIONS

### The XRD pattern of CuONPs synthesized from *Cissus quadrangularis* stems.

The powder XRD pattern of CuO nanoparticales was recorded using XPERT-PRO Diffracto meter system with  $\text{CuK}\alpha$  ( $\lambda = 1.5444\text{\AA}$ ) radiation(Fig. 3). A number of Bragg reflections with  $2\theta$  values of 38.02, 44.64, 57.72, 69.52 and 84.65 quadrangularis to the (100), (111), (211), (220) and (311) reflections of metallic copper oxide visibly representing the crystalline cubic face-centered structure of copper oxide which was associated with the standard powder diffraction card of JCPDS card 05-0661. Here, the constant is 40.80 ( $136.90 - 96.10 = 40.80$ ). Debye-Scherrer formula used for average particle size has been estimated formula [10, 11].  $D = 0.9 \lambda / \beta \cos \theta$  Where ' $\lambda$ ' is wave length of X-Ray (0.1541 nm), ' $\beta$ ' is FWHM (full width at half maximum), ' $\theta$ ' is the diffraction angle and 'D' is particle diameter size. According to Debye-Scherrer equation, the average crystalline size was found to be 19.93nm (table.2).

### Ultra violet and Visible Spectrometric Analysis

The UV-Vis spectral transmission was carried out using Perkin Elmer lambda U-Vis spectrophotometer in the range 190 to 1100 nm(Fig. 4). In the UV-Vis spectra of the reaction mixture of copper acetate solution with *Cissus quadrangularis* stems extract the peak was observed at 725.45nm confirmed the presence of copper oxide nanoparticles which is synthesized by *Cissus quadrangularis* extract.

### Scanning Electron Microscopy of CuO nanoparticles

SEM analysis was carried out to understand the size of the CuO nanoparticles and topology, which showed the synthesis of polydispersed spherical CuO nanoparticles of various sizes with higher density. SEM analysis showed



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the ranges from 20 to 14nm respectively as well cubic and crystalline nature of the nanoparticles. Most of the nanoparticles gathered and only a little of them were dispersed, when observed under SEM (Fig. 5). The average size of the nanoparticle was  $76.61 \pm 25.40\text{nm}$  (Fig. 6). It is observed that most of the CuO nanoparticles were of various spherical shapes.

#### **EDX (Energy-dispersive X-ray spectroscopy) Analysis**

The data that is generated by EDX analysis consists of spectra with peaks corresponding to all the different elements that are present in the sample (Fig. 7). EDX of CuO nanoparticles revealed the presence of pure copper (Cu 57.84%), which was the major constituent element compared to oxygen (21.56%) as represented. The EDX reading demonstrated that the mandatory phase of copper (Cu) was present in the CuO nanoparticles (table. 3).

#### **Photocatalytic Activity**

In this study, the greenly synthesized CuO nanoparticles using *Cissus quadrangularis stem* extract showed great photocatalytic activity with enhanced degradation efficiency against textile dyes such as Rhodamine B. The synthesized copper oxide nanoparticles were utilized for the removal of a hazardous dye, Rhodamine B, and were found to be highly efficient in the removal of this dye. This high efficiency of the copper oxide nanoparticles as photo catalysts may provide a promising application for the degradation of dyes from industrial effluents (Fig. 8 and Table 4). The percentage of photo degradation activity of CuO nanoparticles from *Cissus quadrangularis* is shown in Fig. 9.

#### **Antimicrobial activity of *Cissus quadrangularis* extract and CuONPs**

Antimicrobial activity of *Cissus quadrangularis* extract and CuONPs were tested against bacteria as *Escherichia coli* and *Staphylococcus aureus*. The results showed that the antibacterial activity was directly proportional to the concentrations of *Cissus quadrangularis* extract and CuONPs. The CuONPs possess similar activity to standard drug as Chloramphenicol for bacterial as compared with stem extract. After 24 to 48 hours of incubation, the inhibitory effect of CuONPs from *Cissus quadrangularis* stems extract was significant as compared to *Cissus quadrangularis* stems extract and standard chloramphenicol. Zone of inhibition (Zoi) was used as a measure for comparing microbial activity of these copper acetate and CuO nanoparticles from *Cissus quadrangularis* stems extract (Table 5 and Figure 10). The zone of inhibition of CuONPs was higher than stem extract, copper acetate and nearest to standard as Chloramphenicol.

## **CONCLUSION**

The aqueous extract of *Cissus quadrangularis* stems contained tannin, saponins, flavonoids, steroids, terpenoids, triterpenoids, anthraquinones, polyphenols, glycosides, and coumarins, which developed into copper oxide nanoparticles (CuONPs) with a visible spectrum absorbance of 725.55 nm and an average particle size of 76.61 nm. EDS showed that the synthesised nanoparticles contained only pure CuONPs.

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Table.1: Qualitative analysis of *Cissus quadrangularis* stems aqueous extract

S. No	Phytochemicals	Leaves aqueous extract
1	Tannin	+
2	Saponin	++
3	Flavonoids	++
4	Steroids	–
5	Terpenoids	++
6	Triterpenoids	+
7	Alkaloids	-
8	Antroquinone	+
9	Polyphenol	++
10	Glycoside	+
11	Coumarins	+

Table. 2 The copper oxide nanoparticle grain size

2θ of the intense peak (deg)	Miller indices (hkl)	θ of the intense peak (deg)	FWHM of intense peak (β) radians	Size of the particle (D)nm
38.02	100	19.01	0.331788	24.65206
44.64	111	22.32	0.389558	22.21315
57.72	211	28.86	0.503703	19.13042
69.52	220	34.76	0.606678	13.74802







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84.65	311	42.325	0.738712	128.4761
Average nanoparticle size				19.93591

Table. 3 Percentage of elements present in the CuONPs

Elements	AN	Series	Weight %	Atomic %
Cu	29	K-series	57.84	88.92
O	0	L-series	21.56	11.08
Total			100	100

Table 4: % of Photodegradation activity of CuONPs from *Cissus quadrangularis*

Time interval (Min)	% of Photodegradation
15	7.18
30	13.90
45	23.34
60	42.07
75	56.95
90	65.41
105	73.73
120	78.24

Table 5: Antibacterial activity of CuONPs from *Cissus quadrangularis* stems extract.

Bacterial strains	Dose (30µl)			
	Copper acetate	PE	CuONPs	Std.
<i>Escherichia coli</i> (mm)	3.15±0.22	3.45±0.24	9.35±0.65	11.20±0.79
<i>Staphylococcus aureus</i> (mm)	2.90±0.20	3.25±0.22	8.70±0.60	11.15±0.78

Values were expressed as Mean ±SD

Std. : Standard as Chloramphenicol

CuONPs : Copper nanoparticles

PE : Plant extract

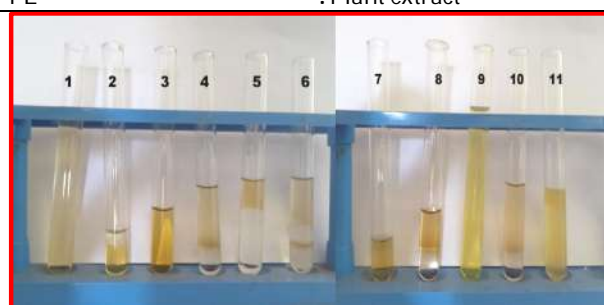


Fig. 1: Qualitative analysis of *Cissus quadrangularis* stems aqueous extract (1. Tannin, 2. Saponnin, 3. Flavonoids, 4. Steroids, 5. Terpenoids, 6. Triterpenoids, 7. Alkaloids, 8. Anthroquinone, 9. Polyphenol, 10. Glycoside, and 11. Coumarins)



Fig. 2: Color changes before (Copper acetate) and after (CuONPs) the *Cissus quadrangularis* extract added.



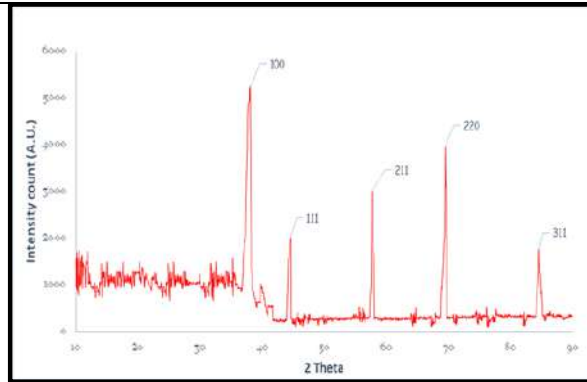


Fig. 3: XRD patterns of Copper oxide nanoparticles synthesized using leaves.

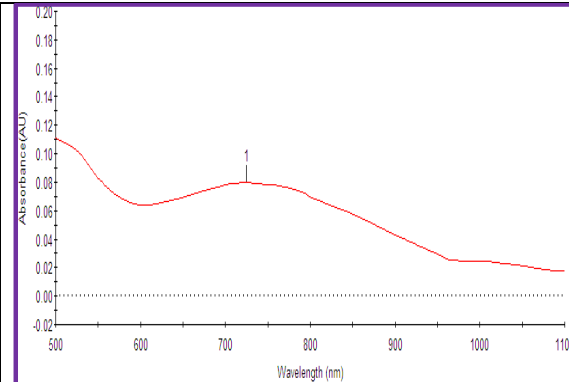


Fig. 4 UV-Vis Spectral analysis of CuONPs

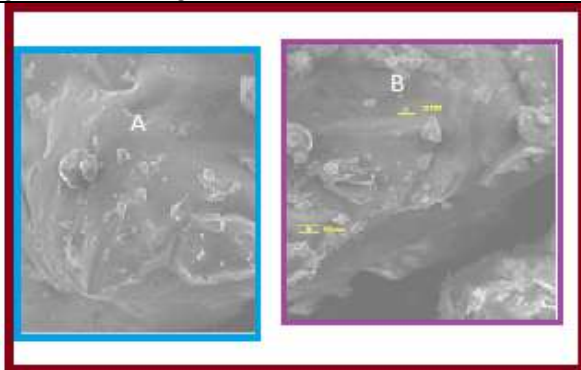


Fig. 5 SEM image of copper nanoparticles(a&b) (CuONPs).

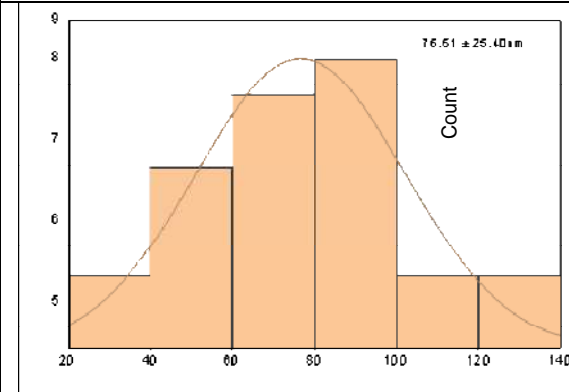


Fig. 6 Polydispersed (Cluster) CuONPs ranged between 20 -140nm.

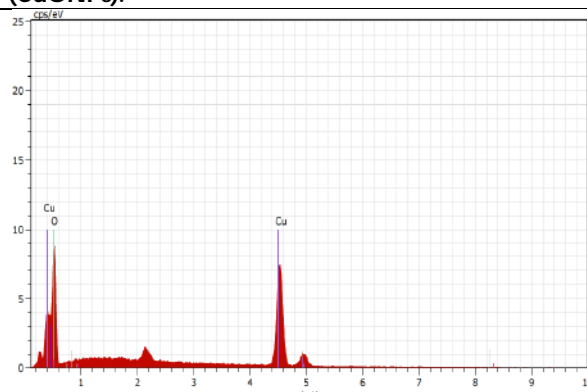


Fig. 7 EDS-Spectroscopy view of the *Cissus quadrangularis* showing synthesis of copper nanoparticles and elemental copper signal in higher percentage.

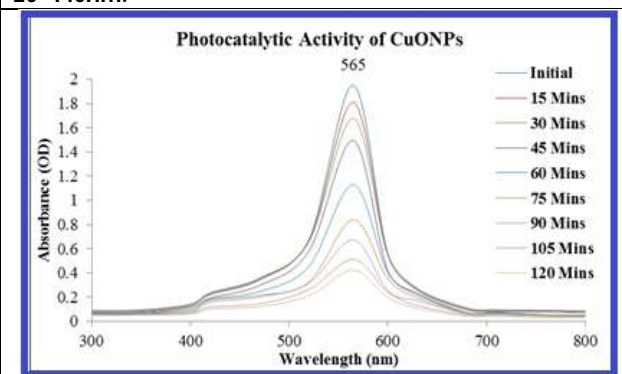


Fig. 8 Photocatalytic activity of CuONPs from *Cissus quadrangularis* stems.





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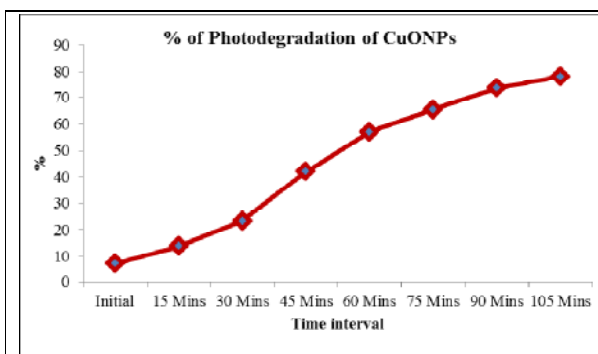


Fig. 9: % of Photodegradation activity of CuONPs from *Cissus quadrangularis*

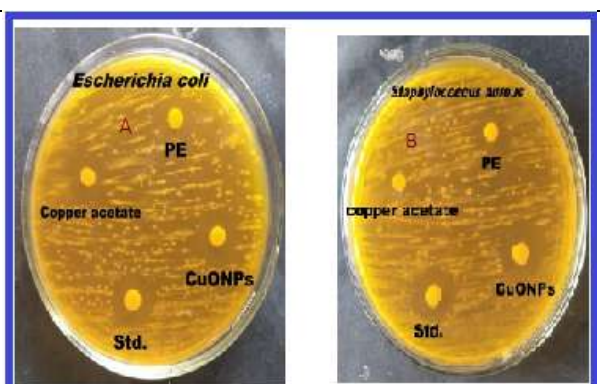


Fig. 10 Antibacterial activity of CuONPs from *Cissus quadrangularis* Stems extract





## A Study on Comparison of the Queue of Customers in Grocery Stores of Rural and Urban Area

Manash Pratim Kashyap\*

Department of Statistics, Assam down town University, Guwahati-781026, Assam, India.

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### \*Address for Correspondence

**Manash Pratim Kashyap**

Department of Statistics,  
Assam down town University,  
Guwahati-781026, Assam, India.  
E.Mail: mpk.stat@gmail.com



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### ABSTRACT

One important aspect of marketing research is to study the flow of consumers in the different stores which decides about the number of servers in any store. The paper compares the nature of the queues of customers in some selected stores bringing about a rural-urban comparison in the matter of queues. Since rural and urban consumers differ in their purchasing capacity, culture, availability of products etc. so the queue of customers in the different stores of rural and urban area are supposed to differ. This paper is an exploratory study in the nature of arrival process and service mechanisms followed in the stores selling grocery items of the district. This would be of specific importance to the business community in general.

**Keywords:** Marketing, Queuing Theory, small business.

### INTRODUCTION

Market research is broadly concerned with the application of the theories; problem-solving methods and the technique to the identification and solution of the problems in marketing (Malhotra, 1996). This paper addresses the queuing behavior of the grocery stores in marketing. In market research, it is necessary to study the queue of customer in stores of rural and urban area because the different grocery stores differ in their sizes, capacity of services etc, so the different sizes of queues are formed in different grocery stores. Queuing theory has been applied in many research investigations by the researchers. The grocery stores of rural and urban area are private and it is operated by the owner itself. There are small numbers of employees in the stores. The flow of customers in the different stores should decide the influence that the service providers have over the customers. This study compares the idiosyncratic nature of the queues formed in the measure of rural and urban stores and the comparison is made between the different grocery stores of rural and urban area.



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## REVIEW OF LITERATURE

Various numbers of studies are referred in review of literature section of the present study in the context of customer impatience. Palm (1953) studied queuing systems with impatient customers by using M/M/C model. He assumed that each customer in the queue follow the exponential distribution. Daley (1965) analyzed an integral equation for the limiting waiting-time distribution function that gives the solution for the cases of deterministic and distributed impatience. He considered GI/G/1 queue in which if the customers entering the system has to wait for long time, he/she may leave the system before starting or completing his/her service. Halfin and Whitt (1981) observe that heavy traffic in multi-server queues in which there are number of servers is allowed to increase along with the traffic intensity but the steady state probability that all the servers are busy is held fixed. Baccelli et al. (1984) noticed the GI/G/1 queue and he find that each 'aware' customer, upon arrival and leaves the queue immediately if he knows that his total waiting time is beyond the threshold. Altman and Borovkov (1997) observed that a customer leaves the system for impatience of customers in a retrial queue if its cumulative break time exceeds some random threshold. Hasija *et. al* (2005) studies a service system with gatekeepers who diagnose a customer problem and then either refer the customer to an expert or attempt by determining the staffing levels and referral rates that minimize the sum of stuffing, customer waiting, and mistreatment costs. They also compare the optimal gatekeeper system with a system staffed with only experts. Jongbloed *et. al* (2001) observe a queuing model with Poisson arrivals having an unknown varying arrival rate and compute the prediction intervals for the arrival rate and compute the waiting time of the consequences for the occupancy level of the call center. Tiritiroglu *et.al* (2008) studied a consumer's purchase behavior who admires a cognitive frame work in such a way as to select queuing model which can be used to assess the credibility of a consumer expression of purchase intention to proceed into purchase action.

### Objective of the Study

The basic objective of the study is to compare some of the selected properties of queues that are formed in the grocery stores of rural and urban area. One of the important criteria of every businessman is to satisfy his/her customers. When a customer comes to a store, then the service providers offer the necessary service to them. The flow of customers comes to the store in rush manner than in the form of a queue. Now questions arises here is

- i) How much time a customer has to wait in the queue?
- ii) Is the rural waiting time of a customer different from the urban one?
- iii) Are the rural stores more ideal than the urban stores?

This paper emphasizes the above questions. If the storekeeper(s) is (are) unable to minimize the waiting time than the customers have most chance to switch the stores to other stores. This study compares the gap between the customer patience and servers service rate for rural and urban customers. The customer is faced with quite dilemma when he/she has to wait for a long time. If a customer waits for a long time, he/she might lose his/her patience and switch to another shop. Our approach might be to compare the different queues which are in the different stores of rural and urban area.

### Grocery Stores as Small Business

A grocery store is established primarily for the retailing of food items. Large grocery stores stock products other than food, such as household items. The grocery store mainly sells fast moving consumer goods (FMCG). Traditionally, grocery stores have offered credit to their customers, a system of payment that works on trust. According to Deakins *et al.* (2009) a small business is a one that is privately owned and operated with small number of employees and relatively low volume of sales. They characterized small business as the owner himself/herself is a manager also. Since, they are managed in a personalized fashion. They have knowledge of what is actual going on in the business. He/ she take effective participation in all matter of business decision making. The grocery stores are operated by the owner himself/herself. Generally, grocery stores have the quality of small business. Again grocery stores are basically provides services to local and regional demand.





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**Queuing System**

Queues (or waiting lines) are an unavoidable component of modern life. The customers are required to stand physically in queues in grocery stores, banks, department stores, amusement parks, movie theaters etc. The term queuing theory is introduced in the year 1909, when a Danish Engineer A.K.Erlang (1878-1929) published paper relating to the study of jamming in telephone traffic (Medhi, 1982). The word queuing system comes when there is a queue i.e. when customers come in random manner at a service facility in need of some kind of service. The term queue means waiting line. Queuing system is also referred as the flow of customers or units for service facility forming the queue if service is not immediately available and leaving the system after being served. There are certain characteristics of the queuing system are given (a) inter arrival time; (b) service time; (c) queue Discipline; (d) the number of service channels, (e) system capacity and (f) size of the calling population.

**Assumption for the Model specification**

This paper looks into the comparison of queue of grocery stores of rural and urban population. The customers come to the grocery stores and forming queue. Assume that the inter arrival time of the customer follows exponential distribution with parameter ( $\lambda$ ). Because the inter arrival time of customer in the system does not affect next inter arrival time of customer i.e. the consecutive inter arrival time of customers are independent and identical with each other. Similarly, the service times of the servers to the customers are also independent and identical. So, assuming that the service time follows exponential distribution with parameter ( $\mu$ ). As an outcome of the study the average servers in urban and rural grocery stores are found to be strictly greater than 1. This study gives that average servers in urban grocery stores are found  $c_1$  and the average servers in rural grocery stores are found  $c_2$  which is greater than 1. Assume that the servers  $c$  work parallel and independently of each. Further there efficiencies are also same. So, service time of these servers distributed accordingly exponential  $\mu$ . Assuming that there is no restriction in system capacity and queue discipline is first in first out (FIFO). Assuming that the size of the calling population is infinite. It is also important to note that only one queue is build and the customer in front of the queue and nearest to the service facility will proceed to that storekeeper who becomes free at the earliest. From the above assumption it is clear that M/M/C model are followed by the queue of the customer when they go to the grocery stores. A comparison is done by using M/M/C model between rural and urban customers. Let, the random variable  $x_i, i=1, 2, \dots, n$  denoted the service time of the grocery stores. The random variables  $x$ 's are independently and identically distributed. The random variable  $x$ 's follows the exponential distribution with mean  $\mu$ . Let,  $\mu_n$  denote the service rate of the system when the system is in state  $n$ . Then the assumption of the model gives that,

$$\begin{aligned} \mu_n &= n\mu ; \text{ if } n \leq c \\ &= c\mu ; \text{ if } n > c \end{aligned}$$

From the state transient rate diagram gives the steady state equations of the system are given below,

**Distribution of Waiting Time in Queue**

Let, the random variable  $T$  denote the waiting time of the queue of an arriving customer. Than the two cases arises (1) the arriving customer will not required to wait in the queue; (2) The arriving customer finds the system is busy.

**Case 1:**

The arriving customer is not required to wait in the queue. In that case the customer finds the system is in state 0, 1, 2, ...,  $c-1$ .The probability that the arriving customer will not required to wait in the queuing system denoted by  $P(T=0)$ . Therefore,

$$p(T = 0) = \sum_{n=0}^{c-1} p_n = \sum_{n=0}^{c-1} \frac{\rho^n}{n!} p_0 \quad \dots (4)$$

**Case 2:**





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The arriving customer finds that the system is in busy i.e. the arriving customer finds that the system is in state  $c, c+1, \dots, \infty$ . The probability that the arriving customer wait in the queuing system is denoted by  $P(T>t)$ . Therefore,

$$P(T > t) = \sum_{n=c}^{\infty} p(\text{ number of customer in the system is } n) \cdot p(T>t|\text{number of customer is } n) \dots(5)$$

Now,

$$\begin{aligned} & p(T>t | \text{ number of customer in the system is } n) \\ &= p(\text{Waiting time in the queue of the arriving customer exceeds } t \mid \text{It finds that } n \text{ customer in the system on arrival}) \\ &= p(X_1+X_2+\dots+X_{n-c+1} > t) \dots(6) \end{aligned}$$

Again from the memory less property of exponential distribution emphasized that

$$X_i \sim \exp(c\mu); \quad i = 1, 2, \dots, n-c+1.$$

Since  $X_i$ 's are independently and identically distributed random variable. Therefore,

$$\sum_{i=1}^{n-c+1} X_i \sim \text{Gamma}(n-c+1, \mu) \dots(7)$$

Applying (7) to get the probability of the waiting time in the queue of the arriving customer exceeds  $t$  given that the customer finds that there are  $n$  customer in the system on arrival i.e.

$$p(T>t|\text{ number of customer in the system is } n) = \frac{(c\mu)^{n-c+1}}{\Gamma(n-c+1)} \int_t^{\infty} e^{-(c\mu)z} z^{n-c} dz \dots(8)$$

Using equation (8) in (5) gives

$$p(T>t) = \frac{\rho^c}{c!} \left(1 - \frac{\rho}{c}\right)^{-1} e^{-(1-\rho/c)c\mu t} p_0 \dots(9)$$

Differentiating (9) with respect to  $t$  gives the probability distribution function,

$$f(t) = \frac{p_0}{(c-1)!} \rho^c \mu e^{-c\mu(1-\rho/c)t} p_0 \dots(10)$$

The probability distribution of the waiting time in the queue is given by the equation (2) and (8).

**Expected Waiting time in the queue**

Expected waiting time of customer in the queue is given by,

$$W_q = \frac{\rho^c}{(c-1)! \mu (c-\rho)^2} p_0 \dots(11)$$

**Expected Waiting time in the system**

It is observed that,

Waiting time in the system = Waiting time in the queue + Service time.

Therefore ,

$$W_s = \frac{\rho^c}{(c-1)! \mu (c-\rho)^2} p_0 + \frac{1}{\mu} \dots(12)$$

**Expected number of customer in the queue**

Little (1961) gives an exact proof of the formula of the equation  $L = \lambda W$  which is known as *Little's formula*. Using this formula to find the average number of customer in the queue. According to *Little's formula*

$$L_q = \lambda W_q = \lambda \frac{\rho^c}{(c-1)! \mu (c-\rho)^2} p_0 \dots(13)$$





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where,  $L$  denote the average number of customer in the system.

#### Expected number of customer in the System

Similarly the expected number of customer in the system is given by

$$L_s = \lambda \left[ \frac{\rho^c}{(c-1)! \mu (c-\rho)^2} p_0 + \frac{1}{\mu} \right] \quad \dots(14)$$

#### Utilization Ratio of the Traffic Intensity

The utilization ratio of traffic intensity shows that in what extent the server of the grocery store is being utilized i.e. how busy are the store. It is calculated by the following formula

$$p = \frac{\lambda}{c\mu} \quad \dots(15)$$

Where,  $P$  = Utilization Ratio,  $\lambda$  = Arrival Rate,  $\mu$  = Service Rate.

#### The Probability that the Store is Idle

The probability that the store remain idle can be denoted by  $p_0$  and is calculated by the following formula

$$p_0 = 1 - \frac{\lambda}{c\mu} \quad \dots(16)$$

This probability gives that how much time the store remaining idle.

## METHODOLOGY AND DATA COLLECTION

The methodology of the study adopted for comparing the different characteristics of queue which are formed in the different grocery stores of rural and urban are as follows

- (a) The investigator notes down that how many numbers of customers arrive in the store within the time period of his observation.
- (b) Similarly, the investigator notes down that how many customers were served completely by the server within the time period of his observation.
- (c) The investigator also notes down the number of server in each store. The above process is repeated for each grocery stores of rural and urban.

The data is collected from Cachar district which is situated in south Assam, India. This study emphasizes the comparison of both rural and urban grocery stores. A sample of 25 grocery stores from urban area and 14 grocery stores from rural area are selected by judgment sampling. The sampling is performed separately for rural and urban area. For rural area, the village Duarbondh is selected by judgment sampling. For urban area, ward no 16 and 17 was selected by judgment sampling.

#### Validity of the assumption for M/M/C model

One of the important aspects of the study is to perceive whether the data follow the assumption of the M/M/C model or not. More clearly it is to test whether the arrival rate and service rate follow the exponential distribution or not. For that purpose one sample Kolmogorov-Smirnov test is performed under the assumption that arrival rate and service rate are exponentially distributed.

Table 2 highlighted that corresponding p-value of the arrival rate and service rate for both the places i.e. rural and urban are greater than the 0.05. So, it can be concluded that both the arrival rate and service rate follow the exponential distribution. Also table 3 highlighted that average servers of the grocery stores for rural and urban





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places are greater than the 1. Queue discipline is first in first out (FIFO). The calling population is also infinite. So, it is clear from the above discussion that the data follow all the assumption of the M/M/C model.

**Analysis and Findings of the Study**

Section 7 gives the validation of the assumption of M/M/C model. So, all the characteristics of the M/M/C model can be can be evaluate and shown in table 3. The purpose of the study is to compare the different grocery store characteristics of rural and urban area using M/M/C model.

Table 6 focused the following result

- Average servers of rural grocery stores is 2 where as average servers of urban grocery stores is 3. This indicates that the mean server of rural grocery store is less than the urban grocery stores.
- It is also observed that the rate of arrival of customer in rural grocery store per hour is 34 whereas the rate of arrival of customer per hour in particular grocery store of urban is 41. So, it is to conclude that arrival rate (per hour) of customer in rural grocery store is less than the rate of arrival (per hour) of customer in urban grocery stores.
- In case of service rate of the servers to the customers in per hour in both the places i.e. rural and urban are same. In more evidently, the efficiency of the servers of both the places i.e. rural and urban grocery stores are same.
- The utilization or the busy period of the rural grocery store in per hour is 37 minutes and 52 second. Similarly, the busy period for the urban grocery stores per hour is 46 minutes 52 seconds. Therefore, the urban grocery stores are busier than the rural grocery stores.
- The ideal periods of rural grocery stores are greater than the urban grocery stores. The urban grocery stores are busier than the rural grocery stores.
- Table 6 highlighted that average number of customer in the system in the rural grocery store is 4 where as the average number of customer in the urban grocery store is 2 which implies that the service is quicker in the urban stores.
- Interestingly it is found that average number of customer in the queue of rural grocery store is 2 where as it is found that average number of customer in the queue of urban grocery store is approximately zero.
- Average waiting time of a customer in the system of rural grocery store is 6 minutes 8 seconds where as average waiting time of customer of urban grocery store is 3 minute 10 seconds. This indicates that the waiting time of customer of a rural grocery store are more than the urban grocery stores.
- It is found that the average waiting time of customer in the queue of a rural grocery store is 4 minute while the average waiting time of customer of urban grocery store is only 24 seconds.

**CONCLUSION AND ARE OF FURTHER RESEARCH**

This paper looks into the comparison of different characteristics of queue of grocery stores located in rural and urban area. The study was performed in a particular geographical area only and the results are true for that located area. The study supports the common believe that rural people are less busy compared to their urban counterpart. An urban grocery shop in order to survive should have more servers so that the customers could be provided necessary service within a short period, while a rural customer keeps waiting for a longer time to get the service. This study is useful when a grosser wish to optimize the number of servers in his store. The study finds that the arrival rate of customers is differing but service rate of the servers in the rural and urban grocery stores are found to be same. This indicates that efficiency of servers in the areas under consideration does not have any significant difference. As an extension of the study a researcher may increase the geographical area and perform the same investigation with a bigger sample size. The movement of customers towards a grocery store follows a cyclical pattern throughout the day. The crowd generally is more in the morning and in the evenings. The location of the store also has a role to play. A grocery store near the market is supposed to pull more customers compared to a store located in a residential area. Similar studies can be carried out at different time periods classifying time by the traffic intensity and cross classifying the stores by their location.





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**Table 1. Steady state equation Table**

State	Steady state equation
0	$\lambda p_0 = \mu p_1$
1	$\lambda p_0 + 2 \mu p_2 = \lambda p_1 + \mu p_1$
2	$\lambda p_1 + 3 \mu p_3 = \lambda p_2 + 2 \mu p_2$
.	.
.	.
.	.
c-1	$\lambda p_{c-2} + (c + 1) \mu p_c = \lambda p_{c-1} + (c - 1) \mu p_{c-1}$
c	$\lambda p_{c-1} + c \mu p_{c+1} = \lambda p_c + c \mu p_c$
c+1	$\lambda p_c + c \mu p_{c+2} = \lambda p_{c+1} + c \mu p_{c+1}$
.	.
.	.
.	.
n	$\lambda p_{n-1} + c \mu p_{n+1} = \lambda p_n + c \mu p_n$

**Table 2. p-value for arrival rate and service rate for rural and urban grocery stores.**

Places	p-value	
	Arrival Rate	Service rate
Rural	0.66	0.72
Urban	0.229	0.267

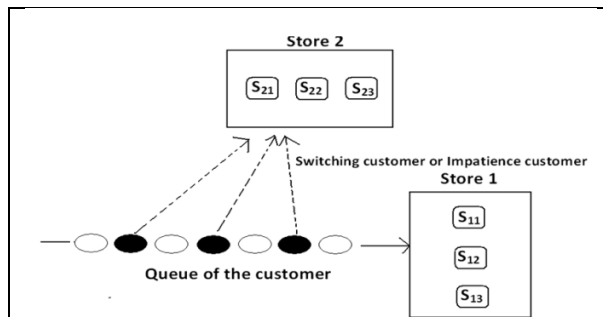




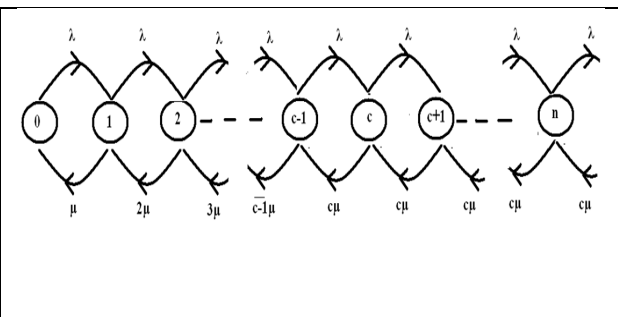
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**Table 6. Comparison table of Store characteristics**

Characteristics of the stores	Places	
	Rural	Urban
Servers	2.1≈2	2.74≈3
Arrival Rate (Per Hour)	33.6 ≈ 34	40.8≈41
Service rate (Per hour)	21.6 ≈ 22	21.6 ≈ 22
Utilization Ratio	37 minutes 52 second	46 minutes 52 second
Ideal period	22 minutes 8 second	13 minutes 8 second
Expected number of customer in the system	3.84≈ 4	2.29 ≈ 2
Expected number of customer in the Queue	2.28 ≈ 2	0.40
Average Waiting time of a customer in the system	6 minutes 8 seconds	3 minute 10 second
Average Waiting time of a customer in the Queue	4 minute	24 second



**Figure 1. Switching Customer or Impatience customer model**



**Figure 2. State transition-rate diagram for an M/M/C Model (Medhi,1982)**





## Green synthesis of Zinc Oxide (ZnO) nanoparticles using vegetable peels and their antimicrobial potentialities.

Santanu Gupta<sup>1\*</sup>, Sudipta Kumar Sil<sup>2</sup> and Priyajit Chatterjee<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Botany, Malda College, Malda, West Bengal -732101, India.

<sup>2</sup>Professor, Department of Botany, The University of Gour Banga, Malda, West Bengal -732103, India.

<sup>3</sup>Technical Assistant, University Science and Instrumentation Centre, The University of Burdwan, Golapbag, Burdwan, West Bengal - 713104, India.

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### \*Address for Correspondence

#### Santanu Gupta

Assistant Professor,  
Department of Botany,  
Malda College, Malda,  
West Bengal -732101, India.  
E.Mail: santanubotanist@gmail.com



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### ABSTRACT

Green synthesis of nanoparticles constitutes a thrust area of research nowadays owing to its omnipotency. Vegetable peels are readily generated everyday and are thrown as organic garbages from Indian kitchen. The objective is to investigate the potentialities of *Luffa acutangula* (L.) Roxb. vegetable peels as a reducing agent to generate zinc oxide nanoparticles and to assess its antimicrobial efficacy on test microorganism. The motto of this work is to generate wealth from waste.

**Keywords:** Nanoparticles, *Luffa acutangula*, Zinc Oxide, Anti microbial, Vegetables, Green synthesis

## INTRODUCTION

Any minute particle whose size varies between 1 and 100 nanometres that displays significantly different physico-chemical properties are called nanoparticles [1]. Such unique properties are attributed owing to their high surface area to volume ratio. Nanoparticles can occur naturally, or can be synthesised chemically or by using any biological specimen through engineering for performing diverse function. The diverse application of nanoparticles includes wide industrial application such as healthcare and cosmetics products, environmental preservation and air purification. The production of toxic free metal nanoparticles has imposed new challenges nowadays [2]. The maximisation of the usage of environment friendly materials in the generation of metal nanoparticles is a major threat in the field of nano biotechnology. Various chemical and physical methods are employed nowadays for



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synthesising metallic nanoparticles with diverse sizes and shapes that includes UV irradiation, microwave assisted synthesis, chemical reduction, photochemical method, electron irradiation etc [3]. However, majority of the synthesis methods involves multistep, high energy requirement, lower output, difficulty in purification and hazardous nature [4]. Green synthesis of nanoparticles is an alternative to chemical synthesis method that employs biological microorganisms or plant extract for chemical reduction. Green synthesis poses advantages over chemical synthesis of nanoparticles as it eco-friendly, cost effective, and can be easily employed for synthesis in large scale [5]. Green synthesis of nanoparticles using plant extracts can be advantageous over other biological processes as it diminishes the hectic job of maintaining cell cultures and can be suitably uplifted for large scale production under aseptic condition [6]. Green synthesised nanoparticles from plant shows enhanced stability, variable shape and size as compared to nanoparticles synthesised from other biological sources. Zinc oxide (ZnO) nanoparticles have drawn much attention in recent days due to their antimicrobial, UV rays shielding, high catalytic and photochemical activities [7]. Zinc Oxide (ZnO) nanoparticles shows potency as an antibacterial and antifungal agent at a very low concentrations and hence are employed for coating fruits and vegetables that enhances their shelf life [8]. Application of ZnO nanoparticles does not affect soil fertility as compared to the traditional antifungal agents. Research on green synthesis of ZnO nanoparticles and their application as an antimicrobial agent is still in the infancy stage with minimum reports of works. Zinc oxide (ZnO) is being extensively used in the fabrication of solar cells, namely quantum dot-sensitized solar cell because it possess exceptional optical and electrical properties, such as thin film transistors, gas sensors, transparent conductor, biomedical and piezoelectric application [9]. The unparalleled semiconducting property, eco-friendly nature along with remarkable stability has resulted ZnO NP as an alternative to TiO<sub>2</sub> [10].

*Luffa acutangula* (L.) Roxb. belonging to the family Cucurbitaceae also known as angled gourd or ridged gourd, is a climbing herb cultivated as a vegetable in West Bengal and other states of India during the summer and monsoon seasons. The plant bears yellow to brown coloured roots and ridged stem from which numerous tendrils arise. Leaves are simple, alternate and orbicular in outline with prominent veins and veinlet. The flowers are dioecious, yellow in colour, fruits cylindrical with prominent ridges, seeds oval to elliptical in shape [11]. The medicinal importance of this plant is well depicted since ancient times to cure various human ailments, but unfortunately very little work has been done to assess its pharmacological properties. With high demand of plant derived bioactive compounds worldwide, many pharma companies are currently engaged in exploring its medicinal potentialities. *Luffa acutangula* (L.) Roxb. also act as an analgesic and also shows haemostatic properties. It contains low amount of saturated fats and calories, with abundant dietary fibre, ascorbic acid, vitamin B1, iron, as well as magnesium [12]. It exhibits promising antitumor properties, CNS depressant, also shows immunomodulatory, anti-inflammatory, anti HIV, hepatoprotective, antimicrobial and larvicidal properties. Aqueous extract of the plant is known to possess 50 different secondary metabolites that includes phenols, flavonoids, anthraquinone, saponins and other phytoconstituents [13]. The higher percentage of phenols, flavonoids and anthocyanins in the powder prepared from the vegetable peels and its crude extracts of *Luffa acutangula* (L.) Roxb. showed substantially higher antimicrobial and antioxidant property [14]. The main focus of this study is to use the peels of *Luffa acutangula* (L.) Roxb. as a reducing agent to initiate green synthesis ZnO nanoparticles, its characterisation and to assess its antimicrobial property *in vitro*.

## MATERIALS AND METHODS

The vegetable peels extract of *Luffa acutangula* (L.) Roxb. were used as a reducing agent for the ZnONP synthesis. About 2 grams of vegetable peels were taken and mixed with 20 mL deionised water, boiled and then it is cooled to room temperature. After that the mixture was kept in incubator at 60° C for overnight. The next day, the mixtures were filtrated through Whatman No 1 filter paper to remove particulate matter and to get clear solution for green synthesis of nanoparticles. 1mM Zinc acetate is mixed with 50 ml of HPLC graded deionized water (Fisher Scientific) and kept for 1 hour in a magnetic stirrer named as Solution A. Then 2gm of NaOH dissolved in 20 ml of HPLC graded deionised water (Fisher Scientific) named as Solution B. After 1 hour, 20 ml of Solution B was slowly added



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to solution A. Then 25 ml of plant extract was added to the mixture and left for 3 hours in a magnetic stirrer to speed up the process. Change in the colour of the solution to light green provides preliminary confirmation of ZnO NP synthesis [15]. After that absorbance was measured using UV-Vis spectrophotometer at range 300nm-400nm (Lasany Li 295). After that the mixture containing ZnO NP were centrifuged at 6000 rpm at room temperature for 20 minutes. Precipitate of ZnO nanoparticles were found to adhere on the bottom of the centrifuge tube, supernatant was discarded and then kept at 60°C in the incubator for drying. After drying the ZnO nanoparticles were observed under Scanning Electron Microscope (SEM). The Scanning electron microscopy was performed in University Science Instrument Centre, The University of North Bengal, West Bengal using JEOL (JSM-IT 100) that operated using Secondary Electron Detector of 5.0kV, working distance 10nm, probe current (PC-#30) and accelerating Voltage 5.0kV. The EDX analysis was performed at University Science Instrument Centre, The University of Burdwan, West Bengal. For antimicrobial activity, pure culture of *Pseudomonas* sp. MTCC accession no. 2575 was used that was maintained in Luria agar (Himedia M557) media. The antimicrobial assay was performed following disc diffusion method.

## RESULTS AND DISCUSSION

The different functional groups present in the aqueous extract of *Luffa acutangula* (L.) Roxb. peels were responsible in the green synthesis converting the metals from micro to nano range. Zinc is highly reactive, hence it is very difficult to synthesise elemental zinc nanoparticle. When the zinc salts are reduced, firstly it is converted into elemental zinc which is readily oxidised into zinc oxide ZnO nanoparticles. The UV-vis Spectrophotometric analysis from 200-400 nm range showed a sharp peak at 335 nm which initially confirmed the synthesis of ZnO nanoparticles. The Scanning Electron micrograph of the ZnO nanoparticles of *Luffa acutangula* (L.) Roxb. ranges from 0.029 µm to 0.034 µm. The EDAX analysis of the ZnO nanoparticles clearly confirmed the presence of metallic zinc oxide in the green synthesised nanoparticles. Amount of zinc (Zn) was 76.41% and that of oxygen (O) was found to be 23.59%. Trace amount of carbon (1.23%) was also found to be present in the EDAX analysis. This indicates that plant phytochemical groups were involved in the reduction and capping of the green synthesised ZnO nanoparticles. Free amino and carboxylic groups of proteins, alkaloids, phenolics or flavonoids, present in the plant extract may bind to the surface of zinc ( $Zn^{2+}$ ) and trigger the formation of ZnO nanoparticles [16]. With the help of disc diffusion method, the antimicrobial property of the green synthesised nanoparticle was assessed. Ampicillin and chloramphenicol antibiotics were used as control to test the efficacy of green synthesised nanoparticles over test microorganism *Pseudomonas* sp. Sterilised paper discs were placed in nanoparticle suspension (10 mg/100 µL) for 2 hours at room temperature. Two such paper discs were placed on the culture plate using the bacterial pure culture of *Pseudomonas* sp. along with two antibiotic disc containing ampicillin and chloramphenicol respectively. After 48 hours of incubation at 28°C, the zone of inhibition were recorded. Chloramphenicol produced highest zone of inhibition (35.5 mm) followed by Ampicillin (24.5 mm). The zone of inhibition of two ZnO NP treated paper discs were 22.5 mm and 22.0 mm respectively. It clearly indicated that the green synthesised nanoparticles have considerable potentialities to restrict the growth of *Pseudomonas* sp as antimicrobial agent. Similar effect of antifungal potentialities of ZnO NP synthesised from *Nyctanthes arbor-trites* were also observed [17]. The thiol groups [-SH] of proteins present on the cell wall of bacteria mostly bind with ZnO nanoparticles resulting in the decrease of the cell permeability and cell lysis [18]. ZnO NP causes disorganisation of the outer and inner cell wall resulting in rupture of the plasma membrane. This results in increase in the generation time of bacterial culture with prolonged lag phase [19].

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Table No-1 Chemical composition of ZnO nanoparticles. from *Luffa acutangula*(L.) Roxb.

Element	Weight	Atomic %	Error	Net Int	K Ratio	Z
O K	23.59	55.79	7.65	705.16	0.1235	1.2398
Zn K	76.41	44.21	4.48	290.38	0.6967	0.9067
C K	1.23	2.23	4.43	190.76	0.1237	0.8765

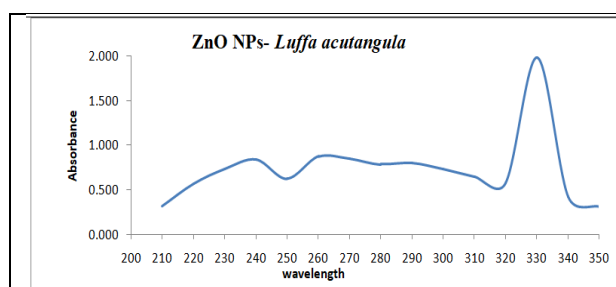




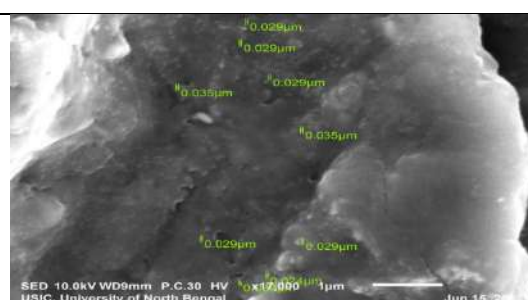
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**Table 2- Antimicrobial efficacy of the ZnO nanoparticles against *Pseudomonas* sp. Zones C1 and C2 represent the replica application.**

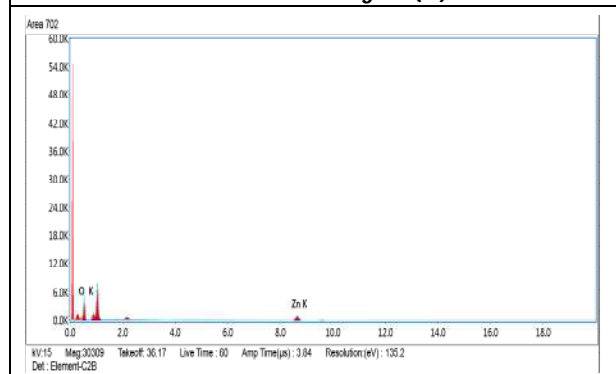
Antimicrobial agent	Zone of Inhibition (in mm)
Chloramphenicol (C)	35.5
Ampicillin (A)	24.5
ZnO NP (C <sub>1</sub> )	22.5
ZnO NP (C <sub>2</sub> )	22.0



**Figure 1- UV-Vis Spectrophotometric analysis of ZnO NP from *Luffa acutangula* (L.) Roxb.**



**Figure 2- Scanning Electron Micrograph of ZnO NP from *Luffa acutangula* (L.) Roxb.**



**Figure 3- EDAX spectrum of the ZnO NP synthesised from *Luffa acutangula* (L.) Roxb.**



**Figure 4- Zone of inhibition of ZnO NP against *Pseudomonas* sp.**







## Soil Fumigants and Crop Stubbles (Parali):A Threat to Air Pollutants and Global Warming

Arpit Totuka<sup>1\*</sup> and Paridhi Jain<sup>2</sup>

<sup>1</sup>Assistant Professor, Manipal University, Jaipur, Rajasthan, India

<sup>2</sup>Research Scholar, Manipal University, Jaipur, Rajasthan, India

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### \*Address for Correspondence

#### Arpit Totuka

Assistant Professor,

Manipal University,

Jaipur, Rajasthan, India.

E. Mail: arpit.totuka@jaipur.manipal.edu



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### ABSTRACT

Farmers are the most important contributors towards the GDP in India. Every year the crop is harvested, and the residue (Parali) or Stubble is left behind. Proper use of this stubble is a big issue, and the disposal of this stubble through traditional methods i.e., burning has posed a big threat to the environment and human health. It is believed and is up to some extent true that by burning the stubble of 'Parali' the soil becomes fertile (Singh, Dhaliwal, Sidhu, Manpreet-Singh, Blackwell). The use of Soil Fumigants and burning of crop stubble (residues) are increasing day by day. The farmers are not concerned for the disastrous effects that will be seen in late years to come. The farmers are not taught or trained for the right use of the fumigants and using the crop residues for the beneficial products. Thus, these methods are becoming a great threat to Air Pollution and Global warming. The policy makers not only should make laws but also focus effective implementation of the laws and policies already structured by the Parliament. Various laws and precedents have laid stress on conservation of the environment and statutes cover the punishments that can be inflicted on the person or the organization causing pollution. But the issue arises when there is lack of compliance and effective monitoring. There is lack of resources with respect to disposal of residues and the lack of technical know-how of to effectively and efficiently deal with leftovers. There has been various research on how the stubble can be best utilized without causing impact to the environment. The research discusses the various techniques and methods of effective utilization of stubble (Parali) and the laws that are in place and the lacuna in the laws.

**Keywords:** Fumigants, Stubble, Air pollution, Residues Burning





Arpit Totuka and Paridhi Jain

## INTRODUCTION

Soil fumigants are volatile substances used to kill soil insects, nematodes, and micro-organisms which damage plant seeds, seedlings, stored food material and the plant. Fumigants may have high vapor pressure and some of them have low vapor pressure. Fumigants commonly used are Dichlopropane, Organo Phosphate, Methyl Bromide, Dibromochloro Propane. These chemicals are generally used as nematocides and insecticides. Chemicals used in Storage Barns are Hydrogen Cyanide, Napthalene and Methyl Bromide to protect Seeds and Storage Foods. These chemicals not only kill the insects and nematodes but also, kill the microorganisms (Bacteria Virus Mycoplasma). At times the beneficial micro-organisms are also damaged. Fumigants are used either by spraying or in liquid form which at high temperature convert into gaseous form and the soil is treated by these fumigants which behave as chemical control for soil treatment. These chemicals are designed to kill the soil micro-organisms, Seed Bulls, Corms and Tubers are treated with chemicals specially to eradicate bacteria and fungi. Incidentally beneficial bacteria are also killed. Soil fumigants are now also used for garden soils. It is natural that when the fumigants are used in gaseous form after vitalization, it directly affects the quality of the air. In rural areas the farmers are neither trained nor educated, and hence use them simply by following other farmers without considering the Pollution they cause to the Air, which in turn is disastrous for animals, human beings, and other living organisms.

Another hazardous problem commonly observed is the burning of crop stubbles (residue) in substantial amounts. In India, crop residue is called Parali. 500 million tonnes of crop residue are produced and 90% is burnt in India. On study of 2 states of India where crop residue is burnt the AQI (Air Quality Index) reaches above 300, which is so high that it causes symptoms of suffocation to the people living in the vicinity and even on the people living at some distance. Despite dumping facility, lot of people notoriously burn the residue causing great amount of Air Pollution and discomfort to the people. Study shows (Liu, L.F., Li, H.Q., Lazzaretto, A., Manente, G., Yi Tongc, C., Liud, Q.B., Ping Li, N., 2017.) that, in Seoul (South Korea), the crop residues are packed in large bags, which are carried away by the government and ensure its proper disposal resulting in AQI of 68 for Seoul.

The method of burning residue is derived from 'Slash and Burn' method observed in older era where plants of forest and woodlands were cut and dried and, then burnt creating a field called Swidden. The cut trees were called 'Slash'. The resulting ash was a nutrient rich layer making the soil fertile. The process was carried after every 5-8 years as the nutrition of the soil depleted during this period. In those days there were no environment laws. As well, there was very little concern for environment as there was very less pollution, which now a days is created through industrialization and motor vehicles and various other sources.

Burning of residue is a criminal act defined under Section 188 I.P.C. and the Air Pollution Act of 1981, amended in 1987. However, the implementation of these statutory provisions lacks teeth, as very little attention is paid towards disastrous air pollution created through fumigants and residue burning. Most states have not implemented the policy for management and disposal of Crop Residue to protect the environment. The NGT (National Green Tribunal) put a ban on stubble burning in States of Rajasthan, Haryana, Punjab, and Uttar Pradesh in India (Singh, Singhal, Singhal, Sharma, Agarwal, & Arora, S. 2018). However, hardly any efforts have been made for enforcement on these bans. The image shown below shows the rise of temperature in states of Punjab and Haryana during the stubble burning (Kant, Y., Chauhan, P., Natwariya, A. *et al.* 2022)

### Health Risks

Stubble burning is one of the major contributors towards air pollution. In fact it is the third major contributor towards air pollution (Sharma *et al.*, 2010). Crop residue burning and soil fumigants release 160 million tonnes of carbon dioxide (CO<sub>2</sub>) and 10-15 million tonnes of Carbon Monoxide (CO), 0.2 million tonnes of Sulphur Dioxide (SO<sub>2</sub>) and carbon dust and other solid materials (Abdurrahman, Chaki & Saini, 2020).





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These pollutants mis in the air and travel to distances through winds and cause severe health ailments such as asthma, suffocation, and long-lasting respiratory troubles. Apart from this, Global Warming and rise in temperatures are obvious consequences.

Alternate methods to dispose crop residues and soil rehabilitation.

#### 1. Biological Control

- a. To avoid chemical soil fumigants the crop growers should be trained and educated for use of "Biological Control" methods to control disease producing micro-organisms. This method is based on the phenomenon of "Antagonism". Through this the disease-causing agents are either killed, or the growth is limited by competition for available food material. Studies have shown that a technique is available in which 'green manure' such as 'alfalfa' is introduced in the soil on which the saprophytic micro-organisms feed and deprive the pathogen from nitrogen.
- b. Another method is "soil suppression" initially defined by Cook and Baker (1983) by which the pathogen does not persists in the soil. This method does not harm the crop but limits the growth of harmful micro-organisms.
- c. Another research shows that the roots of Tagetes Species (Marigold) excrete "terphenyls" which suppresses the growth of pathogenic bacteria.
- d. The mustard crop decomposition produces components called "Allyl Isothiocyanate" which seems to be similar to commercially available soil fumigants organo Sulphur "Sodium Methyldithiocarbonte", used as pesticide, fungicide, and herbicide. This can be used as a natural fumigant.(Sunita, G.; Lata, N.; Patel, V.B.)
- e. Similarly, in Citrus plants "Triliza Virus" K84 strain is inoculated and introduced in the soil to avoid Crown Gall disease in Citrus plants.
- f. Several Antibiotics are used for disease agents, like Streptomycin and Tetracycline to kill some bacteria and mycoplasma like micro-organisms.

#### 2. Crop Rotation

A method to avoid disease causing agent is crop rotation. The same crop grown in every season every year in the same field increases the possibility of the disease agents and decreases the fertility of the soil by decreasing the nutrients. If rich crops like Legumous Plants, mustard crops and many such crops will reduce the pathogenic bacteria and will make the soil naturally fertile, by increasing the nitrogen content and changing the micro-organisms of the rhizosphere. This would facilitate sustainable disease management in agriculture by harnessing the potential or indigenous soil microbes.

#### Management of Subtle or Crop

A current example to avoid air pollution by crop subtle burning is the utility of crop residue. As seen in South Korea the residue used by the government as cattle feed, compost manure, roof up of houses in rural areas, in mushroom cultivation (rice residues), biomass energy and, in developing picnic spots. Similar practices can be followed by the Indian Government, for control of Pollution caused by the subtle burning and efficient utilization of resources. In India the problem of shortfall of electricity in rural areas can be addressed with Biomass energy (Satpathy & Pradhan, 2020). Biomass energy can be produced parallelly to the Solar Energy and Wind energy. The residue can also be used to make Bioethanol and other industrial products. With use of these methods the pollution can be reduced remarkably and would also open new opportunities for entrepreneurship and economic development.

#### Legal view

Law in India has always protected environment. In ancient India the plants and trees were worshiped and held to be scared. Various Hindu deities have been associated and have symbols which are related to the natural world. E.g., Goddess Laxmi is always depicted as sitting on Lotus and an Owl besides her. Similarly, the Banyan tree is worshiped and again considered to be sacred under Hindu Mythology. In medieval India the grand architecture of various Mughal, Rajput, Maratha rulers was always accompanied by huge and lush green gardens. Many of such gardens do exist till date. However, with the advent of industrialization and growing concerns of pollution various traditional practices such as stubble (Parali) burning has raised the environmental concerns and needs to be checked.



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The Ministry of Agriculture, Government of India to control the air pollution caused by the stubble burning introduced the National Policy for Management of Crop Residues (NPMCR, 2014). However, the policy itself does not ensure results. The important aspect is the compliance of the policy which is lacking and resultantly the policy has been ineffective in controlling pollution caused due to stubble burning. Strict implementation of Environment Laws will ensure that people abstain from such acts of subtle burning and soil fumigation. Stringent penalties will motivate the crop growers to not indulge in such activities. Along with provisions under Section 188 I.P.C. and Air Pollution Act, the guidelines of WHO (World Health Organization) guidelines should be followed which states that there should be mandated outdoor (Ambient) Air Quality Standards for all (2021) which are widely misaligned. Only 31% countries have introduced Ambient Air Quality Standards, which should be adopted and implemented by all. UNWEP (UN Government Program) has decided 7<sup>th</sup> September as the International Day for clean air for blue skies. If all the above-mentioned methods are followed and the policies are implemented efficiently, the impact of air pollution will be highly reduced.

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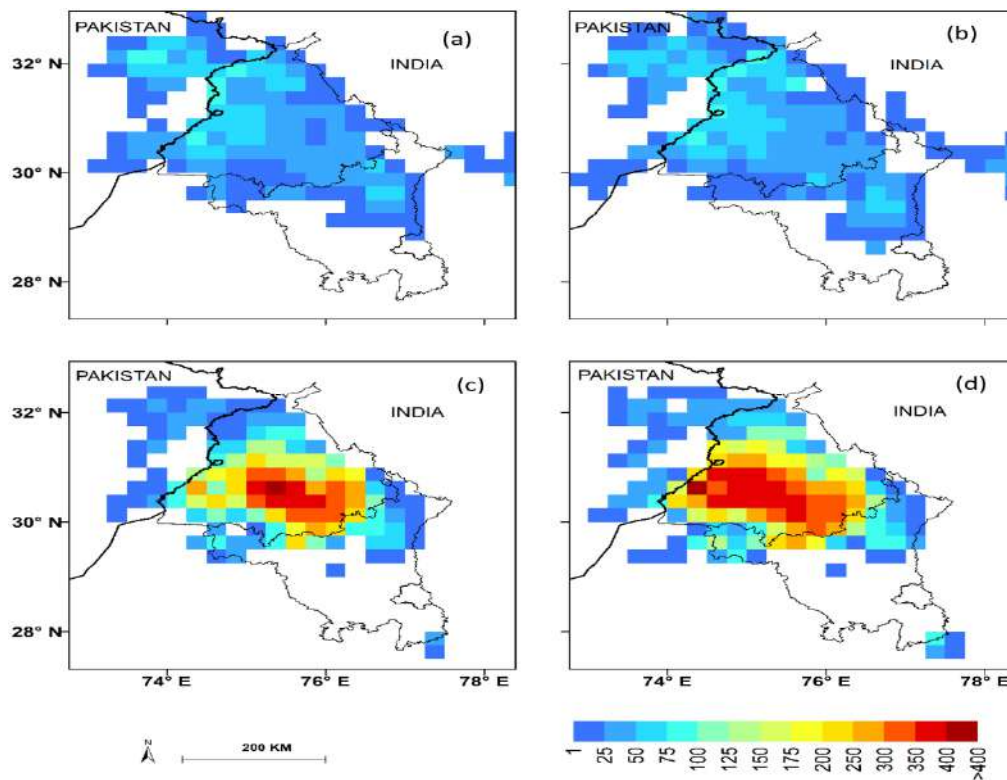
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Source: <https://www.nature.com/articles/s41598-022-06043-8/figures/2>

**Fig.1. National Green Tribunal**





## Implementation of highly efficient multiply and accumulation units using modified Vedic Multiplier

Telugu Maddileti<sup>1</sup>, S.K.Firdose<sup>2\*</sup> and Chenna Nithin<sup>3</sup>

<sup>1</sup>Associate Professor, Department of ECE, Malla Reddy Engineering College, Hyderabad, Telangana-500100, India.

<sup>2</sup>Assistant Professor, Department of ECE, Malla Reddy Engineering College, Hyderabad, Telangana-500100, India.

<sup>3</sup>PG Scholar, Department of ECE, Malla Reddy Engineering College, Hyderabad, Telangana-500100, India.

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### \*Address for Correspondence

#### S.K.Firdose

Assistant Professor, Department of ECE,  
Malla Reddy Engineering College,  
Hyderabad, Telangana-500100, India.  
E.Mail: santanubotanist@gmail.com



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### ABSTRACT

Multiply and accumulation (MAC) units are the essential programmable logic blocks in microprocessors, microcontrollers. However, the conventional MAC units were developed by basic adders and multipliers, which resulted in higher area, delay and power consumption. Thus, this work is focused on implementation of Vedic-MAC using modified Vedic multiplier and high-speed parallel adder (HSPA). Initially, N-bit HSPA is developed with the advanced carry-propagations, carry-generation concepts. Then, N-bit modified Vedic multiplier is implemented with HSPA modules through fast carry calculation properties. Further, the proposed Vedic-MAC is developed by introducing HSPA and modified Vedic multiplier. The simulation results shows that the proposed Vedic MAC-consumed lower area (look up tables-LUTs), power and delay consumptions as compared to other MAC methods.

**Keywords:** Multiply and accumulation, high-speed parallel adder, modified Vedic multiplier, look up tables.

## INTRODUCTION

In the current scenario everyone is dealing with electronic devices with bulky circuits in one or the other form as the gadgets, computers, TV, camera etc. Today electronics world has spread in all areas such as, healthcare, medical

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diagnosis, automobiles, etc. It has taken a situation and convinced everyone that it is impossible to work without electronics. A circuit is constructed from the logic gates [1], the basic electronic circuit that could be used to construct any combinational circuit. These combinational circuits function on the Boolean logic. A logic gate is created from one or more electrically controlled switches like transistors. Another form of digital MAC circuit is constructed from LUTs, termed as Programmable logic device. The LUTs can be configured to work as that of any logic circuit to arrive at logical or arithmetic values. This performs with pre-loaded values from a memory location [2]. This helps in the reprogramming of the circuit or error rectification easily without changing the internal wire arrangement. For small volume outputs these programmable logic devices are the preferred ones [3]. The architecture of electronic digital MAC circuits has seen a remarkable evolution during the last several decades. A pair of vacuum tubes and two transistors were used in the construction of the very first digital MAC circuits. The development of integrated circuits, in which all of the necessary logic gates were included on a single chip. The first integrated circuits, or IC chips, were of a kind known as small scale integration [4]. The gate count was quite low in several instances. The advancement in the technologies has made the designers to place hundreds of gates in a single chip, which are termed as medium scale integration chips. The technology further developed to large scale integration [5], which was able to accommodate thousands of gates. Because to the development of Very Large-Scale Integration, or VLSI, the design of the circuits on this chip may now include more than a hundred thousand transistors. Complexity is the ability to incorporate N number of transistors in a chip [6]. The Complexity for the particular IC increases with the number of transistors to be fabricated in it. In the fabrication process a huge circuit with more processing stages would require higher number of basic components [7]. In the current scenario, the ICs are to be designed in such a way that it could occupy less area and this certainly would lead to less power consumption. A VLSI circuit would be efficient only if it could utilize a smaller number of transistors, reduce the propagation delay and dissipates less power [8]. When the complexity of the circuit reduces then it would be certainly possible to accommodate a larger circuit in a specified die size of an IC. Hence compactness, reliability due to low interconnection and less power consumption can be achieved. The complexity of the circuits has made it impossible for the verification of the digital MAC circuits manually with the breadboards [9]. In this juncture electronic design automation tools were evolved for these processes. Some computer aided techniques were needed for the verification and layout formation [10]. The gate level digital MAC circuits were built manually by the designers till the numbers of the gates were less. It became essential to use computer-aided approaches for the verification and design of VLSI-based digital MAC circuits [11]. This also grew widespread in the circuit layout routing and automated placement of components, both of which gained popularity. It was necessary to evaluate the functioning of these circuits before they were built on chip, hence the development of logic simulators was necessary. Because of the increased complexity of the design, logic simulation became an increasingly significant part of the design process [12]. The functional bugs in the architecture were able to be addressed by the designers and sort out the flaws if any in the design before it is fabricated. As a result, the most significant contributions that this study has made are as follows:'

- Design of N-bit HSPA with the advanced carry-propagations, carry-generation concepts.
- Development of N-bit modified vedic multiplier is implemented with HSPA modules through fast carry calculation properties.
- Design and implementation of vedic-MAC by introducing HSPA and modified vedic multiplier.

The remaining parts of the article are structured as follows: Section 2 deals with a literature study, Section 3 deals with the suggested implementation of vedic-MAC, Section 4 deals with an analysis of the findings along with a performance comparison, and Section 5 deals with a conclusion that discusses probable options for the future.

**Literature Survey**

The authors of the article [13] advocated for the use of an energy-efficient CMOS full adder in a reduced complexity Wallace Multiplier as part of the process to cut down on area and power consumption while simultaneously increasing processing speed. This was accomplished by reducing the complexity of the Wallace Multiplier. This was carried out in order to accomplish the goals that were set. The Reduced complexity reduction approach drastically cuts down on the amount of half adders, with a decrease of between 70 and 80 percent in the amount of half adders



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in comparison to the conventional Wallace multipliers. In [14], the authors described a way for reducing the latency in Wallace multipliers by applying parallel prefix adders, also known as fast adders, in the last part of the process. Parallel operations are carried out by Wallace multipliers, which leads to a significant increase in speed. In the phase when they do the reduction, it makes use of full adders and half adders. Carry propagating adders are used in the last step of both multipliers, which contributes to an increased latency in the process.

The authors of [15] compared the vedic multiplier against a traditional multiplier in order to demonstrate the speed of the vedic multiplier, which also lowered the amount of power that was used. Any marked (or unmarked) integers should be able to have their value increased using a multiplier if at all practicable. There is a vast variety of multiplier designs that are feasible, yet even the fastest one cannot do jobs any faster than the others. One such multiplier that may be realized is called the "Wallace" tree multiplier. This multiplier is able to complete jobs more quickly while still producing useful results for unsigned numbers.

The authors of [16] presented a rapid multiplier that was also conscious of its power consumption and was designed for error-resistant systems. The suggested estimate algorithm 17 is carried out with the assistance of an altered bit-width aware methodology in addition to a carry-in expectation method, whilst the proposed hybrid Wallace tree is realized with the assistance of high request counters. These suggested algorithms are realized with the help of the HDL programming language, synthesised using the Quartus and Modelsim tools, and displayed with the Modelsim software. The purpose of this article was to find ways to cut down on their power usage by lowering the required level of accuracy while simultaneously increasing their rate of operation.

In [17], the authors explored several adder types and constructed the algorithm in every possible combination. A MAC unit is one of the designs that is used in the applications of digital signal processing (DSP) the most, and it is also used in a significant number of FPGA layouts. Additionally, it is one of the designs that is used in the most. It is one of the designs that is used the most often. Because of this, the reversible implementation of a 32-bit MAC unit—which is something that is sometimes used in the digital world—is carried out in the course of this research attempt. This is something that is sometimes utilised in the digital world. Radix-16 Booth encoded vedic multiplier is a factor that is considered during the building process of this MAC unit. This multiplier produces superior results.

In [18] authors presented an inexact 2-bit adder that was purposefully built for the purpose of computing the sum of the bits one and two of a binary value. This adder requires very little space, very little power, and a very short delay in the most basic form. Because it is easier to generate partial products using the radix-4 algorithm (also known as the adjusted Booth algorithm), a multiplier that uses this algorithm is very effective. In contrast, the radix-8 Booth multiplier [19] is less effective because it is more difficult to generate odd products using this algorithm. After that, the approximation multipliers are related to the construction of a low-pass FIR filter, and they show that their execution is chosen over that of various inexact Booth multipliers. The authors of [20] produced a High speed and Low power implementation of a 3-bit flash analogue to digital converter. This implementation was shown in the article. Within the scope of this study, it is recommended that a comprehensive investigation of a 3-bit flash ADC circuit that makes use of a diode-based stacked power gating method and a low leakage stacked power gating methodology [21] be carried out. The total number of techniques used is 18. These methods of power gating are quite effective in lowering both the standard power and the leakage current. In order to evaluate the power gating strategies, a simulation was carried out making use of the cadence virtuoso tool at the arranged power supply provided by the 90nm technology. The authors of [22] presented a method of fine-grained power gating. This method involves gradually and favorably turning on or off the power supply for functional components in advance. In the deep submicron technology, the power leakage has evolved into a significant portion of the embedded processor's [23] overall power usage. According to the findings of the research, the method may reduce the dynamic power consumption of a LEON3 processor by 48% and the leaky power consumption by 39% while maintaining the same level of execution quality.

A design and control plan for a chip with internal capacity units that are power gated at the instruction-by-instruction basis was published by the authors in [24]. This plan was presented as part of the chip's design. Within a





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temperature range of 25-85 degrees Celsius, it was estimated that the developed chip in the 65nm CMOS technology would have aftereffects that would lower energy usage by a range of 211-35% using the technique [25]. The novel strategy was able to reduce the amount of energy that was lost by as much as fifteen percent when contrasted with the conventional fine-grain power gating technology that was used in the identical temperature range.

**Proposed Method**

In microprocessors and microcontrollers, the most important programmable logic blocks are referred to as MAC units. The standard MAC units, on the other hand, were created using simple adders and multipliers, which resulted in a greater need for space, a longer delay, and increased power consumption. As a consequence of this, the major focus of this work is on the implementation of Vedic-MAC via the use of a modified vedic multiplier in conjunction with HSPA, as can be seen in Figure 1. The next step is to create an N-bit modified vedic multiplier using HSPA modules by utilizing their quick carry computation features. Here, the multiplier outcomes are applied as input to HSPA. The innovative carry-propagations and carry-generation principles are included into the development of N-bit HSPA. Then, the accumulator stores the adder output, which is stored and added back with adder circuit.

**Modified vedic multiplier**

A N-bit Modified vedic multiplier has been built as part of MAC architecture as shown in Figure 2. The Modified vedic multiplier was selected because it produces a lower total number of partial products, resulting in a decrease in the total number of adders and HSAs needed for the accumulation of these products, which in turn results in a decrease in the overall amount of space required as well as the amount of power needed. AND gates are used in the operation of multiplication, which ultimately results in the production of partial products.

The multiplication operation is executed by using "AND" gates for producing partial products. The Multiplication could also be achieved by shift operations of the multiplicand. It gives non regular PP for the further reduction stages while it could be a faster approach with less PPs. This technique of generation could best suited for the conventional array multipliers with CSA. The partial products are re arranged to form an inverted pyramid structure where all the columns are shifted upward till the first row. Then the partial products produced are grouped into multiple levels of seven rows each. These sub groups are then processed with the novel HSAs as detailed above. The PPRs are processed in parallel with multiple HSAs. As the overall die size is a major thing to be taken into consideration, the implementations of the gates with the latest CMOS techniques are capable to resolve these issues.

The first level in the Stage –I shall have the first seven rows for processing and the next level will process the next sub group of seven rows and so on till the group has less than seven rows, these rows are not processed in the first stage and passed over to the next stage. Each group is processed with the HSAs, so the columns in the group with less than seven inputs are carried over to the next stage for compression. This almost eliminates first six and last six columns in the level one compression. Similar processing is done for all the groups. Every HSA will deliver a sum and carry of one bit level higher as the output and two carry-outs to the adjacent stages of HSA as intermediate carries. The sum and carry generated from each level of stage one is considered to be two rows of data for the next stage. The number of levels in the first stage decides the rows for the next stage along with the left-out rows while grouping. The rows generated are  $2n$  rows where  $n$  is the number of levels in stage one. These rows are again sub grouped along with few rows not considered in the first stage and taken for processing in the reduction sequence. These procedures are repeated till all the rows shrink to two rows. The Partial products that are left out unprocessed either as row or in a column are compressed with a lower level of HSAs, the initial columns with one or two elements, are directly passed to the final adders. Within the framework of the  $16 \times 16$  Modified vedic multipliers that we have presented, all of the PPs may be organised into two tiers, with just two rows being reserved for the subsequent stage. In order to accomplish a greater reduction in complexity and latency, the columns containing three data are reduced using a full adder, while columns containing four and five items are processed using HSA. Same, HSA is used for both the column of six elements and the column of seven elements itself. By using this strategy, it is possible to cut down on the total amount of delay as well as the area by a respective 23% and 12%. The outputs of the HSAs each contain a sum and carry that carries them to the next 98 level. Aside from this, each stage of the HSA



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provides two-bit data to the stage that comes after it for processing. Stage 2 is responsible for the addition of the output from the HSPAs located on levels one and two of stage 1. The first step has resulted in the generation of four rows. For the case of 16-bit multiplier, the three rows left out in the stage one and the four rows of the result of stage two are processed with various HSPAs depending on the corresponding column length as utilized in the stage one. In the second stage, only the center column has 6 bits which is processed with HSPAs. The preceding stages from this column are processed with HSPAs. The just first HSPA preceding the HSPA stages have a bit extra which pushes the reduction stage to have a row extra. Since this has only one element and to avoid an additional row for addition, the last HSPA's carries are added with a Half adder and passed to the next HSPAs. By having this additional half adder, the delay is maintained at the same level which would have otherwise increased by one gate level. The complexity of this adder is meagre and does not add a considerable net value in the circuit. After being condensed into only two rows, the PPs are added using a ripple adder, which produces the final product result.

**HSPA**

In this study, HSPA is employed as the final adder. A straight implementation of this research would need an  $m$ -bit adder, which would be a  $2N$ -bit adder with carry propagation. The implementation of different HSPAs for various column lengths will improve the efficiency on complexity. The efficiency factor increases to a greater level as the bit length of the multiplicand and the multiplier increases. With increase in the data length large numbers of rows are processed by HSPAs. The successive stages of the partial product reduction are made up of the sum and carry that are formed from the stage levels that came before them. The percentages of HSPAs are larger when compared to the lower-level HSPAs which add for the efficiency.

The unprocessed columns that have a lower bit count are carried over to the subsequent step so that they might be added. The formula for dividing rows into levels in the PPs that are created as well as the rows that are not used is  $r_i$  divided by seven, where  $r_i$  is the number of rows in the PP matrix. Because of this, it is necessary to include a greater number of bits in the column being compressed whenever the degree of compression is increased. The requirement for Full adders or other HSPAs is contingent on the reduction of extra stages in the system; in the absence of this reduction, the number of stages in the system may rise, which would then result in an increase in latency and complexity.

**RESULTS AND DISCUSSION**

It was necessary to make use of the Xilinx ISE software in order to create each and every one of the Vedic-MAC designs. This piece of software has the capacity to generate two separate kinds of outputs, namely simulation and synthesis. These outputs are both possible. The results of the simulation make it possible to conduct an in-depth analysis of the Vedic-MAC architecture with reference to the many permutations of input and output byte levels. While performing a simulation study of correct encoding, it is possible to estimate a straightforward decoding method by making use of a large number of distinct input combinations and observing a broad range of outputs in the process of approximating the method. As a direct and immediate consequence of the findings of the synthesis, it is going to be carried out that the application of area in relation to the LUT count will be carried out. In addition, a time summary will be collected with reference to the various route delays, and a power summary will be created making use of the static and dynamic power consumption. Both of these summaries will be prepared using the information provided. The aforementioned summaries will both be completed.

Figure 4 shows the simulation result of proposed Vedic-MAC. Here, X, Y are the inputs and reg\_pro is the output. Further, clk and reset are the basic inputs. The design (area) overview of the suggested technique may be seen in Figure 5. In this case, the suggested technique makes use of a very small portion of the slice LUT space, namely 1626 of the total 17600 that are accessible. The timing breakdown of the suggested technique may be shown in Figure 6. The suggested technique resulted in a total time delay consumption of 6.410ns, of which 2.362ns was accounted for by logic delay and 4.048ns by route delay.



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The report on the power consumption of the suggested Vedic-MAC may be shown in Figure 8. In this scenario, the suggested Vedic-MAC has a power consumption of 0.065 watts. The comparative analysis of the performance of the different TRNG controllers is shown in Table 1. In this study, the proposed Vedic-MAC resulted in superior (reduced) performance in terms of LUTs, time-delay, and power consumption when compared to conventional approaches such as Standard MAC [22], Booth-MAC [24], and Hybrid-MAC [25]. [22] Booth-MAC [24] and Hybrid-MAC [25] are examples of these conventional approaches.

**CONCLUSION**

Implementation of the Vedic-MAC algorithm utilizing the modified vedic multiplier and HSPA is the primary focus of this work. Initially, advanced carry-propagations and carry-generation concepts are incorporated into the development of N-bit HSPA. The next step is to implement an N-bit modified vedic multiplier with HSPA modules by utilizing their fast carry calculation properties. In addition, the HSPA and the modified vedic multiplier are incorporated into the development of the proposed vedic-MAC. When compared to other MAC methods, the proposed vedic MAC was found to have lower area (LUT) consumption, as well as lower power and delay consumptions. These findings were gleaned from the simulation. This work can be extended with hybrid MAC units with hybrid adders, and hybrid multipliers.

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**Table 1. Performance Evaluation.**

Metric	Standard MAC [22]	Booth-MAC [24]	Hybrid-MAC [25]	Proposed Vedic-MAC
LUTs	3467	2855	2442	1626
Time delay (ns)	20.927	13.837	10.735	6.410
Logic delay (ns)	9.927	7.837	5.735	2.362
Route delay (ns)	10.927	9.837	7.735	4.048
Power consumption(w)	2.61	1.41	0.26	0.065





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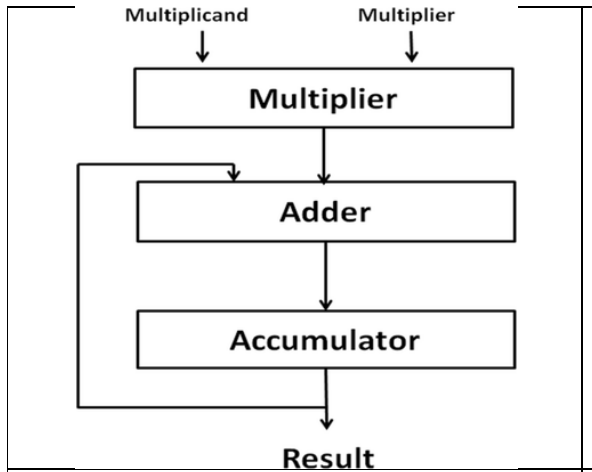


Figure 1. Proposed Vedic-MAC block diagram.

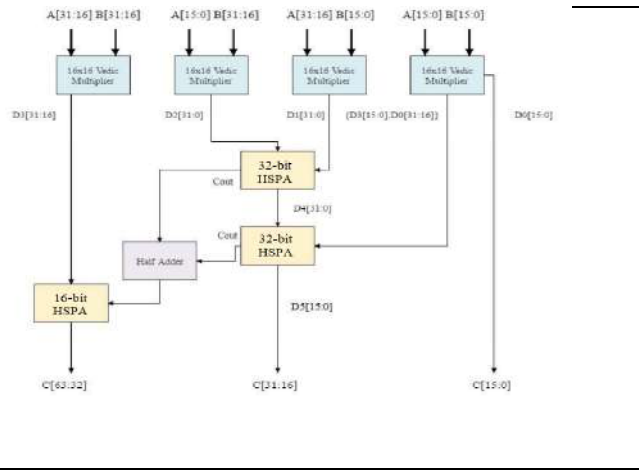


Figure 2. Block diagram of modified Vedic multiplier.

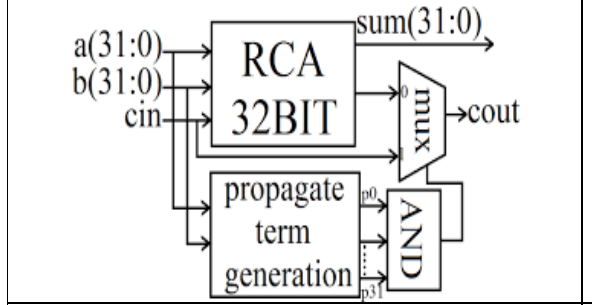


Figure 3. Block diagram of HSPA.

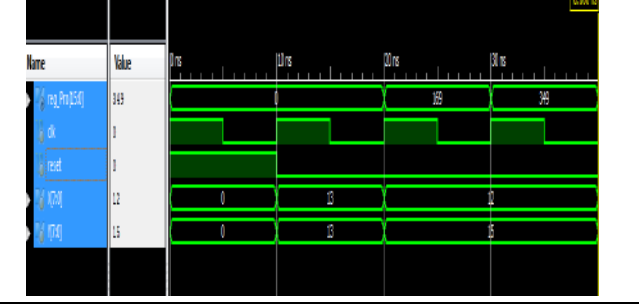


Figure 4. Simulation Result

Device Utilization Summary (estimated values)			
Logic Utilization	Used	Available	Utilization
Number of Slice LUTs		1626	17600 9%
Number of fully used LUT-FF pairs	0	1626	0%
Number of bonded IOBs	128	100	128%

Figure 5. Design Summary.

Logic	Time	Logic	Time	Logic	Time	Logic	Time
LUT6:I0->O	1	0.043	0.000	dsx2/_1000006/CPA2/Madd_fsum_lut<45>			
MUXCY:S->O	1	0.230	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<45>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<46>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<47>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<48>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<49>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<50>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<51>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<52>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<53>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<54>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<55>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<56>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<57>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<58>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<59>			
MUXCY:CI->O	1	0.013	0.000	dsx2/_1000006/CPA2/Madd_fsum_cyc<60>			
XORCY:I->O	3	0.251	0.438	dsx2/_1000006/CPA5/aa[61].b1/OCC1/Mmu:			
LUT3:I0->O	2	0.043	0.347	dsx2/_1000006/CPA5/aa[61].b1/OCC1/Mmu:			
LUT6:I3->O	1	0.043	0.580	dsx2/_1000006/CPA5/aa[62].b1/OCC2/Mmu:			
LUT6:I0->O	1	0.043	0.000	dsx2/_1000006/CPA5/Madd_fsum_lut<62>			
MUXCY:S->O	0	0.230	0.000	dsx2/_1000006/CPA5/Madd_fsum_cyc<62>			
MUXCY:CI->O	1	0.251	0.279	dsx2/_1000006/CPA5/Madd_fsum_xor<63>			
OBUF:I->O		0.000		Product_63_OBUF (Product<63>)			
Total		6.410ns		(2.362ns logic, 4.048ns route)			
				(36.8% logic, 63.2% route)			

Figure 6. Time Summary

Device	On-Chip Power (W)	Used	Available	Utilization (%)	Supply	Total	Dynamic	Quiescent
Family	2mc7000	Logic	0.000	66	17600	0		
Part	xc7a7010	Signal	0.000	144				
Package	qsg400	IO	0.000	98	230	43		
Temp Grade	Commercial	Leakage	0.063					
Process	Typical	Total	0.063					
Speed Grade	-3							
Environment					Thermal Properties	Effective T/A	Max Ambient	Ambient Temp
Ambient Temp (C)	25.0	IC (W)	4.0	IC (C)	44.7	IC (C)	25.3	
User-defined T/A (C/W)	NA							
Custom T/A (C/W)	NA							
Ambient (T/A)	250							
Heat Sink	Medium Profile							
Custom T/A (C/W)	NA							
Board Selection	Medium (10x10)							
Diff Board Layer	8oz Fl							
Custom T/A (C/W)	NA							
Board Temperature (C)	NA							
					Supply Power (W)	Total	Dynamic	Quiescent
						0.045	0.000	0.045

Figure 7. Power Summary





## Bio-active Phytochemical Compounds Identify in the Ethyl Acetate Extract of *Cassitha filiformis* Stem by GC-MS Analysis

Arumugam Subramanian\*

Assistant Professor, Department of Chemistry, Nehru Memorial College, Puthanampatti - 621007, Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

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### \*Address for Correspondence

#### Arumugam Subramanian

Assistant Professor,  
Department of Chemistry,  
Nehru Memorial College,  
Puthanampatti - 621007,  
Affiliated to Bharathidasan University,  
Tiruchirappalli, Tamil Nadu, India.  
E. Mail : nmcaaru@gmail.com



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### ABSTRACT

*Cassitha filiformis* is a leafless plant. It has a long history of use in traditional medicine, being used in many areas to treat a wide range of complaints. The whole plant, especially the stem, contains a series of alkaloids, tannins, saponins and leucanthocyanins. In this study, ten phytochemical compounds are isolated and identified from ethyl acetate extract of *Cassitha filiformis* stem by using GC-MS analysis. The phytochemical compounds are 10,13-Octadecadiynoic acid, methyl ester (3.57%), Caryophyllene oxide (5.60%), 3,7,11,15-Tetramethyl-2-hexadecen-1-ol(5.51%), Dodecanoic acid, 10-methyl-, methyl ester (5.54%), 10-Octadecenoic acid, methyl ester (8.85%), Phytol (10.79%), Oleic acid(20%), n-Hexadecanoic acid(17.24%), 1-Monolinoleoyglycerol trimethylsilyl ether(8.85%) and Glycine, N-[(3a',5a',7a',12a') -24-oxo-3,7,12-tis [(trimethylsilyl)oxy]cholan-24-yl]-, methyl ester(5.95%). Out of ten phytochemical compounds, nine phytochemical compounds are bio-active compounds isolated and identified using this analysis. Isolate the individual bio-active phytochemical compound may proceed to find a novel drug.

**Keywords:** *Cassitha filiformis* stems, Ethyl acetate extract, Phytochemical compound, Bio-active compound and GC-MS analysis.

### INTRODUCTION

*Cassitha filiformis* is a leafless and perennial vine with small scales as a replacement of the leaves and adheres to the host by the haustoria that penetrates the epidermis of the other plants, and hence helps to spread through the tops of

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the trees and bushes, thus ultimately forming a long festoons of colourful greenish yellow vines. The individual stems that are copiously branched have a range of 1 to 3 millimetres in the diameter and finally attain a maximum length of 10 to 20 feet [1]. Extensive survey of literature reveals the medicinal importance of *Cassytha filiformis*. Few of its traditional medicinal uses include the use of stems in the treatment of digestive problems such as indigestion, biliousness and diarrhoea; feverish conditions including malaria; urinary system problems, including nephritis and oedema; headache, hepatitis, piles, sinusitis and spermatorrhoea [2]. Phytochemical reports on this plant reveal that *Cassytha filiformis* contains glycosides, alkaloids, flavonoids etc. [3]. They are the phytochemical compound present in medicinal plants which are responsible for anti-oxidant [4] anti-trypanosomal [5] and diuretic activity [6]. It has more medicinal value but the people do not take this plant seriously. Even though there are few reports on the plant, a systematic investigation has not been taken up. In view of the above fact, the present investigation is taken.

## MATERIALS AND METHODS

### Collection, Authentication and Preparation of Plant Materials

The stems of *Cassytha filiformis* are collected from Kumari Village in Cuddalore District of Tamil Nadu, India during January to December 2012 and authenticated by the Director of the Rapinat Herbarium (**Voucher No: SJCBOT2117**) and Centre for Molecular Systematic, St. Joseph's college (campus), Tiruchirappalli, Tamil Nadu, and India. Fresh stems are cleaned with running tap water and dried under shade. Then the dried plant stems are ground to fine powder mechanically and preserved in airtight containers for further analysis.

### Extraction Procedure

Stems of *Cassytha filiformis* plant were subjected to Soxhlet extraction with extracted with ethyl acetate (500ml, 6 h) at temperature between 45-50°C by using Soxhlet extractor. The solvents were evaporated by using Rotary Vacuum Evaporator, (Model RE-801) to obtained semi solid state of crude extract of *Cassytha filiformis*. The semi solid dry ethyl acetate crude extract were suspended in water and it analyzed by GC-MS.

### GC-MS Analysis

The GC-MS (Gas Chromatography-Mass Spectrometry) were performed on a combined GC-MS instrument using a HP-5 fused silica gel capillary column. The method to perform the analysis were designed for both GC and MS. 1 µL aliquot of sample were injected into the column using a PTV injector whose temperature were set at 275°C. The GC Program were initiated by a column temperature set at 60°C for 5 min, increased to 300°C at a rate of 8 C/min, held for 10 min Helium were used as the carrier gas (1.5 ML/min). The mass spectrometers were operated in EI mode with mass source were set at 200°C. The chromatogram and spectrum of the peaks were visualized. The particular phytochemical compounds present in the sample were identified and isolated by matching their mass spectral fragmentation of the respective peaks in the chromatogram with those stored in the NIST database library.

## RESULT AND DISCUSSION

The GC-MS Chromatogram (Figure-2) of ethyl acetate extract of *Cassytha filiformis* stem was found that the ten phytochemical compounds were isolated and identified list out in the Table 1. Out of ten, nine phytochemical compounds are bio-active compounds such as 10,13-Octadecadiynoic acid, methyl ester, Caryophyllene oxide, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol, 10-Octadecenoic acid, methyl ester, Phytol, Oleic Acid, n-Hexadecanoic acid, 1-Monolinoleoyglycerol trimethylsilyl ether and Glycine, N-[(3a',5a',7a',12a')-24-oxo-3,7,12-tis [(trimethylsilyl)oxy]cholan-24-yl]-, methyl ester. The GC-MS matching spectrums of all the phytochemical compounds of ethyl acetate extract of *Cassytha filiformis* stem were show in the figure 3-12. The highest peak area percentage of phytochemical compound in ethyl acetate extract of *Cassytha filiformis* stem is oleic acid (20.00%) and lowest percentage is 10,13-Octadecadiynoic acid, methyl ester (3.57%) and it show in figure-1. From the graph conclude that more content of phytochemical compound present in ethyl acetate extract of *Cassytha filiformis* stem is oleic acid. The various biological activities of these bio-active phytochemical compounds are listed in table 2.



**Arumugam Subramanian****CONCLUSION**

In this present study, found ten phytochemical compounds were isolated and identified in ethyl acetate extract of *Cassytha filiformis* Stem. The importance of this study, nine phytochemical compounds are bio-active. The presence of various bio-active compounds justifies the use of the *Cassytha filiformis* Stem for various ailments by traditional practitioners. It could be concluded that *Cassytha filiformis* Stem is of phyto-pharmaceutical importance and recommended to isolate the individual bio-active phytochemical compound in *Cassytha filiformis* Stem may proceed to find a novel drug.

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**Table 1: Phytochemical Compounds Isolated and Identified in the Ethyl Acetate Extract of *Casstha filiformis* Stems**

S.No	Compound Name	Molecular Formula	MW	RT	Peak Area	%Peak Area
1	10,13-Octadecadiynoic acid, methyl ester	C <sub>15</sub> H <sub>24</sub> O <sub>2</sub>	236	10.3	8113488	3.57
2	Caryophyllene oxide	C <sub>15</sub> H <sub>24</sub> O	220	12.5	12724608	5.60
3	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	C <sub>20</sub> H <sub>40</sub> O	296	15.28	12533312	5.51
4	Dodecanoic acid, 10-methyl-, methyl ester	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	228	16.5	12448384	5.54
5	10-Octadecenoic acid, methyl ester	C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	296	17.95	20111056	8.85
6	Phytol	C <sub>20</sub> H <sub>40</sub> O	296	18.10	24514304	10.79
7	Oleic Acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	282	18.60	45441504	20.00
8	n-Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	256	16.87	39177312	17.24
9	1-Monolinoleoyglycerol trimethylsilyl ether	C <sub>27</sub> H <sub>54</sub> O <sub>4</sub> Si <sub>2</sub>	498	19.50	20123344	8.85
10	Glycine, N-[(3a',5a',7a',12a')-24-oxo-3,7,12-tis[(trimethylsilyl)oxy]cholan-24-yl]-,methyl ester	C <sub>5</sub> H <sub>6</sub> F <sub>3</sub> NO <sub>3</sub>	185	24.6	13535536	5.95

MW: Molecular Weight, RT: Retention Time

**Table 2: Bio-Active Compounds Isolated and Identified in the Ethyl Acetate Extracts of *Cassstha filiformis* Stem**

S.No	Compound Name	Molecular Formula	Nature of compound	**Activity
1	10,13-Octadecadiynoic acid, methyl ester	C <sub>15</sub> H <sub>24</sub> O <sub>2</sub>	Unsaturated fatty acid ester	Antimicrobial [7, 8 & 9]
2	Caryophyllene oxide	C <sub>15</sub> H <sub>24</sub> O	Sesquiterpene	Antitumor, anesthetic, Antibacterial, Anti-inflammatory, Analgesic, Anti-inflammatory, Antioxidant [10 & 11]
3	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	C <sub>20</sub> H <sub>40</sub> O	Terpene alcohol	Antimicrobial, Anti-inflammatory [7 & 12]
4	Dodecanoic acid, 10-methyl-, methyl ester	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Fatty acid methyl ester	No activity reported
5	10-Octadecenoic acid, methyl ester	C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	Unsaturated fatty Acid methyl ester	Antibacterial, Antifungal, Antioxidant, Decrease blood cholesterol [9,10 & 13]
6	Phytol	C <sub>20</sub> H <sub>40</sub> O	Diterpene	Hypocholesterolemic, Antimicrobial, Anticancer, Cancer preventive, Diuretic Anti-inflammatory [14,15,16]
7	Oleic Acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Mono unsaturated fatty acid	Antiinflammatory, Antiandrogenic Cancer preventive, Dermatitigenic Hypocholesterolemic, Insectifuge [7,12]
8	n-Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Fatty acid	Antioxidant, Hypocholesterolemic, Anti-inflammatory, Antibacterial [17 & 18]
9	1-Monolinoleoyglycerol	C <sub>27</sub> H <sub>54</sub> O <sub>4</sub> Si <sub>2</sub>	Steroid	Antimicrobial, Antioxidant,

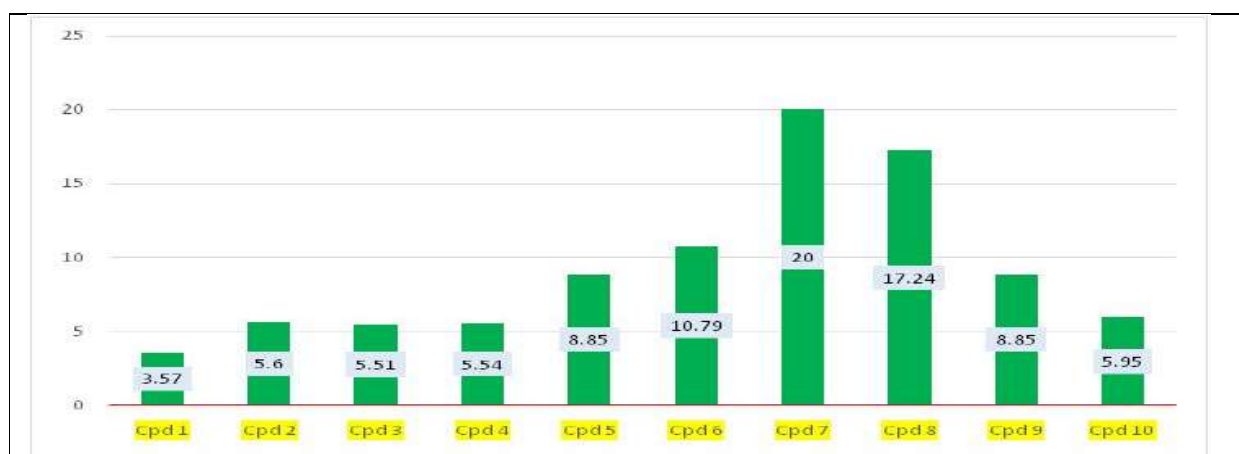




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	trimethylsilyl ether			Antiinflammatory, Antiarthritic, Antiasthma, Diuretic [14,15 &16]
10	Glycine, N-[(3a',5a',7a',12a')-24-oxo-3,7,12-tis[(trimethylsilyl)oxy]cholan-24-yl]-, methyl ester	C <sub>5</sub> H <sub>6</sub> F <sub>3</sub> NO <sub>3</sub>	-	Antiperspirants, Antibacterial [15,17 & 18]

**\*\*Activity source: Dr. Duke's Phytochemical and Ethnobotanical Database**



**Fig 1: Peak Area % of Phytochemical Compounds Isolated and Identified in the Ethyl Acetate Extract of *Cassytha filiformis* Stems**

**Cpd 1-** 10,13-Octadecadiynoic acid, methyl ester

**Cpd 2 -** Caryophyllene oxide

**Cpd 3 -** 3,7,11,15-Tetramethyl-2-hexadecen-1-ol

**Cpd 4 -** Dodecanoic acid, 10-methyl-, methyl ester

**Cpd 5 –** 10-Octadecenoic acid, methyl ester

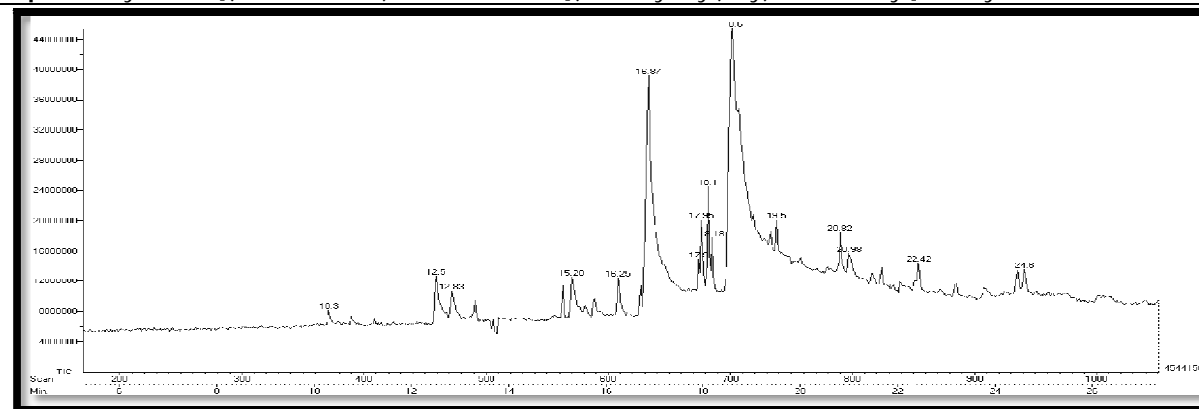
**Cpd 6 –** Phytol

**Cpd 7 -** Oleic Acid

**Cpd 8 -** n-Hexadecanoic acid

**Cpd 9 -** 1-Monolinoleoyglycerol trimethylsilyl ether

**Cpd 10-** Glycine, N-[(3a',5a',7a',12a')-24-oxo-3,7,12 tis[(trimethylsilyl)oxy] cholan-24-yl]-,methyl ester



**Fig 2: GC-MS Chromatogram of Ethyl Acetate Extract of the *Cassytha filiformis* Stem**





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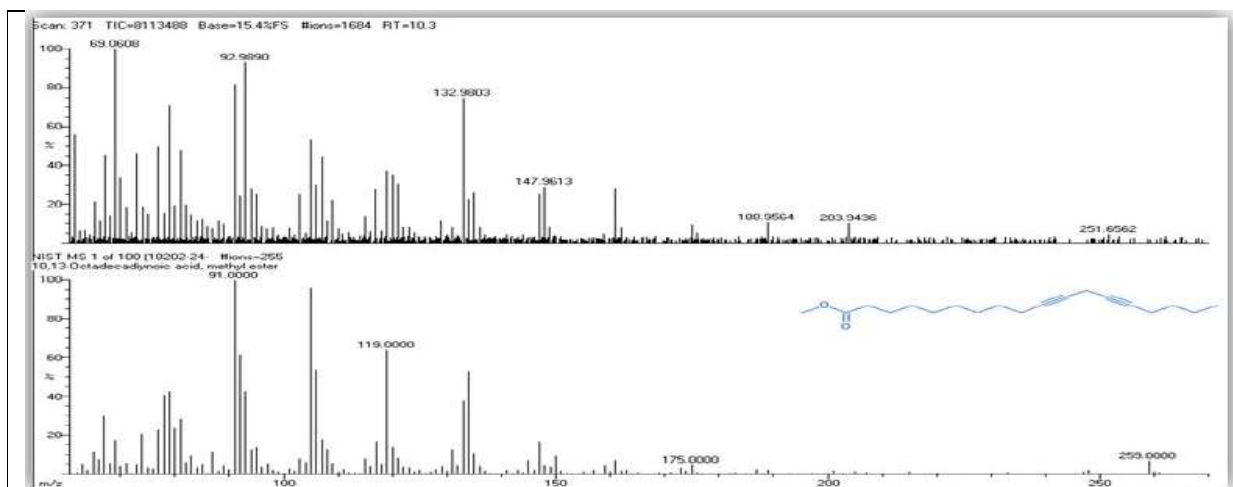


Fig. 3: GC-MS matching spectrum of 10,13-Octadecadiynoic acid, methyl ester with data base (RT: 10.3)

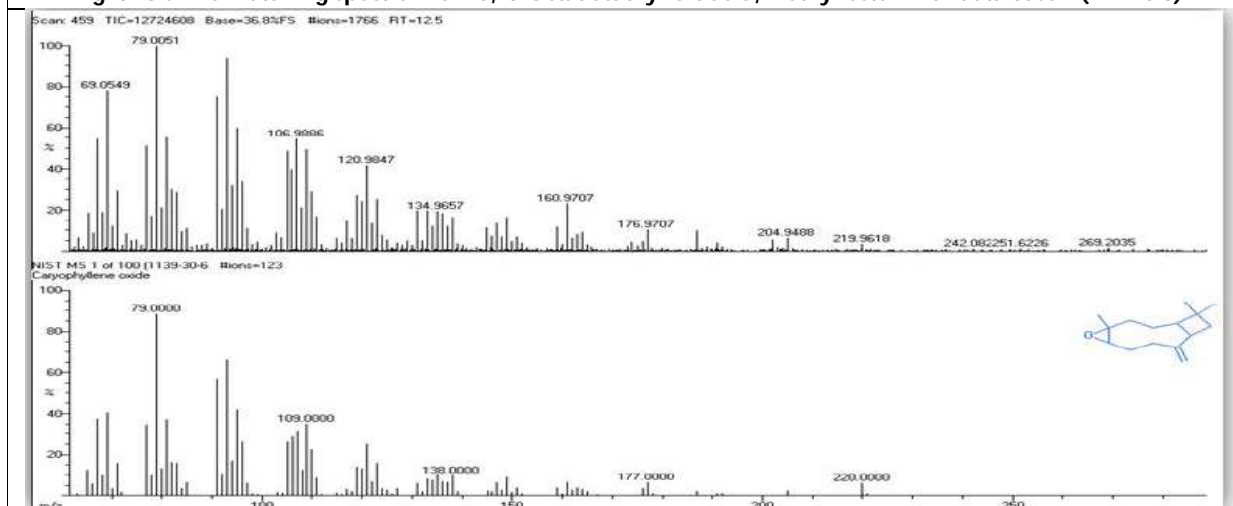


Fig. 4: GC-MS matching spectrum of caryophyllene oxide with data base (RT: 12.5)

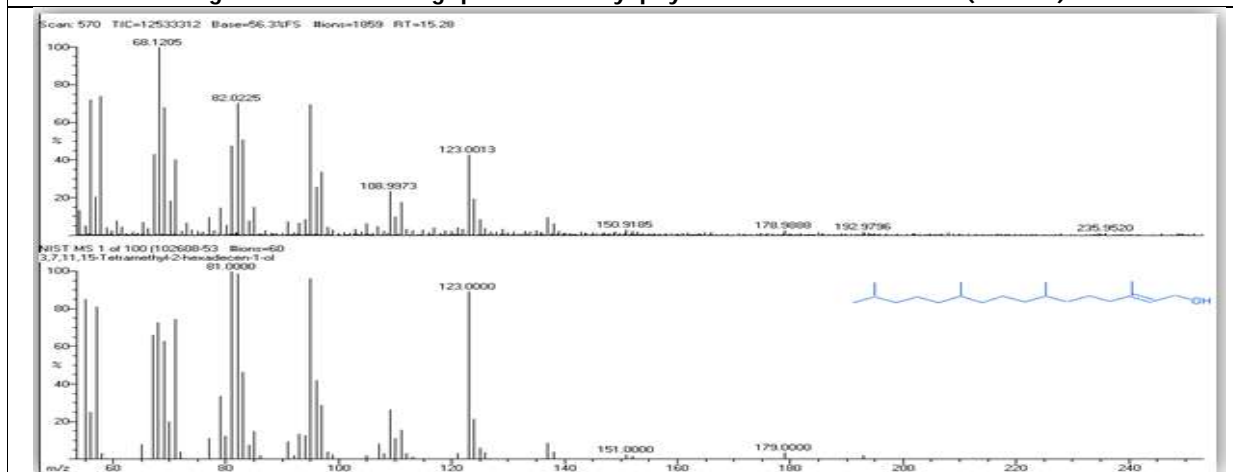
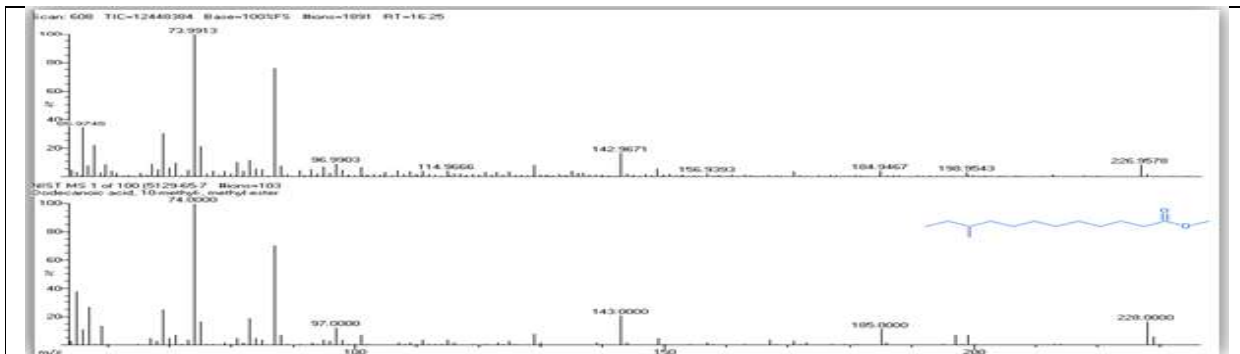


Fig. 5: GC-MS matching spectrum of 3,7,11,15-Tetramethyl-2-hexadecen-1-ol with data base (RT: 15.26)

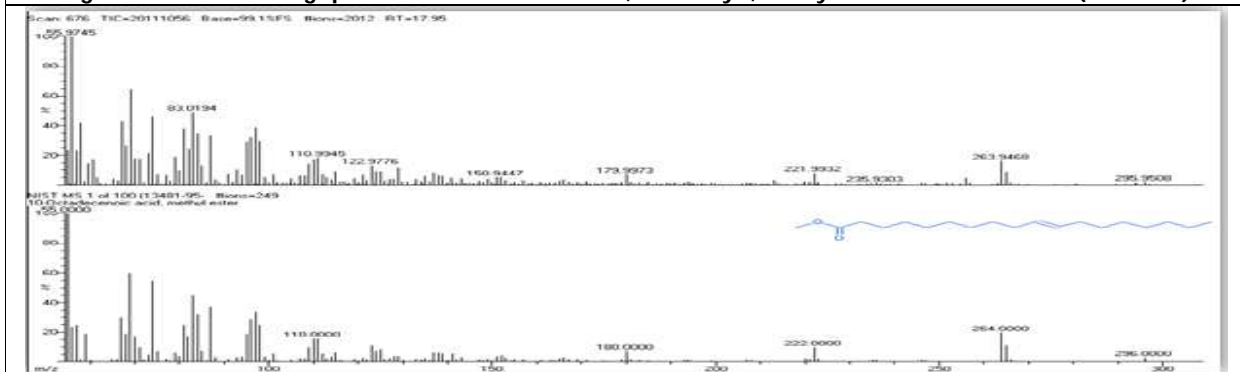




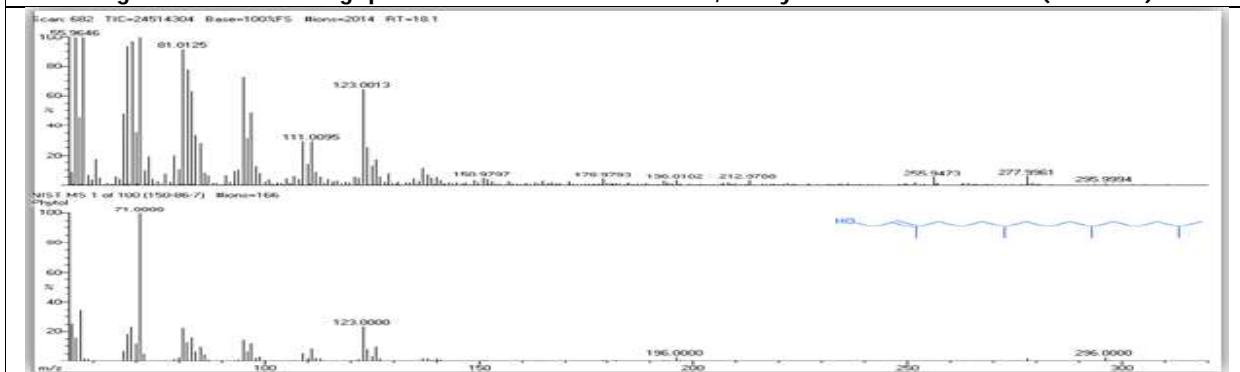
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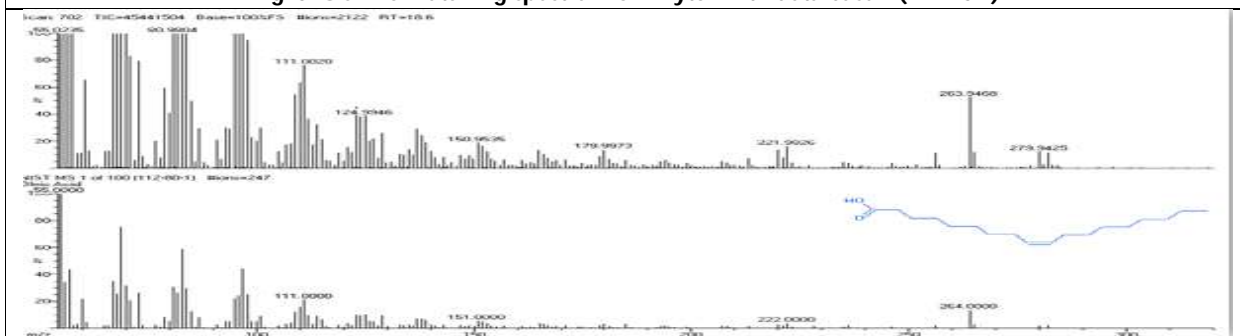
**Fig. 6: GC-MS matching spectrum of dodecanoic acid, 10-methyl-, methyl ester with data base (RT: 16.25)**



**Fig. 7: GC-MS matching spectrum of 10-Octadecenoic acid, methyl ester with data base (RT: 17.95)**



**Fig. 8: GC-MS matching spectrum of Phytol with data base (RT: 18.1)**



**Fig. 9: GC-MS matching spectrum of oleic acid with data base (RT: 18.6)**





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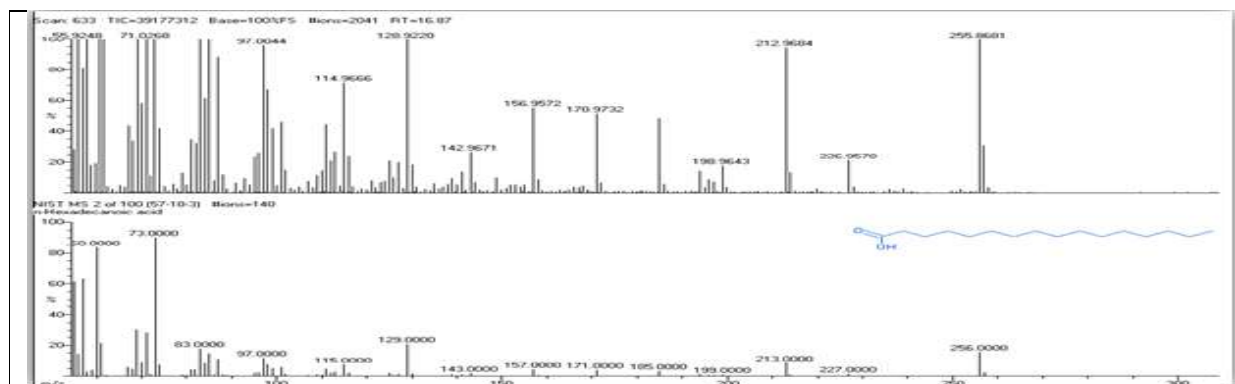


Fig. 10: GC-MS matching spectrum of n-Hexadecanoic acid with data base (RT: 16.87)

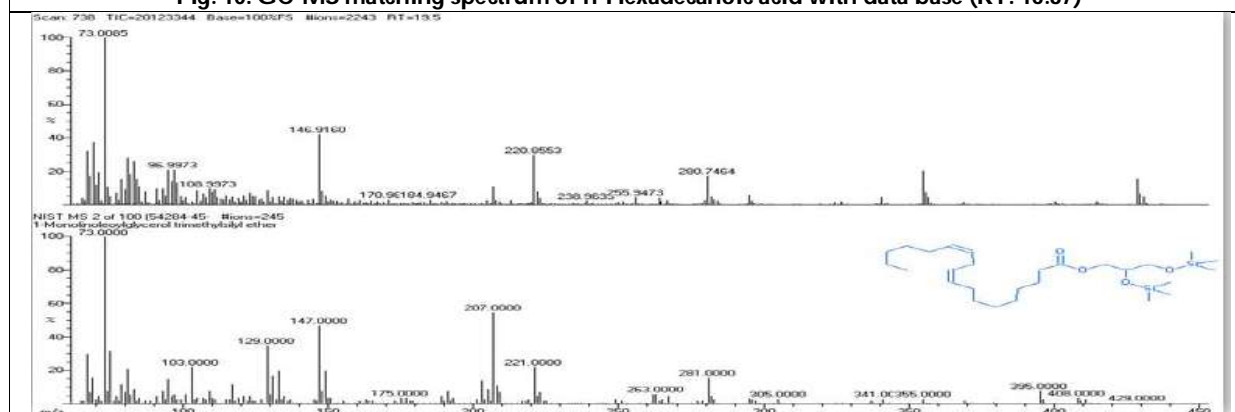


Fig. 11: GC-MS matching spectrum of 1-Monolinoleoylglycerol trimethylsilyl ether with data base (RT: 19.5)

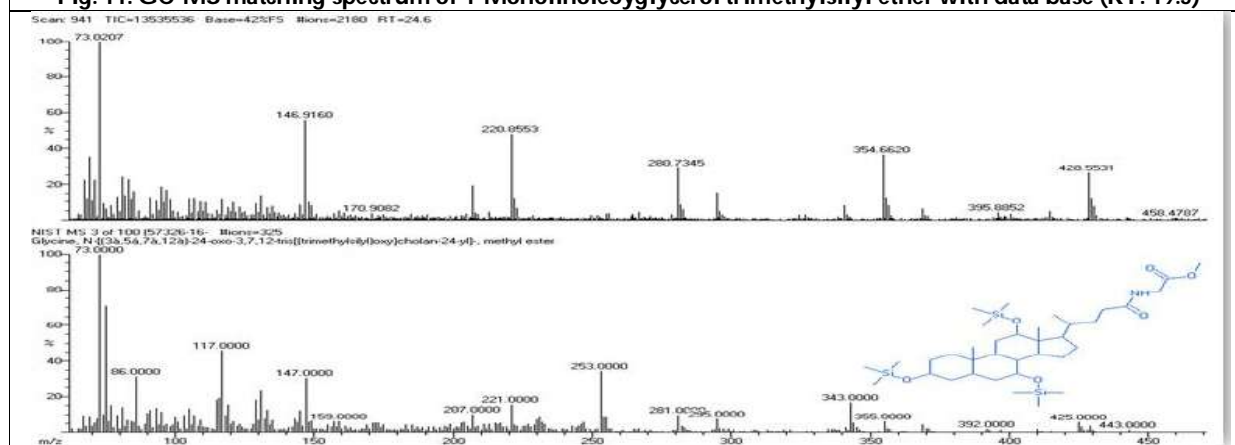


Fig. 12: GC-MS matching spectrum of Glycine,N-((3a,5a,7a,12a)-24-oxo-3,7,12-tris(trimethylsilyloxy)cholan-24-yl)-methyl ester with data base (RT: 19.5)





## Bisphosphonates in Bone Mineralization: A Revolutionary Drug for Inflammation of Periodontium

Shivani Sachdeva<sup>1\*</sup>, Harish Saluja<sup>2</sup>, Amit Mani<sup>3</sup>, Sayali Patil<sup>4</sup>, Syeda Nikhat Mohammadi<sup>5</sup> and Sanket Shinde<sup>6</sup>

<sup>1</sup>Professor, Dept. of Periodontology, Pravara Institute of Medical Sciences, Rural Dental College, Loni, Maharashtra, India.

<sup>2</sup>Professor, Dept. of Oral and Maxillofacial Sciences, Pravara Institute of Medical Sciences, Rural Dental College, Loni, Maharashtra, India

<sup>3</sup>Professor and HoD Periodontology, Pravara Institute of Medical Sciences, Rural Dental College, Loni, Maharashtra, India.

<sup>4</sup>Reader, Dept. of Periodontology, SMBT Dental College, Sangamner, Maharashtra, India

<sup>5</sup>Reader, Dept. of Public Health Dentistry, Aditya Dental College, Beed, Maharashtra, India,

<sup>6</sup>Periodontist, Private Practitioner, Mumbai, Maharashtra, India.

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### \*Address for Correspondence

#### Shivani Sachdeva

Professor, Dept. of Periodontology,  
Pravara Institute of Medical Sciences,  
Rural Dental College,  
Loni, Maharashtra, India,  
E.Mail : dr.shivani19@gmail.com



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### ABSTRACT

The processes of resorption and production are constantly reshaping bone tissues. With the exception of growth, bone resorption and formation are balanced in health, culminating in homeostasis. Periodontal disorders are characterized by the loss of connective tissue attachment and alveolar bone and are mediated by the host's inflammatory and immunologic responses to one or more bacterial infections. Changes in the other tissues of the periodontium are important, but in the final analysis, destruction of bone is responsible for the loss of teeth [1]. Alveolar bone loss is clearly associated with an alteration in the normal balance between bone resorption and formation. It can be hypothesized that a pharmacological agent resulting in suppression of bone resorption or an acceleration of bone formation could protect against alveolar bone loss in periodontitis. This approach could provide a novel way to prevent periodontal disease.

**Keywords:** Bisphosphonates, Bone Mineralization, Revolutionary, Inflammation, Periodontium





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## INTRODUCTION

Bisphosphonates are a specialized form of pharmacological drug that inhibits osteoclast bone resorption while also having an effect on osteoblasts. Pyrophosphate is a normal metabolic by-product. Bisphosphonates are pyrophosphate analogues that have powerful anti-resorption properties. They are useful medications in bone illnesses that cause bone resorption, such as cases of Paget's disease, osteoporosis, cancer-related hypercalcemia, multiple myeloma, and bony metastases. [1]

### History

Bisphosphonates were originally studied in the 1960s for use in bone metabolism problems after being produced in the 19th century. Water softening in irrigation systems used in orange groves was one of their non-medical applications. The potential for them to prevent the disintegration of hydroxylapatite, the main bone mineral, and hence inhibit bone loss was the initial rationale for their usage in humans. Only in the 1990s was their actual mechanism of action demonstrated [2].

### Chemistry of Bisphosphonates

Numerous anabolic processes produce pyrophosphate. It is readily hydrolyzed into the two phosphate groups. A bisphosphonate is generated when the pyrophosphate molecule's linking oxygen atom is replaced with a carbon atom. These counterparts are chemically exceedingly stable and totally resistant to hydrolysis. They bind to the hydroxyapatite crystals in bone, just as pyrophosphate, and prevent them from dissolving [3].

### Bisphosphonate Structure and Classification [3]

Bisphosphonates are structurally similar to **pyrophosphate**, a calcium-chelating natural product of human metabolism found in serum and urine. Both the name "bisphosphonate" and the function of the medications are determined by the two PO<sub>3</sub> (phosphate) groups covalently bonded to carbon. The chemical characteristics, mechanism of action, and strength of bisphosphonate medicines are all determined by the long side chain (R<sub>2</sub> in the diagram). The short *side chain* (R<sub>1</sub>) mainly influences chemical properties and pharmacokinetics. Pyrophosphate controls mineralization in vitro and in vivo by binding to hydroxyapatite crystals, although it is not a particularly stable molecule in vivo. Its labile P-O-P bond is rapidly hydrolyzed by pyrophosphatase and even alkaline phosphatase activity. A bisphosphonate is formed when a carbon atom replaces the connecting oxygen atom in the pyrophosphate molecule [4].

The analogs are entirely resistant to enzymatic hydrolysis (alkaline phosphatase, pyrophosphatase) and chemically highly stable. Bisphosphonates, like pyrophosphate, attach to the hydroxyapatite crystals in bone and inhibit them from growing and dissolving. By including a hydroxyl group at R<sub>1</sub>, the binding to bone mineral is strengthened. Bisphosphonates' cellular actions and relative efficacies as bone resorption inhibitors are determined by their R<sub>2</sub> structure and 3-dimensional configuration. The activity profile of each bis-phosphonate is determined by its distinct side chain. Substituting various side chains for hydrogen at R<sub>1</sub> and R<sub>2</sub> alters the compound's efficacy and side effect profile in vitro and in vivo. Alkyl side chains (e.g., etidronate) characterize first-generation bisphosphonates. Amino-bisphosphonates with an amino-terminal group (e.g., alendronate and pamidronate) are examples of Second-generation Bisphosphonates. Third-generation bisphosphonates have cyclic side chains (e.g., risedronate). The antiresorptive properties of bisphosphonates increase approximately 10- fold between drug generations [4]

Of the bisphosphonate that is resorbed (from oral preparation) or infused (for intravenous drugs), about 50% is excreted unchanged by the kidney. The rest has a strong affinity for bone tissue and is quickly absorbed onto the surface of the bone.





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### Clearance

The half-life of bisphosphonates in the circulation is short, with 20-80% of administered bisphosphonate being taken up by bone and the remainder swiftly eliminated in urine (0.5-2 hours). Bone deposition occurs at the sites of bone production and resorption. When bisphosphonate coated with technetium 99 is used in bone scanning in nuclear medicine, this property is used. Bisphosphonates are stored in bone after being taken up by bone and causing an effect. The half-life appears to be very long (probably upto several years) because of this skeletal storage. Single or short courses of intravenous injections can be therapeutic for a long period in patients with disorders that have a high turnover of bone, such as Paget's disease, because of this prolonged skeletal retention. Bisphosphonates that have been stored deep in the bone are likely inactive, although large amounts can be released during the resorption process [3,4].

### Side-Effects

> Oral bisphosphonates can cause stomach distress, inflammation, and esophageal erosions, which is the most common side effect of oral N-containing medications. Being sitting upright for 30 to 60 minutes after taking the medication can prevent this.

> After the initial infusion, intravenous bisphosphonates can cause a fever and flu-like symptoms. These symptoms do not reoccur with consecutive infusions, which is significant.

There is a modest increase in the risk of electrolyte abnormalities, but not enough to warrant routine testing.

> Drugs are excreted significantly more slowly in chronic renal failure, and doses are lowered. It is necessary to make adjustments [5].

> Bisphosphonates can cause osteonecrosis of the jaw, which can be fatal. Bisphosphonates stay linked to the bone for a long time, thus postponing bisphosphonate treatment until after dental work is important. The majority of instances occur in cancer patients on high-dose intravenous bisphosphonates, while a limited percentage of cases occur in patients taking oral bisphosphonates.

### Contraindications of Bisphosphonates

There are indeed a few absolute contraindications to using bisphosphonates, such as hypersensitivity to the medication or one of its components, and hypocalcemia. Contraindications to oral amino-bisphosphonates like alendronate include esophageal abnormalities such as stricture or achalasia, which delay esophageal emptying, and inability to stand or sit upright for at least 30 minutes, in which case parenteral medicines like risedronate can be utilized [5].

### Bisphosphonate Mechanism Of Action

Bisphosphonates have previously been used to prevent bone resorption. Bisphosphonates are taken up preferentially by bone tissue and suppress osteoclast development and function at relatively high doses. Bisphosphonates that have accumulated in high concentrations in the bone may become accessible to the surrounding tissue. When tested under a variety of settings, both in culture and in vivo, bisphosphonates have proven to be very effective inhibitors of bone resorption. Bisphosphonates are hypothesized to adhere to the surface of the bone and act directly on osteoclasts, inhibiting their resorptive activity and promoting apoptosis [5,6].

Bisphosphonates may also impact the creation of protein in osteoblasts, according to research. Bisphosphonates have been linked to a potential role in periodontal disease in animal models and altered MMP production in human periodontal ligament cells, according to previous research. Furthermore, animal studies show that bisphosphonate-complexed implants improve osteoconduction and repair, implying that inhibiting bone resorption aids bony healing. Bisphosphonates have been demonstrated to suppress the activity of both MMP-1 and MMP-3 in cultured periodontal ligament cells. The release of matrix metalloproteinases from resident cells in the periodontal attachment apparatus, including the periodontal ligament, is thought to be influenced by these compounds.

Several modes of action have been investigated including bisphosphonate mediated inhibition of the development of osteoclasts, induction of osteoclastic apoptosis, reduction of activity, prevention of the development of osteoclasts





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from hematopoietic precursors, and stimulation of production of an osteoclast inhibitory- factors. In an osteoclast-like cell line, the bisphosphonate alendronate was also demonstrated to cause an increase in intracellular calcium levels. This research is noteworthy since it could indicate the presence of a bisphosphonate receptor on osteoclasts. Several sarcoma cell lines were exposed to several second generation bisphosphonates, and bone resorption was reduced, which was connected with suppression of matrix metalloproteinases (MMPs).[6]. Similarly, mammalian cells have been demonstrated to digest low molecular weight bisphosphonates. These findings have subsequently been confirmed, and it appears that bisphosphonates that do not contain nitrogen cause osteoclast apoptosis through activating the capsase pathway. Conversely, more potent nitrogen containing bisphosphonates are not metabolized and appear to affect protein prenylation in osteoclasts through inhibition of the mevalonate pathway, which is involved in cholesterol synthesis.

Bisphosphonates are known to alter bone remodeling by acting directly on osteoclasts. A more indirect mechanism of action proposes that the synthesis of an osteoclast inhibitory factor produced by osteoblasts in response to bisphosphonate exposure can affect osteoclast activity. In vitro studies clearly reveal that the bisphosphonate-1-hydroxyethylidene-1, 1-bisphosphonate (HEBP) has osteostimulative capabilities, in addition to their evident effects on bone resorbing cells. As evidenced by HEBP-mediated increases in matrix formation and higher mineralized bone formation after HEBP treatment was withdrawn.

These data also showed that HEBP treatment in vivo promotes osteoblastic differentiation in clavial wounds, as well as a reversible stimulation of alveolar and clavial bone width and reversible reductions in periodontal ligament space with. Other data showed that, bisphosphonates have been shown to inhibit the generation of interleukin (IL)-6 in human osteoblastic cells, which could alter osteoclastic activity. Bisphosphonates have a great affinity for the surface of solid phase calcium phosphate, as is well known. Yet, the mechanisms of bisphosphonate action on bone resorption in vivo are likely not mediated by their physicochemical effects on crystal growth regulation. Bisphosphonate effects on osteoclasts and other bone cells, on the other hand, are likely to be more direct and manifested at the molecular level. Osteoclasts release bisphosphonates bound to bone mineral during bone resorption. This could result in a localized buildup of bisphosphonate, which could affect osteoclastic activity directly or indirectly via osteoblasts and macrophages, resulting in decreased osteoclastic chemotaxis and activity [7]

**Bisphosphonates: uses in Bone**

Bisphosphonates have been proven to be effective therapeutic agents for osteoporosis prevention and treatment. In addition, many regions have approved Etidronate and Alendronate, which have been proven to improve bone mass and reduce fracture rates in postmenopausal women in the spine, hip, and other osseous locations. Bisphosphonates are also utilized to treat Paget's disease and tumor-induced hypercalcemia in clinical settings. Similarly, they're administered as osteoclast inhibitors to relieve bone pain caused by the production of biochemical mediators in metastatic bone disease. They can also reduce malignancy-related hypercalcemia, normalizing calcium concentrations within 48 hours of treatment and lowering the likelihood of pathological or tumor-related fractures in those individuals, in addition to reducing bone pain. Bisphosphonates increase bone mass due, in large measure, to their ability to inhibit bone resorption and to reduce activation frequency of bone remodeling units, but they also may enhance mineralization.

Bisphosphonates were formerly thought to promote bone balance through preventing bone resorption rather than directly affecting bone growth. However, recent evidence suggests that it's not entirely correct. Morphological studies on the basic structural unit point to an increase in formation in the bone multicellular unit (BMU), implying that a stimulating impact on bone development may persist. Bisphosphonates have been demonstrated to boost osteoblast and cartilage cell proliferation in vitro, as well as bone cell production of collagen and osteocalcin and cartilage cell biosynthesis of proteoglycans. The effect on collagen could be attributed to a decrease in intracellular collagenolysis. In human cell cultures in vitro, alendronate can enhance colony formation of osteoblasts and the production of mineralized nodules, a phenomenon that is accompanied with an increase in the formation of basic



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fibroblast growth factor. Some of these effects may be mediated by protein-tyrosine phosphatases, according to some theories. As a result, it's possible that bisphosphonates could also increase bone growth in certain circumstances [6]

#### **Effects of Bisphosphonates on Osteoblasts**

Bisphosphonates have the ability to both inhibit and promote osteoblast-like cells and other connective tissue cells in vitro. Bisphosphonates' antiproliferative impact has been reported in vitro with a host of other cell types (including macrophages, tumor cells, and slime mold amoebae), but it is unlikely to be of physiologic consequence because they do not inhibit bone formation. The observation that bisphosphonates may have more modest effects on osteoblasts, triggering the release of a substance that suppresses osteoclast activity or development, is of particular relevance. Sahni et al. discovered that treatment of osteoblast-like CRP10/30 cells in vitro with  $10^{-7}$  M ibandronate or  $10^{-6}$  M clodronate inhibited bone resorption when these cells subsequently were cultured for 24 hours with osteoclasts. Similar effects were obtained when osteoclasts were cultured with conditioned medium taken from the bisphosphonate treated osteoblast-like cells, suggesting that the osteoblasts released a soluble factor that inhibited bone resorption. Subsequent studies concluded that this factor was of low molecular weight (<10 kilodalton) and acted on osteoclast precursors, thereby preventing osteoclast formation. Given that bisphosphonates appear to act intracellularly, it is remarkable that concentrations of bisphosphonates as low as  $10^{-11}$  M had an effect on osteoblasts. Furthermore, treatment of osteoblasts for just 5 minutes appeared to be sufficient to cause release of this factor, although this may be an artefact because negatively charged bisphosphonates may be sequestered and retained in culture by binding electrostatically to cell membranes or extracellular matrix proteins during the 5-minute treatment. Other studies have shown that UMR106 osteoblast like cells and calvarial osteoblasts treated with bisphosphonates in vitro also are capable of releasing factor(s) that inhibit bone resorption by osteoclasts [6].

#### **Effects of Bisphosphonates on Osteoclasts**

Because of the high affinity of bisphosphonates for hydroxyapatite bone mineral, these drugs are targeted to areas of bone turnover and are especially concentrated to sites of osteoclastic bone resorption. Therefore, the most likely route by which bisphosphonates could inhibit bone resorption is by a direct effect on resorbing osteoclasts. There have been many reports supporting the view that bisphosphonates have direct effects on osteoclasts, with the majority of studies having been performed with rodent or avian osteoclasts but also more recently with human osteoclast-like cells. Rowe et al. and others observed that several bisphosphonates, including clodronate, etidronate, and pamidronate, caused degenerative changes suggestive of a toxic effect on rat and mouse osteoclasts *in vitro* and *in vivo*, including osteoclast retraction, condensation, and cellular fragmentation. More recently, studies have demonstrated that bisphosphonates etidronate, clodronate, pamidronate, and risedronate, at of  $> 10^{-7}$  M) can cause apoptotic cell death of mouse, rat, and rabbit osteoclasts *in vitro* and *in vivo* [7]. Apoptotic osteoclasts can be distinguished from other cell types by morphologic changes (cytoplasmic and nuclear shrinkage, chromatin condensation, and nuclear fragmentation) as well as biochemical changes (internucleosomal DNA fragmentation and activation of caspase proteases). Some of these morphologic traits have also been seen in osteoclasts undergoing apoptosis after bisphosphonate treatment in rats and mice *in vivo*. Apoptosis causes cells to lose adherence, while cell attachment loss can also cause apoptosis (also known as cell death- termed anoikis). Bisphosphonates have been found to be ineffective in preventing bone loss in several investigations.

Despite the fact that inducing osteoclast apoptosis would certainly inhibit bone resorption, studies *in vitro* with human osteoclast-like cells and rat osteoclasts revealed that alendronate, pamidronate, and etidronate inhibited bone resorption without causing toxicity or a decrease in osteoclast number, except at high concentrations ( $> 10^{-5}$  M). Bisphosphonates can thus cause more subtle changes in osteoclasts, reducing their ability to resorb bone while also causing osteoclast cell death. A striking feature of osteoclasts treated with bisphosphonates *in vitro* or *in vivo* is the lack of a ruffled border, the convoluted region of plasma membrane adjacent to the bone surface that is essential for the resorption process. Bisphosphonates also can disrupt the osteoclast cytoskeleton and cause loss of actin rings, which are an ultrastructural arrangement unique to osteoclasts comprised of F-actin, vinculin, and other cytoskeletal proteins. At concentrations of bisphosphonates that are not toxic to osteoclasts *in vitro*, loss of the



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osteoclast ruffled border and inhibition of actin ring formation by bisphosphonates is sufficient to prevent bone resorption and may even be a reversible effect when bisphosphonate is withdrawn. Because resorbing osteoclasts are highly metabolically active, inhibition of cellular metabolism also could indirectly inhibit processes required for resorption, such as release of lysosomal enzymes or acidification brought about by the activity of the ATP-dependent proton pump in the ruffled border [8].

#### **Effects of Bisphosphonates on Osteoclast Formation**

Several research have suggested that some bisphosphonates may decrease bone resorption indirectly by affecting osteoclast precursors, hence inhibiting osteoclast development, in addition to harming mature osteoclasts that have resorbed osteoclast-coated bone. Boonekamp et al. discovered that low doses ( $10^{-6}$  M) of pamidronate inhibited the recruitment, differentiation, and fusion of osteoclast precursors in 17-day old embryonic mouse metacarpals (which lack mature osteoclasts), but clodronate and etidronate had no effect. Because pamidronate (and other nitrogen-containing bisphosphonates in later studies) did not prevent osteoclast precursors from proliferating or migrating to the site of cell fusion at the bone surface, and because direct treatment of osteoclast precursors did not inhibit osteoclast formation, the inhibitory effect appeared to be dependent on bone mineral-bound bisphosphonate.

Higher concentrations of pamidronate, clodronate, and etidronate ( $>10^{-6}$  M) inhibited bone resorption in fetal mouse radii by influencing the mature osteoclasts already present. These findings imply that depending on the concentration of bisphosphonates in the bone microenvironment, different bisphosphonates may have varied effects on different cell types. Bisphosphonates have also been demonstrated to suppress the production of osteoclasts in bone marrow cultures in vitro in other investigations [9,10]. Hughes et al. (1989) discovered that the antiresorptive potency of numerous bisphosphonates (risedronate > pamidronate > neridronate > clodronate > etidronate) matched the sequence of antiresorptive potency (risedronate > pamidronate > neridronate > clodronate > etidronate). Van Beek et al. demonstrated that bone marrow isolated from the long bones of mice treated with alendronate in vivo could still form osteoclasts when cultured with osteoclast free bone explants ex vivo, emphasizing the importance of bone mineral-bound bisphosphonate for the antiosteoclastogenic effect. Bisphosphonates, on the other hand, have been found to have no effect on osteoclast development in vitro in multiple studies.

Breuil et al. (1998) discovered that alendronate did not inhibit the generation of human osteoclast-like cells from peripheral blood mononuclear cells cultivated on bone slices at a concentration ( $10^{-7}$  M) that greatly inhibited bone resorption. Furthermore, low doses of the amino-bisphosphonates pamidronate and olpadronate have been shown to accelerate osteoclastic resorption, whereas the number of osteoclasts may increase transiently in vivo following bisphosphonate treatment. The paradoxical increase in osteoclast number seen with amino-bisphosphonates could be due to a transient increase in parathyroid hormone (PTH) and thus osteoclast recruitment in response to resorption inhibition or stimulation of histidine decarboxylase and histidine release by bone marrow cells, both of which could enhance osteoclast recruitment. As a result, the relative impact of inhibitory effects on the production of osteoclasts in vivo is unknown [11]

#### **Bisphosphonates: use in Diagnosis and Management of Periodontitis Management of Periodontal Bone Loss**

Various studies have shown the concept of bisphosphonates' possible use in the therapy of periodontal disease-related bone loss. Alendronate, a bisphosphonate, is released from hydroxyapatite in an acidic environment (inflamed periodontal pocket) and has local cytotoxic effects on other stromal cells. Interleukin-1 and Interleukin-6 activation by nitrogen-containing bisphosphonates may upregulate inflammatory processes in vivo. This suggests that greater dosages of Alendronate in the periodontal pocket may enhance the inflammatory host response. Studies focusing on local applications may be more successful in managing or suppressing alveolar bone resorption by adjusting the actual medication concentration.





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Bisphosphonates have been demonstrated in several investigations to limit collagen production in bone. Bisphosphonates may be effective in preventing bone loss in humans from the standpoint of osteoclast suppression, according to several researchers. It has also been shown that stimulating mineralization inhibits the development of bone matrix. Bisphosphonates limit mineralization in a reversible manner, which can quicken bone development. Other studies have focused on the potential effects of bisphosphonates in relation to "Regional accelerated phenomena" in addition to the potential benefits of bisphosphonates in preventing periodontitis-related bone loss (RAP). As early as 1962, this phenomenon was identified, or at least findings relevant to it were seen. Indeed, as a result of flap elevation and associated RAP, the bisphosphonate Alendronate was demonstrated to decrease bone resorption. Interestingly, these researchers initially reported that topical bisphosphonate therapy was unsuccessful in preventing flap-induced bone resorption, although intravenous medication was extremely effective. Later research by the same group showed that topical administration using a different local administration vehicle could, in fact, prevent flap-induced bone loss. Taken together, it would appear that there may be a potentially important role for bisphosphonates in the prevention of periodontitis or flap – associated bone loss that occurs in the periodontium [4,11]

#### **Diagnosis of Periodontal Bone Loss**

Bisphosphonates' strong avidity for Ca<sup>2+</sup> ions is the basis for their bone-targeting capability, which has led to their employment as bone scanning agents when combined with a  $\gamma$ -emitting radioisotope like technetium. It's worth noting that bisphosphonates' capacity to adsorb to bone mineral in vivo targets them to active bone remodeling areas, where they're effective inhibitors of osteoclast-mediated bone resorption. As a result, bisphosphonates have surpassed all other medication classes in the treatment of disorders characterized by high osteoclast activity, such as Paget's disease, tumor-associated bone disease, and postmenopausal osteoporosis. Although it would seem that the most important clinical sue for bisphosphonates would be related to inhibition of bone loss, their affinity for newly mineralizing bone or actively remodeling bone makes these drugs ideal for diagnostic purposes as well, when combined with radiolabels, a field known as nuclear machine. There are a number of investigations suggesting that radiolabeled bisphosphonate can be used to detect periodontal bone loss in animal models. This has also been demonstrated in human periodontitis. Further studies also demonstrated that radiolabeled bisphosphonates can be used to detect changes of metabolic activity at skeletal sites, bone loss associated with periodontal disease, and cessation of bone loss following treatment with the anti-inflammatory flurbiprofen in both animals and humans. These findings suggested it is conceivable that early intervention or more aggressive therapy can be initiated if and when radiolabeled bisphosphonate uptake demonstrated with nuclear scanning indicates that bone loss is occurring.

Given the above, it would appear that in the area of Periodontology, bisphosphonates might have potential usefulness not only for treatment or prevention of bone loss associated with periodontitis but also possibly aids in diagnosis and early intervention. Because bisphosphonates must be administered intravenously, they are unlikely to be used routinely for diagnostic purposes because to expense, accessibility, and the risk of full-body irradiation. Nonetheless, it appears that there is a compelling case for utilizing bisphosphonates therapeutically to prevent bone loss in periodontitis patients [12]

#### **The Potential Role of Etidronate for Stimulation of Bone Formation Inverse Relationship between Mineralization and Bone Matrix Formation**

The most of bisphosphonates can prevent mineralization. Bisphosphonates in general have this potential, but the newer medications have been developed to enhance their anti-resorptive effects, allowing them to be administered at levels that do not impair bone mineralization. Indeed, it would appear sensible to limit the potential inhibitory effects of bisphosphonates on mineralization at first appearance. An inverse link between osteoid matrix production and mineralization has been discovered in a laboratory research. Using an in vitro periosteal model system that has been shown to cause bone growth. When bone mineralization is promoted, bone matrix formation is hindered, according to laboratory studies. Based on these findings, it's possible that



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reversible mineralization inhibition may be employed to enable faster bone development (osteoceleration) [14]

### **Osteoceleration with Etidronate**

A pharmacological drug with the ability to inhibit bone reversibly is required. One of the first-generation Bisphosphonates, etidronate, appeared to have potential in this regard if administered in a pulsatile form at a dose high enough to impede mineralization without being harmful. In fact, a similar technique (pulsatile dosage) has been reported previously for osteoporosis, however the concept of deliberate inhibition had not been clarified. As a result, etidronate has been shown to decrease bone resorption at a dose that is also very close to the level required to inhibit mineralization.

Further research was conducted in the lab to see whether etidronate might be utilized in a high-dose pulsatile method to accelerate mineralized bone growth. The reasoning behind this was that if etidronate could temporarily block bone mineralization, matrix formation may be boosted. It was hypothesized that after the "excess" matrix had formed, removing the etidronate would allow mineralization to occur, resulting in enhanced bone growth. Based on these in vitro studies, it was determined that etidronate was capable of reversibly inhibiting mineralization and thus stimulating osteoid formation, and that when etidronate was removed from the culture media, mineralization occurred with a net increase in total bone volume that was also more densely mineralized than the controls. This impact was discovered in another study employing an in vivo ankylosis model system, however the phenomenon described here was apparently neglected. This phenomenon has also been established in vivo using two wound healing models: a periodontal wound healing system and a clavicular wound healing model. Given the above, bisphosphonates, particularly etidronate, appear to be effective not only for preventing osteoclast-mediated bone loss but also, under the right circumstances, for stimulating bone growth. In fact, research is currently underway to see whether etidronate could be utilized to stimulate bone matrix formation in a porous coated titanium endosseous implant system [11,13]

### **Potential Mechanisms Underlying Hebp-Induced Stimulation Of Bone Formation**

The mechanisms by which mineralization and osteoid production are linked in physiological and pathological processes are poorly understood, in part because modeling these processes in vitro can be difficult. Mechanistic studies of matrix production and mineralization, as well as the discovery of genes that govern coupling, are possible with in vitro osteogenic model systems. Induction of mineralization with organic phosphate reduces bone matrix formation in these settings, whereas inhibition of mineralization increases bone matrix formation. Phosphoethanolamine (PEA) and pyridoxal phosphate (PLP), which are breakdown products of organic phosphates, may regulate or even drive mineralization by being metabolized intracellularly by osteoblasts after alkaline phosphatase-mediated hydrolysis.

Ethanolamine, pyridoxal, and glycerol (all breakdown products of alkaline phosphatase-mediated organic phosphate hydrolysis) are known to impact gene expression in osteoblastic cells. Preliminary data demonstrate that pyridoxine, like pyridoxal, is a dephosphorylated breakdown product (both are dietary forms of vitamin B6), induces mineralization in vitro and inhibits collagen formation on its own, suggesting a mechanism in which HEBP and other components may play a role. HEBP may interfere with alkaline phosphatase-mediated hydrolysis of organic phosphatase, which would otherwise have mediated downstream effects on bone formation such as upregulation of the synthesis of putative nucleators of mineralization such as bone sialoprotein and downregulation of collagen synthesis, in addition to directly inhibiting hydroxyapatite formation [5,14]

## **CONCLUSION**

Bisphosphonates are a type of pharmacological drug that has the potential to be useful in periodontics and the treatment of metabolic bone disorders. It's also possible that, in the future, similar medications will be utilized to





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encourage new bone production as well as prevent bone loss seen in periodontal disorders and around implants. Bisphosphonates could thus be utilized in conjunction with regenerative therapies, as well as to stimulate bone development around and within endosseous implants. It has to be established whether early or later biomechanical advantages or disadvantages exist in terms of implant retention. The early osteoid phase of healing, for example, would likely lower initial implant stability, although higher bone in growth could lead to greater implant stability and retention success in the long run. In any event, it appears that the use of bisphosphonates in Periodontics, both diagnostically and therapeutically, offers a potentially promising option for future research [14]

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Table 1. Orally Administered Bisphosphonates [4]		
Brand Name	Manufacturer	Generic Name
Actonel	Procter & Gamble Pharmaceuticals	Risedronate
Boniva	Roche Laboratories	Ibandronate
Fosamax	Merck & Co.	Alendronate
Fosamax Plus D	Merck & Co.	Alendronate





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Skelid	Sanofi Pharmaceuticals	Tiludronate
Didronel	Procter & Gamble Pharmaceuticals	Etidronate

Brand Name	Manufacturer	Generic Name
Aredia	Novartis	Pamidronate
Zometa	Novartis	Zoledronic acid
Bonefos	Schering AG	Clodronate

**Table 3: bisphosphonates – constituents of r<sub>1</sub> and r<sub>2</sub> side chains Pharmacokinetics**

BISPHOSPHONATE	R <sub>1</sub> SIDE CHAIN	R <sub>2</sub> SIDE CHAIN
Etidronate	OH	CH <sub>3</sub>
Clodronate	Cl	Cl
Pamidronate	OH	CH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub>
Alendronate	OH	(CH <sub>2</sub> ) <sub>3</sub> NH <sub>2</sub>
Residronate	OH	CH <sub>2</sub> -3-pyridine
Tiludronate	H	CH <sub>2</sub> -S-phenyl-Cl
Ibandronate	OH	CH <sub>2</sub> CH <sub>2</sub> N(CH <sub>3</sub> )(pentyl)
Zoledronate	OH	CH <sub>2</sub> - imidazole
YH 529	OH	CH <sub>2</sub> -2-imidazo-pyridinyl
Incadronate (YM 175)	H	N - (cyclo-heptyl)
Olpadronate	OH	CH <sub>2</sub> CH <sub>2</sub> (CH <sub>3</sub> ) <sub>2</sub>
Neridronate	OH	(CH <sub>2</sub> ) <sub>5</sub> NH <sub>2</sub>
EB-1053	OH	CH <sub>2</sub> -1- pyrrolidinyl

Tissue Level	Cellular Level	Molecular level
↓ Bone turnover due to ↓ Bone resorption  ↓ Number of new bone multicellular units  Net positive whole body bone balance	↓ Osteoclast recruitment ↑ Osteoclast apoptosis ↓ Osteoclast adhesion ↓ Depth of resorption site ↓ Release of cytokines by macrophages ↑ Osteoblast differentiation and number	Inhibit mevalonate pathway (can result in perturbed cell activity and induction of apoptosis)  ↓ Post translational prenylation of GTP-binding proteins.





## Implementation of Energy Efficient Hybrid Adder for Approximate Computing Applications

Telugu Maddileti<sup>1</sup>, M.Jagadeesh Chandra Prasad<sup>2</sup>, Aaradhana<sup>3\*</sup> and K.Maheswari Devi<sup>4</sup>

<sup>1</sup>Associate Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>2</sup>Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>3</sup>PG Scholar, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>4</sup>Assistant Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

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### \*Address for Correspondence

#### Aaradhana

PG Scholar,  
Department of ECE,  
Malla Reddy Engineering College,  
Secunderabad, Hyderabad,  
Telangana 500100, India.  
E.Mail: aaradhana543@gmail.com



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### ABSTRACT

As the dimensions of transistors have shrunk to sub-micron scales, new challenges, including power efficiency and undetected radiation hazards, have emerged as important areas of concern in the realm of extremely large-scale integration. Because they are key areas of worry, these new problems have recently come to the forefront as important areas of concern. In addition, complementary metal oxide semiconductors, which are more often referred to as CMOS transistors, have a greater consumption of space, power, and delay than the various other kinds of transistors. As a consequence of this, a brand-new 10 Transistor (10T) Multiplexer Logic based Full Adder (MLFA) has been created and is now being simulated. Utilizing both kinds of transistors was necessary in order to achieve this goal, which is considered one of the possible answers to the problems caused by standard CMOS. Additionally, the MLFA that is being presented functions on the basis of a multiplexer selection logic, which has the capability of effectively reducing the route delays as well as the number of transistors. In addition, employing suggested MLFAs allowed for the development of a 4-bit ripple carry adder (RCA). In the end, the simulations are performed with the help of the Tanner-EDA simulation programme. The results







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of the simulation indicated that the recommended approach resulted in superior performance when compared to other approaches that are presently regarded to be state of the art in the field.

**Keywords:** Full adder, Multiplexer, simulation, CMOS, RCA, Tanner EDA etc.

## INTRODUCTION

Conventionally, computing systems are built to function with the highest feasible degree of accuracy. However, this tendency is met with significant obstacles in terms of technology, such as high performance and power consumption, as well as dependability of circuits. Computer systems have been gradually improving in both their performance and their power consumption for well over half a century, with scaling technologies being the primary factor in this improvement [1]. It is anticipated that this pattern will maintain its prevalence far into the foreseeable future. In accordance with Dennard's scaling, the size of a transistor has been noticeably smaller during the course of its development, and the supply voltage has likewise become lower. As a direct consequence of this development, electronic circuits can now function at higher frequencies while nearly preserving the same amount of power dissipation. However, because Dennard's scaling is drawing ever-nearer to its end, it is becoming increasingly difficult to achieve additional performance improvements while adhering to the same 10.1109/JPROC.2020.2975695 power limits. This is because Dennard's scaling is getting closer and closer to its conclusion. Consumption of electricity has been a major source of concern for a very long time, and in recent years, it has developed into a problem that impacts the whole industry as a whole and is of critical importance. This is because it is difficult to monitor and avoid parameter fluctuations and defects at advanced nanoscales, which is the reason why this is the case [2]. As a consequence of this, there will be a significant increase in the costs associated with the manufacturing and verification processes in order to ensure the success of the complete accuracy of the signals, logic values, devices, and interconnects [3].

When it comes to the creation of digital processing devices, with an emphasis on portable systems, the key goals are to lower the amount of power that is needed while concurrently improving the processing speed[4]. In most cases, increasing the speed of the precise processing unit results in an increase in the amount of power that is required to run [5]. The accuracy of the calculation is compromised as one of the strategies for increasing processing power without sacrificing speed. It is possible to utilise this method, which is known as approximate computing, for the applications in which it is acceptable to have some inaccuracies [6]. Among these are the applications in which digital signal processing, often known as DSP, is carried out on the signals connected to human senses. The capabilities of human perception are restricted, thus most of the time; approximation computing is used for processing these signals in bespoke DSP blocks. This is done since it is more accurate than human perception [7]. The realisation of this component utilising the technique of approximation computing was motivated by these facts, which can be found in the previous sentence. Previous studies on approximation adders have focused on either reducing the error weight or the error probability, both of which are considered to be more broad techniques. This is because, in most cases, the majority of the operations take place in the LSB section. The second method makes use of structures that are pure approximation adders. The primary design goals for these adders are to cut down on the amount of power they use and the amount of delay they incur, as well as the error probability associated with the summing. They could also be accompanied with an error correcting unit, which incurs overhead costs in terms of both time and power consumption [8].

The ECG signals coming from a patient's body are continually monitored by a device based on WBSN. A continuous monitoring result in the production of an excessive amount of data, which, in turn, calls for a greater quantity of storage space, results in higher expenses associated with transmission, and raises the required amount of power consumption. In addition, in order for the Processing Subsystem of the WBSN device to be able to deal with this enormous volume of data, it needs additional processing time to be carried out, which results in an extraordinarily



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high level of power consumption. As a result, data compression methods are routinely applied in order to accomplish sparse encoding of this data. Sparse encoding has the effect of lowering the needs for processing, which in turn leads to a reduction in the amount of power that is lost by the Processing subsystem[9]. It is possible to reduce the amount of data being transferred by cutting down on the number of bits being sent (which are what make up the packets) [10]. This is due to the fact that the reconstructed signals are not exactly the same as the original signals.

**Literature Survey**

Betzel *et al.* [11] highlighted the potential advantages of approximation computing for the reduction of communication by conducting a review of three possible strategies for approximate communication. These techniques were compression, relaxed synchronization, and value prediction. A comparison of the methods is made using an assessment methodology that takes into consideration factors such as the reduction of communication costs, performance, energy reduction, applicability, overheads, and output deterioration. In conclusion, this essay offers a number of recommendations for further research on approximation communication methods.

Mahmud and colleagues presented a thorough assessment with connection to the processing and analysis of large data of the procedures and techniques of data partitioning and sampling[12]. The first thing that students do when they begin this course is get an overview of the most widely used big data frameworks that can be operated on Hadoop clusters. Following that, we will go through the fundamental approaches to data partitioning, which will include a discussion of the three most frequent horizontal partitioning schemes: range, hash, and random partitioning. Following that, we shall go to the subsequent part of this discussion. The topic of data partitioning on Hadoop clusters is also discussed, along with an overview of novel methodologies for the partitioning of large amounts of data, such as the recently developed Random Sample Partition (RSP) distributed model. In addition, the topic of data partitioning on Hadoop clusters is also discussed. In addition, the topic of data partitioning on Hadoop clusters is covered.

Wei *et al.* [13] suggested a novel method of using static analysis for the purpose of performing security checks on Android applications, as well as a generic framework known as Amandroid. In an Android app component, Amandroid will do data flow and data dependency analysis on the component in addition to determining points-to information for every objects inside the component in a flow- and context-sensitive manner (which is configured by the user). Additionally, Amandroid monitors the activities of inter-component communication. In order to undertake intra-app or inter-app analysis, it is able to stitch together information at the component level and information at the app level.

Stanley-Marbell *et al.* [14] made the observation that it could be useful to provide an overview of the research results on computer systems that only produce as many mistakes as their end-to-end applications can tolerate. This action was taken as a direct reaction to a suggestion made by the previously stated organisation. [There must be other citations for this] The results include a broad spectrum of academic disciplines, such as information theory, computer-aided circuit design, digital system design, computer architecture, programming languages, and operating systems, to mention just a few of them. Instead of over-provisioning the resources that are controlled by each of these layers of abstraction to prevent errors, it is more efficient to take advantage of the masking of errors that are occurring at one layer in order to stop those errors from propagating to a higher layer. This is because errors that occur at one layer can be masked by errors that occur at higher layers. This is due to the fact that faults that take place at one layer might be concealed by errors that take place at a higher layer. This is because errors that occur at one layer can be masked by errors that occur at higher layers. This is achieved by eliminating the possibility of mistakes arising at a more fundamental level in the first place.

An edge-computing-based lightweight block chain framework (ECLB) was suggested for mobile devices by Liu *et al.* [15]. In order to achieve greater performance, this work presents a unique set of ledger structures and implements a transaction consensus procedure. In addition, taking into consideration the permission block chain environment, we



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make explicit use of various cryptographic approaches in order to create a pluggable transaction regulation module. In conclusion, the results of our security analysis and performance evaluation demonstrate that ECLB is capable of maintaining the same level of security as block chains similar to Bit coin while achieving superior performance in terms of the cost of ledger storage in mobile devices, the cost of computing blocks, the throughput of transactions, the confirmation latency of transactions, and the transaction regulation cost.

zhou, *et al.* [16] created a Java annotation-based offloading framework for android mobile devices and gave it the name MCAF. This framework was created with the intention of easing the process of developing android apps that have the potential to offload their processing to a remote server. The only thing that the developers need to do is import the SDK library of our MCAF, and then they need to annotate the methods that need a lot of calculation. MCAF has the capability to automatically build the code that will be executed in the cloud as well as extract the annotated source code. In addition, the programmes that make the judgements about offloading are automatically integrated into the code that was originally written. Additionally, they carried out the actual trials in order to demonstrate that our MCAF is applicable.

The Wireless Body Sensor Nodes was a concept that was suggested by Gosh *et al.* [17]. (WBSN). These wireless body sensor networks (WBSNs) initially comprise of bio-sensors that collect signals from a patient's body and wireless transmitters that transfer the acquired data to a server that is located in either a private or public cloud. The collected data may then be analysed. These WBSNs are equipped with the appropriate hardware to process signals before sending them to the cloud in order to be stored there. In energy-constrained WBSNs, the simultaneous occurrence of all of these actions results in a large level of power consumption, which, in turn, shortens the operational lifetime of these networks. The vast majority of these data that are being sent to the servers are, by their very nature, duplicated; as a consequence, the therapeutic value that they have is negligible. This is because error-resilience is an inherent property of signal processing algorithms. In conclusion, the findings of the experiments reveal a 96% increase in system-level energy efficiency with just a 2% reduction in the effect on signal quality.

Liu, *et al.* [18] suggested an examination of approximation computing from both its past and its potential future. The size of a transistor has been greatly reduced from the beginning in line with Den nard's scaling, and the supply voltage has been decreased during the course of the years. As a direct consequence of this development, electronic circuits can now function at higher frequencies while nearly preserving the same amount of power dissipation. Not only does an increase in power consumption occur when the feature size of complementary metal-oxide-semiconductor (CMOS) technology is reduced to 7 nanometres, but an improvement in reliability also occurs at this point. This is due to the fact that it is more difficult to regulate and steer clear of parameter changes and flaws at advanced nanoscales.

It was thought that a reverse carry propagate adder (RCPA) should be used, as stated by Pashaeifar *et al.* [19]. Even if there are variations in the latency, the overall system will be more stable if you use this sort of carry propagation at the beginning of the process. We describe three distinct implementations of the reverse carry propagate full-adder (RCPFA) cell; each of these implementations differs from the others in terms of the amount of delay, power, and energy it consumes, as well as the accuracy it provides. It is possible to produce hybrid adders with varied degrees of accuracy by combining the structure that has been described with an accurate carry adder that works in reverse. Using a variety of different permutations of these structures allowed for the generation of these adders. The discrete cosine transforms (DCT) block of the JPEG compression and the finite-impulse response (FIR) filter applications are analysed in order to determine whether or not the recommended RCPAs are successful. This is the last but not the least of the topics covered.

Marchisio *et al.* [20] presented their idea of using deep learning for edge computing. In the beginning, as DNNs increase in complexity, the linked issue of their high energy consumption becomes a difficult one to deal with. This task is made much more difficult by edge computing, in which the computing devices have restricted access to resources and must function within a limited energy budget. As a direct result of this, it is necessary to carry out





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specific optimizations for deep learning on both the software and the hardware levels. In this work, we undertake a complete analysis of the current trends of such optimizations, and we address key outstanding research concerns both in the medium term and in the long term.

#### Proposed Method

Because full adders are the fundamental components of any integrated circuit, their design and development must be approached with extreme caution in order to get optimal results. Conventional CMOS full adders have much greater power, delay, and energy consumption figures than their digital counterparts. As a result, the alternative technologies of FinFET and GnrFET are the technologies that may give reduced resource utilisation in lieu of the fundamental CMOS technology. In this part, an in-depth discussion of the creation of a full adder via the use of FinFET and GnrFET technology, together with 10T modelling, is presented. The MLFA is shown in the block diagram seen in figure 1. It demonstrates the operation of adding one bit by making use of a number of different components, such as XOR gates, NOT gates, and a Multiplexer 2 to 1 (MUX21), in that order. The functions of the MLFA are mostly focused on the switching operations for MUX21. Because of its performance, which is characterised by the rapid triggering of data in comparison to that of other building blocks, the computational complexity of the MUX21 is very low in this instance. In addition to that, the logic of FA is satisfied by this activating procedure. In this setup, each individual component is crafted by the use of the FinFET and GnrFET technologies, in that order. In addition, both the process of sum generation and the process of carry out generation are shown in Table 1. The fact that the lines in Figures 1 as well as Table 1 all have different colours indicates that they represent the same procedure.

In the beginning, inputs A and B are placed into the XOR gate, which ultimately produces the half adder sum output. This is the outcome of the first step. The output of this generation is sent as the data input to the MUX21 once it has been processed (input 0). Additionally, the XOR gate is used on the NOT gate, which leads in the output being referred to as XNOR. This is because of the way in which the XOR gate is utilised on the NOT gate. In addition to this, the result of the XNOR operation is fed into the MUX21 as the data input (input 1), and the MUX21 utilises C in as its selection input in the appropriate manner. In addition, depending on the value of C in, MUX21 will choose the data inputs using either the XOR or XNOR outputs. This is shown by the equations (2) and (3) that are presented below, in that order. The total adder sum, which is represented by the symbol S, is found in equation (1), which can be found below.

$$S = A \oplus B \oplus C_{in} \quad (1)$$

$$C_{in} = 0 \rightarrow S = A \oplus B \oplus 0 \rightarrow A \oplus B \quad (2)$$

$$C_{in} = 1 \rightarrow S = A \oplus B \oplus 1 \rightarrow A \odot B \quad (3)$$

In a similar fashion, the result of the XNOR operation is fed into the second MUX21 as the selection input, with C in serving as "data input 0" and B being the "data input 1." This, in turn, produces the carry out (C out). In addition, Equation 4 demonstrates the fundamental process of MLFA carry out, and it is altered in accordance with the XOR-XNOR logic for implementations that are based on multiplexers.

$$C_{out} = AB + C_{in}(A \oplus B) = C_{in}(A \oplus B) + \bar{B}(A \odot B) \quad (4)$$

Additionally, equations (5) and (6) illustrate the method of carry out generation in the following manner:

$$A \odot B = 0 \rightarrow C_{out} = C_{in} \quad (5)$$

$$A \odot B = 1 \rightarrow C_{out} = B \quad (6)$$

The varied colours in Figure 2 and Table 1, respectively, reflect how these equations are used in practise. This can be seen in both of these figures.





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Figure 2 illustrates the FinFET modelling of the proposed MLFA that has been developed. The proposed MLFA is constructed from 5 numbers of FinFET PMOS transistors and 5 numbers of FinFET NMOS transistors, each in their own separate 5 number configuration. Due to the fact that the NMOS and PMOS transistors used in this particular implementation are carbon copies of one another, it is essential to include an equilibrium state into the MLFA. This is done in order to ensure that the unbiased electron-hole pair is both regulated and synchronised. In addition to this, the condition of balance also helps to maintain the appropriate level of power consumption while simultaneously improving energy efficiency. The combination of P1 and N1 FinFET transistors performs the function of an inverter, and it gives the value B minus as the output for any value of B that is input. Therefore, the combination of P2 and N2 FinFET transistors functions as an XOR gate, taking the values B and A as its inputs and producing the values A and B as its outputs.

In addition, as an inverter, the combination of P3 and N3 FinFET transistors causes them to produce the XNOR result AB in response to the XOR input AB. AB is the output of the XNOR operation. This is because the result of performing the XOR operation on AB is AB. In addition, the functionality of a MUX21 is accomplished by combining P4 and N4 FinFET transistors in a single device. The letter C in represents the selection input, data input-0 represents AB, data input-1 also represents AB, and the letter S represents the sum output. This specific arrangement of transistors is referred to as a MUX21 and has been given that name. The MUX21 that is generated by the combination of P5 and N5 FinFET transistors operates in the following manner: A and B are used as the selection input, data input-0 is used as C in, data input-1 is used as B, and the carry output is created as C out, respectively. This brings us to our final point, which is that the combination of these transistors creates a carry output. The implementation of a MLFA using GnrFETs makes use of the same transistor level circuit as before, and the operation remains the same.

## RESULTS AND DISCUSSIONS

For the creation of each and every MLFA design, The Xilinx ISE software was the one that was used. This piece of software has the capacity to generate two separate kinds of outputs, namely simulation and synthesis. These outputs are both possible. The results of the simulation make it possible to conduct an in-depth analysis of the MLFA architecture with relation to the many permutations of input and output byte levels. A simple decoding technique may be approximated by applying a large number of different combinations of inputs and watching a wide variety of outputs while doing a simulation study of accurate encoding. As a consequence of the conclusions of the synthesis, the use of space in proportion to the number of transistors will be carried out. In addition, a time summary will be obtained with reference to the various route delays, and a power summary will be prepared making use of the static and dynamic power consumption. Both of these summaries will be gathered. Both of these summaries will be done. The results of the simulation of the existing MLFA are shown in Figure 3. Here, the outputs are wrong. Further, the results of the simulation of the proposed MLFA are shown in Figure 4. Table 2 presents a comparison and contrast of the results of performance assessments conducted on a number of different MLFA controllers. In this instance, the proposed MLFA resulted in superior (reduced) performance in terms of transistors, time-delay, and power consumption when compared to conventional approaches such EFA [9], 16T-FA [17], 12T -FA [16], and 11T-FA [13]. This was the case because the MLFA used fewer transistors than the conventional approaches. This was the case because the MLFA was able to reduce the time-delay without sacrificing the number of transistors.

## CONCLUSION

This academic article focuses mostly on the design and manufacturing of a MLFA as well as a 4-bit RCA by making use of FinFET and GnrFET technologies. This is the primary topic of the study. It is engaged between the XOR results and the XNOR outcomes so that the entire output is created. In addition, a second multiplexer enabled the data inputs and produced the carry output, both of which contributed to the successful reduction of the route delays. The suggested MLFA is constructed on the basis of the logic used by the multiplexer selection, and as a result, it is activated between those two possibilities in order to provide the sum output. In addition to this, the technique that



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was proposed was able to reduce the amount of power that was used by activities that were quickly activated. These libraries were used to create the final product. The results of the simulation make it possible to reach the conclusion that the design that was supplied is an excellent choice for a broad variety of addition-based applications. This conclusion can be reached because the findings of the simulation enable it. In addition to this, this strategy is extensible, meaning that it is used to build the complete the subtractor and the multiplication operations in the order given.

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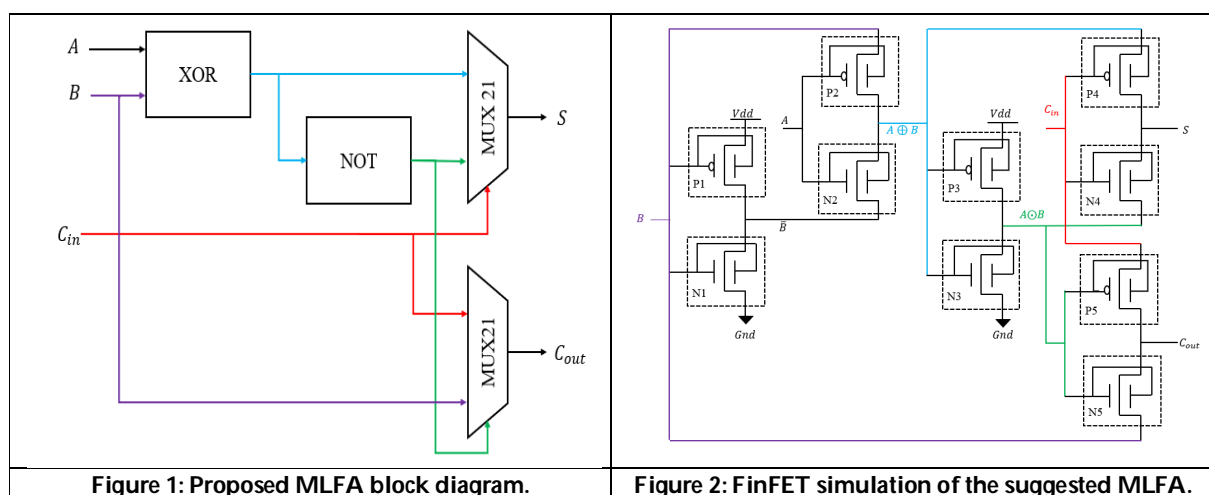
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**Table 1: Entire Proposed Adder Operating Table.**

Inputs			Sum Output	Comments for sum	Temporary outcome XNOR(A,B)	Carry out Outcome C <sub>out</sub>	Comments for Carry out
C <sub>in</sub>	A	B	S				
0	0	0	0	Eq.(2) is Indicated by blue colour	1	0	Eq.(5) is Indicated by REDcolour
0	0	1	1		0	0	
0	1	0	1		0	0	
0	1	1	0		1	1	
1	0	0	1	Eq.(3) is indicated by green colour	1	0	Eq.(6) is indicated by violet colour
1	0	1	0		0	1	
1	1	0	0		0	1	
1	1	1	1		1	1	

**Table 2. Comparison Table**

METHOD	Transistor count	Average power	Max power	Delay
EFA [9]	16	15.2uw	1.11mw	20.05ns
16T-FA [17]	15	13.8uw	1.17mw	60.16ns
12T -FA [16]	12	5.477uw	0.963mw	20.21ns
11T-FA [13]	11	4.90uw	0.510mw	40.28ns
proposed MLFA	10	2.90uw	0.421mw	12.34ns





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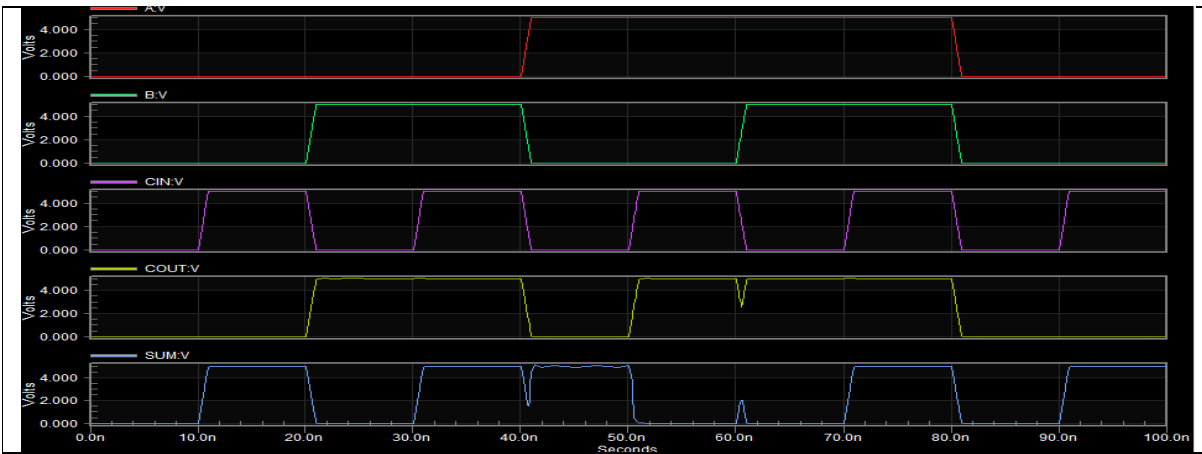


Figure 3. Simulation output of existing

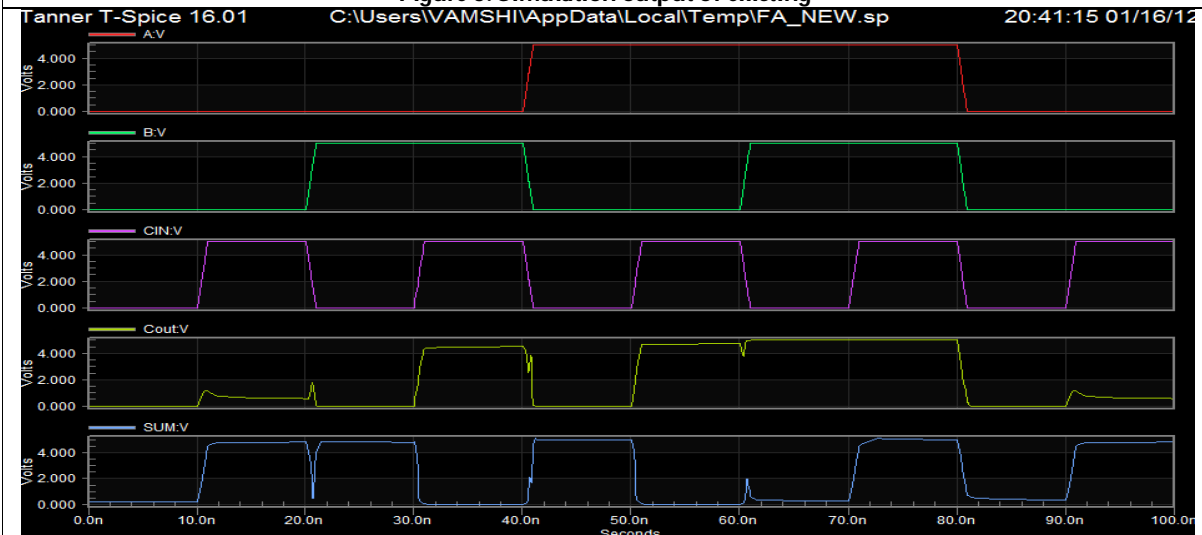


Figure 4. Simulation output of proposed MLFA







## Farming Barriers and Challenges Faced by Small Farmers in Erode District

R.Kanya Priya<sup>1\*</sup> and P.Jeevitha<sup>2</sup>

<sup>1</sup>Assistant Professor in Mathematics, Sri Ramakrishna College of Arts and Science for Women, Coimbatore, Tamil Nadu, India

<sup>2</sup>Assistant Professor in Commerce, Sri Ramakrishna College of Arts and Science for Women, Coimbatore, Tamil Nadu, India

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### \*Address for Correspondence

**R.Kanya Priya**

Assistant Professor in Mathematics,  
Sri Ramakrishna College of Arts and Science for Women,  
Coimbatore, Tamil Nadu, India.  
Email Id: kanyamaths@srcw.ac.in



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### ABSTRACT

This paper examines the challenges and problems that are faced by the small farmers in India. The traditional occupation of our country is farming. More than 65 percent of the population in India is residing in rural areas of the country. Out of them about 80 percent of the public depend on agriculture and allied industries of agriculture. Due to inadequate storage facilities some of the vegetables and other commodities are difficult to store for longer time. The major problem faced by the farmers are unavailability of good quality seeds, lack of modern equipment, poor irrigation facilities, small and fragmented holding of land dealing with local trades and middleman, lack of storage facility. The storage facility and the transportations facility both should be in the mordent line. This study going to list out the major problems which are faced by the farmers.

**Keywords:** Challenges, Problems, Farmers.

### INTRODUCTION

Erode district total area under cultivation is 1,69,815 hectare In that, Horticultural crops have been cultivated in about 55,030 hectare and the prominent crops are turmeric, jack fruit, Banana, Mango, Guava, Tapioca, Tomato, Brinjal and other vegetables. Paddy is the main food crop of the district and it accounts for 86,939 hectares of land. The second most important crop is Cholam which is cultivated in more than 11,240 hectare of land. Erode is known as the 'turmeric city' and cultivation of turmeric exceeds over 14,533 hectare of land.



**Kanya Priya and Jeevitha****Major Problems faced by farmers**

The major problem faced by farmers are unavailability of good quality of seeds and lack of modern equipment, poor irrigation facilities, small and fragmented holding of land dealing with local traders and middlemen, lack of storage facility. The storage facility and the transportation facility both should be in the modern line.

**Wild animals conflict in Agriculture**

When the Rabi season begins, the farmer constantly efforts to save his crop from all the dangers of pest, disease outbreak, flood, drought, unseasonal rain, but while facing all these dangers, the problem of crop destruction by wild animals does not end, even from the time of planting to cultivation, whether the farm is fenced with barbed wire, solar fence or chain-link fence, have to deal with the destruction of wild animals like Elephant, monkeys, deer, peacocks and rabbits. These fences can protect the crop to some extent, but it is not a permanent solution. There have been many incidents of wild boar digging a hole under the fence and animal like Elephant easily entering the field over the 5-6 feet high fence and damaging crops. Even the cost of fencing is not affordable for a common farmer. In such a case, the farmer has no other option without guarding the field, the farmer who has to work in the field all day and watch the field all night has to face the problems of darkness like snake bite. The growing presence and invasion of wildlife is creating more problems for farmers, already burdened by poor living conditions and the crisis of the agricultural sector. In hilly areas, almost everything farmers grow is destroyed by wild boars, elephants and monkeys. Even when harvests are ready, they can be destroyed overnight. Meanwhile, the number of people killed in wild animal attacks is on the increase. In the past 10 years, nearly a thousand people in Kerala have lost their lives in such incidents.

Fencing is a popular wild animal deterrent that can last for many years. Agricultural fences are quite an effective wild animal protection technology. However, utilizing fences as a practice is often regulated. Some local and state entities may restrict or prevent the use of certain types of fences. Therefore, before deciding on a suitable fence, it's important to check local laws and regulations. The quality of fencing depends on the material and structure. Depending on how it is made and what it is made of, some permanent fences can last up to 30 years. Farmers usually use one of the following types of fences:

**Wire fences**

Are constructed of metal wires woven together forming a physical barrier. The fences are effective, long-lasting, and require relatively little maintenance. However, they are expensive and recommended only for the protection of high-value crops.

**Plastic fences**

Poly propylene fences are generally less expensive and easier to install and repair than other types. Additionally, these fences are widely acceptable and meet various regulations. Their disadvantage includes their short lifespan (up to 10 years) and questionable effectiveness in areas with a higher possibility of wild animal crop damage.

**Electric fences**

Are constructed to inflict an electric shock to animals that come in contact with the fence, thus preventing animals from crossing the fence. These fences are long-lasting and an effective crop protection measure. Costs vary depending on the specific type and size of an area. Before purchasing electric fences, it's very important to make sure they are allowed for use in a specific area, and for protection against endangered animal species. Additionally, it's recommended that electric fences are marked with a warning sign to prevent any possible human contact.

**Natural repellents**

Some farmers prefer using natural resources instead of mechanical or chemical protective practices. There are various ways to minimize crop loss from wild animals, including:





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- **Smoke**; in some areas, farmers burn elephant dung or other materials that smolder and create heavy smoke
- **Fish or garlic natural emulsion**; repels rabbits and deer
- **Beehive fencing**; for instance, elephants are repelled by the sound of honey bees; this practice is beneficial as it serves as an extra source of income
- **Chili peppers**; the chemical Capsaicin makes chili peppers hot; an excellent repellent against elephants, monkeys, squirrels, and some other wild animals; farmers who plant chili peppers will also benefit from an extra source of income
- **Lavender, soybean, peas, and beans** are excellent repellents against rabbits and are also an additional source of income
- **Egg-based repellent**; homemade repellent against deer
- **Castor oil**; is a natural repellent that keeps away burrowing animals such as moles
- **Chemical repellents** which include active substances such as Anthraquinone, Butanethiol, and Methyl Anthranilate can be used to keep wild animals away from crops.

#### Workers shortage

Farmers are unable to harvest on time due to the shortage of workers. But due to the lack and high cost of workers there is increasing demand. If the crop received sufficient water and there have been no problems in cultivation. While this is a good thing, it is also a problem for farmers because of the lack of workers. Both the mill has opened in succession and this has driven the increase in demand. Many workers are unavailable as they are pre-booked by the farmers for the harvest season. Hence many fields and its surrounding area have flowered. This will lead to farmers losing profits." At present, people are paying between Rs 1,200 to Rs 1,500 to the workers per day. As sugarcane cutting is a seasonal task, many people have abandoned this work. Farmers have no choice but to wait for the workers to allot them their time. But in the meantime, the sugarcane is flowering."

Our estimates show that there has been a dramatic reduction in prime working-age Indians engaged in agriculture, with their share falling to 23.3% in 2018-19 from 40% in 2004-05. Even in rural India, only one in three prime working-age adults was employed in the sector in 2018-19. There was an even sharper decline in the share of young adults (20-29 years) who work in agriculture. Only about 14.4% of young adults were working on farms in 2018-19, down from 34% in 2004-05. A decline of young people in agriculture work partly explain reports of shortages of agriculture labour. Further, this also means that the median age of agriculture workers has increased to 40 years in 2018-19 from 35 in 2004-05.

#### Quality of seeds

Poor seed quality leads to low vigor and poor growth. They are also prone to weeds, insects, and diseases. The problem arises as most farmers in India keep their own seed and do not tend to do any seed processing to ensure varietal purity or seed quality. There are various problems affecting crop establishment. These are cloddy soil, seed too deep, soil too soft at seeding, poor emergence in low spots in fields, heavy rainfall at seeding, soil crusting, poor seed distribution, low seed rate, water stress, muddy water at seeding, clogged seeder and/or pests such as ants, birds and rats that remove seed at planting. To confirm the cause of problem, check or ask farmer about seed source and quality. It may be necessary to check germination, thousand-grain weight, seed purity and the extent of non-seed materials (e.g., inert matter or weeds). Poor seed quality is a major problem throughout India. Yields are reduced due to poor vigor, diseases, and weeds introduced in the seed.

#### Poor Irrigation

Irrigation is one of the essential steps for a crop to grow perfectly. India has the second-largest irrigated land in the world, but still, India faces this problem. Punjab has the highest percentage area of irrigated land in the country of about 98% irrigated land availability, followed by Hariyana. The reason for good irrigation facilities is the availability of water throughout the year from the rivers and dam. This helps the farmers to conduct agricultural



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operations timely. But scenario all over the country is not the same. In central India, rivers don't carry water throughout the year. Due to this, farmers have to depend on the monsoon water for irrigation which is very uncertain. It becomes difficult for a farmer to irrigate and harvest in fragmented lands because a lot of time is wasted in moving the resources from one field to another. The main reason for this kind of system is the inheritance law of India.

The sub-soil in the most parts of the district is sandy and the surface soil is thin and of poor quality, so the farmers have to depend on irrigation facilities. The uncertain conditions of the North-East monsoon and not favorable South-West monsoon also make the plight of the farmers miserable. The main source of irrigation of Erode is canals and wells. More than 98,805 hectare of land is dependent on canals for irrigation while wells are the main source of irrigation of 68,570 hectare. A total of 209,432 hectare are irrigated in Erode. Rivers coming from the Western Ghats, like Kaveri and Noyyal, are the main source of irrigation in Erode. These rivers are mostly fed by the South-West monsoon. Farmers also depend on the jungle streams for irrigation and drainage, but these streams are uncertain in their water carrying capacity. The Lower Bhavani Project is the most important irrigation project of the district. The development of irrigation is generally considered an efficient way to reduce poverty in rural areas, although its impact on the inequality between farmers is more debated. In fact, assessing the impact of water management on different categories of farmers requires resituating it within the different dimensions of the local socio-technical context.

**Subsidy**

100% road tax exemption till 2022. 100% State Goods and Services Tax (SGST) reimbursement for manufacturers till 2030 and in cases where SGST reimbursement is not applicable, 15% capital subsidy is provided. 100% electricity tax exemption till 2025. 100% stamp duty exemption till 2022. In order to encourage the farmers and to offset the special efforts taken by them incentive is provided for all the seeds produced by the farmers. Premium for the production of Certified class seeds Rs.2/- per Kg of seed. A subsidy of Rs.5 per kg of paddy seeds will be allowed in the sale price at the time of purchase at the Agricultural Extension Centers or 50% cost whichever is less Assistance for improved seed, Conoweeder, Marker, Bio fertilizers and Micro Nutrient Mixture - Subsidy of Rs 3000 per demonstration of 0.4 each.(Farmers Field School) - A lumpsum provision of Rs.17,000 includes Honorarium, Training material and conduct of field days .During the southwest monsoon there was extensive damage to crops across Tamil Nadu with Rabi crops being the most affected in the state. Tamilnadu government had then announced special subsidy schemes for the farmers and that money would be allocated to provide loan subsidies to the farmers. The Kuruvai farmers had suffered huge losses in the recent rain and even the harvesting machines could not be used due to heavy inundation in the paddy fields. Most of the farmers had suffered losses and the announcement of the government allocating Rs 2,339 crore as crop insurance subsidies has come as a big relief.

**Dealing with middlemen and traders**

Farmers who are unaware of the market fluctuations and prices, sell their outputs to traders with negligible profit. Traders, who have good knowledge of the market, in-turn make handsome profits. It also happens that, after the conclusion of agricultural activity, no one is ready to purchase the farm outputs due to less demand for the produced crop. Moreover, farmers, who have the burden of repayment of loans, seek cash and thus sell crops at less or no profit at all. All such exploitations make farming a less demanding field for profit-making.

**Scarcity of Credit/Capital**

Fertilizers, seeds, agri-tools, pesticides, etc. are the prime necessities for running agri-operations smoothly. Majority of the Indian farmers are poor and don't have enough capital to invest in agriculture. This further impedes the agricultural progress of the nation. Efforts only from the government's side are not enough for providing credit facility, active participation of start-ups and private institutions will make a difference and bring positive change in the lives of farmers.



**Kanya Priya and Jeevitha****Scattered or Small Holdings of Land**

Indian farmers are poor. They either own a small amount of land or have multiple scattered pieces of land. It becomes arduous for farmers to harvest in such scattered lands as it is time-consuming to shift resources from one place to another. According to a survey, the average size of holding of land is decreasing every year. The main reason for this is the inheritance law of India. If a man holding a land dies, his land will be distributed to his sons, but this does not guarantee the entailment of land. Hence, most of the farmers of India have scattered or less amount of land.

**CONCLUSION**

From above the study it is concluded that farmers are facing a lot of problems. The problems are low quality seeds, irrigation problem, and demand in fertilizers, Monsoon failure and insufficiency of labour. So the government should afford an appropriate price structure to the poor farmer to be benefited. This agricultural land depends on monsoon rains. If monsoon fails, and then the farmer will be in trouble. In this situation, the government has to provide some financial support to farmers at correct time, especially to the small and medium farmers. Result indicated that farmers do aware of what is happening to the surroundings with regards to the modern cultivating methods to reduce production cost and insure their product on time to get proper support from the government. Farming labourers are documented as informal sector employees. Modern technological interventions have been fostering agriculture development practices in the study area. The economy of this block is purely based on agro-forestry based rural economy. Farming labourers face lot of difficulties and constraints and they does not know the solution for their problems such as not paid work, discrimination in earnings, customary surrounded, solid work and poor quality of livelihood and so on. Agricultural labourer's position is very poor by means of all social economic and political indicators. The foregoing discussions and findings of the study will help the sampled respondents in the study area to lead a better successful life.

Overall farming labourers forever subjugated by the agriculturist from side to side the wage bargaining. On the whole, farming labourers are deprived, unvoiced, immobilized, and option less and they have been facing the recurring and discussed joblessness harms since extended instants in India.

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## Food Colors and Dyes - Its Safety and Concern in Modern World: a Review

Rabiah Ayman<sup>1</sup>, Lakshmi P K<sup>1</sup>, Bhavana D<sup>2</sup>, Shivarudraswamy D<sup>3</sup>, Harsha T S<sup>4</sup> and Nagalambika Prasad<sup>5\*</sup>

<sup>1</sup>Student, Department of Microbiology, JSS Academy of Higher Education and Research, (Deemed to be University), Shivarathreshwara Nagar, Mysuru 570 015, Karnataka, India.

<sup>2</sup>Ph.D Student, Department of Microbiology, JSS Academy of Higher Education and Research, (Deemed to be University), Shivarathreshwara Nagar, Mysuru 570 015, Karnataka, India.

<sup>3</sup>Junior Scientist, Prosetta Bioconfirmatics Pvt Ltd, Near Infosys, Hotagalli, Ilavala, Mysuru – 570 018, Karnataka, India.

<sup>4</sup>Assistant Professor, Department of Environmental Science, Karnataka State Open University, Mukthagangotri, Mysuru, Karnataka, India.

<sup>5</sup>Assistant Professor, Department of Microbiology, JSS Academy of Higher Education and Research, (Deemed to be University), Shivarathreshwara Nagar, Mysuru 570 015, Karnataka, India.

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### \*Address for Correspondence

#### Nagalambika Prasad

Assistant Professor,

Department of Microbiology,

JSS Academy of Higher Education and Research, (Deemed to be University),

Shivarathreshwara Nagar,

Mysuru 570 015, Karnataka, India.

Email: ambikap@jssuni.edu.in



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### ABSTRACT

The colors that are used in the food are now used in a higher rate for the production of important food commodities like dairy, bakery, food industries. The Food dyes also plays an important part by providing a positive impact on the commercialization of food. The dyes are of two types mainly, the natural dyes as well as synthetic dyes. The natural dyes are naturally isolated processed and used as coloring agents, whereas the synthetic dyes are chemically synthesized and is used worldwide as the coloring agent, but these agents could be harmful for the human health. This review paper is mainly concentrated on the various dyes, their uses and the negative impact on human health and an alternative source for the coloring purpose which could be used in the modern food industry to expand the commercialization as well as providing safe consumption to the public.

**Keywords:** natural dyes, synthetic dyes, health benefits, demerits, colors, control





## INTRODUCTION

Food colors and dyes are the first eye catching ingredients found in food in the modern food industries, these dyes are classified into natural, which are primarily evolved from vegetable sources which could be called as vegetable dyes, certain inorganic ingredients, nowadays a combination of organic or inorganic as well as metallic compounds are used as coloring agents too. These food color additives are used in various food commodities like sausage casings, bakery products, candies, carbonated drinks, certain gelatin desserts as well as few powdered drink mixes and other foods. These additives are also used in other industries like, cosmetics, toothpastes, mouth washes etc. [1]. Dating back to the history of color additives, it was used by Egyptians as coloring agent for hair, until 300 B.C, the wine was colored artificially at the beginning of this era. These dyes are usually natural derivatives like, Paprika, Turmeric, saffron etc. [2]. The importance of food dyes or colors is important in identifying food, sometimes are used to judge their quality, aesthetic pleasure etc., the significance of color has its own purposes in the food industry, it increases the food marketing as it strike the senses, which the consumers get attracted to. [3]. The first synthetic dye Mauveine, was created by Sir William Henry Perkin who was a British Chemist.

The various legislations have been made in order to control the use of dyes as there is advancement in the safety concern for human health benefits, the natural food products are usually the ones which are obtained through natural products as mentioned above, the food colors that are synthesized synthetically are equal to naturally derived or sometimes are natural, the use of natural dyes is in demand for their reliability, its function as well as health benefits, but there are few demerits of natural dyes as it can react with the food commodity when exposed to air or instability in water, the synthetic dyes are produced chemically, the production compared to natural dyes are a bit complicated in contrary to the production of natural dyes. The production is complicated because it has set of chemical processes involves extraction as well as few modifications while selecting the product for the production of dyes [4]. The advancement in food preservation using various techniques like refrigeration, canning as well as processing has extended shelf life of food but has also tend to alter the coloration of food, but the overuse of these dyes have been causing a concern for healthconcern to public. These could be poisonous and can aid for the poor quality of production of food and pass off the imitation foods for real [5].

## NATURAL AVAILABLE COLORS AND DYES:

### Curcumin

Curcumin (E 100) is supplied as a spice called as ' Indian Saffron' that is obtained from rhizome of *Curcuma longa*, it gives yellow orange color to food commodities, its solubility is witnessed in ethanol and glacial acetic acid whereas insoluble in water and diethyl ether, it also has flavoring properties which are applied on Mustard, curry and certain fermented milk products, the advantage of Curcumin is that it is less toxic as well as no traces of Genotoxicity is seen as well, its availability permitted for daily intake is 15.75 mg.kg, their demand in market is increasing every day because of their anti - toxicity and anticancer properties, but the only adverse effect is that it causes certain allergic reactions as well as mutations [4,15].

### Riboflavin

Riboflavin, the vitamin B2 or lactoflavin and Riboflavin-5'-phosphate are the plant-based colors or dyes synthesized via plants or certain microorganisms, they are taken as a part of essential micronutrients in human food diet. They are usually yellow or orange – colored compounds available as crystalline powders that has slight odor available with codes as E101(i) and E101(ii). With the use of genetic engineering, pure products are produced through certain strains of bacteria as well as fungal species in the fermentation technology [4]. Riboflavin is obtained chemically or through biotechnological methods but riboflavin is obtained through chemical synthesis by two compounds, riboflavin and phosphoric acid. The natural sources for riboflavin is milk and other veggies has appreciable amounts of riboflavin compared to Milk, it gives yellow color to whey but are sensitive to lights (sunlight as well as





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fluorescent light) that leads to decomposition reactions which tends to alter the taste of the food products, the acceptable limit on daily basis is 0.5mg/kg., the additives mentioned above are used in various food commodities like fermented milk products, desserts, cheese, flavored milks, chewing gums etc [4,15].

### **Caramel**

The oldest code E150 of Caramel is the most often used colorants in food and certain beverages, they produce a dark yellow to brownish color in food industry, and are seen being miscible in water and in oils, that is produced usually as paste or emulsions, these are prepared by caramelization, there are other codes which differ in raw materials that are used for preparation, which gives a good odour of sugar and appears to be brown colored. During the process of caramelization, the carbohydrates partially decompose, dehydrate and gets polymerized at very high temperatures that produces a mixture of chemical substances, at a specific temperature, glucose and fructan are formed by sucrose, whereas at 185–190 °C isotopecan ((C<sub>12</sub>H<sub>24</sub>O<sub>10</sub>)<sub>n</sub>) is synthesised and so on [4]. E150a, E150b are widely used in flavored drinks and other alcoholic as well as non alcoholic beverages, desserts, malt bread, edible cheese rind, puddings etc. The colorants E150c and E150d are used in bakery as well as pastry industries for the decorative as well as coating purpose. Other than this they are usually used in desserts, jellies, pastries, hamburgers, brine or oil, jams, breath refreshing and chewing gums [4].The caramelpcodes E150a and E150b has no negative impact but high doses can have a negative impact on health appear that includes pain, decreased leukocytes count and certain gastrointestinal disorders [4,15].

### **Carotenoids**

Carotenoids are the carbon atoms which are natural occurring in plants and could be used as a colouring agents, which are used in various food commodities. Based on the presence of carbon, hydrogen and oxygen, they are classified as carotenes (the presence of only carbon and hydrogen) or xanthophylls, (the presence of all three carbon, hydrogen and oxygen). They usually impart yellow orange color, but their color could decrease due to unstability in pH, thus tend to remain stable at a pH 4 to 6, the oxidation of carotenoids is because of the presence of oxygen, but other physical as well as chemical factors can also affect its activity[7].The carotenoids are widely seen in various parts of plants like roots, fruits etc., because of the presence of red or yellow color they have been widely used in various food industries, especially in the production of bread, bun and other bakery items as well as in the production of cheese [3].More than 700 carotenoids have been known till date and they can be extracted from various methods, the carotenoids can be classified into polar as well as non - polar, based on the polarity, the isolation can be witnessed using various chemical compounds like hexane, acetone, alcohol or ethanol etc. [12].It has been estimated that there are nutritional defects which occur at various parts of the world, especially the deficiency of Vit A that can cause blindness amongst the people, but the studies have proved that they can be used as antioxidant which can treat various diseases like cancer, disorders related to eye etc., thus the carotenoids could be used in food industry as well as for medical purpose. The developments in food industry are constantly made to produce carotenoid rich products, the natural sources of carotenoids are seen in various fruits, vegetables as well as certain dry fruits[8].

### **Chlorophyll**

The characteristic feature of these pigments is the natural green color. The most common forms of chlorophyll are a and b, these differences are due to the presence of methyl group in chlorophyll A and the presence of aldehyde group in chlorophyll B which have been gaining interest in the food industry, but their color reduces because of the physical and chemical factors like temperature, light as well as enzymatic activity, but their stability can be restored or maintained by loss of enzymatic activity or by passing a very hot steam or using thermal treatment which is called as blanching, the degradation of color was witnessed at various temperatures [24],but there are cases where the stability gets reduced when there is decrease in ph. of the pigment even though adding certain antioxidants, the alternate for using chlorophyll derived pigments is transferring them to the derivatives of metallic chlorophyll [7]. The magnesium which is located at the center is replaced with the copper, and could be used in restaurants for the preparation of soup as well as in the production of dairy products [03] which is more stable and could be used as a food coloring agent in other food industries too [7,21].



**Rabiah Ayman et al.,****Synthetic Dyes**

The use of synthetic dyes is in demand rather than natural food colors because of certain relevant traits like budget friendly, defiance to environmental factors like, synthetic food colors are manufactured by complete chemical synthesis, or few changes of certain precursors, they can be used without further transformation and doesn't get degraded while manufacturing [4].

**Tartrazine:**

The synthetic dye tartrazine (E120) is an azo dye which imparts color yellow, red, brown when added to the food commodities, these are prepared via aromatic amines that comprises two nitrogen atoms linked together ( $-N=N-$ ) which are linked to aromatic rings. The chemical name of tartrazine is 5-hydroxy-1-(4-sulfonatophenyl)-4-(4-sulfonatophenylazo)-H-pyrazol-3-carboxylate trisodium, that takes form of granules or sometimes a light orange colored powder, that solubilizes in water and sparingly in ethanol. They are described in the form of salts of sodium, potassium and calcium, although they give a lemon-yellow color but when used together with blue dyes they give green color [4]. The applications of these dyes are used in various food products like flavored drinks, certain alcoholic beverages, edible cheese rinds, ice creams, certain pastes like fish and crustacean, sweets or desserts, fish roe, breath refreshing gums, fruit preserves and few other food stuffs etc. It is determined that the daily intake should not cross more than 7.5mg/kg the health hazards of these are making its use limited, they induce certain allergic reactions like asthmatics etc. [15]. They have been also seen causing few problems like childhood hyperactivity and may be carcinogenic, but the recent studies on carcinogenic effects on rats have showed that there was no carcinogenic effect on gastric area, other than these the release of histamine causes swelling problems like urticaria and angioedema which further acts as neurotoxin [4,16,17].

**Quinoline Yellow**

The food color quinoline yellow is seen in the category of quinophthalone dyes, these are usually combination of synthetic colors, they impart yellow powder granules that consists sulfonate groups which poorly solubilizes in ethanol but readily solubilizes in water, the mixtures could be Mono sulfonate, disulphonate or Tri sulphonate, these are usually a sodium salt, but salts of potassium as well as calcium are permitted too. Its applicability in food industries has been used in food industries marmalades, for coating purpose in pastry as well as other bakery products, other food items like chewing gums, flavored drinks like fermented milk and its products as well as other alcoholic beverages [4,15].

**Azorubine**

Azorubine (E122) which are also commonly called as Carnosine which comes under an azo dye that usually consist of two naphthalene subunits ( $C_{20}H_{12}N_2Na_2O_7S_2$ ). As the name suggests (CI food red 3) it imparts red or maroon color when added to the food. They get easily soluble in water, but not in vegetable oil and partially soluble in ethanol solution, since azo dyes are quite stable, their stability in pH, heat and does not disappear when it is subjected to light and oxygen, they are used in foods that are heat treated after the fermentation process. They have been extensively used in foodstuffs like flavored milks, canned foods like red fruits, fermented dairy products, seasoning, alcoholic beverages, ice creams, desserts, as a coating purpose in pastries and other bakery items, fruit syrups, fish as well as crustacean paste, and other appetizers [4]. The daily acceptable intake is 4mg/kg, [15] in few rare cases it causes few skin and other respiratory allergic reactions, but has no other effect like mutagenesis or carcinogenesis or other histopathological effect, recent studies that the negative effects of azorubine has seen causing DNA damage and induces tumors in animals and alteration in solenocytes [4,18].

**Amaranth**

A modified form of red azo dye is the amaranth (E123) is produced synthetically that gives a reddish to brown color when added to the food commodities which readily decomposes without melting at a temperature of 120°C. These are available as trisodium salts but salts like potassium and calcium are permitted too. These have been restricted and limited for the production of soft drinks as well as other alcoholic drinks like wine etc., these cause hazard only



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when the daily intake increases more than 0.15 mg/kg, amaranth is associated with certain allergic reactions, cancer, stillbirths, early fetal deaths, it has been also seen that they can induce calcareous deposit on kidneys [4,15].

### **Harmful effects of Dye on human health**

The usage of the food colors and dyes have been increasing day by day in the food industry for the commercialization of their product, the synthetic dyes that have been used in basic food stuffs like candies, ice cream, jellies and jams, bakery items. These dyes when added to the food makes it look more attractive and thus increasing the consumption demand amongst the children, but these dyes have been seen causing certain serious illness like allergic reactions, causing various cancers, although the use of allergic reaction are not life threatening but they are a matter of interest that has to be taken care of, since the synthetic dyes are synthesized through chemical compounds, which could be harmful to humans, even for the ones who work in their production [6]. Not only the above mentioned dyed, there are few other food coloring agents that have been seen causing pro inflammatory responses, that could be toxic, mutagenic as well as can cause various forms of cancer, there are certain acceptable forms which are given by World Health Organization and are termed to be safe until the prescribed limits [7, 20]. Tartrazine is widely used in food and beverage industries that are particularly seen in Singapore, where as Allura red, sunset yellow, ponceau 4 R, carnosine are the other dyes which are followed by tartrazine, the experiments were carried out by N Latasha et.al by invitro synthesis of LTB 4 and F 2 - isoprostanes from neutrophils, were the tartrazine was in higher content than the other dyes. Thus, the high use of these dyes in the food supply of Singapore, and their capability to produce proinflammatory response, suggested certain health risks to the public [7,20]. R. shahid et.al have gone a recent review on the diagnosis, management of the food additives in USA which have concluded that the use of food additive caused certain allergic reactions on skin. The diagnosis was carried out using the information of the patient which comprised: detailed medical history, physical examination of the patient, to rule out allergens caused via food, to have a look on the other foods which the patient might be allergic too, having a additive free diet for few weeks etc. the diagnosis was carried out in a sequential process and the conclusions were made based on the results that were obtained whether the patient is allergic to the specific dye by the symptoms like [9]. The allergic reactions of skin, causing serious disease in the gastrointestinal tract as well as in the rare cases of anaphylaxis.

According to certain researchers in United States, stated that due to the consumption of various commercially available soft drinks had also a great impact on the behaviors of the children, another study revealed that few children showed hyperactive behaviors which was also an impact of the dyes and were thus advised to reduce the consumption of food which were colored using the dyes, thus various countries like Europe, United States of America, India as well as Japan has started implementing certain rules and regulations for control use of dyes, although implementing rules have yet caused the illegal use of dyes in various industrial commodities which is an emerging concern [13]. A recent study has also revealed that the dyes had also negative impact on the respiratory system, where it caused acute to chronic infections, including normal allergies to serious disease like Asthma too [14,22].

### **CONTROLUSEOFDYES**

The food dyes play an important role food industry, the addition of colors enhances the appearance of food, as well as plays an important role in look more enticing, these colors could also assist the consumers to identify the flavor that the food might produce. The Food and Drug Administration (FDA) has imposed few rules and regulations in regard with artificial coloring of food, the use of these food dyes is seen causing health problem, although the use FDA approved dyes are termed as safe, but they can impose few allergic reactions from one or two dyes [2], thus the alternate sources for the usage of dyes have to be looked into in order to provide safe consumption of the food. Few examples of alternate forms of usage of dyes bare discussed below.



**Rabiah Ayman et al.,****Red Tomato and its products ASAN Alternative to Reduce Synthetic Dyes**

The synthetic dyes that are used in the food manufacturing has negative impact on health, since tomatoes are naturally available thus it could be replaced with the synthetic dyes, which are prone to cause major health risks. These have been used in the fast foods like, pasta, burgers, sausages. Few studies have also shown that they are also used in the preparation of buns, breads, biscuits, they have been used widely in other food preparations like cheese muffins etc., the red tomatoes comprises of the pigment lycopene which comprises the antioxidant properties which has potential to discard the other dyes or other synthetic dyes completely or partially, and the nutritional factors and its demand by the consumers, are the other advantage using tomato products in food industry but there is no much research on the exploitation of carotenoids that are present in tomatoes, thus it is boon for food research scholars to look into this field of food [10,23].

**MICROALGALPIGMENTS**

As the world is progressing, the modern population's demand for organic lifestyle has been increasing in great demand, the usage of microalgal pigments which are unicellular in nature, constitute the large number of producers which are used in the production of chemical energy via solar energy through process called photosynthesis, these pigments have been used in greater demand because of its ability to grow faster as well as produce certain important components like proteins, lipids, carbohydrates. Thus it can be used for dual purpose, firstly as an alternate source of coloring agent, secondly for its nutritional beneficial, thirdly their ability to produce certain important pigments which are found in almost all photo synthesizers like chlorophylls, carotenoids etc., fourthly they do not cause and environmental hazards, fifthly there production doesn't require much investment, thus it is cost effective and is easily produced by providing the minimum growth factors, appropriate temperature, pH etc., by providing these minimal requirements a proper amount of product in terms of quality as well as quality product can be produced, their commercialization in various food products have been in growing in greater amount [11,19].

**CONCLUSION:**

The food colors are an important aspect in the food commodities especially in the manufacturing process of candies, chocolates, bakery products, dairy products. They can impart color as well as could be used as a source for coating in pastries as well as other bakery items. The synthetic dyes used in foods causes chemical instability, changes in enzymatic activity, protein activity, metallic instability, thus the alternative must be developed, the new procedures have to be brought into the action which should not only provide attractiveness in the food, but also should impart a positive impact on human health. The use of the colorants, should be set in limits in order to avoid the harmful effects, The only drawback of using natural colors is unstable with few processing conditions, thus stabilization of these natural colors is the major challenge in the upcoming generation as well as a source of research, because of its growing demand amongst the consumers, instead of synthetic dyes.

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## Translation, Cross Cultural Adaptation and Validation of the Foot Function Index Questionnaire for Gujarati Speaking People with Foot Complaints

Mukul Chauhan<sup>1\*</sup>, Krupa Mehta<sup>2</sup>, Dinesh Sorani<sup>3</sup>, Sheshna Rathod<sup>4</sup> and Himanginiben Patel<sup>5</sup>

<sup>1</sup>Assistant Professor, Shri Suleshwari College of Physiotherapy, (Affiliation with HNGU University), Bhandu, Gujarat, India.

<sup>2</sup>Assistant Professor, Shree K.K Sheth Physiotherapy College, Rajkot, Gujarat, India.

<sup>3</sup>i/c Principal, Government Physiotherapy College, Jamnagar, Gujarat, India.

<sup>4</sup>Tutor cum Physiotherapist, Government Physiotherapy College, Jamnagar, Gujarat, India.

<sup>5</sup>Physiotherapy Assistant at Addenbrookes Hospital, Cambridge, United Kingdom.

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### \*Address for Correspondence

#### Mukul Chauhan

Assistant Professor,

Shri Suleshwari College of Physiotherapy,

(Affiliation with HNGU University),

Bhandu, Gujarat, India.

E. Mail: mukulchauhan1475369@gmail.com



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### ABSTRACT

This study was designed to translate, cross-culturally adapt and validate the Foot Function Index (FFI) questionnaire for use in Gujarati language speaking people with foot related complaints. FFI questionnaire was translated into Gujarati language according to the guidelines of WHO (forward backward translation). Validity of Gujarati version of FFI was carried out by the expert panel verification. A total of 30 subjects were included in the study. Spearman's correlation coefficients were used to assess the strength of association between the measures of both the versions. Strong and highly significant correlation was found between English and Gujarati version of FFI. The Gujarati version of the Foot Function Index (FFI-G) is a valid tool for assessment of pain, disability and limitation of the function of the foot, in clinic as well as research.

**Keywords:** Translation, Cross cultural adaptation of FFI, Gujarati FFI-G, validity of FFI questionnaire.





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## INTRODUCTION

Assessment of musculoskeletal disorders is pre-dominant factor to determine physical impairments amongst the individuals. These disorders can affect the state of physical health and quality of life of the patients. So, healthcare professionals are giving more importance to analyse the impairment from the patient's perspective.[1] The feet and ankles are the part of our body which maintains balance (static as well as dynamic) and it transfers internal forces generated by the body which allows ambulation. [1] More studies are required to increase knowledge on the pathologies affecting the feet by using questionnaires reporting of pain, function, disability and activity limitation. One in every five middle aged individuals complains of foot and ankle pain, which may lead to impairment in balance, compromise the locomotion and affect the functional activities of daily living. [2] So before giving the intervention the healthcare professional uses a self-reported questionnaire to know the patient's perception of pain, disability and activity limitation and then plan out the treatment protocol accordingly. These questionnaires have been standardized in order to take follow up and evaluate the efficacy of a given treatment protocol. [3]

One such questionnaire is the Foot Function Index (FFI) questionnaire which is frequently used in clinics and for research purposes. It was developed to evaluate the impact of foot pathologies on function in terms of pain, disability and activity limitation. The questionnaire includes 23 questions which is divided into 3 subscales: pain (9 questions), disability (9 questions) and activity limitation (5 questions). [4] The reliability and validity of the FFI questionnaire has been evaluated in patients with ankle and foot disorders such as: rheumatoid arthritis [5], ankle arthritis [6], calcaneal heel spur [7], metatarsalgia [8], plantar fasciitis [8,9] and ankle/foot fracture [9]. FFI was developed in English language and valid translated versions have been produced for use in various languages like German [10], Italian [11], Spanish [12], French [13], Korean [14], Brazilian-Portuguese [15], Chinese [16], Turkish [17], and Arabic [18].

Gujarati language is a modern Indo-Aryan language that has evolved from Sanskrit. It is a native language in Gujarat state of India and it is predominantly spoken by the Gujarati people. Gujarati is one of the 22 official languages and 14 regional languages of India. It is officially recognised in the state of Gujarat and the union territory of Dadra & Nagar Haveli as well as Daman & Diu. Unfortunately for the patients whose primary language is Gujarati for them there is no measure available for assessing the foot pathologies. When there is no availability of self-administered questionnaires in the patient's native language at that time the therapist may be forced to self-translate and interpret the questionnaire to the patient, which may impact the essential construct of the measurement. A Gujarati version of the FFI questionnaire would provide the Gujarati language speaking population an opportunity to communicate more effectively and easily to their healthcare professional. In that case, it becomes necessary to get the translated version of the FFI questionnaire so it can help a large number of people who only speak their regional/native language through a scale which is self-administered and in turn this will make research and clinical management more effective. With the same purpose, this study was conducted to translate the FFI questionnaire into Gujarati language (FFI-G) and to culturally adapt & validate the FFI-G questionnaire.

## MATERIALS AND METHODS

The present study was a cross-sectional study. The translation process was carried out following the guidelines given by the WHO. The methodological steps were followed for cultural adaptation of the measuring instruments so as to make an equivalence between the original version and the modified version of the questionnaire and to ensure the quality of this process.

### 1<sup>st</sup> Phase- Forward Translation

Forward translation was done by an independent bilingual Gujarati language expert translator. The expert translator advised that the translation should be conceptual, natural and acceptable to the wide audience. In addition, the





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expert translator was also asked to modify the questions according to the environment and culture of Gujarat. The first Gujarati language translated version of FFI was termed as FFI-G(f).

### **2<sup>nd</sup> phase- Verification by the Expert panel**

During this phase of the study, five people were approached by the researchers and with their consent one expert panel was formed. The panel consisted of 3 physiotherapists (MPT/Ph.D.), 1 General Physician, and 1 person who understands the medical terminology as well as the regional/native language and works in direct contact with the common people. The original English version of FFI and FFI-G(f) version was provided individually to each member of the panel via google form and they were asked to give their response by selecting one of the options (accepted, rejected and other). If the member selected 'other' option, then they were directed to give their suggestion regarding the modification required for a particular question. The result given by the expert panel showed that consensus was achieved for more than 85% of the questions. The suggested modifications given by the expert panel for other questions were accepted by the researchers and none of the questions were rejected. In this phase, face lingual validity of the Gujarati version of the questionnaire was assessed.

### **3<sup>rd</sup> Phase- Backward Translation**

As per the suggestions given by the expert panel members, the required modifications were done and the questionnaire was provided to an independent bilingual English language expert translator for backward translation. This backward translated questionnaire was termed as FFI-E(b). The original English version of FFI and FFI-E(b) had some questions which were culturally different but they were conceptually equivalent. However, FFI-E(b) adheres to the sense of the original version of the questionnaire. After the completion of this 3-phase process, one final questionnaire was developed which was termed as FFI-G.

### **Pre-Testing**

The research team approached 30 individuals who participated in the study. An individual with age group between 30 to 65 years, both male and female, who could read and understand the Gujarati and English languages, and people who suffered from plantar fasciitis and calcaneal spur were included in the research. The people with any ankle – foot fracture or surgery, foot deformities, taken steroid injection within last 6 month for ankle-foot pain were excluded from the study. All the subjects were explained about the nature and type of the study, the use of the FFI questionnaire and also the grading system of the questionnaire. A simple random technique of flipping the coin was used to determine the order of administration of both questionnaires. People whose coin turned head first completed the English version first and people whose coin turned tail first completed the Gujarati version first. An interval of 1day was kept between administrations of 2 questionnaires. Flowchart of the study design is shown in Figure-1. Gujarati version of foot function index (FFI-G) is given in appendix.

### **Statistical Analysis**

Statistical analysis was carried out using the SPSS version 26 with level of significance kept at 5%. To identify the normality of the data Shapiro wilk test was used. Mean and Standard Deviation (SD) were calculated as a measure of central tendency and measure of dispersion respectively. Spearman's correlation coefficient was used to assess the strength of association between FFI English and FFI Gujarati version.

## **RESULTS**

Total 30 participants took part in the study out of which there were 13 males and 17 females. Mean age of them was  $45.37 \pm 7.97$  years (As shown in Table 1). Spearman's correlation coefficient shows significant correlation between English and Gujarati version of FFI questionnaire (As shown in Table 2 and Graph 1).







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## DISCUSSION

FFI questionnaire has been translated into many regional languages. As a result of in-depth research, it was identified that, no research has been published on translation of original FFI to Gujarati language though Gujarati language is a native language of one of the states of India. This encouraged us to conduct this research on translation of FFI into Gujarati language and obtained validation of Gujarati version of FFI. The process of translation and cultural adaption of the English to Gujarati was completed according to the recommended guidelines of WHO. In the 1st phase of forward translation total two questions were modified according to culture and environment of Gujarat. Question number 5 and 6 were modified because all the individuals does not wear shoes, most of the population preferred to wear chappals so the “shoes” word was translated as “બૂટ/ચપ્પલ” in Gujarati version of FFI. In 2nd phase none of the translated questions were rejected by the panel though some linguistic and grammatical corrections were suggested by them. And at the end of backward translation both versions have same conceptual meaning. Results showed significant correlation between English and Gujarati version of FFI questionnaire (as seen in table 2 & graph 1). This suggests that translated version of FFI is fully understandable and effortlessly administered in Gujarati speaking people.

Yi LC *et al.*, conducted a study for translation and cultural adaptation of the revised foot function index for the Portuguese language. The Portuguese-language version was given to 35 individuals with plantar fasciitis and metatarsalgia to determine their level of understanding of the assessment tool. In that study the terms which were not understood by more than 10% of the sample were altered based on the suggestions received by the patients. It was concluded that translation and cultural adaptation of the revised foot function index for the Portuguese language were completed and the Brazilian version was obtained. [9]Khan S *et al.*, did research to translate and adapt the FFI into Arabic and to evaluate its psychometric properties of validity and reliability. In that study it was found out that the internal consistency was good with the Cronbach's alpha value of 0.882, 0.936 and 0.850 for the pain, disability and activity limitation subscales, respectively. In addition to that the reproducibility of the FFI-Arabic version was analysed by intra-class correlation coefficient which revealed good to excellent test-retest reliability. So, it can be concluded that the FFI-Arabic version showed good validity and reliability in patients with foot and ankle problems and this tool can be used in usual practice and research for analysing foot and ankle disorders in Arabic-speaking population. Similarly, based on the current study result, it is concluded that Gujarati FFI can help the people to identify their foot related problems with self-screening method. Translated version of FFI questionnaire can engage more Gujarati speaking people with foot complaints to understand their symptoms in better way as it is self-administered and cost-effective questionnaire which can be completed in very less time. The present study is subject to the following limitations. First, as it is self-reported questionnaire, the participant has a chance to recall questions and may give score accordingly and this can lead to subjective bias. Second, the data of this study may not be representative of the population of the whole Gujarat.

In future, criterion validity for this questionnaire can be done by comparing with any gold standard instruments for measuring the impact of foot pathology on function in terms of pain, disability and activity restriction. It can be carried out on a larger population. There are various confounding factors that we came across while taking the data which might impact the level of understanding of FFI and therefore affect the scoring of FFI. Physical, psychological, environmental and social interactions are some of the main factors. In addition to that education level, type of occupation (long standing work, sitting work, repetitive movement work, and non-working people), sedentary or active lifestyle, weight of person also have some impact on the scoring of FFI. So, such questions can be added in future in revised FFI questionnaire. Reliability of this questionnaire can be done.

## CONCLUSION

Gujarati version of FFI is a valid tool for assessment of pain, disability and limitation of the function in Gujarati speaking people with Foot complaints. Furthermore, Gujarati FFI can also be used for research purpose.





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## APPENDIX

Gujarati version of the foot function index (FFI-G)

## ફુટ ફંક્શન ઇન્ડેક્સ (પગ નાં કાર્ય નો સૂચકાંક) (Gujarati Version)

નંબર - દર્દી નું નામ - તારીખ -  
 ઉંમર - જાતિ -પુરુષ / સ્ત્રી રહેઠાણ -  
 અસરગ્રસ્ત બાજુ -

❖ ફુ:ખાવા નો માપદંડ - તમારા પગ (પંજા) નો ફુ:ખાવો કેટલો ગંભીર (અતિશય) છે.										
કોઈ ફુ:ખાવો નહીં						અતિશયફુ:ખાવો				
૧. પગ માં સૌથી વધારે ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૨. સવાર ના ભાગ માં પગ નો ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૩. ખુલ્લા પગે ચાલવા માં ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૪. ખુલ્લા પગે ઉભા રહેવા માં ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૫. બૂટ/ચપ્પલ પહેરી ને ચાલવા માં ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૬. બૂટ/ચપ્પલ પહેરી ને ઉભા રહેવા માં ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૭. ઓર્થોટીક્સ પહેરીને ચાલવા માં ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૮. ઓર્થોટીક્સ પહેરીને ઉભા રહેવા માં ફુ:ખાવો કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
૯. પગ નો ફુ:ખાવો દિવસ ના અંતે કેટલો છે ?										
0	1	2	3	4	5	6	7	8	9	10
❖ તકલીફ નો માપદંડ - તમને કેટલી મુશ્કેલી થાય છે										
કોઈ મુશ્કેલી નહીં						અસમર્થ				





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૧૦. ઘર માં ચાલવા માં કેટલી તકલીફ થાય છે ?										
0	1	2	3	4	5	6	7	8	9	10
૧૧. ઘર ની બહાર ચાલવામાં કેટલી તકલીફ થાયછે?										
0	1	2	3	4	5	6	7	8	9	10
12. ચાર બ્લોક(મકાન) જેટલુ ચાલવામાં કેટલીતકલીફ થાય છે?										
0	1	2	3	4	5	6	7	8	9	10
૧૩. દાદરા(સીડી) ચડવામાં કેટલી તકલીફ થાય છે ?										
0	1	2	3	4	5	6	7	8	9	10
૧૪. દાદરા(સીડી) ઉતરવામાં કેટલી તકલીફ થાયછે?										
0	1	2	3	4	5	6	7	8	9	10
૧૫. પગ ની આંગળીઓ ના ટેરવા ઉપર ઉભારહેવામાં કેટલી તકલીફ થાય છે?										
0	1	2	3	4	5	6	7	8	9	10
૧૬. ખુરશી માંથી ઉભા થવામાં કેટલી તકલીફ થાય છે?										
0	1	2	3	4	5	6	7	8	9	10
૧૭. રસ્તા ની ધાર (પાળી) પર ચડવામાં કેટલી તકલીફ થાય છે?										
0	1	2	3	4	5	6	7	8	9	10
૧૮. ઝડપ થી ચાલવામાં કેટલી તકલીફ થાયછે?										
0	1	2	3	4	5	6	7	8	9	10
❖ પ્રવૃત્તિ કરવામાં થતી મર્યાદા નો માપદંડ- તમને કેટલો સમય થાય છે કોઈ પણ સમયે નહીં દરેક સમયે										
૧૯. પગ ની તકલીફ ના કારણે આખો દિવસ ઘર માં રહેવુ પડે છે ?										
0	1	2	3	4	5	6	7	8	9	10
૨૦. પગ ની તકલીફ ના કારણે આખો દિવસ ખાટલા(પલંગ) માં સૂતુ રહેવુ પડે છે ?										
0	1	2	3	4	5	6	7	8	9	10
૨૧. પગ ની તકલીફ ના કારણે તમારુ કામ અટકી પડે છે ?										
0	1	2	3	4	5	6	7	8	9	10
૨૨. ઘર માં મદદકારક ઉપકરણ વાપરો છો ?										
0	1	2	3	4	5	6	7	8	9	10
૨૩. ઘર ની બહાર મદદકારક ઉપકરણ વાપરો છો ?										
0	1	2	3	4	5	6	7	8	9	10





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Table 1: Demographic data

Gender distribution	Age (Mean ± SD)
Male- 13(43.33%), Female- 17(56.67%)	45.37 ± 7.97 years

Table 2: Spearman’s correlation coefficients between Individual Questions of FFI English and FFI Gujarativersion

Question Number	ρ - value	p - value	Question Number	ρ - value	p - value
1	0.993	0.00	13	0.977	0.00
2	0.88	0.00	14	0.97	0.00
3	0.945	0.00	15	0.919	0.00
4	0.983	0.00	16	0.822	0.00
5	0.933	0.00	17	0.963	0.00
6	0.931	0.00	18	0.989	0.00
7	0.945	0.00	19	0.918	0.00
8	0.98	0.00	20	0.947	0.00
9	0.972	0.00	21	0.986	0.00
10	0.982	0.00	22	0.943	0.00
11	0.987	0.00	23	0.952	0.00
12	0.991	0.00			

ρ=Spearman’s correlation coefficient

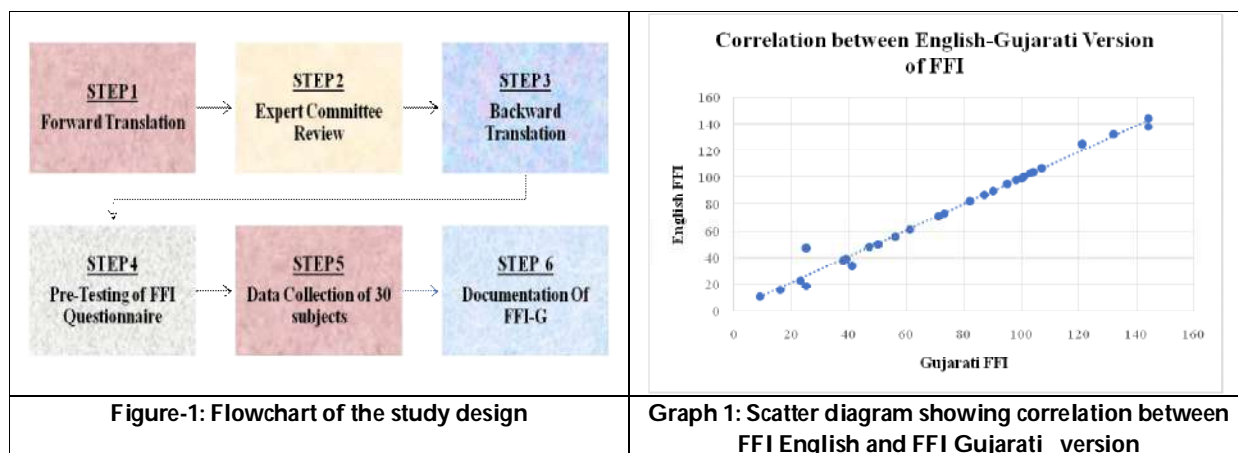


Figure-1: Flowchart of the study design

Graph 1: Scatter diagram showing correlation between FFI English and FFI Gujarati version





## Implementation of LMS Adaptive Filter using Distributed Arithmetic based HSCG-SCS adder

Telugu Maddileti<sup>1</sup>, R. Ajay Kumar Reddy<sup>2\*</sup> and K. Maheswari Devi<sup>3</sup>

<sup>1</sup>Associate Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>2</sup>PG Scholar, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>3</sup>Assistant Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

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### \*Address for Correspondence

#### R. Ajay Kumar Reddy

PG Scholar, Department of ECE,  
Malla Reddy Engineering College,  
Secunderabad, Hyderabad,  
Telangana 500100, India.

E. Mail: harryhari127@gmail.com



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### ABSTRACT

Modern wireless communication systems have tightened the requirements of adaptive beam formers when implemented on Field Programmable Gate Array. The set requirements imposed additional constraints such as designing a high throughput, low complexity system with fast convergence and low steady state error. Recently, a parallel multi-stage least mean square (LMS) structure is proposed to mitigate the listed constraints. The LMS is a two stages LMS operating in parallel and connected by error feedback with Half Sum Carry Generation based Sum Carry generator (HSCG-SCG) adder. This was accomplished by replacing the array multiplier by distributed arithmetic (DA) memory units. The DA based HSCG-SCG adders are used by this design in order to successfully complete this task. The memory capacity has been lowered by a factor of at least four as a direct result of this, although the filter order has stayed the same. The simulation results shows that the proposed method resulted in reduced area, delay, power consumption as compared traditional adaptive filter.

**Keywords:** Adaptive Filter, Distributed Arithmetic, Least Mean square, Sum Carry generator.





## INTRODUCTION

The least mean square technique has higher stability and quicker convergence than other algorithms, making it ideal for adaptive filters, which have a broad variety of applications but are most often employed for DSP. This architecture features a very simple register layout. [1]. This feature is explained in this article, along with its potential to support large input sampling rates. Constructing a DLMS adaptive filter that has low-adaptation latency and an efficient pipelined design is conceivable, and doing so will allow for increased convergence performance. When doing calculations using Vedic Math, you can find it helpful to make use of a multiplier that has 8 bits. The DSP [2] relies heavily on adders as a fundamental building block. The DLMS adaptive filter has the capability to minimize the complexity of the registers, the capacity to enable a speedier convergence, a very little adaptation delay, and does not need a pipelining approach. All of these benefits come without the requirement for a pipelining technique. Zero adaptation delay The DLMS method offers superior performance compared to those of other algorithms, in addition to having no adaption delay. The DLMS algorithm needs the least amount of energy (EPS) [3] per given sample, and it also needs the least amount of space compared to other designs. In applications involving electroencephalograms (EEGs), the DLMS method may also be used for the cancellation of interference [4].

Implementing the LMS adaptive algorithm and the changes to it may also be done in a variety of different methods beyond those that have been described. Only a few of the many possible applications of these methods for DSP have been discussed in this article [5], despite the fact that they may be used extensively for those applications. Since the multiplier might cause bottlenecks, the DA method may also be used to replace the multiplier block that is used by the LMS algorithm. This is because the multiplier can slow things down. To simulate the operation of multiplication [6]. Using the radix-8 Booth method, we were able to significantly cut down on the quantity of incomplete products that the DA design produced. In order to do serial bit calculations, DA is used. Because of this, the LMS adaptive filtering approach may use DA throughout the process of developing the VLSI architecture for it. In DA, the limited products of the input model and the filter factors are stored in "two" different LUTs. These LUTs are separate from one another. In direction to realize a higher near of performance, the LUTs are multiplexed after being accessed and their contents have been added together [7]. This will happen after the error has been calculated. This is going to happen once they have been removed from the system. By integrating the functionality of two adaptive filters, it is possible to create a DA-based low-complexity pipelined least-mean-square filter. Because of this, the amount of labour needed to install the filter will be reduced. The total step heights are broken out as follows: The convergence performance may be adjusted using adaptive filters; however, in this case, the two ADFs that were previously utilised have been replaced with a single DA-based ADF. Because odd multiples are symmetrical to one another, an adder tree may be used to add offset words [8]. Only a minimal number of adders are required for the creation of odd multiples from longer words, and all that is required is a single offset adder tree to complete the process. The PAS and PSA are the names given to each of these methodologies (BLMS-ADF). When contrasted with the PSA approach, the PAS methodology results in a shorter critical path [9].

### Literature Survey

Khan *et al.* [10] developed three designs built for pipelined DA based LMS adaptive filter with optimal complexity. These architectures were created with the goal of reducing the amount of computational work required. Mixtures of input samples are implemented on hardware using the offset-binary-coding (OBC) technique may aid in reducing the complexity of the structures that are proposed. Nevertheless, some outputs that are not OBC are made, and later on, when the clock is being cycled through its initial phases, these outputs are removed from the calculation that determines whether or not there was an error. This occurs when the clock is cycling through its earliest stages. These implementations are all totally different from one another. The phrase that came before this one mentioned all of these things. In summary, the results of the studies show that using the 32<sup>nd</sup> order filter may result in power-per-throughput cost reductions of 68.4, 47.33 percent, 33.72 percent, and 43.19% respectively.



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Within the parameters of their research, Khan *et al.* [11] proposed the use of two-optimized partial look-up table (LUT) designs as a low-complexity implementation of DA based block LMS (BLMS) adaptive filtering. It has been shown in this article that making use of the redundancies that are present between the partial inner products and the sliding window input block is an essential component of a unique strategy for optimising results. It has been shown that this approach is one of the primary components of the method. A comparison between the two approaches may be done, and it has been observed that the PAS technique results in a shorter critical-path-delay than the PSA methodology does. This is one way in which the two methodologies can be contrasted with one another. Each of these percentages is lower than the finest job that has previously been done. According to these findings, the PAS-based BLMS ADF has a more limited coverage area and generates less power than the PSA-based BLMS ADF does. Both of these results are better than the most current and most significant work that has been done up to this point.

The sign–magnitude representation of the error signal was used by Meo *et al.* [12] to suggest the usage of approximately fixed-width and static section multipliers in the construction of Delayed LMS (DLMS) adaptive filters. These multipliers were used in the construction of DLMS adaptive filters. These multipliers were used throughout the development of DLMS adaptive filtering systems. Both of these strategies are intended to minimise the approximation error. These traits, when combined, are supposed to reduce the amount of inaccuracy introduced by the approximation. Both of these qualities were developed with the intention of bringing the level of inaccuracy brought on by the approximation down to a more acceptable level. When representing the error signal, using a symbol–magnitude representation may assist to decrease the amount of switching action, which in turn can help to reduce the amount of power that is lost. This is place at the period in which the filter is learning. In conclusion, the adaptive filters that were investigated were able to surpass the state-of-the-art by reducing the amount of space that they occupied and the amount of power that they consumed in comparison to the conventional implementation by up to -18.0% and -64.1%, respectively, while still maintaining their capacity for learning.

The work that Mula *et al.* [13] did allowed for the Pt-NLMS algorithms to be realised as physical implementations, bringing them one step closer to reality. Many other reformulations have been proposed in attempt to make the original Pt-NLMS algorithms suitable for realtime VLSI implementations. This has been done in an effort to improve performance. These rewrites are attempts to make the algorithms more straightforward. Both of these algorithms are known as the delayed -law proportionate LMS (DMPLMS). These two algorithms are together known as the delayed-law proportionate LMS (DMPLMS). In conclusion, the findings of the simulations demonstrated that the performance loss that would be caused by implementing the recommended reformulations would be, at most, insignificant. This was demonstrated by the fact that the loss in performance would not even reach the threshold of being noticeable.

Ahmad *et al.* [14] developed a composite architecture that uses DA to replace the bottleneck multiplier with memory units that store Partial Products (PPs) to simulate multiplication. This design is referred to as an imitation of multiplication. Because of the design that was advised, considerable gains have been made with regard to output, critical route latency, power consumption, and use of FPGA properties. The last approach, which is referred to as the Half-Delay technique, decreased the latency by a factor of 2, while concurrently raising the power and area quality to some degree. The authors Esposito, *et al.* [15] built state-of-the-art approximation multipliers and evaluated the effect that these multipliers had on the LMS algorithm's performance. In addition, a unique approximation multiplier that has been presented, which has precision that can be tweaked at the time of design in order to better fit to the application situation. We are able to analyse the power vs. quality trade-off of the LMS approximation filters because of the results of the implementation in the 28-nm CMOS technology. These filters were examined in two different applications.

Shen *et al.* [16] used the conventional LMS method with a fixed number of steps. The traditional fixed-step LMS algorithm has the benefit of being straightforward and easy to put into practise. On the other hand, one of its inherent drawbacks is that it raises the step factor in order to accelerate the convergence, which in turn results in a significant increase in the steady-state error. An enhanced LMS algorithm that is based on the nonlinear relationship







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function between  $x(k)$  and  $(k)$  is provided on the basis of the findings of an investigation of the performance of the LMS algorithm. Comparison of the  $v$  LMS approach is shown to be achievable, according to the findings of the theoretical study as well as the simulations. It is beneficial to overcome the shortcomings that are inherent to the LMS algorithm. F.Lavalle-Aviles and colleagues [17] proposed a completely low-pass filter (LPF) with programmable cutoff frequency, adaptive powerfully differential is what the FD designation refers to, while low voltage is what the LV designation refers to. These features were included into the design of the filter. In order to fulfil the performance requirements of the stringent filter, a low-voltage field-depletion (LV FD) amplifier with feedforward gain-boosting implementation is used.

Vinitha and others [18] made a proposal. An innovative new DA design for the adaptive FIR filter. The LMS algorithm is cast-off in order to bring the filter's weights up to date. We were able to increase the filter's area efficiency as well as its power efficiency by combining the DA approach and the CSD number in this design. LUT-less DA calculation is done. Instead, a calculation that is based on registers is employed. After all is said and done, the proposed architecture is given a VHDL coding. After that, it is simulated, synthesised, and ultimately applied in a Virtex FPGA device. The trick consumption report for the construction reveals that the structure's improved competence in terms of both space and power compares well to designs from the past. Prasad *et al.* [19] came up with the idea for an adaptive filter that is founded on the LMS method and has a lower computation delay. This filter takes up less space than other filters and requires less memory. To begin computing each filter partial product of a FIR filter, the method that has been suggested takes use of a single multiplier as its starting point. After that, a time-shared architecture for LMS-ADF is used in order to calculate the coefficient increment term, and this multiplier is put to use in order to do so. The LMS algorithm is what's utilised to slowly ratchet up the weights, however. The technique consists of using a single multiplier for one purpose during one half cycle of the process and then again for another reason during the second half cycle of the process. Finally, according to the findings, it has been determined that the suggested design would utilise about half the area of the traditional design while simultaneously boosting the operating speed in an efficient manner.

Student *et al.* [20] came up with a straightforward implementation that is effective. [20] In the delayed LMS method, the conventional multiplier is what makes it possible run more slowly; for this reason, the most recent high speed Because of the great convergence rate that it has, the Vedic Multiplier is the multiplier of choice. In addition, the Vedic Multiplier is being researched for its ability to reduce the number of logic levels and timing levels, as well as for its potential to shorten the amount of time required for logic operations. Both of these possibilities are being examined. Adders that are as power-, size-, and delay-efficient as possible are put to use in applications that include DSP in order to reduce the amount of power that is needed.

### Proposed Method

#### LMS Adaptive Filter

The following is an example of a potential encoding for the  $N$ -tap involvement signal vector, which is referred to as  $S(k)$ .

$$S(k) = [s(k), s(k-1), \dots, s(k-N+1)]^T \quad (1)$$

where the letter  $s$  denotes an input signal at the  $k$ th time occurrence and the symbol  $T$  denotes a transposition of the vector.  $k$  is the number of times the signal will occur. An input signal at the  $k$ th instance is denoted by the symbol  $s(k)$ . The value of  $k$  represents the total number of times the signal has been seen.

One possible way to write down a representation of the signal that is produced by an executive filter is as follows:

$$y(k) = ST(k)W(k) \quad (2)$$

where the vector is denoted by  $W(k)$  that corresponds to the  $k$ th coefficient and  $N$  is the entiresum of factors in the expression.

$$W(k) = [w_0(k), w_1(k), \dots, w_{N-1}(k)]^T \quad (3)$$

For those interested in gaining even more comprehension on this subject, the  $w_i k$  is the  $i$ -th tap coefficient of the adaptive filter.

The LMS process developed by Widrow and colleagues in 1975 may be expressed as





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$$W(k + 1) = W(k) + 2\mu e(k) S(k) \tag{4}$$

wherever  $e(k)$ , which stands for an error signal,  $d(k)$ , which stands for a step-size parameter, and  $d(k)$ , which stands for the desired signal, respectively, represent a desired signal, a step-size restriction, and the intended signal. Both the pace of convergence and the accuracy of the estimate are determined by the step-size parameter, which is responsible for generating the value. The following procedures are required in order to get the error signal:

$$e(k) = d(k) - y(k) \tag{5}$$

Figure 1 presents an overview of the LMS adaptive filter's primary architectural components. The signal for the filter input, which is indicated by the notation  $s(k)$ , is sent across the delay line is moved and shifted in the appropriate direction for each and every sampling event that takes place. The delayed input signal is generated by the taps on the delay line, which directly correspond to the delay components in the circuit. The number of taps serves as a determinant of the extent to which the delay is applied. The LMS adaptive filter calculates the value of the filter's output by adding the products that are obtained by multiplying the outputs of the taps by the coefficients that are connected with those taps. These products are generated by multiplying the outputs of the taps by the coefficients that are connected with those taps. The difference between the signal that is sought and the signal that is formed by the filter is referred to as the "error signal," and it is referred to by that term. This discrepancy is referred to as the error signal. It's feasible to use an arrow to indicate this particular difference. First, the input signals are multiplied by the scaled fault signal in command to modify the tap coefficients. Next, the result of that multiplication is multiplied by itself in order to have the tap coefficients adjusted. This process is repeated until the tap coefficients have been adjusted.

**Distribute Arithmetic based HSCG-SCS Adder**

The computation of an inner product utilising a table lookup approach is the basis of the DA, an effective calculation technique. Now let's look at the interior decoration that has been finished.

$$y = a^T v = \sum_{i=1}^N a_i v_i \tag{6}$$

that corresponds to the constant vector of the Nth order

$$a = [a_0, a_1, \dots, a_{N-1}]^T \tag{7}$$

then the variable vector

$$v = [v_0, v_1, \dots, v_{(N-1)}]^T \tag{8}$$

The  $v_i$  is presented as a representation based on B-bit static point and 2's complement in equation (8), which can also be written as,

$$-1 \leq v_i < 1 \tag{9}$$

and

$$v_i = -v_i^0 + \sum_{k=1}^{B-1} v_i^k 2^{-k}, i = 0, 1, \dots, N - 1 \tag{10}$$

In equation (10),  $v_i^k$  denotes the k-th bit of  $v_i$ , which may be either 0 or 1. By changing Equation (10) for Equation (6),

$$y = -\Phi(v_0^0, v_1^0, \dots, v_{N-1}^0) + \sum_{k=1}^{B-1} \Phi(v_0^k, v_1^k, \dots, v_{N-1}^k) 2^{-k} \tag{11}$$





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is accomplished. The definition of the function that, when called, gives back the partial-product that corresponds to the input is.

$$\Phi(v_0^k, v_1^k, \dots, v_{N-1}^k) \equiv \sum_{i=0}^{N-1} a_i v_i^k \tag{12}$$

In equation 11, the inner product of  $y$  may be determined by doing a weighted summation of the partial products. This can also be done in practise. On the right-hand side of the equation, the primary period has a weight of -1, which represents the sign bit. This weight is applied to the primary period. The significance of the weight of the 2-k symbol is ascribed to each of the phrases that follow it. The essential structure of the FIR filter, which makes use of the DA, is shown in figure 2, which offers a visual depiction of the fundamental structure. (DA-FIR). The operation of right-shifting is performed with the assistance of an adder, and the operation of addition is implemented with the assistance of a register. These partial-products were saved in the ROM. According to the above considerations, the amount of time that is necessary for the operation is essentially solely dependent on the word length  $B$ , and not on the total amount of terms  $N$ . This is because the word length  $B$  is the only variable that changes throughout the process. This suggests that the length of the  $B$  word is the only element that affects the output delay. [Cause and effect] It is possible to reduce the quantity of hardware by implementing the FIR filter using the DA rather than requiring multipliers. This would allow for the use of fewer multipliers. This indicates that it is possible to construct the filter.

**HSCG-SCS Adder**

An adder will produce the sum bit that corresponds to a given input bit position based on its knowledge of any carry inputs that may be present. This awareness is based on the fact that an adder is aware of any carry inputs that may be present. The carry might be generated and/or distributed internally amongst the multiple bit positions that comprise the input. This could happen either way. When an adder is used, a production of the sum bit that corresponds to a particular input bit position takes place. This happens when the adder is put into operation. To put it another way, the generation of the sum bit is contingent on having prior knowledge of any carry input. This is because the sum bit is used to calculate the total. This is due to the fact that the sum bit is used in the process of calculating the total amount. Because of this, it is feasible to transform the linear time that is experienced during an RCA into the necessary logarithmic time addition. Both of these operations are performed on the bits  $XQ$  and  $YQ$ . Both of these operations are performed on the bits  $XQ$  and  $YQ$ . Both of these operations are performed on the bits  $XQ$  and  $YQ$ . Equation may be used to explain any of these two processes (1). In line with the equation, the generation of the amount bit that corresponds to the  $Q$ th bit spot takes place (14).

$$CQ + 1 = GQ + PQCQ \tag{13}$$

$$SumQ = PQ \oplus CQ \tag{14}$$

Because equation (15) is naturally recursive, this property may be used to produce carries that correspond to following bit positions in advance. These carries are referred to as look-ahead carries since they involve looking forward. Equations (15)– (17). The bit locations in question are places 1, 2, 3, and 4. Utilizing these equations will allow one to get an understanding of the look-ahead carry. In the equations (15)– (17),  $CK$  represents the carry input to a 4-bit HSCG-SCS adder;  $PK+3$  to  $PK$  represents the propagate signals;  $GK+3$  to  $GK$  represents the generate signals; and  $CK+4$  to  $CK+1$  represents the look-ahead carry outputs received. Figure 3 is an illustration of the conventional HSCG-SCS adder that was created by putting the Equations (15)– (17) into practise.

$$CK + 1 = GK + PKCK \tag{15}$$

$$C_{K+2} = G_{K+1} + P_{K+1}C_{K+1} = G_{K+1} + P_{K+1}G_{K+1}P_{K+1}PKCK \tag{16}$$

$$C_{K+3} = G_{K+2} + P_{K+2}C_{K+2} = G_{K+2} + P_{K+2}G_{K+1} + P_{K+2}P_{K+1}G_{K+1}P_{K+2}P_{K+1}PKCK \tag{17}$$

Given that this is the most common method, it is common practise to construct an  $N$ -bit HSCG-SCS adder by first producing a cascade of  $M$ -bit HSCG-SCS adders. This is done in order to get the desired result. It is necessary that



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both N and M have an even number of occurrences, and the value of N must be 0 when modulo M. This requirement can only be satisfied if both N and M are even. For instance, it is feasible to construct a HSCG-SCS adder with 32 bits by cascading eight HSCG-SCS adders, each of which only has four bits. Using the cascade operator is one way to accomplish this goal. In line with the structure of an N-bit HSCG-SCS adder, which is shown in the block diagram of an N-bit HSCG-SCS adder displayed in Figure 4, an N-bit HSCG-SCS adder may be formed from a number of 4-bit HSCG-SCS adders. This is depicted in the structure of an N-bit HSCG-SCS adder. The essential path, which can be recognised by the orange dotted line, is the one that absolutely has to be taken. It is the path that would be travelled by the essential path. The HSCG-SCS adder would be traversed along this route while it was being investigated. If the crucial route that the 4-bit HSCG-SCS adder was going to take was like the one depicted in Figure 3, then the following would apply, then this would be the case. The number of AND gates and OR gates that can be included into a conventional digital cell library at the present time is limited to a maximum of four in each case. Deconstructing an AND/OR gate that has five inputs into a combination of two AND/OR gates that each have three inputs is thus doable. If the 4-bit HSCG-SCS adder that is shown in Figure 3 is also present in the last step of Figure 4, at that time the dashed blue line that is shown in Figure 3 draws attention to the significant route that would be taken. This is because it highlights the fact that the route would be travelled. This would be the case if both figures are accurate.

It is clear from looking at Figure 4 that the first 4-bit HSCG-SCS adder, which is the one with the least significance, does not have a carry input, but the carry input is present in all of the other 4-bit HSCG-SCS adders. Figure 3 shows a representation of what the gate-level realisation of a 4-bit HSCG-SCS adder that does not contain any carry participation would look like. The attention-getting pink dashed line that emphasises the essential path brings focus to this particular aspect of the design. This is because a 4-bit HSCG-SCS adder's gate-level realisation without a carry input would be as explained above in the absence of a carry input. This is because in the lack of a carry input, that is, when assuming CK to be equal to zero in the equations, this result occurs.

## RESULTS AND DISCUSSIONS

This section gives the detailed analysis of various simulation results, which are implemented using XILINX-ISE software and Verilog programming. Figure 4 shows the simulation waveforms, where proposed LMS adaptive filter functionality is justified. The design description (RTL schematic) of the suggested technique may be seen in Figure 5. The timing breakdown of the suggested technique is shown in Figure 6. In this situation, the suggested technique incurred a total time delay of 6.7690ns, of which 5.759ns was considered to be logical delay and 1.01ns was considered to be route delay. The report of the suggested proposed LMS adaptive filter's power consumption may be seen in Figure 7. In this case, the suggested proposed LMS adaptive filter had a power consumption of 0.065. Figure 8 shows the design summary of proposed method. Table 1 compares the performance of various approaches. Here, the proposed LMS adaptive filter, resulted in reduced LUTs, power consumption, Flip-Flops, delay, as compared to conventional CONV-FOAF filter [12], Fixed FOAF filter [17], DFG FOAF filter [13].

## CONCLUSION

In order to alleviate the problems caused by the stated limitations, a parallel multi-stage least mean square structure has been developed. The LMS consists of two stages that work in parallel and are coupled to each other through error feedback. The sum carry generator adder is based on half sum carry generation. In order to fulfil this goal, the array multiplier was switched out for distributed arithmetic memory units. In order for this design to be able to properly execute this duty, the DA-based HSCG-SCG adders are used. As a direct consequence of this, the memory capacity has been reduced by a factor of at least four, despite the fact that the filter order has remained same. The findings of the simulation indicate that the implementation of the suggested technique led to a reduction in area, latency, and power consumption when compared to the conventional adaptive filter. Further, this work can be extended with hybrid architectures for improved performance.





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Table 1. Comparison Table.

Parameter	CONVFOAF [12]	Fixed FOAF [17]	DFG FOAF [3]	Proposed LMS filter
Time delay (ns)	20.118	13.35	10.34	1.486
Power utilised (uw)	1.293	2.356	1.46	0.065
Slice Lookup tables	271	562	72	66
Slice registers	237	395	103	12

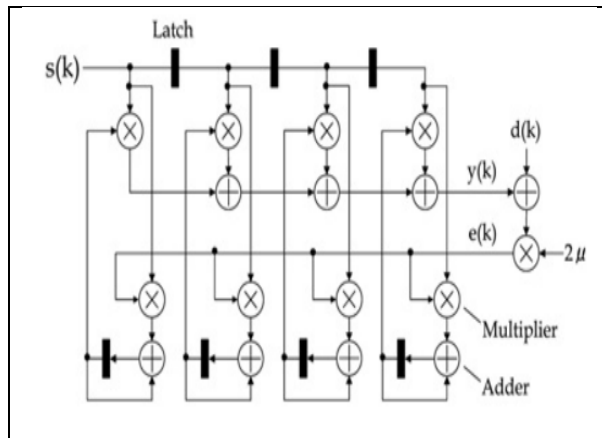


Fig. 1.The 4-tap LMS adaptive filter's composition.

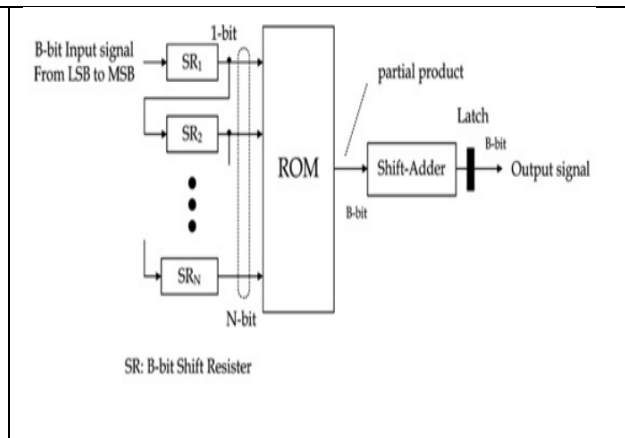


Fig. 2.DA-based LMS Adaptive Filterarchitecture.

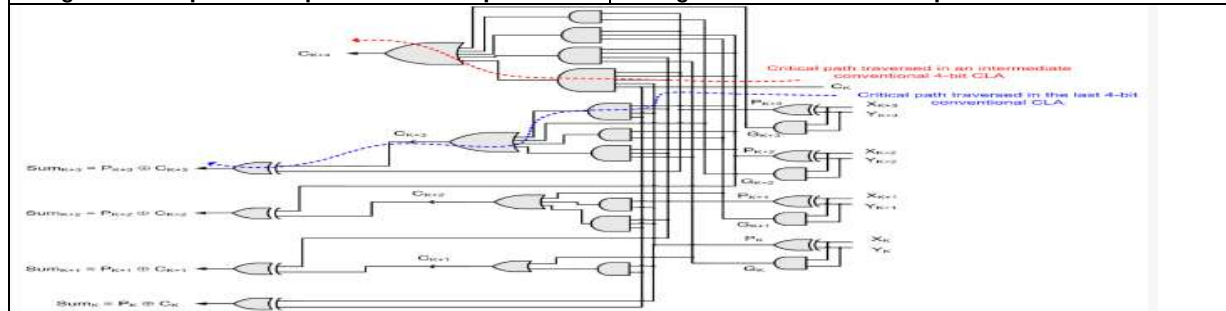


Fig. 3. Comprehension of 4-bit HSCG-SCS adder at the gate level with the carry input  $C_K$ .

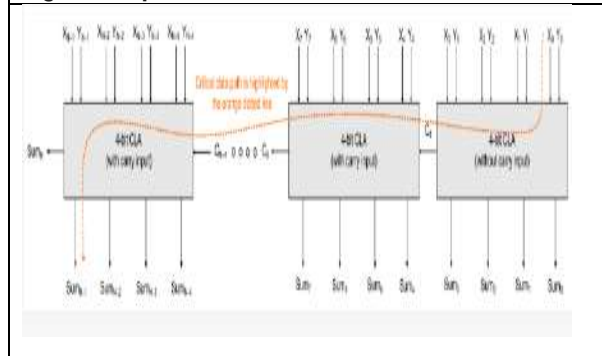


Fig. 4. Block illustration of an even N-bit HSCG-SCS adder implemented with a series of 4-bit HSCG-SCS adders.



Fig.5. Simulation Results.





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Fig. 6. RTL Schematic

Minimum period: 1.563ns (Maximum Frequency: 639.795MHz)  
 Minimum input arrival time before clock: 3.427ns  
 Maximum output required time after clock: 1.704ns  
 Maximum combinational path delay: 1.486ns

Fig. 7. Time summary.

Device	Family	Part	Package	Temp Grade	Process	Speed Grade	On-Chip Logic	Power (W)	Used	Available	Utilization (%)	Supply Source	Summary Voltage	Total Current (A)	Dynamic Current (A)	Quiescent Current (A)
							Logic	0.000	34	17630	0	Vccint	1.000	0.000	0.000	0.000
							SRAMs	0.000	75	-	-	Vccaux	1.800	0.006	0.000	0.006
							RAM	0.000	50	230	22	Vccint	1.800	0.001	0.000	0.001
							Blockage	0.063	-	-	-	Vccint	1.000	0.000	0.000	0.000
							Total	0.063	-	-	-	Vccint	1.000	0.000	0.000	0.000
Environment							Thermal Properties	Relative TJA (C/W)	Max Ambient (C)	Junction Temp (C)		Supply Power (W)				
							25.1	4.0	84.7	25.3	Total Dynamic Quiescent					
							Use custom TJA?	No			0.069 0.000 0.069					
							Custom TJA C/W	NA								
							Reference I/FM	250								
							Heat sink	Medium Profile								
							Custom VS/C (M)	NA								
							Board Selection	Medium (11x18")								
							Pin Board Layer	8 to 11								
							Custom TJA C/W	NA								

Fig.8. Power summary

Device Utilization Summary (estimated values)			
Logic Utilization	Used	Available	Utilization
Number of Slice Registers		12	126800 0%
Number of Slice LUTs		66	63400 0%
Number of Fully Used LUT/FF pairs	9	69	13%
Number of bonded IOBs	25	210	11%
Number of BUFG/BUFGCTRL/BUFGCEs	1	120	0%

Fig.9. Device Utilization Summary.





## Morphometric and Gravimetric Studies of Mulberry Leaves

G.S.Chithra<sup>1</sup>, J.P Jespa<sup>2</sup>, V. Sheelu<sup>3</sup> and M.Thilsath Fatima Quraiza<sup>4\*</sup>

<sup>1</sup>Ph.D Scholar, Reg.No.19123092192007, Department of Zoology, Muslim Arts College, Thiruvithancode, Kanyakumari Dist., Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India.

<sup>2</sup>Ph.D.Research Scholar, Reg. No.11779, Department of Zoology, Holy Cross College, Nagercoil, Kanyakumari Dist., Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India.

<sup>3</sup>Jr. Assistant Police Department, Joint Commissioner Office, Guindy, Chennai, Tamil Nadu, India

<sup>4</sup>Assistant Professor, Department of Zoology, Muslim Arts College, Thiruvithancode, Kanyakumari Dist., Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India

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### \*Address for Correspondence

#### M.Thilsath Fatima Quraiza

Assistant Professor,  
Department of Zoology,  
Muslim Arts College,  
Thiruvithancode, Kanyakumari Dist.,  
Affiliated to Manonmaniam Sundaranar University,  
Tirunelveli, Tamil Nadu, India.



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### ABSTRACT

Silkworm obtains its entire nutritional requirement from mulberry leaves only, because this insect is monophagous and can complete the life cycle on mulberry leaves exclusively. Nutrition plays an important role in improving the growth and development of the silkworm, like other organisms. Silk production is dependent on the larval nutrition and nutritive value of mulberry leaves that plays a very effective role in producing good quality cocoons moisture in mulberry leaves is one of the most important factors in silkworm nutrition. The present study shows that the moisture content in the tender leaf was very low compared to middle aged and tough leaves. The results of the morphometric analyses of leaf length and width had shown highly significant positive correlation between length and width in tender leaves The results reveal the high retaining capacity of the tough leaves than the tender and middle-aged leaves.

**Keywords:** Monophagous, Silkworm, morphometric, petiolate, gravimetric







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## INTRODUCTION

Silk is a highly prized natural fibre with unique characteristics not matched by artificial fibres. Countries such as China, Japan and India have amassed a large amount of information about moriculture, sericulture and post-cocoon technology (Petercore and Dingle, 2000). Mulberry silkworm, *B. mori* is an economic insect that contributes substantially the national economy of India. The role of silk quality is the success of silkworm rearing and cocoon production (Dandinet al., 2001). The growth and development of the larvae and subsequent cocoon production are very much influenced by the nutritive value of mulberry leaves (Krishnaswami, 1978).

Gordon (1990) found out exposure to wide humidity fluctuations or extremes may result in behavioral, physiologic, and morphologic changes. According to Paul et al. (1992) moisture in mulberry leaves is one of the most important factors in silkworm nutrition. In mulberry, leaf moisture content (LMC) and moisture retention capacity (MRC) are the two important factors that maintain the nutritive levels of leaves was assessed by Bongale and Chaluvachari (1995). According to Santhoshet al. (2006) temperature controls all atmospheric conditions and the biochemical reactions of aquatic systems. Mulberry is a fast growing deciduous, deep rooting perennial tree that grows throughout the temperate, subtropical and tropical regions. The leaves are simple, alternate, stipulate, petiolate, entire or lobed. As the morphometric and gravimetric analyses of mulberry leaves were found essential for determining the amount of water content and other various aspects taken for a detailed analysis in this study elsewhere in this thesis for discussing growth parameters of silkworm, this aspect is incorporated here. Leaf moisture content and moisture retention are reported as positive influence on the growth of silkworm larvae.

## MATERIALS AND METHODS

### Morphometric and Gravimetric Determination of Mulberry Leaves

For determining the leaf morphometry, normal, healthy and an infested mulberry leaves were plucked at random from various well grown healthy mulberry plants grown to a height of about 5 feet. Large number of leaves was plucked separately from the trees in such a way, to have a few from the terminal end of the shoots (Classified as tender leaves), had some others just below the terminal apex ring (Classified as middle aged), and had some others still below the middle aged ring of leaves (Classified as tough leaves) (Figure 1). Several replicates of each lot having not less than 10 leaves of the above three categories were taken separately for measurement of their length and width. Length from the petiolar base of the leaves to the tip, and the width at the broadest area at about the middle were separately measured by placing the leaves on a graph paper, to the nearest 1.0 mm and recorded. Mean and standard deviation were calculated and the relationship between length and width of the above three categories of leaves were determined separately through analyses of correlation ('r'). As and when the morphometry of leaves were recorded, gravimetric determination was carried out for the very same leaves of the three categories separately, in an electric balance to the nearest 1.0 mg. Mean and standard deviation values for each category were calculated. The relationship between the results obtained for morphometric analyses and the gravimetric analyses for each category of leaf was determined through analyses of regression and 'r' values calculated.

### Determination of Water Content in Normal, Healthy Mulberry Leaves

Large number of mulberry leaves were plucked separately from the trees in such a way, to have a few from the terminal end of the shoots (Classified as tender leaves), had some others just below the terminal apex ring (Classified as middle aged), and had some others still below the middle aged ring of leaves (Classified as tough leaves). The fresh leaves were brought immediately to the laboratory in separate polyethene containers. Wet weight of known number of fresh leaves from each category was found out in an electric balance to the nearest 1.0 mg and recorded. The very same number of leaves was then oven dried at 37°C for overnight. The dry weight of different categories of leaves was weighed out separately. The change in weight between wet and dry weight was determined as water content (Moisture content) in leaves of each category. From the results obtained, water content per gram weight of green wet leaves of tender, middle aged and tough categories was calculated. The results were depicted graphically.



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## RESULTS

Plate 2 depicts the entire morphology of the young, mature, and robust mulberry leaves. Calculated values for the mean and standard deviation of the leaf length and width of tender leaves were 7.49 1.04 cm and 4.38 0.56 cm, respectively. Calculated values for the mean and standard deviation of the leaf length and width of middle-aged leaves were 14.22 0.57 cm and 11.15 1.20 cm, respectively. Tough leaf measurements had a mean and standard deviation of 19.25 0.73 cm and 15.77 0.50 cm, respectively (Table 1). Following are the computed relationships between the width and length of mulberry leaves at various stages:

- i) There is a considerable positive connection ( $r = 0.830$ ) between the leaf length and width of tender leaves.
- ii) While there is a positive association between leaf length and breadth of middle-aged leaves ( $r = 0.223$ ), it is substantially smaller than that of tender leaves.
- iii) Although there is a positive link between tough leaf length and width ( $r = 0.049$ ), it is significantly less pronounced than it is for tender leaves.

According to gravimetric analyses of mulberry leaves, the average fresh weight, average dry weight, and average percentage of moisture content for tender leaves were 482 mg, 374 mg, and 22.171 mg, respectively (Table 2 and Fig. 1). For the fresh weight, dry weight, and percentage of moisture content in middle-aged leaves, the mean and standard deviation were 83365.32 mg, 60367.99 mg, and 27.694.74%, respectively (Table 2 and Fig. 1). The fresh weight, dry weight, and percentage of moisture in tough leaves had the following means and standard deviations: 96664.32 mg, 66786.41 mg, and 31.094.96%, respectively (Table 2 and Fig. 1). The following chart shows the correlations between the fresh weight and dry weight of mulberry leaves at various stages: relationships calculated between fresh weight and dry weight of different stages of mulberry leaves are as follows:

- i) The delicate leaf dry weight and fresh weight are correlated with one another with  $r = 0.949$ .
- ii)  $R = 0.853$  is the correlation coefficient between the fresh weight and dried weight of middle-aged leaves.
- iii)  $R = 00.775$  is the correlation coefficient between the fresh weight and dry weight of tough leaves.

## DISCUSSION

The moisture content of mulberry leaves is a genetic character and is related to the available soil moisture content and root proliferation. The moisture content of the leaf determines the digestibility of silkworm (Kasiviswanathan *et al.*, 1973). Usually moisture content varies from 64-83% in mulberry leaves (Yokoyama, 1975) and moisture above 70% is considered as optimum (Singh and Singh, 1976). Babu *et al.* (1994) observed the tukra affected mulberry leaves ( $S_{13}$ ) and showed significant decrease in moisture content. The tukra infested mulberry leaves with symptoms of minute mealy bugs infested mulberry garden shows curling of apical leaves. The beetles feed on plant sap lead to a decrease of 3.57% in leaf moisture content (Kumar *et al.*, 1997). Etebari *et al.* (1998) reported that mulberry thrips reduces the moisture by 3.57% therefore has a negative impact on the quality of the leaves consumed by silkworm. Muthuswami *et al.* (2010) studied the damage by thrips cause loss of moisture from leaves; besides, causing appreciable reduction in nutritive value of leaves by inducing biochemical changes in leaves. The results of the morphometric analyses of leaf length and width had shown highly significant positive correlation between length and width in tender leaves ( $r = 0.830$ ) while very low highly insignificant positive correlation was found for the tough leaves ( $r = 0.049$ ); and a via media correlation was found for the middle aged leaves ( $r = 0.223$ ). It can be attributed that the growth accelerating tender apical leaves are always under the process of extending their length and width equally proportional to their size; and the middle aged leaves are in between the promoting point and nearing the senile point of growth in extending their size; but the tough leaves have attained their maximum size in growth. Hence the relationship between length and width of leaf during the growth phase is quite natural. Anyhow, these results contribute statistically to know about the ratio of growth of mulberry leaf at different stages. The overall results of the present study shows that the moisture content in the tender leaf was very low compared to middle aged and tough leaves. The results reveal the high retaining capacity of the tough leaves than the tender and





middle-aged leaves. This can be speculated that this phenomenon might be either due to one of the genetic characteristics or due to the physiological functions with reference to environmental conditions.

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**Table 1. Morphometric analyses of mulberry leaves**

Sl. No.	Tender leaves		Middle aged leaves		Tough leaves	
	Leaf length (cm)	Leaf width (cm)	Leaf length (cm)	Leaf width (cm)	Leaf length (cm)	Leaf width (cm)
1	6.3	3.7	13.1	9.0	18.2	15.3
2	6.7	3.8	13.6	11.5	18.3	15.6
3	6.9	4.2	13.7	11.9	18.6	16.1
4	7.0	3.6	14.2	11.7	18.7	16.3
5	7.1	4.3	14.3	12.6	19.4	15.1
6	7.2	4.6	14.5	12.8	19.5	15.7
7	7.4	4.9	14.5	9.8	19.7	16.5
8	7.6	4.5	14.6	10.4	19.9	16.2
9	9.3	5.0	14.8	10.8	20.0	15.1



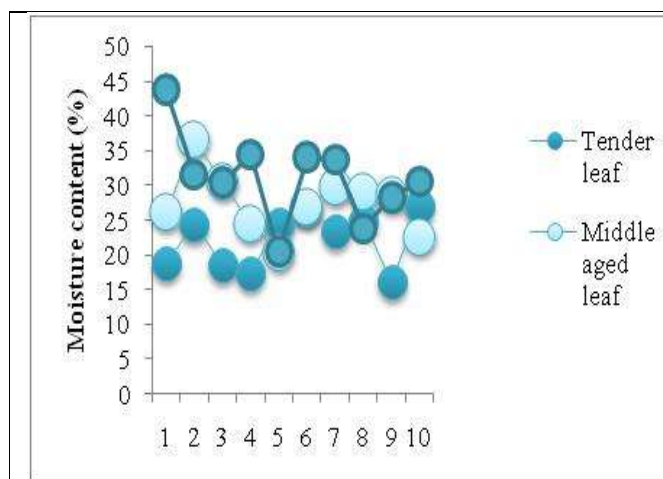


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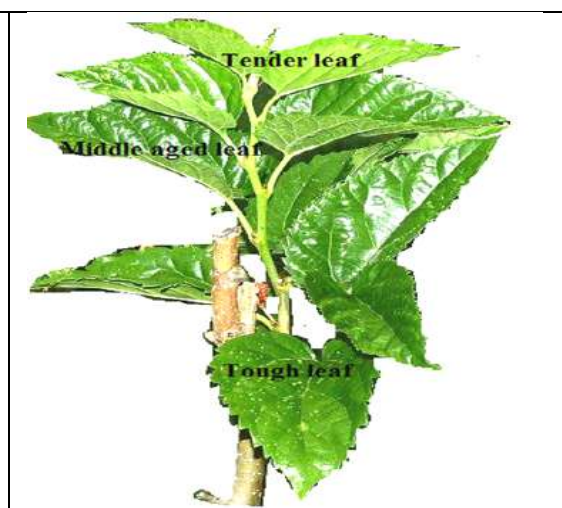
10	9.4	5.2	14.9	11.0	20.2	15.8
Mean & SD	7.49±1.04	4.38±0.56	14.22±0.57	11.15±1.20	19.25±0.73	15.77±0.50

**Table 2. Gravimetric analyses of mulberry leaf**

Sl. No.	Tender leaves			Middle aged leaves			Tough leaves		
	Fresh weight (mg)	Dry weight (mg)	Moisture content (%)	Fresh weight (mg)	Dry weight (mg)	Moisture content (%)	Fresh weight (mg)	Dry weight (mg)	Moisture content (%)
1	320	260	18.75	720	530	26.38	890	500	43.82
2	410	310	24.39	760	480	36.84	920	630	31.52
3	430	350	18.60	780	540	30.76	920	640	30.43
4	460	380	17.39	810	610	24.69	930	610	34.40
5	490	370	24.48	830	660	20.48	930	740	20.43
6	490	360	26.53	850	620	27.05	940	620	34.04
7	510	390	23.52	870	610	29.88	980	650	33.67
8	520	390	25.00	890	630	29.21	1010	770	23.76
9	560	470	16.07	900	640	28.88	1060	760	28.30
10	630	460	26.98	920	710	22.82	1080	750	30.55
Mean & SD	482±84.9 5	374±62.3 9	22.171±2.3 7	833±65.3 2	603±67.9 9	27.69±4.7 4	966±64.3 2	667±86.4 1	31.09±4.9 6



**Fig. 1. Moisture content in tender, middle aged and tough leaves**



**Fig. 2: Leaf Morphometry**





## Supplementation Therapies for Type-2 Diabetic Patients

Aarti Sati<sup>1</sup>, Kritika Saini<sup>2\*</sup>, Mandeep Narang<sup>3</sup> and Mamta Bansal<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Pharmacology, SGRR University, Patel Nagar, Dehradun, 248001, Uttarakhand, India.

<sup>2</sup>Student, Department of Pharmacology, SGRR University, Patel Nagar, Dehradun, 248001, Uttarakhand, India.

<sup>3</sup>Associate Professor, Department of Hospital Studies, School of Management and Commerce Studies, SGRR University, Patel Nagar, Dehradun, 248001, Uttarakhand, India.

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### \*Address for Correspondence

**Kritika Saini**

Student,

Department of Pharmacology,

SGRR University, Patel Nagar,

Dehradun, 248001, Uttarakhand, India.

Email: sainikittu13@gmail.com



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### ABSTRACT

Type 2 diabetes mellitus (T2DM) is a complex metabolic condition that has grown to be one of the major health issues in the globe. Diabetes and its vascular consequences share a number of pathogenetic traits, such as prolonged platelet activation, altered oxidative/antioxidant state, and subclinical, low-grade inflammation. Even though there are numerous interventions available to combat these metabolic changes, such as appropriate diet, consistent exercise, weight control, and medications, epidemiological data show a growing trend in the issue, reflecting both the multifactorial nature of these diseases and the low patient adherence to recommended tactics. It has been demonstrated that a variety of nutraceuticals used in clinical practise target the aetiology of metabolic syndrome, diabetes mellitus, and its consequences as well as to favourably regulate a number of biochemical and clinical endpoints. Vitamins C and E, flavonoids, vitamin D, conjugated linoleic acid, omega-3 fatty acids, minerals like chromium and magnesium, -lipoic acid, and dietary fibres are some of the chemicals that fall under this category. The use of dietary supplements and nutraceuticals in this context raises a number of issues, including the requirement for evidence-based indications, the necessity for product standardisation, the establishment of the ideal dose regimen, potential adverse effects, and medication interactions.

**Keywords:** T2DM, Diabetes, Nutraceuticals, Sarcopenia, Hyperglycemia

### INTRODUCTION

Diabetes is a group of metabolic diseases characterized by hyperglycemia, resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long term damage, dysfunction, and



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failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Several pathogenic processes are involved in the development of diabetes. These range from autoimmune destruction of the pancreatic b-cells with consequent insulin deficiency to abnormalities that result in resistance to insulin action. The basis of the abnormalities in carbohydrate, fat, and protein metabolism in diabetes is deficient action of insulin on target tissues. Deficient insulin action results from inadequate insulin secretion and/or diminished tissue responses to insulin at one or more points in the complex Pathway of hormone action. Long-term complications of diabetes include retinopathy with potential loss of vision; nephropathy leading to renal failure; peripheral neuropathy with risk of ulcers, amputations, and Charcot joints; and autonomic neuropathy causing gastrointestinal, genitourinary, and cardiovascular symptoms and sexual dysfunction. Patients with diabetes have an increased incidence of atherosclerotic cardiovascular, peripheral arterial, and cerebrovascular disease.(1) Type 2 diabetes is a chronic metabolic disorder resulting from defects in insulin secretion, insulin action or both, leading to hyperglycemia (2). Type 2 diabetes is a chronic metabolic disease that has a significant impact on the health, quality of life, and life expectancy of patients, as well as on the health care system. Exercise, diet, and weight control continue to be essential and effective means of improving glucose homeostasis. However, lifestyle management measures may be insufficient or patient compliance difficult, rendering conventional drug therapies (i.e., oral glucose lowering agents and insulin injection) necessary in many patients. In addition to adverse effects, drug treatments are not always satisfactory in maintaining euglycemia and avoiding late stage diabetic complications.(3) It is one of the most common chronic diseases in the world, which is also a major risk factor for coronary heart disease (CHD), blindness, kidney failure, and all types of cancer. The global prevalence of diabetes was 422 million at 2014, and it was the seventh leading cause of death in 2016, along with tremendous economic and public health burdens. It has been stated that most of T2DM can be partly prevented by proper diets and healthy lifestyles, which triggered the investigation of specific dietary interventions.(4) Most can control their blood glucose with diet and exercise, though some may require medications for hyperglycemia or concomitant cardiovascular disease. The question arises as to whether dietary supplements can provide Dietary intervention can be a potential strategy for changing the composition of the gut nutritional support, in conjunction with other modalities, to improve glycemic and lipidemic control in diabetes.(5) . Between dietary factors, probiotics, and prebiotics have particular importance. According to the definition of FAO/WHO, probiotics are 'live microorganisms that when administered in adequate amounts, confers a health benefit on the host. The FAO clarifies prebiotic as a 'non-viable food component that confers "health benefit on the host in association with modulation of the microbiota" (6).

Frequently Used CAM Diabetes Therapies for -Individuals with diabetes, cancer, and hypertension are found to be the predominant followers of CAM as compared to their healthy counterparts . Individuals with diabetes tend to use CAM therapies mostly to complement conventional therapy and resort to nutritional advice or lifestyle diets, herbal remedies, massage therapy, spiritual healing, and meditation training. of the CAM therapies, those most popularly used and studied for diabetes treatment are herbs, dietary supplements, and mind-body medicine . This is not surprising as many of them are widely available and inexpensive and are inherent in peoples' cultures and ancestral beliefs. An investigation using ethnographic methods was carried out on an urban population of Kerala to understand the usage of complementary therapies in managing type 2 diabetes mellitus (T2DM). The study pointed out that patients' perceptions of a disease and its management are largely based on their cultural background and environmental resources. Many of them frequently use Ayurvedic and traditional herbal medicines as supplements to conventional therapy. Dietary supplements and herbs are used.(7)

### **Diabetic Nephropathy**

Diabetic nephropathy (DN), also called diabetic kidney disease, is a significant and long-term complication of diabetes mellitus. It is currently the leading cause of end-stage renal disease (ESRD) and a major contributor to mortality of diabetic patients globally . It affects about 20–30% of type 1 diabetes mellitus (T1DM) patients and 35–40% of type 2 diabetes mellitus (T2DM) patients globally . It is characterized by clinical features such as persistent albuminuria, decrease glomerular filtration rate, hypercreatininemia, uremia and elevated blood pressure . Recent studies have shown that a major molecular mechanism underlying the pathogenesis and progression of DN is excess production of reactive oxygen species (ROS) of which little therapeutic avenues have been explored. ROS are free



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radicals which are principally produced by mitochondria during metabolic processes, and their over-production leads to oxidative stress, which mediates tissue injury as observed in pathological conditions such as diabetes mellitus. Interestingly, oxidative stress has been established in the pathogenesis and progression of DN in T2DM in human patients. DN, they only retard DN progression but do not reverse or prevent it. Therefore, there is urgent need to identify novel pharmacological agents and strategies to target signaling pathways including ROS-induced oxidative stress. (8)The former approach is based on lifestyle modifications such as diet (reduction in sugar and sodium intake), physical exercise, psychological and social interventions and diabetes self-management education. The pharmacological interventions are based on reduction of hyperglycemia using anti-diabetic drugs and blockade of the renin-angiotensin-aldosterone system using angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers, and non-dihydropyridine calcium channel blockers, thus ensuring strict glycemic and blood pressure control to attenuate proteinuria and slow down progression of DN to ESRD and cardiovascular complications. Whereas these pharmacological agents have been approved as cornerstone for the management.

### **Alpha Lipolic Acid**

Alpha-lipoic acid (ALA), also known as thioctic acid, is a sulphur-containing natural antioxidant and a cofactor for several important mitochondrial multienzyme complexes involved in mitochondrial bioenergetics and amino acid metabolism. It is endogenously produced by lipoic acid synthase in the mitochondria of tissues including the kidney and is also derived from plant and animal sources or given as a dietary supplement. There are studies showing that circulating ALA levels are decreased in diabetic patients, and that ALA supplementation is beneficial in the management of both T1DM and T2DM and diabetic complications such as diabetic peripheral neuropathy in preclinical and clinical settings. ALA has also been shown to improve blood glucose, lipid profiles and gamma-glutamyl transferase in pregnant women with gestational diabetes mellitus. Rodent models also show acceleration of DN following genetic inhibition of lipoic acid synthase and that ALA supplementation attenuated development and progression of DN while it further showed beneficial effect in ESRD patients on hemodialysis. However, its effect with conventional anti-diabetic therapy against DN in T2DM has not been described. Therefore, we hypothesize that ALA supplementation would prevent hyperglycemia and protect the kidney beyond that offered by conventional anti-diabetic therapy.(8)Induction of T2DM resulted in hypoinsulinemia, hyperglycemia and renal pathology. ALA supplementation maintained  $\beta$ -cell function, normoinsulinemia and normoglycemia in diabetic rats, and prevented renal pathology (PAS, KIM-1, plasma creatinine, total protein, blood urea nitrogen, uric acid and urine albumin/creatinine ratio) and triglycerides level compared to diabetic control ( $p < 0.001$ ). Additionally, ALA supplementation significantly prevented elevated serum and tissue malondialdehyde, collagen deposition,  $\alpha$ -SMA expression, apoptosis and serum IL-1 $\beta$  and IL-6 levels while it markedly increased renal glutathione content and plasma HDL-C compared to diabetic control group ( $p < 0.001$ ). (8)

### **VITAMIN-D**

Vitamin D deficiency has been consistently associated with hypertension, diabetes mellitus, cardiovascular disease, stroke, multiple sclerosis, inflammatory bowel disease, osteoporosis, periodontal disease, macular degeneration, mental illness, propensity to fall, chronic pain and various cancers. Little or no research has determined the effect of vitamin D3 supplementation when given in conjunction with existing non-pharmacological and pharmacological approaches to the DM2 population. Hence, this study primarily determined the effect of vitamin D3 supplementation on diabetic patients.(9)Vitamin D supplementation as a way of either preventing new onset Type 2 diabetes or for improving glycaemic control in patients with Type 2 diabetes or impaired glucose tolerance. Vitamin D supplementation may have a role in modifying other aspects of the metabolic and cardiovascular derangements that accompany Type 2 diabetes, including hypertension and endothelial dysfunction, but larger, longer studies focusing on micro- and macrovascular outcomes are required, rather than continuing to focus on the surrogate measures of glucose and glycaemic control.(10)



**Aarti Sati et al.,****AMINO ACID**

A decrease in lean muscular mass causes sarcopenia, a disease frequently found in the elderly population. The reduction of muscle mass may be responsible for reduced insulin sensitivity and decreased glucose uptake, thus increasing the risk for hyperglycemia and insulin-resistance syndrome in elderly subjects with type 2 diabetes mellitus.(11)Ability of AAs to increase protein anabolism and muscle tissue synthesis may play an important role in improving blood glucose control and insulin sensitivity .The improvement in insulin sensitivity and the reduced fasting hyperinsulinemia could be considered important metabolic consequences of oral AA support in our group of elderly subjects with type 2 diabetes. These effects could be dependent on either recovery insulin activity on the muscle target or an insulin-dependent increase of skeletal muscle anabolism and mass. Effects were demonstrated in elderly subjects with type 2 diabetes during short-term supplementation with AAs, and progressively improved throughout the long-term 60-week observation period. AA supplements positively influence metabolic control in elderly subjects with type 2 diabetes.(11)

**SARCOPENIA**

A decrease in lean muscular mass causes sarcopenia, a disease frequently found in the elderly population. The reduction of muscle mass may be responsible for reduced insulin sensitivity and decreased glucose uptake, thus increasing the risk for hyperglycemia and insulin-resistance syndrome in elderly subjects with type 2 diabetes mellitus. This tissue may be important for glucose metabolism and could be an original target to treat metabolic disorders, eg, insulin resistance, reduced glucose tolerance, and type 2 diabetes mellitus. Reduced muscle mass (defined also as sarcopenia) is very frequent in old age. Furthermore, this condition could be associated with the reduced activity of anabolic hormones and with muscle protein turnover disorders.(11)

**Chromium Picolinate**

Inulin-type fructans are the best known oligosaccharides due to their effect on intestinal microbiota, and are considered as the main prebiotic substrates [8]. Inulin, a heterogeneous collection of fructose polymers, belongs to a class of dietary fibers known as fructans and is available in more than Cr is a trace element essential in carbohydrate, lipid, and protein metabolism. Cr is a cofactor for insulin function that increases insulin binding, the number of insulin receptors, and insulin receptor phosphorylation, resulting in enhanced glucose transport into liver, muscle, and adipose tissue. Since Cr is required for normal glucose and lipid metabolism, low Cr status can adversely affect blood glucose, insulin, total cholesterol, triglycerides, and high-density lipoprotein cholesterol.(5)Data indicate that CrPic supplementation represents a uniquely efficacious modality for glycemic control in subjects with diabetes. Indeed, 13 of 15 clinical studies reported significant improvement in at least one outcome of glycemic control. All 15 studies showed significant benefits in a least one parameter of diabetes management, including blood lipid control. Other positive outcomes linked to CrPic therapy included improved electrocardiograms, reduced need for hypoglycemic medications, and no reported adverse effects(5)

**COENZYME Q10**

-Type 2 diabetes mellitus (T2DM) is a major cause of morbidity and mortality with ever increasing prevalence in the United States and worldwide. There is growing body of evidence suggesting that mitochondrial dysfunction secondary to oxidative stress plays a critical role in the pathogenesis of T2DM. Coenzyme Q10 is an important micronutrient acting on the electron transport chain of the mitochondria with two major functions: (1) synthesis of adenosine triphosphate (ATP); and (2) a potent antioxidant. Deficiency in coenzyme Q10 is often seen in patients with T2DM. Whether restoration of coenzyme Q10 will help alleviate oxidative stress, preserve mitochondrial function, and thus improve glycemic control in T2DM. It is clear that mitochondrial dysfunction secondary to oxidative stress contributes to the pathogenesis of T2DM. Deficiency in CoQ10 is often present among patients with T2DM due to various reasons. As a potent antioxidant, CoQ10 is assumed to scavenge excessive ROS and provide protection to cells, especially mitochondria from oxidative damage. Therefore, restoration of CoQ10 level among patients with T2DM by supplementation of exogenous CoQ10 could potentially alleviate oxidative stress, preserve mitochondrial function, and eventually lead to improvement of glycemic control.(12)





**Aarti Sati et al.,****Flax Seed**

Flaxseed (FS) botanically known as *Linum Usitatissimum*, belongs to the Linaceae family, is a versatile blue flowered crop. This nutty flavored seed comes in a variety of colors ranging from a reddish brown to a light yellow. It is commonly consumed in three forms: as a whole seed, ground powder, or as oil. FS is composed of 41% fat, 20% protein, 28% dietary fiber, 7.7% moisture, and 4% ash. The active components of FS are dietary fiber (cellulose, mucilage, gums, and lignin), phytochemicals, and omega 3 fatty acids.(13) Supplementation with Flax seed powder brings about favorable changes in biochemical profiles of the diabetics, thereby improving their metabolic profile. The hypoglycemic action of Flax seed powder should help prevent hyperglycemia among diabetics, which should, in turn, prevent or retard development of secondary complications of diabetes. Thus, in the present nonrandomized and nonblinded study carried out in type 2 diabetics, FS supplementation helped control hyperglycemia and improve lipid profiles.(13)

**Butyrate and Inulin**

36000 species of plants, including chicory root, wheat, onion, banana, and garlic. Inulin due to its  $\beta(2-1)$  bonds is resistant to hydrolysis by intestinal digestive enzymes in the upper part of the gastrointestinal tract; therefore, it reaches to the colon entirely and serves as a fermentable substrate for colonic micro flora. High-performance (HP) inulin has a long-chain and high-molecular weight mixes of inulin-type fructans, without any fructan that has a degree of polymerization. The protective effects of Na But with and without inulin supplementation, on the markers of glycemia (glucose, HbA1c, and insulin) is studied. Butyrate, which has 4 carbons in its molecule, can be combined with sodium to become sodium butyrate (Na But). Na But is a dietary component found in foods such as butter and cheese.(6) In conclusion, intense results were observed in intra-group analysis with no significant differences between groups in measures of glycemia or anthropometric parameters, which can be due to low sample size, short supplementation period or insufficient supplementation dose. Due to possible gastrointestinal symptoms in concomitant prescription of these supplements, 10 g per day of inulin was recommended, which is less than previous doses used. However, No serious adverse effects were observed after intervention. Therefore, better results might be obtained by using higher doses of inulin in other clinical trials(6).

**Magnesium**

Magnesium is the second most abundant intracellular cation. It plays an important role in insulin homeostasis and glucose metabolism through multiple enzymatic reactions. With increasing data on magnesium deficiency in diabetic patients and epidemiological studies demonstrating magnesium deficiency as a risk factor for diabetes, it is logical to search for its possible beneficial effects on diabetes control and prevention. We aimed to determine whether oral magnesium supplementation improves metabolic control, lipid profile and blood pressure in patients with type II diabetes.(14) In conclusion, intense results were observed in intra-group analysis with no significant differences between groups in measures of glycemia or anthropometric parameters, which can be due to low sample size, short supplementation period or insufficient supplementation dose. Due to possible gastrointestinal symptoms in concomitant prescription of these supplements, 10 g per day of inulin was recommended, which is less than previous doses used. However, no serious adverse effects were observed after intervention. Therefore, better results might be obtained by using higher doses of inulin in other clinical trials(6)

**Vitamin E**

Vitamin E is one of the most important component of cellular antioxidant systems. In nature, it is present under eight different forms, four tocopherols ( $\alpha$ -,  $\beta$ -,  $\gamma$ -, and  $\delta$ ), and four tocotrienols ( $\alpha$ -,  $\beta$ -,  $\gamma$ -, and  $\delta$ ), of which  $\alpha$ -tocopherol is the most bioactive. Vitamin E has been found decreased in patients with type 2 diabetes mellitus (DM). High concentrations of  $\alpha$ -tocopherol have been associated with decreased risk of diabetes in the general population but not in middle-aged smokers. The effect of Vitamin E on risk of diabetes and its complications is most probably due to its role as antioxidant; a decrease in plasma tocopherol has been observed in diabetic subjects with longer duration of the disease related to lipid peroxidation and cardiovascular complications, as well as with total cholesterol and central type obesity (1).



**Aarti Sati et al.,****Zinc and Chromium**

Cr on plasma glucose and related variables of people with type 2 DM and steroid-induced diabetes. Cr also improves cellular antioxidant capacity. Correction of Zn deficiency in patients with type 1 DM also leads to decreased lipid peroxidation and improvements in glucose homeostasis. Therefore, since Cr and Zn act in normalizing glycemia and are postulated to function as antioxidants, a restored Zn and Cr status in people with type 2 DM may counteract the deleterious effects of oxidative stress and help to prevent complications associated with diabetes. Combined Zn and Cr supplementation on variables associated with glucose metabolism and oxidation.(15)

These data suggest the potential beneficial antioxidant effects of individual and combined Zn and Cr supplementation in people with type 2 DM. Neither adverse effects of Zn supplementation on Cu status and HDL cholesterol, nor interaction of Zn nor Cr on absorption were observed. These results are particularly important in light of the deleterious consequences of oxidative stress in people with diabetes.(15). RESVERATROL- Resveratrol is a naturally occurring polyphenolic compound. Numerous animal studies have been reported on its wide-ranging beneficial effects in the biological system including diabetes mellitus (DM). Oral supplementation of resveratrol would improve the glycemic control and the associated risk factors in patients with type 2 diabetes mellitus (T2DM). Resveratrol (3,5,4'-trihydroxystilbene) is a naturally occurring phytoalexin. The richest source of this compound is *Polygonum cuspidatum* Reynoutria japonica, a plant that has been used in oriental folk medicine. Considerable amount of resveratrol is found, among others, in grapevine and peanuts. This compound is available today in various dosage forms and is recommended as a dietary supplement. Although numerous animal studies have been reported on its wide-ranging beneficial effects including DM.(16) Resveratrol supplementation improves glycemic control and the associated risk factors in patients with T2 DM. The study also suggests that resveratrol could be used as an effective adjuvant therapy with a conventional hypoglycemic regimen to treat T2DM. The results reveal that supplementation of resveratrol for 3 months significantly improves the mean hemoglobin. (16) Resveratrol supplementation in the presence of standard antidiabetic medication has major benefits in T2DM patients, which include a pronounced lowering of blood glucose, HbA1c, insulin levels, and insulin resistance, as well as improvement in HDL levels

It is also important to note the beneficial effects of resveratrol observed on metabolic parameters, despite the fact that there was no appreciable effect on body weight or body composition. Some of the observed reductions in HbA1c and HDL with resveratrol supplementation are very significant that they can be compared to benefits achieved with front line antidiabetic drugs(17).

**Inulin**

Inulin is a prebiotic that has a long-chain, high-molecular weight mix of inulin-type fructans, without any fructans that have a degree of polymerization. The beneficial effects of oligofructose exist in regards to the blood glucose and lipid profile of diabetic patients. In contrast, a couple of other studies have failed to show any beneficial effects of inulin-type fructans in diabetic patients. Inulin effect on glycemic and antioxidant status, the present study was designed to assess the hypoglycemic and antioxidant effects of inulin in women with type 2 diabetes.(18)

**Fish Oil**

Mainly found in fish oils, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are marine n-3 polyunsaturated fatty acids (PUFAs) involved in human physiology; received increasing attention in recent years due to its wide range of biological activities. Some studies showed that n-3 PUFAs may reduce the risk of CHD, ischemic stroke, alleviate inflammation and promote healthier cognitive aging. SIGNIFICANT EFFECT ON TYPE 2 DIABETICS PATIENT.(4) Patients with T2DM, fish oil supplementation leads to a favorable blood lipids profile (i.e., reduced TG levels and elevated HDL cholesterol levels), but does not improve glucose levels (4).

**Vanadium**

Insulinmimetic (increase insulin sensitivity). On prolonged high dose cause renal toxicity and GIT .(7)



**Aarti Sati et al.,****Broccoli Sprout**

Supplementation of type 2 diabetics with high sulforaphane content broccoli sprouts resulted in increased total antioxidant capacity of plasma and in decreased oxidative stress index, lipid peroxidation, serum triglycerides, oxidized low-density lipoprotein (LDL)/LDL-cholesterol ratio, serum insulin, insulin resistance, and serum high-sensitive C-reactive protein. Sulforaphane could prevent nephropathy, diabetes-induced fibrosis, and vascular complications. Potential efficacy of sulforaphane and probably other bioactive components of young broccoli sprouts makes it as an excellent choice for supplementary treatment in type 2 diabetes.(19) Type 2 diabetes is characterized by a clustering of metabolic disorders accompanied by other pathogenic conditions, including subclinical inflammation and oxidative stress, which subsequently leads to IR and long-term diabetes complications. The rising trend in the prevalence of diabetes complications suggests that current medical treatments for the management of diabetes are not sufficient and the use of supplementary treatments, including functional foods and nutraceuticals, could increase the effectiveness of current treatments. Based on in vitro studies, animal models and some clinical trials, broccoli sprouts, a main source of bioactive components, especially sulforaphane, has been proposed as an effective supplement for diabetes management and prevention of its long-term complications. Further studies with longer durations and various doses may shed more light on the importance of the therapeutic effects of broccoli sprouts in type 2 diabetic patients.(19)

**Soya and Stevioside**

The diterpene glycoside stevioside (SVS) and soy bean protein isolate have both been shown to have beneficial effects in diabetes treatment. As they each show different benefits we investigated whether the combination of both substances. n in the systolic blood pressure ( $p < 0.001$ ). In conclusion, the combination of stevioside and SPI has synergistic positive effects on the characteristic features of the metabolic syndrome, i.e. hyperglycemia, hypertension and dyslipidemia (20).

**Ginseng**

Use of ginseng, a traditional Chinese medicine, is implicated in various indications including diabetes, cancer, heart disease, fatigue, immune boost, erectile dysfunction, high blood pressure, so on.1–7 There are 11 commercially available species of ginseng; however, the Asian (*Panax ginseng*) and the American (*Panax quinquefolius* L) ginseng are the 2 widely consumed varieties. The pharmacologically active component of ginseng is the triterpene b-glycosides, known as ginsenosides or panaxosides (21). The current results suggest that the ginseng related therapy exert better glycemic control, with an excellent safety profile. Furthermore, it might be a better option in drug naive diabetic patients, rather than as an adjunct therapy in patients on anti-diabetic medications. The present analysis did not show an improvement in the pooled HbA1c levels, which might be attributed to variations in the species and dosage of ginseng-related therapy, along with the shorter treatment duration. We propose a standardized treatment regimen with duration greater than 3 months, before any strong conclusions can be drawn, on the safety and efficacy of ginseng extracts as a dietary supplement in patients with diabetes mellitus or glucose intolerance.(21)

**Coffee**

Coffee is among the most widely used beverages worldwide. Coffee contains several substances that may affect glucose uptake and metabolism. Coffee is obtained from the tea leaves, guarana and cola plant seeds. Other sources of coffee are black tea, green tea, white tea and herbal teas. Numerous epidemiological, clinical and/or experimental researches have been conducted on coffee to investigate its effects on cardiovascular diseases, cancers, cholelithiasis, neurological disorders, endocrine disorders, kidney stones and T2 DM.(22) Consumption does impart its significant effects to stop the pathogenesis of T2 DM and should be considered as an alternate supplement along with other anti-diabetic agents (22).

**CONCLUSION**

Insulin resistance and long-term diabetes problems are caused by type 2 diabetes, a clustering of metabolic disorders,





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which is also accompanied by additional pathogenic factors such subclinical inflammation and oxidative stress. Given the growing trend in the incidence of diabetes complications, it is likely that existing medical treatments for the management of diabetes are ineffective and that the use of additional therapies, such as functional foods and their nutraceuticals, might improve the management of diabetes.

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Table 1. Effects

NAME	BENEFIT EFFECT	SIDE EFFECT	REFERENCE
ALPHA LIPOLIC ACID	ALA supplementation prevents early development and progression of DN by exerting anti-hyperglycemic, antioxidant, anti-inflammatory, anti-fibrotic and anti-apoptotic effects. clinical treatment of DN in T2DM patients.	Can affect thyroid function in patients with thyroid disease, might produce allergic skin reactions, abdominal pain, nausea, vomiting, diarrhea, and vertigo.	(8),(7)
VITAMIN D	Vitamin D supplementation as a means of improving glycaemia or insulin resistance in patients with diabetes, normal fasting glucose or impaired glucose tolerance.	Non diabetic patient-VITAMIN D DEFICIENT	(9),(10),(23)
AMINO ACID	AA supplements positively influence metabolic control in elderly subjects with type 2 diabetes. Role in improving blood glucose control and insulin sensitivity		(11)





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CHROMIUM PICOLINATE	CrPic supplementation included reduced blood glucose, insulin, cholesterol, and triglyceride levels and reduced requirements for hypoglycemic medication.	No reported adverse effect	(5)
COENZYME Q10	Improvement in pain and paraesthesia in diabetic neuropathy	No effect on blood glucose, additive effects with antihypertensive drugs	(7),(12),(24)
FLAX SEED	role in the controlling or postponing of development of these secondary complications FS supplementation helped control hyperglycemia and improve lipid profiles.	No major side effect.	(13)
BUTYRATE AND INULIN	ROLE IN CONTROLLING HYPERGLYCEMIA	GASTRO IRRITATION. NO MAJOR SIDE EFFECT	(6)
MAGNESIUM	Insulin secretae, essential in glucose metabolism, prevent diabetic complications, increased insulin sensitivity	Diarrhea, abdominal cramping, magnesium toxicity in individuals with renal failure, antibiotics, drug interactions with drugs to prevent osteoporosis, calcium channel blockers, muscle relaxants, diuretics	(7),(14),(25),
VITAMIN E	Reducing glucose level Nephropathy, retinopathy	Poor glycemic control	(26),(1)
ZINC AND CHROMIUM	Lipid-lowering effects(16), insulin-sensitizing effect by decreasing tyrosine phosphatase activity or direct effect on insulin receptor by increasing tyrosine kinase activity at the insulin receptor may promote glucose transport	Renal toxicity and dermatological reactions, potential hypoglycemia with secretagoggs, steroids may decrease chromium levels, vitamin C may increase chromium absorption	(15),(27),(28)
RESVERATROL	The results reveal that supplementation of resveratrol for 3 months significantly improves the mean hemoglobin Improving glycemic control and cardiovascular control.	No such side effect is shown in the study.	(16),(17)
INULIN	Inulin supplementation may improve some glycemic and antioxidant indices and decrease malondialdehyde levels in women with type 2 diabetes.	Delay gastric emptying. Antioxidative action in colon	(18)
FISH OIL	Lowers triglycerides, antiinflammatory, antiplatelet, hypotensive, slight increase in blood glucose	High intake might cause bleeding, fish meat to be eaten with caution because of contamination with high levels of methyl mercury; may increase LDL, drug interactions with anticoagulant and antihypertension drugs	(4),(7),(29)
VANADIUM	Insulin mimetic, increase insulin	Prolonged high doses may cause	(7)





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	sensitivity	renal toxicity, gastrointestinal upset	
BROCCOLI SPROUTS	Stimulate glucose uptake Decrease H.PYLORI infection Lipid management Prevent cancer Prevent diabetic nephropathy	Endothelial damage Cardiovascular damage	(19)
SOYA AND STEVIOSIDE	Proteins are rich in arginine and glycine, which can influence insulin and glucagon secretion from the pancreas. Delay the onset of diabetes Treatment of hyperglycemia, hypertension and dislipidemia	GIT PROBLEMS , ALLERGIC REACTIONS	(20)
GINSENG	Insulin mimetic, hypoglycemic action, enhances psycho-physiological performance, stimulates immune system, may decrease carbohydrate absorption in portal circulation, may increase glucose transport and uptake, may modulate insulin secretion, alters hepatic glucose metabolism	Estrogenic effect with breast tenderness, amenorrhea, vaginal bleeding and impotence, hypertension, insomnia, interacts with anticoagulant and antiplatelet medications; hypoglycemic agents; corticosteroids; oral contraceptives; digoxin; MAO inhibitors and tricyclic antidepressants; diuretics	(21)
COFFEE	Stimulatory effect on pancreas Secreation of insulin by beta cell is stimulated Effect on post prandial glucose level only	acute myocardial infarction, high blood pressure, increased risk of coronary heart disease and diabetic complications , Acute coronary disease,	(22)





## Visual Support; It's Influence on Communication among Children with Autism Spectrum Disorder

Amjad Hussain<sup>1\*</sup> and Joicey P. Manickam<sup>2</sup>

<sup>1</sup>Research Scholar, PG and Research Department of Rehabilitation Science, Holy cross College (Autonomous) Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

<sup>2</sup>Associate Professor, PG and Research Department of Rehabilitation Science, Holy cross College (Autonomous) Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

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### \*Address for Correspondence

**Amjad Hussain**

Research Scholar,  
PG and Research Department of Rehabilitation Science,  
Holy cross College (Autonomous),  
Affiliated to Bharathidasan University,  
Tiruchirappalli, Tamil Nadu, India.  
Email: amjed.wani@yahoo.com



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### ABSTRACT

A considerable deal of attention among the researchers around the globe has been attracted by autism in recent years. Autism spectrum disorder is a term used to narrate a constellation of early-appearing social communication deficits and repetitive sensory-motor behaviors. The communication difficulties among children with autism are many a times mistakenly perceived as difficulties in speech and language. As autism poses varying challenges in many aspects of life of an individual including the challenges in communication which may range from mild to moderate to severe to profound. Research suggests that in children with autism the language parameter develops much later than their typically developing peers. Recent research however reflects that more than 70 % of children with autism develop their speech just before the age of five years. Visual supports are cognitive tools to empower the production of language and learning many a times employed as an intervention strategy to support children with autism. Though beneficial to this specific population in reducing wide range of challenges in autism, visual supports are strenuous and time consuming to make, distribute and use. The current study was carried out in two special schools (School 1 and School 2). The objectives are set and hypothesis are proposed by the researcher. For the convenience and prosperity of this descriptive study the researcher chose 40 out of 50 respondents in school 1 and 10 from school 2 through simple random sampling. Two self-prepared non standardized tools using communication board and cue card kit are used for the collection of data through interviewing teachers and observation. The collected data is analyzed using various statistical measures including SPSS. Instead of the fact that sampling size for the current study is low, various





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statistical tests of significance suggests that there is significant impact of visual support to augment communication in children with autism.

**Keywords:** Autism Spectrum Disorder, Communication, Visual support, cognitive, challenges.

## INTRODUCTION

Autism Spectrum Disorder (ASD) an umbrella term, is a neurobiological and developmental disorder that has recently been put under the list of 21 disabilities in Rights of Persons with Disabilities (RPWD) act, 2016 which impacts the way they communicate and behave. Recent advancements have made it possible to diagnose it at very early age, though the symptoms often appear in the first two years of life. Autism if diagnosed altogether affects the physical, social, emotional as well as cognitive aspects of life and consequently has an impact on their daily living activities. Moreover, it's very often that the disability is also accompanied with other types of disabilities, e.g., learning disability, mental retardation, low vision, ADHD (Attention Deficit Hyperactivity Disorder) etc. Despite all the restrictions that come alongside this particular disability it's not uncommon to see them grow, learn and develop to quite a large extent in their life which is viable with the right sort of support they receive from the family and society they live in. The disability of autism has a significant impact on the social life of an individual especially in communication that fluctuates from initiating to maintaining interactions with their fellow mates. They develop their natural speech at an age very late than their peers without autism which consequently has marked impact on the other aspects of the life. Pictures, cards can make the conversation meaningful as the children with autism are many times called as visual learners. Visual strategies reflect the use of visual tools and supports that are put to use for amplifying the communication process. Stretching from body language, facial expression, objects and pictures to charts and posters, visual tools further effective reception, processing, feedback and action. Because of the fact that information conveyed through visual tools is stagnant and speculated, it permits the child with autism to rely on recognition instead of recall memory, to gain language input and to produce language output. Research conveys that pictures and word schedules can subside anxiety and foster independence in activities and their transitions. Additionally, if the words spoken by the peers without autism are supported with simple visuals can augment the comprehension. The most paramount reason to use visual support is the help that it provides to obtain and ameliorate comprehension, lessen fear and anxiousness, support relevant behavior and participation, enhancement of expressive mode of communication and to teach self-regulation.

## COMMUNICATION PROBLEMS IN CHILDREN WITH AUTISM

Individuals with autism exhibit difficulties in more or less all aspects of communication which we take mostly for granted, like their ability to comprehend and use verbal as well as non-verbal communication and to start off a conversation.

1. Echolalia: The child repeats whole or part of what has just been said or asked.
2. Auditory processing deficits: Lack of ability to comprehend and interpret spoken language.
3. Problems with prosody: Difficulty in patterns of stress and intonation in a language.
4. Pragmatic language difficulties: Difficulty in communicating effectively and efficiently.

## STRATEGIES TO ENHANCE NON-VERBAL COMMUNICATION

1. Signing
2. Pictographs (Line Drawing)
3. Photographs/Objects
4. PECS (Picture Exchange Communication System)
5. AAC (Alternative and Augmentative Communication)



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## REVIEW OF LITERATURE

A study by Dettmer, S et al. (2000), reveals that while employing visual support there is considerable reduction in the latency between the time the students were provided instruction and the time they start off their adjoining activity. The findings from a study by K S Thiemann and Goldstein (2001), endorses for implementing visual cued strategies to direct the social language social language development of young population of autism as they intercommunicate with the mainstream fellows without disabilities. Investigation attempts by Kathy S. Thiemann and Howard Goldstein (2003), recommends the use of written text cues to boost their social interactions with peers. Teaching On-Task and On-Schedule behaviors to children with autism through picture activity schedules reflects increment in performance of students with autism in a study conducted by Linley C. Bryan and David L. Gast (2004). In an experimental study by RubinaLal and Meeta Bali (2007), the outcome conveys that visual strategies were noted to be more efficacious in development of interactive skills in children ranging from age of 5 years to 11 years. Furthermore, PECS (Picture Exchange Communication System) mode of instruction points out concomitant augmentation in production of speech, either in initiating a purposeful communication or in responding or both discloses research by Carr D. Felce J (2007). An experimental study by Panerai S et al. (2009) suggests that TEACCH (Treatment and Education of Autistic and related Communications Handicapped Children) program enhances the result of the experimental group in contrast to controlled group using non-specific approaches.

## MATERIALS AND METHODS

### RESEARCH DESIGN

Descriptive research design is employed by the researcher to carry out the study.

### UNIVERSE AND SAMPLING

For the prosperity of the study the researcher chose 40 out of 50 respondents in school 1 and 10 from school 2 through simple random sampling.

### HYPOTHESIS

1. There is no significant association corresponding to attention and organizing routine in communication of children with autism through picture cards.
2. There is no significant association in regard to attention and expressing needs/choice making in communication of children with this disability of autism through picture cards.
3. There is no significant association with regard to memory and activity schedule in communication of children with autism through picture cards.

## Variables

### Independent Variables

1. Age
2. Gender
3. Level of autism
4. Language spoken
5. Type of communication
6. Echolalia

### Dependent Variables

1. Visual time tables
2. Activity schedule
3. Sharing information
4. Express needs/choice making



**Amjad Hussain and Joicey P. Manickam****Description of Tool**

Pertaining to the study, the data collection tool used is non-standardized and self-prepared, comprised of questionnaire, communication board and cue card kit.

**Procedure for Data Collection**

Post selection of topic the objectives for the study are selected and later permission from the authorities of the respective schools is sought for the prosperity of this research. Moreover, the teachers and parents are interviewed to gain the requisite data of predetermined questionnaire in addition to observation of children with autism during the course of their social interaction with their fellow mates. The collected data is analyzed using various statistical measures including SPSS. Instead of the fact that sampling size for the current study is low, various statistical tests of significance suggests that there is significant impact of visual support to augment communication in children with autism.

**Significance**

The communication difficulties among children with autism are many a times mistakenly perceived as difficulties in speech and language. As autism poses varying challenges in many aspects of life of an individual including the challenges in communication which may range from mild to moderate to severe to profound. Research suggests that in children with autism the language parameter develops much later than their typically developing peers. Visual supports are cognitive tools to empower the production of language and learning many a times employed as an intervention strategy to support children with autism. The study unveils the description of impact of visual support in communication of children with autism.

**RESULTS AND DISCUSSIONS**

For the prosperity of the study the researcher chose 40 out of 50 respondents in school 1 and 10 from school 2 through simple random sampling. The collected data unveils that 52% respondents are reported using verbal communication. During their communication through picture cards, 37.6% respondents always initiated eye contact, 8% have interest in using picture cards, 13.6% always took lead or nod, 30.4% always got distracted using picture cards and 11.2% asked for more while communicating with fellow mates.

**CONCLUSION**

Employed significance tests (t-test, chi-square test) reveal that (a) There is no significant association corresponding to attention and organizing routine in communication of children with autism through picture cards, (b) There is no significant association in regard to attention and expressing needs/choice making in communication of children with this disability of autism through picture cards and (c) There is no significant association with regard to memory and activity schedule in communication of children with autism through picture cards. Through the course of this study it is reported that plenty of respondents demonstrate strength in comprehending visual information in contrast to their ability to respond to what they hear.

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#### **Conflict of Interest**

I declared there is no potential conflict of interest with respect to this research study.

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## VLSI Implementation of Sobel Edge Detector using Mode Selection-Based Hybrid Reconfigurable Adders

Telugu Maddileti<sup>1</sup>, P.Manmohan Shashank Varma<sup>2\*</sup> and P.Nandha Kumar

<sup>1</sup>Associate Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>2</sup>PG Scholar, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

<sup>3</sup>Assistant Professor, Department of ECE, Malla Reddy Engineering College, Secunderabad, Hyderabad, Telangana 500100, India.

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### \*Address for Correspondence

**P.Manmohan Shashank Varma**

PG Scholar, Department of ECE,  
Malla Reddy Engineering College,  
Secunderabad, Hyderabad,  
Telangana 500100, India.  
Email:shashankvarma@gmail.com



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### ABSTRACT

The Sobel Edge Detector is essential to the operation of a great deal of software for digital image processing, such as programmes for pattern identification and area detection, amongst others. The hardware implementation for sobel edge detection is the essential to meet the specifications of these applications. However, the conventional methods are suffering with improper edge estimations with higher hardware resource utilizations. Therefore, this work is focused on implementation of hybrid sobel edge detector (HSED) using half sum-carry generation square root carry select adders (HSCG-SQRT-CSLA). In practice, the HSED process is carried out by conducting a matrix multiplication between the pixel values of the picture and the HSED. Further, this matrix multiplication operation is performed through successive HSCG-SQRT-CSLA additions. In addition, subtraction in matrix multiplication process is achieved by twos complement addition through HSCG-SQRT-CSLA. The simulations demonstrated that the suggested HSED resulted in improved performance when compared to the more traditional edge detection approaches.

**Keywords:** Hybrid sobel edge detector, half sum-carry generation, square root carry select adders, twos complement addition.





## INTRODUCTION

The design of edge detector-based VLSI circuits needs to be improved for the development of VLSI technology [1]. In order to improve the controllability and observability methods of edge detector, partitioning and random test pattern are necessary. The edge detector methods should cover 90% of perfect edge coverage [2]. The edge detector-based VLSI circuits with more than 20000 gates can be implemented in simulation. The cost of perfect edge simulation is also to be reduced. Certain guidelines need to be followed in designing of VLSI circuits to make the edge detector-based VLSI simple and perfect edge free [3]. The factors such as test strategy, initialization, synchronous system, test mode logic, wired logic, floating signals, one shot, clock control, power on reset and analog modules are to be considered for the best design of VLSI circuits [4]. The test strategy is to be identified at the time of designing itself. Proper test strategy is not determined at the beginning it will be too difficult to identify the perfect edge at later stage. In order to test the VLSI circuit, it is to be driven from a known state [5]. When a reset signal is received, all of the digital circuits, including flip-flops, counters, latches, registers, and so on, must have their starting values fed into them in order to function properly as edge detectors [6]. These initial values are to be loaded by a separate driven circuit. It reset signal is given the driven circuit will load the initial values. This initialization is to be done before test vectors is passed to the circuit under test. All the components in the VLSI circuit are to be synchronized to avoid race condition [7]. The clock and reset signals are the two types of signals specifically designed for proper synchronization of VLSI circuits. Certain hardware is specifically designed in the chip for edge detector purpose [8]. This hardware is separated from the normal functions of the chip. In the test mode logic various components of chip is detected. The VLSI input output pins are multiplexed for normal operation and edge detector mode operation. The number of pins used for this purpose is maintained as minimum as possible. The wired AND, wired OR logic sometimes creates problems during edge detector. This can be avoided by using AND/OR logic or OR/AND logic [9]. The floating signals need to be monitored carefully, otherwise it can store charge in the temporary capacitor which act as a dynamic RAM. This memory will be refreshed and make some changes in data stored in the static memory. In order to get good reliability, the floating signals are to be avoided. One stable multivibrator is unstable during edge detector [10]. The use of one stable multivibrator is to be avoided, instead counters, logic gates and time generating circuits. The one-shot circuits will not be compatible with synchronous design circuits. As a result, the most significant contributions that this study has made are as follows:

- Execution of HSED using matrix multiplication between image pixel values to the HSED through HSCG-SQRT-CSLA.
- Construction of novel HSEDs and matrix multiplication operation is performed through successive HSCG-SQRT-CSLA additions.
- Subtraction in matrix multiplication process is achieved by twos complement addition through HSCG-SQRT-CSLA.

The remaining parts of the article are structured as follows: The essay is concluded with some potential future directions in section 5, after which sections 2 and 3 deals with the literature review, section 3 with the suggested implementation of HSED, section 4 with the analysis of data with performance comparison, and section 2 with the conclusion.

### Literature survey

In [11] authors used the two-point crossover for the edge generation. The crossover points are created randomly. There is a 50% possibility of each chromosome in the chromosome pair to appear in the new edge. The new chromosome pair inherits the properties of parent chromosomes. The same procedure is repeated till the whole population of chromosomes pair have been created. In [12] authors have introduced mutation operator to create diversity in the edge. Adaptive mutation is followed to create new population. The mutation probability rate considered for this test pattern generation is 1% and this may be increased to higher values to generate a greater number of populations if there is no perfect edge coverage in three successive generation of genetic algorithm with respect to Global Record Table [13]. The delay test system uses mutation property. External clock control can be used by the VLSI circuit for edge detector purpose by disabling the input clock generator. The use of external clock signal



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avoids race condition. The race condition normally takes place in master slave flip flop [14]. If the internal clock generator is not manageable during edge detector, then the need of external clock generator arises. The power on reset is an option available in VLSI circuits for function during the start of the particular applications [15]. But during edge detector the power on reset option is not necessary and it should be bypassed. The edge detector for power on reset is also necessary.

Additional circuits for bypassing the power on reset hardware during edge detector should be included in the design stage itself [16]. Analog circuits such as amplifiers, analog to digital converter, digital to analog converter comparators etc. may be presented in the VLSI chip. A Separate control for analog circuit is necessary for edge detector; otherwise, it will create short circuit or race condition in the circuit. The isolation of analog and digital circuit is necessary for the proper implementation, design and edge detector-based VLSI circuits [17]. The fitness function and the perfect edge simulation function [18] in relation with the global record table allow the scoring function to assign fitness value to a chromosome pair. The perfect edge coverage of the chromosome is satisfactory then the chromosome pair will enter into the delay test. Then the chromosome pair is then updated in the Global Record Table. In [19] authors designed a new infrastructure design analog and digital system. In this new structure the System on Chip (SOC) is combined with the analog cores for efficient edge detection. The remaining parts of the article are structured like this: The article is concluded with a discussion of possible future directions in section 5, after which sections 2 and 3 deal with the literature review, section 3 with the proposed implementation of HSED, section 4 with the analysis of results and performance comparison, and section 2 with the conclusion. The audio CODEC circuits are combined with SOC in cellular phone applications. This infrastructure circuits can be detected in this design. The test wrapper infrastructure circuit consists of digital test control circuit, digital RTCED clock, serial to parallel conversion registers.

The high-speed image edge detection (HSIED) [21] circuit can be combined with other RTCED techniques. The requirement of the analog signal for the RTCED can be obtained from the HSIED. This RTCED approach reduces the edge detector time and overall cost of the system [22]. This HSIED optimization easily handles the analog cores and digital circuits easily. The area of the system is also reduced. The experimental result of edge detector the SOC with the analog cores is presented. In [23] authors proposed digital fuzzy system edge detection (DFSED) algorithm for open defects in the VLSI circuits. The open circuit may take place in two layers of the digital circuits such as inter layer opens and intra layer opens. A branch and bound algorithm were designed, which reduces the functions of ATPG. The flow is designed for detecting the open circuit perfect edge and analyzing the parameters of the digital circuits [24]. By tracking the fan-out structure the interconnect open can be detected. Edge open defect model is designed for the inter layer and intra layer open defects. Energy efficient sobel edge detection (EESD)[25] is used for this model. This model functions by extracting the layout capacitances values obtained from the circuit layout. The open circuit defect model is combined with automatic test pattern generation to improve the edge detector.

**Proposed Method**

The HSED takes less time to calculate than the traditional Roberts, canny, and prewit edge detection techniques, but because of its wider convolution kernel, which more thoroughly smooths the input picture, the operator is less sensitive to noise. In comparison to Roberts's edges, the operator often yields output values that are noticeably greater for comparable edges. For picture formats that only permit modest integer pixel values, the operator's output values may quickly exceed the maximum permissible pixel value, similar to the Roberts Edge detection (e.g., 8-bit integer images). The remaining portions of the article are structured as follows: The article is concluded with a discussion of possible future directions in section 5, after which sections 2 and 3 deal with the literature review, section 3 discusses the proposed implementation of HSED, section 4 discusses the analysis of results along with a performance comparison, and section 2 deals with the literature survey. Using an image type that allows pixel values with a wider range can help you avoid the issue. Due to the HSED's smoothing effect, lines with natural edges in photos often result in output images that are several pixels wide. To combat this, some thinning could be beneficial. If it doesn't work, hysteresis ridge tracking could be used, similar to the Canny operator. The HSED is able to identify portions of an image that have a high spatial frequency and which correlate to edges by carrying out a





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measurement of the two-dimensional spatial gradient on the picture. In most circumstances, it is used to find out the estimated absolute magnitude of the gradient at each place in a grayscale input picture. This is the case because grayscale images include gradients that vary in magnitude. At least in principle, the operator may be partitioned into two convolution kernels, each of which has a total of 33 nodes, as is seen in Figure 1. The other kernel is simply rotated through 90 degrees to create one kernel.

The HSED is able to emphasise parts of an image that have a high spatial frequency and which correlate to edges thanks to a measurement that it does on an image that is called a two-dimensional spatial gradient. The majority of the time, it is used in order to determine the estimated absolute magnitude of the gradient at each place in a grayscale input picture. As can be seen in Figure 1, the operator may, at least in principle, be partitioned into two convolution kernels, each of which has a total of 33 nodes. It is therefore possible to calculate the absolute gradient magnitude at each location as well as the direction of the gradient by combining them. It is possible to determine the magnitude of the gradient by:

$$|G| = \sqrt{G_x^2 + G_y^2} \tag{1}$$

An approximate magnitude is often calculated using:

$$|G| = |G_x| + |G_y| \tag{2}$$

The HSED is able to emphasize areas of an image that have a high spatial frequency and which correlate to edges thanks to a measurement that it does on an image that is called a two-dimensional spatial gradient. In most circumstances, it is used to find out the approximate absolute magnitude of the gradient at each point in a grayscale input picture. This is the case since the magnitude of the gradient might vary significantly depending on the position in the image. As can be seen in Figure 1, the operator may, at least in principle, be decomposed into two convolution kernels, each of which has a total of 33 nodes.

$$\theta = \arctan(G_y/G_x) \tag{3}$$

The HSED is able to identify parts of an image that have a high spatial frequency and which correlate to edges by carrying out a measurement of the 2-D spatial gradient on the picture. In most circumstances, it is used to find out the approximate absolute magnitude of the gradient at each point in a grayscale input picture. This is the case since the magnitude of the gradient might vary greatly depending on the position in the image. As can be seen in Figure 1, the operator may, at least in principle, be segmented into two convolution kernels, each of which has a total of 33 nodes. It stands for pseudo-convolution kernels that are swiftly utilized to calculate the estimated gradient magnitude.

Further, the  $G_x$  and  $G_y$  are derived by performing the dot-wise matrix multiplication between  $G_x$  kernel and  $G_y$  kernels to the 3x3 patch of image.

$$G_x = (P_3 + 2P_6 + P_9) - (P_1 + 2P_4 + P_7) \tag{4}$$

$$G_y = (P_1 + 2P_2 + P_3) - (P_7 + 2P_8 + P_9) \tag{5}$$

The estimated magnitude may be calculated using this kernel as follows:

$$|G| = |(P_1 + 2P_2 + P_3) - (P_7 + 2P_8 + P_9) + (P_3 + 2P_6 + P_9) - (P_1 + 2P_4 + P_7)| \tag{6}$$

Here,  $P_1$  to  $P_9$  represents the image pixels. Equation 6 represent the magnitude of Sobel edge detection process, which consisting of additions, subtractions, and multiplication by factor 2. Figure 3 illustrates the VLSI design of HSED, which is then put into action by the application of Equation 6.





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The VLSI design of HSED may be seen shown in Figure 3, and it is put into action with the help of Equation 6. Here, multiplication by factor 2 is implementable by introducing the left shifting operation. Further, this matrix multiplication operation is performed through successive HSCG-SQRT-CSLA additions. In addition, subtraction in matrix multiplication process is achieved by twos complement addition through HSCG-SQRT-CSLA.

**Proposed HSCG-SQRT-CSLA**

The HSCG-SQRT-CSLA is an improved version of conventional SQRT-CSLA, which is generated by incorporating the HSCG, SCS modules as shown in Figure 4. The conventional SQRT-CSLA does not able to select the carry outputs and sum outputs parallelly, which is overcome in HSCG- SQRT-CSLA by introducing the SCS block. The VLSI design of HSED may be seen shown in Figure 3, and it is put into action by the application of Equation 6. The multiplexer-based selection logic also minimizes the logical delays and propagation delays. Here, multiplexer is used to select the carry of AND outputs and sum of XOR outputs. Here, CIN provides the input to the multiplexer selection purpose. If CIN is zero, the XOR of inputs will be selected; else XNOR of inputs will be selected and resulted in SUM output. Table 1 depicts the truth table of the proposed HSCG-SQRT-CSLA, which consist of A, B, CIN as inputs with SUM, CARRY as outputs, XOR, ~XOR, OR, AND are the temporary outcomes.

Further, HSCG-SQRT-CSLA is developed by using HSCG-SCS-Full adder modules. Initially, HSCG-SCS-RCA is developed, which is replaced by conventional RCA modules as shows in Figure 5. The proposed structure of the HSCG-SCG SQRT-based CSLA has been updated from the structure of the prior SQRT-based CSLA in order to accommodate this adding procedure. The earlier modules of traditional CSLA were built using RCA-based structures, and then those structures were updated with RCA-BEC-based structures. At this time, those structures have been further developed to include HSCG and SCS units. SCS will be able to shorten the critical path by using this approach of adding in the processes of HSCG, as well as get rid of the superfluous arithmetic functions and logic operations in sequences. In the long run, arithmetic operations benefit from this adder's ability to cut down on the size of the logic and the propagation latency.

**RESULTS AND DISCUSSIONS**

For the creation of each and every HSED design, the Xilinx ISE software was used. This piece of software has been designed to provide two distinct kinds of outputs, namely simulation and synthesis. The findings of the simulation allow for a comprehensive investigation of the HSED architecture with regard to the various combinations of input and output byte levels. A simple decoding technique may be approximated by applying a large number of different combinations of inputs and watching a wide variety of outputs while doing a simulation study of accurate encoding. As a consequence of the conclusions of the synthesis, the use of space in proportion to the number of transistors will be carried out. In addition, a time summary will be acquired with reference to the different route delays, and a power summary will be generated making use of the static and dynamic power consumption. Both of these summaries will be done. The results of running the HSED simulation are shown in figure 6. In this situation, P0, P1, P2, P3, P4, P5, P6, P7, and P8 are the input pins, and each of them has 64 bits, while out is the output port, which has 65 bits.

The design (area) overview of the suggested technique may be seen in Figure 7. In this case, the suggested technique makes use of a very small portion of the available slice LUTs, namely 1117 of the total 17600. The timing breakdown of the suggested technique is shown in Figure 8. In this instance, the suggested procedure used a total of 21.217ns of time delay, of which 1.720ns of delay was logical and 19.4974ns of delay was route. The report on the power consumption of the proposed HSED may be seen in Figure 9. In this scenario, the suggested approach has a power consumption of 0.166 watts. The results of the performance assessment of several HSED approaches are compared in Table 2. In this case, the proposed HSED resulted in superior (reduced) performance in terms of LUTs, time-delay, and power consumption in comparison to conventional approaches such as Optimized RTCED [20], HSIED [21], and DFSED [23]. This was the case because the proposed HSED resulted in fewer LUTs, a shorter time-delay, and lower power consumption.





## CONCLUSION

The implementation of HSED using HSCG-SQRT-CSLA is the main goal of this work. By applying the matrix multiplication of image pixel values to the HSED, the HSED operation is carried out. Additionally, this matrix multiplication operation is carried out using a series of additions using the HSCG-SQRT-CSLA formula. Additionally, the HSCG-SQRT-CSLA twos complement addition method is used to accomplish subtraction in the matrix multiplication process. Based on the results of the simulations, the newly suggested HSED performed much better than the conventional edge detection methods. Combined edge detection approaches such as sobel-canny and sobel-prewit that use modified adders and subtractors can be used to enhance the scope of this study.

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**Table 1. Verification table of HSCG-SCS-Full adder**

A	B	CIN	-XOR	XOR	AND	OR	SUM	CARRY
0	0	0	1	0	0	0	0	0
0	0	1	0	1	0	1	1	0
0	1	0	0	1	0	1	1	0
0	1	1	1	0	1	1	0	1
1	0	0	1	1	0	0	1	0
1	0	1	0	0	0	1	0	1
1	1	0	0	0	0	1	0	1
1	1	1	1	1	1	1	1	1

**Table 2. Performance Comparison.**

Metric	RTCED [20]	HSIED [21]	DFSED[23]	Proposed HSED
LUTs	2913	2448	1572	1117
Time delay (ns)	43.28	32.284	.453	21.217
Power consumption (w)	1.49	1.34	1.049	0.166

<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; padding: 5px; text-align: center;">-1   0   +1</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">+1   +2   +1</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px; text-align: center;">-2   0   +2</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">0   0   0</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px; text-align: center;">-1   0   +1</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">-1   -2   -1</td> </tr> </table> <p><b>Figure 1. Sobel convolution kernels, (a) <math>G_x</math> kernel, (b) <math>G_y</math> kernel</b></p>	-1   0   +1	+1   +2   +1	-2   0   +2	0   0   0	-1   0   +1	-1   -2   -1	<table style="margin: auto; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_1</math></td> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_2</math></td> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_3</math></td> </tr> <tr> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_4</math></td> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_5</math></td> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_6</math></td> </tr> <tr> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_7</math></td> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_8</math></td> <td style="border: 1px solid black; padding: 2px 5px;"><math>P_9</math></td> </tr> </table> <p style="text-align: center;"><b>Figure 2: 3x3 patch of image.</b></p>	$P_1$	$P_2$	$P_3$	$P_4$	$P_5$	$P_6$	$P_7$	$P_8$	$P_9$
-1   0   +1	+1   +2   +1															
-2   0   +2	0   0   0															
-1   0   +1	-1   -2   -1															
$P_1$	$P_2$	$P_3$														
$P_4$	$P_5$	$P_6$														
$P_7$	$P_8$	$P_9$														





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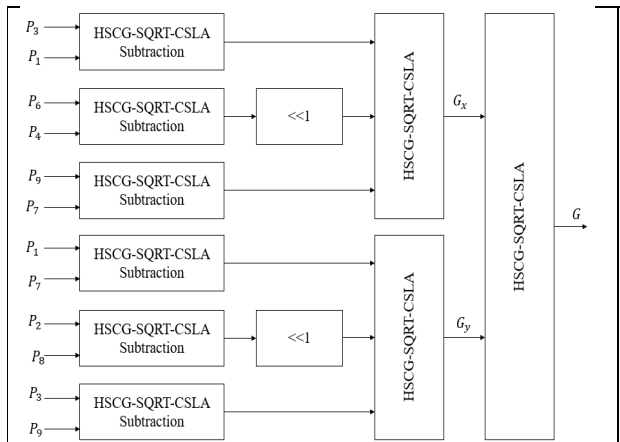


Figure 3. Proposed HSED Architecture.

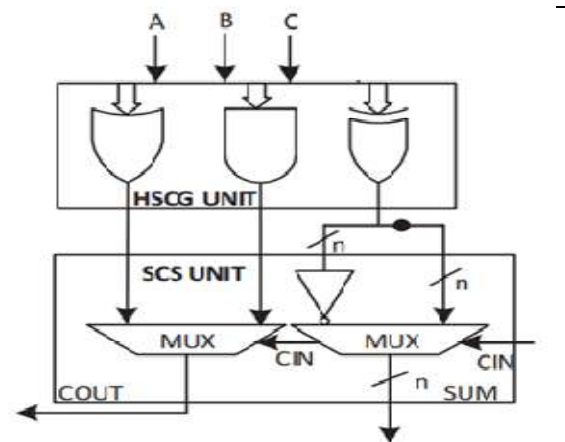


Figure 4. HSCG-SCS-Full adder

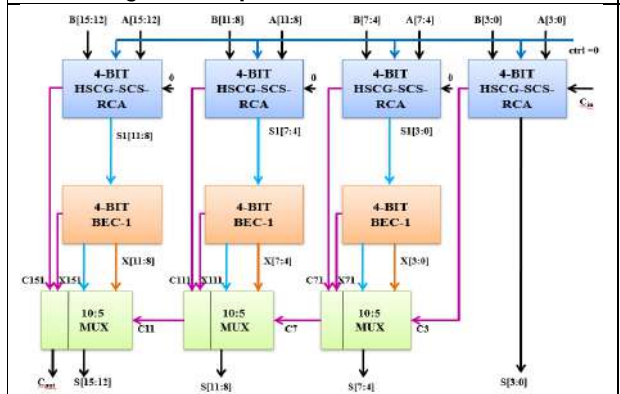


Figure 5. Architecture of HSCG-SQRT-CSLA.

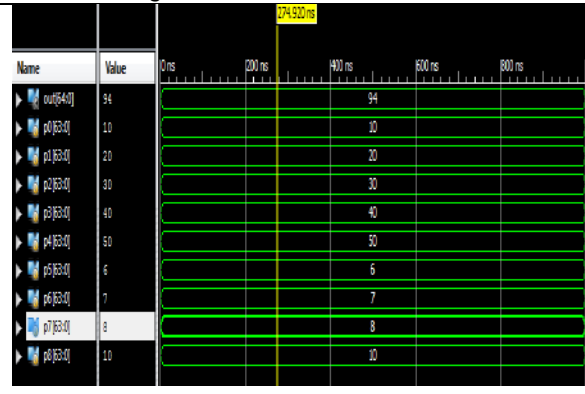


Figure 6. Simulation outcome of HSED

Device Utilization Summary (estimated values)			
Logic Utilization	Used	Available	Utilization
Number of Slice LUTs	1117	17600	6%
Number of fully used LUT-FF pairs	0	1117	0%
Number of bonded IOBs	573	100	573%

Figure 7. Design summary.

Name	Value	0 ns	200 ns	400 ns	600 ns	800 ns
LUT6:I2->0	1	0.043	0.343	A9/RK1/a6/gc_16/f2/z3_SWO (N1072)		
LUT6:I4->0	8	0.043	0.582	A9/RK1/a6/gc_16/f2/z3 (A9/RK1/g6<31>)		
LUT6:I0->0	2	0.043	0.293	A9/RK2/a5/gc_0/f2/z1 (A9/RK2/a5/gc_0/f2/z1)		
LUT6:I5->0	8	0.043	0.582	A9/RK2/a5/gc_0/f2/z1 (A9/RK2/g5<7>)		
LUT6:I0->0	6	0.043	0.573	A10/RK2/s1/p0_0/f2/q1 (A10/RK2/p1<8>)		
LUT6:I0->0	5	0.043	0.561	A10/RK2/s2/bc_8/f2/a_c_AND_2_01 (A10/RK2/p2<8>)		
LUT5:I0->0	3	0.043	0.466	A10/RK2/s3/bc_8/f2/a_c_AND_2_01 (A10/RK2/p3<8>)		
LUT4:I0->0	5	0.043	0.569	A10/RK2/s4/bc_8/f2/a_c_AND_2_01 (A10/RK2/p4<8>)		
LUT6:I3->0	4	0.043	0.442	A10/RK2/s5/bc_0/f2/z (A10/RK2/g5<15>)		
LUT6:I3->0	1	0.043	0.343	A10/RK2/s6/gc_16/f2/z3_SWO (N1066)		
LUT6:I4->0	4	0.043	0.556	A10/RK2/s6/gc_16/f2/z3 (A10/RK2/g6<31>)		
LUT5:I0->0	5	0.043	0.508	A11/RK1/s2/gc_0/f2/z1 (A11/RK1/g2<0>)		
LUT5:I4->0	6	0.043	0.451	A11/RK1/s3/gc_1/f2/z1 (A11/RK1/g3<2>)		
LUT6:I3->0	2	0.043	0.347	A11/RK1/s5/gc_7/f2/z1 (A11/RK1/s5/gc_7/f2/z1)		
LUT6:I4->0	2	0.043	0.554	A11/RK1/s5/gc_7/f2/z1 (A11/RK1/g5<14>)		
LUT6:I0->0	1	0.043	0.279	A11/RK1/s7/bac2_0_g3<11>_14_woc0<1 (out_15_OBUF; OBUF:I->0		
OBUFF:I->0	0.000			out_15_OBUF (out<15>)		
Total		21.217ns	(1.720ns logic, 19.497ns route) (8.1% logic, 91.9% route)			

Figure 8. Time summary





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A	B	C	D	E	F	G	H	I	J	K	L	M	N		
Device		On-Chip		Power (W)	Used	Available	Utilization (%)	Supply Summary		Total	Dynamic	Quiescent			
Family	Virtex4	Clocks	0.000	1	--	--	Source		Voltage	Current (A)	Current (A)	Current (A)			
Part	xc4vfx12	Logic	0.000	23	10944	0	Vccint		1.200	0.071	0.000	0.071			
Package	sf363	Signals	0.000	38	--	--	Vccaux		2.500	0.031	0.000	0.031			
Temp Grade	Commercial	DCMs	0.000	0	4	0	Vcco25		2.500	0.001	0.000	0.001			
Process	Typical	IOs	0.000	18	240	8									
Speed Grade	-12	Leakage	0.166												
		Total	0.166							Total	Dynamic	Quiescent			
Environment		Thermal Properties		Effective TJA	Max Ambient	Junction Temp	Supply Power (W)		0.166	0.000	0.166				
Ambient Temp (C)	50.0			(C/W)	(C)	(C)									
Use custom TJA?	No			14.7	82.6	52.4									
Custom TJA (C/W)	NA														
Airflow (LFM)	250														
Characterization															
PRODUCTION	v1.0.02-02-08														

**Figure 9. Power Summary.**





## Impact of Multi Media on Behaviour of Students with Intellectual Disability

Rayees Zahoor Shah<sup>1\*</sup> and P.Swarnakumari<sup>2</sup>

<sup>1</sup>Research Scholar, PG and Research Department of Rehabilitation Science, Holy Cross College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

<sup>2</sup>Associate Professor and Dean of Research, PG and Research Department of Rehabilitation Science, Holy Cross College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

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### \*Address for Correspondence

#### Rayees Zahoor Shah

Research Scholar

PG and Research Department of Rehabilitation Science

Holy Cross College (Autonomous)

Affiliated to Bharathidasan University,

Tiruchirappalli.

E. Mail: rayeeszahoor@gmail.com



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### ABSTRACT

Behavioral challenges are persistent in children with intellectual disability regardless of the underlying etiology. These behavioral challenges are often chronic and various types of them are present together in the children disabling the children further. Multimedia has a particularly detrimental effect on the behavior of students with intellectual disability. Multimedia can stimulate the imagination of the students and open up the opportunities, stories have a role in the emotional development of the student. Mass media develop inter and intra personal intelligences. Present study describes the impact of multimedia on the behaviors of students with Intellectual disability. Researcher used descriptive research design for this study. Special schools for intellectual disability were chosen as the centers for collection of data. About 50 samples of students with intellectual disability were chosen. The study finds that 66 percent of students have the habit of watching television regularly, 40 percent sample remembers the concepts by listening the music. 54 percent sample improves vocabulary by listening the radio programs.

**Keywords:** Intellectual disability, challenging behaviors, multimedia





## INTRODUCTION

### Intellectual Disability – An Overview

Intellectual disability is not an easy phenomenon or process but is a complex one. It is a developmental disability and generally refers to substantial constraints in present functioning reflected in inappropriate or immature reactions to one's environment and below average performance in academic, psychological, physical, linguistic and social domains. Rights of persons with disabilities act 2016 defines Intellectual disability a condition characterized by significant limitation in both intellectual functioning (reasoning, learning, problem solving) and in adaptive behaviors which covers a range of everyday social and practical skills. Sub average general intellectual functioning which originates during the developmental years and is associated with impairment in adaptive behavior. Severity of intellectual disability is based on the levels of intellectual quotient: Mild (IQ =55-69), moderate (IQ=40-54), severe (IQ=25-39), profound (IQ below 25).

Students with intellectual disability are with Challenging behaviors which often exist because of being inadvertently reinforced. Usually, people called it problematic behaviors because it resides a list of problems with it, challenging behavior's present the challenges to the professional like rehabilitation professionals, special educators, care givers and the families, in which they have to work, plan and to overcome the child with these behaviors. Children with intellectual disability having these problems are not problems to be fixed as child is doing nothing wrong but the behaviors in child which are the signs of not working properly means that there is a bafflement or need or in communication. Challenging behaviors may be self-injurious, aggressive, stereotyped, and non-person directed behaviors.

### Multimedia and the Intellectual Disability

One of the notable changes in our social environment in the modern times has been the saturation of behavior with the mass media. Unfortunately, the consequences on particular common electronic element of the mass Multimedia have a particularly detrimental effect on the behavior of children. The use of multimedia has become the need due to different reasons. The technological advancement has bought the use of sophisticated hardware and software like radio, television, tape recorder, films etc. The professionals like teachers, today employ numerous multimedia instruments like information communication technology (ICT) supported methods and materials in the classroom to enhance the teaching learning process more effectively. But at the same time children with disabilities also needs to use these technologies. There is need for inclusion and it is the fundamental right of children with disabilities to get education in regular or special schools. The use of multimedia technology for the students with intellectual disabilities as per the research is very affective as these children are with the behavior challenges which makes very complications in handling of these children in the classrooms and at home. Television is one such media which can serve as a wonderful storyteller, animated videos, pictures serve as an entertainment as well as the reduction of hyperactivity. Students with intellectual disabilities when given exposure of stories will enjoy the same and there will be improvement in the behavior. Multimedia can stimulate the imagination of students and open up the opportunities, stories have a role in the emotional development of the child. Mass media develop inter and intra personal intelligences. Play is also important as through play children will get interaction with others get exposure of others behavior and plays magnificent role in the emotional development of the child.

### Significance

Multi media has an ability to create positive changes in the behavior of students with intellectual disability, through the multimedia modalities communication can be improved by the exposure of different instruments of multimedia. Students with intellectual disability are given the exposure of television, radio, computer, videogames, audio books etc. the study attempts to find the impact of multimedia on the behavior of students with intellectual disability. Understanding the positive impact and its awareness to the teachers and parents will help in getting the students in the right path of development. The results of the study hopefully will be very beneficial to the parents and





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professionals working with intellectually disabled children to overcome challenging behaviors in the students with intellectual disability.

#### Objectives

- To study the impact of multimedia on the behavior of students with intellectual disability.
- To find the impact of radio and television, Cellphones, computer on behavior of students with intellectual disability.
- To study the demographic variables of the sample.

## RESEARCH METHODOLOGY

#### Research Design

Researcher has used descriptive research design for this research

#### Universe and Sampling

Sample was collected in special schools in Tiruchirappalli district of Tamil Nadu, a total of fifty samples were collected for the purpose of this study.

#### Special School Selection

Special school of the Holy Cross College, Tiruchirappalli named Blossoms opportunity special school was selected for the collection of data.

#### Selection of Respondents

students with intellectual disability already diagnosed in the age group of 05- 20 years were selected as the samples of the study.

#### Variables

Independent variable

- Age
- Gender
- Birth order
- Number of siblings
- Occupation of Guardians
- Religion
- Onset Of Disability
- Locality
- Type of Intellectual disability

Dependent variable

- Impact of television
- Impact of books
- Impact of radio
- Impact of cell phones

#### Description of Research Tool

Researcher used self-prepared questionnaire to collect the details from respondents. The questionnaire consists of four major details consisting of questions on books, television, cell phones etc.







### Collection of Data

Data was collected by the method of interview with parents and teachers and the direct observation of the students with intellectual disability.

## RESULTS AND DISCUSSION

Table 1. Depicts that 34 percent of students are from the age group of 11-15 years and 38 percent are from 15-20 years. Male students are about 58 percent which outnumber the percentage of females. First order born students are about 62 percent. 66 percent of students have one or two siblings. In case of parent's occupation most of them are coolie workers. The disability is genetic in 64 percent of the sample. Majority of the sample is from urban location. Most of the sample is the students with mild intellectual disability which is also shown in fig 1. Table 2 describes that more than half of the students about 66 percent watch television most of the times, habit of reading is same in all the students, half of the sample shows that they rarely use computer. Table 3 describes that 387 percent of the sample try to read alphabets in calendars, shops and buses. 32 percent among them are showing interest in playing games that comes in newspapers and magazines daily. 76 percent of the sample never try to explain the content. 58 percent of the sample rarely watch or read stories in books finally 70 percent of the total sample rarely use the words which they have read in the books.

Table 4 depicts that 40 percent of the sample sometimes listens the songs on radio and sing with the song together. 44 percent of the sample sometimes remember the concepts by listening the radio songs. 54 percent of the sample rarely improve their vocabularies by listening the radio program. 50 percent of the sample hardly improves their attention and concentration on listening the radio. Finally, 44 percent of students rarely try to speak out the words which they have heard through the radio. Table 5 shows that about 48 percent of the sample rarely shows the interest to speak on phone. About half of the sample rarely improves attention on using the phone. Game Playing on phone is also rare. Students find it difficult to identify the pictures on the phone. Table 6. shows that about 58 percent of students imitate the actions they saw on watching television. About 44 percent of the sample sometimes repeats and use dialogues seen on television. About 38 percent rarely improve their fine and motor skills by using the same. 46 percent of the sample develops violent behavior on watching some actions on television. Finally, the 54 percent of rarely try to use vocabularies listened on watching television or the computer.

### Findings of the Study

Most of the sample show little improvement on the exposure of multimedia like television, music, games, reading books etc. more than half of the sample about 66 percent watch television regularly plus the habit of reading is same as that of watching television. Results also show that most of the respondents never use the computer which is about 82 percent. Study also shows that 38 percent of the sample try to read alphabets on buses, shops, calendars. About 40 percent of the sample sometimes listens to the audio songs and sings with the audio. Only about 44 percent sample sometimes remembers concepts by listening the music. There is an improvement of vocabulary in about 54 percent of the sample, there is also an improvement in attention and concentration in about 50 percent of the sample. Students with intellectual disability try to Imitate the things on the exposure of computer or the television.

## CONCLUSION

Multi media has an ability to create positive changes in the behavior of children with intellectual disability, through the media communication can be improved by the exposure of different instruments of multimedia. The need is the proper planning and the strategies on using the multimedia for the intervention of behaviors among students with intellectual disparity. As the sample strength was less which can have an impact on the results of this study. Multimedia can stimulate the imagination of the child and open up the opportunities, stories have a role in the emotional development of the child. Mass media develop inter and intra personal intelligences.





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#### Limitations

- Researcher selected the small number of samples which can have impact on the generalization of results.
- As the data collection was through the interview of parents and teachers there is a chance of manipulation by the teachers to seek the social prestige.

#### Recommendations for Future Studies

- There is a need of experimental studies on the impact of multimedia on the behavior of persons with intellectual disability.
- Researcher recommends the Same study to be conducted on the large sample.

## ACKNOWLEDGEMENT

I am very thankful to my research supervisor and Dean Research Holy Cross College Dr. P. Swarnakumarai Ma'am. I am also thankful to Bharathidasan university for giving me the opportunity of doing research to find interventions for the people with disability. I am also thankful to Dr. Joicy P.Manickam, associate professor and Dean schools of behavioral sciences, Holy cross college necessary support.

#### Conflict of Interest

I declared there is no potential conflict of interest with respect to this research study.

#### Funding

Researcher received no financial support for this research

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**Table 1. Profile of the students with intellectual disability**

S.no	Variables	Characteristics	Percentage
1.	Age	5-10	28
		11-15	34
		16-20	38
2.	Gender	Male	58
		Female	42
3.	Birth order	First	62
		Second	36
		Third or above	02





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4.	No. of siblings	No siblings	26
		One or two	66
		Three or above	08
5.	Gaudian Occupation	Government job	16
		Business	32
		Coolie worker	48
		Others	04
6.	Religion	Muslim	10
		Hindu	82
		Christian	08
7.	Onset of disability	Congenital	64
		Acquired	36
8.	Locality	Urban	62
		Rural	38
9.	Type of intellectual disability	Mild	72
		Moderate	24
		Severe	04
		Profound	00

**Table 2. Use of Multimedia by children with intellectual disability in percent**

S. No	Variables	Never	Rarely	Sometimes	Most of the time
1.	Watching Television	02	06	26	66
2.	Read Books	24	26	24	26
3.	Use cell phones	12	50	30	08
4.	Use computer	82	10	06	02

**Table 3 impact of books on behavior of students with intellectual disability in percent**

S.no	Books	Never read	Rarely read	Sometimes	Most of time
1	Read alphabet, letters	10	38	22	30
2	Show interest in games	18	32	28	22
3	Try to explain the content	76	18	06	00
4	Watch stories	16	58	20	06
5	Use of words read in book	10	70	18	02

**Table 4 impact of radio on students with intellectual disability in percent**

S.no	Impact of Radio	Never listen	Rarely	sometimes	Most of times
1	Listen and sing songs together	06	20	40	34
2	Remember the songs	14	26	44	16
3	Improvement in vocabularies	34	54	06	06
4	Improvement in attention	04	50	38	08
5	Tring to speak words	14	44	36	06

**Table 5. impact of cell phone in students with intellectual disability in percent**

S.no	Impact of cell phone	Never	Rarely	sometimes	Most of times
1	Interest to speak through phone	06	48	30	16
2	Improve attention during call	08	58	34	00
3	Understand the game on phone	38	44	10	08



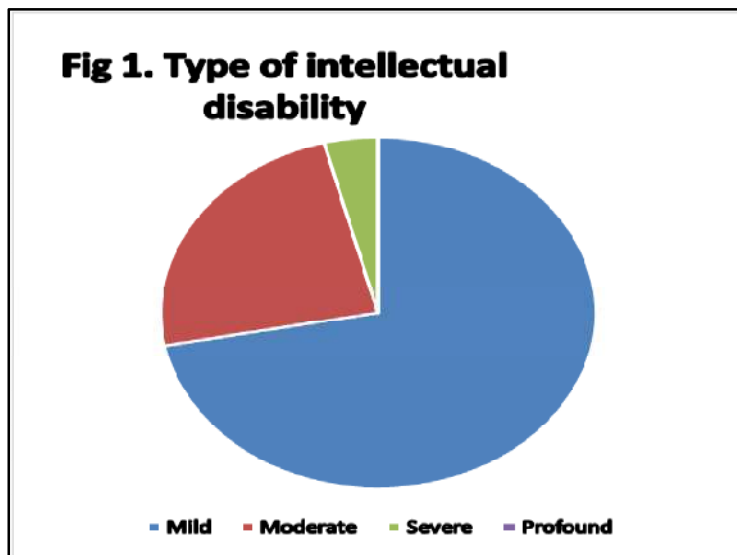


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4	Identify pictures on phone	02	42	26	30
5	Improvement in fine motor coordination	28	42	24	06

**Table 6. Impact of Computer or Television on behavior of students with intellectual disability in percent.**

S.no	Impact of computer/TV	Never	Rarely	sometimes	Most of times
1	Does Imitate the Actions Seen on Computer/Tv	04	04	34	58
2	Does Repeat the Dialogues	14	22	44	20
3	Improvement in fine or motor skill on using computer	30	38	22	10
4	Develop violent behavior on watching Movies	00	30	46	24
5	Imitate the vocabs from Tv/Computer	20	54	26	00



**Fig.1 Type of intellectual disability**





## On Weakly $\tilde{O}$ - $\mathcal{J}$ -Closed Sets with Respect to an Ideal Topological Spaces

K. Amutha<sup>1\*</sup>, O.Ravi<sup>2</sup> and A. Pandi<sup>3</sup>

<sup>1</sup>Assistant Professor and Head, Department of Mathematics, Nadar Saraswathi College of Arts and Science, Theni, Tamil Nadu, India

<sup>2</sup>Principal, Pasumpon Muthuramalinga Thevar College, Usilampatti-625 532, Madurai District, Tamil Nadu, India

<sup>3</sup>Assistant Professor, Department of Mathematics, Rathinam Technical Campus, Coimbatore-21, Tamil Nadu India.

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### \*Address for Correspondence

**K.Amutha**

Assistant Professor and Head,  
Department of Mathematics,  
Nadar Saraswathi College of Arts and Science,  
Theni, Tamil Nadu, India  
E. Mail: perumalammu69@gmail.com.



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### ABSTRACT

In this paper, we introduce a new class of generalized closed sets called weakly  $\tilde{O}$ - $\mathcal{J}$ -closed sets. We also discuss some  $w\tilde{O}$ -cld sets compare with  $wg$ -closed,  $w\pi g$ -closed and  $rwg$ -closed.

**Keywords:**  $\tilde{O}$ - $\mathcal{J}$ -cld,  $w\tilde{O}$ - $\mathcal{J}$ -cld,  $wg$ -cld,  $w\pi g$ -cld,  $rwg$ -cld.

## INTRODUCTION

After the advent of generalized closed sets, a new trend was created by Sundaram and Sheik John. Accordingly, a new notion called weakly closed sets were introduced by them. In this direction, many modifications of weakly closed sets are being introduced by the modern topologists due to their requirements. In this way, Ravi et al [18] introduced weakly  $\pi g$ -closed sets and Sundaram and Nagaveni [25] introduced weakly  $g$ -closed sets in topological spaces. In 1961 Levine [14] obtained a decomposition of continuity. Later Professor Rose improved Levine's decomposition. In 1986 Tong [27] obtained a decomposition of continuity and proved that his decomposition is independent of Levine's. In 1989, Tong [28] improved upon his earlier decomposition and obtained yet another decomposition of continuity. In 1990, Ganster and Reilly [8] obtained a decomposition of continuity improving the first result of Tong. A. Acikgoz and *et al.* [1], introduced on  $\alpha$ - $l$ -continuous and  $\alpha$ - $l$ -open functions. J. Antony Rex Rodrigo and *et al.* [2], the introduced the mildly- $l$ -locally closed sets and decompositions of  $\star$ -continuity. K. Kuratowski [11], introduced topology. S. Jafari and N. Rajesh [12], introduced the generalized closed sets with respect to an ideal. N. Levine [13], introduced the generalized closed sets in topology. O. Njastad [17], introduced the

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### Preliminaries

An ideal  $I$  on a topological space (briefly, TPS)  $(X, \tau)$  is a nonempty collection of subsets of  $X$  which satisfies

(1)  $A \in I$  and  $B \subseteq A \Rightarrow B \in I$  and

(2)  $A \in I$  and  $B \in I \Rightarrow A \cup B \in I$ .

Given a topological space  $(X, \tau)$  with an ideal  $I$  on  $X$  if  $\wp(X)$  is the set of all subsets of  $X$ , a set operator  $(\cdot)^*$ :  $\wp(X) \rightarrow \wp(X)$ , called a local function [10] of  $A$  with respect to  $\tau$  and  $I$  is defined as follows: for  $A \subseteq X$ ,  $A^*(I, \tau) = \{x \in X : \cup A \notin I \text{ for every } U \in \tau(x)\}$  where  $\tau(x) = \{U \in \tau : x \in U\}$ . A Kuratowski closure operator  $cl^*(\cdot)$  for a topology  $\tau^*(I, \tau)$ , called the  $\star$ -topology and finer than  $\tau$ , is defined by  $cl^*(A) = A \cup A^*(I, \tau)$  [10]. We will simply write  $A^*$  for  $A^*(I, \tau)$  and  $\tau^*$  for  $\tau^*(I, \tau)$ . If  $I$  is an ideal on  $X$ , then  $(X, \tau, I)$  is called an ideal topological space (briefly, ITPS). A subset  $A$  of an ideal topological space  $(X, \tau, I)$  is  $\star$ -closed (briefly,  $\star$ -cld) [10] if  $A^* \subseteq A$ . The interior of a subset  $A$  in  $(X, \tau^*(I))$  is denoted by  $int^*(A)$ .

**Definition 2.1** A subset  $K$  of a TPS  $X$  is called

(i) semi-open set [9] if  $K \subseteq cl(int(K))$ ;

(ii) regular open set [22] if  $K = int(cl(K))$

The complements of the above-mentioned open sets are called their respective closed sets.

**Definition 2.2** A subset  $K$  of a TPS  $X$  is called

(i)  $g$ -closed set (briefly,  $g$ -cld) [13] if  $cl(K) \subseteq V$  whenever  $K \subseteq V$  and  $V$  is open.

(ii) semi-generalized closed (briefly,  $sg$ -cld)[8] if  $scl(K) \subseteq V$  whenever  $K \subseteq V$  and  $V$  is semi-open.

(iii) generalized semi-closed (briefly,  $gs$ -cld)[19] if  $scl(K) \subseteq V$  whenever  $K \subseteq V$  and  $V$  is open.

The complements of the above-mentioned closed sets are called their respective open sets.

**Definition 2.3** A subset  $K$  of a ITPS  $X$  is called

(i)  $I_g$ -closed (briefly,  $I_g$ -cld) set [9] if  $K^* \subseteq V$  whenever  $K \subseteq V$  and  $V$  is open.

The complements of the above-mentioned closed sets are called their respective open sets.

**Definition 2.4**

A subset  $A$  of a topological space  $X$  is called:

(i) a weakly  $g$ -closed (briefly,  $wg$ -cld) set [25] if  $cl(int(A)) \subseteq U$  whenever  $A \subseteq U$  and  $U$  is open in  $X$ .

(ii) a weakly  $\pi g$ -closed (briefly,  $w\pi g$ -cld) set [18] if  $cl(int(A)) \subseteq U$  whenever  $A \subseteq U$  and  $U$  is  $\pi$ -open in  $X$ .

(iii) a regular weakly generalized closed (briefly,  $rwg$ -cld) set [18] if  $cl(int(A)) \subseteq U$  whenever  $A \subseteq U$  and  $U$  is regular open in  $X$ .



**Definition 2.5 [21]**

A subset  $K$  of  $X$  is called

(i)  $\tilde{O}$ - $\mathcal{J}$ -closed (briefly,  $\tilde{O}$ - $\mathcal{J}$ -cld) if  $K^* \subseteq V$  whenever  $K \subseteq V$  and  $V$  is  $\mathcal{J}$ -open.

The complement of  $\tilde{O}$ - $\mathcal{J}$ -cld is called  $\tilde{O}$ - $\mathcal{J}$ -open.

The family of all  $\tilde{O}$ - $\mathcal{J}$ -cld in  $X$  is denoted by  $\tilde{O}\mathcal{J}C(X)$ .

(ii)  $\tilde{O}$ - $\mathcal{J}_\alpha$ -closed (briefly,  $\tilde{O}$ - $\mathcal{J}_\alpha$ -cld) if  $\alpha \text{ cl}(K^*) \subseteq V$  whenever  $K \subseteq V$  and  $V$  is  $\mathcal{J}$ -open.

The complement of  $\tilde{O}$ - $\mathcal{J}_\alpha$ -cld is called  $\tilde{O}$ - $\mathcal{J}_\alpha$ -open.

**Weakly  $\tilde{O}$ - $\mathcal{J}$ -Closed Sets**

We introduce the following definition

**Definition 3.1**

A subset  $K$  of  $X$  is called a subset  $H$  of an ideal topological space  $(X, \tau, \mathcal{J})$  is called a weakly  $\tilde{O}$ - $\mathcal{J}$ -closed (briefly,  $w\tilde{O}$ - $\mathcal{J}$ -cld) set if  $(\text{int}(A))^* \subseteq V$  whenever  $H \subseteq V$  and  $V$  is  $\mathcal{J}$ -open in  $X$ .

**Theorem 3.2**

Every  $\tilde{O}$ - $\mathcal{J}$ -cld set is  $w\tilde{O}$ - $\mathcal{J}$ -cld but not conversely.

**Example 3.3**

Let  $X = \{p, q, r\}$  and  $\tau = \{\emptyset, \{p, q\}, X\}$  with  $\mathcal{J} = \{\emptyset\}$ . Then the set  $\{p\}$  is  $w\tilde{O}$ - $\mathcal{J}$ -cld set but it is not a  $\tilde{O}$ - $\mathcal{J}$ -cld in  $X$ .

**Theorem 3.4**

Every  $w\tilde{O}$ - $\mathcal{J}$ -cld set is  $w\mathcal{J}$ -cld but not conversely.

**Proof**

Let  $H$  be any  $w\tilde{O}$ - $\mathcal{J}$ -cld set and  $V$  be any open set containing  $H$ . Then  $V$  is a  $\mathcal{J}$ -open set containing  $H$ . We have  $(\text{int}(A))^* \subseteq V$ . Thus,  $H$  is  $w\mathcal{J}$ -cld.

**Example 3.5**

Let  $X = \{p, q, r\}$  and  $\tau = \{\emptyset, \{p\}, X\}$  with  $\mathcal{J} = \{\emptyset\}$ . Then the set  $\{p, q\}$  is  $w\mathcal{J}$ -cld but it is not a  $w\tilde{O}$ - $\mathcal{J}$ -cld.

**Theorem 3.6**

Every  $w\tilde{O}$ - $\mathcal{J}$ -cld set is  $w\pi\mathcal{J}$ -cld but not conversely.

**Proof**

Let  $H$  be any  $w\tilde{O}$ - $\mathcal{J}$ -cld set and  $V$  be any  $\pi$ -open set containing  $H$ . Then  $V$  is a  $\mathcal{J}$ -open set containing  $H$ . We have  $(\text{int}(H))^* \subseteq V$ . Thus,  $H$  is  $w\pi\mathcal{J}$ -cld.

**Example 3.7**

In Example 3.5, the set  $\{p, r\}$  is  $w\pi\mathcal{J}$ -cld but it is not a  $w\tilde{O}$ - $\mathcal{J}$ -cld.

**Theorem 3.8**

Every  $w\tilde{O}$ - $\mathcal{J}$ -cld set is  $rw\mathcal{J}$ -cld but not conversely.

**Proof**

Let  $h$  be any  $w\tilde{O}$ - $\mathcal{J}$ -cld set and  $V$  be any regular open set containing  $H$ . Then  $V$  is a  $\mathcal{J}$ -open set containing  $H$ . We have  $(\text{int}(H))^* \subseteq V$ . Thus,  $H$  is  $rw\mathcal{J}$ -cld.

**Example 3.9**

In Example 3.5, the set  $\{p\}$  is  $rw\mathcal{J}$ -cld but it is not a  $w\tilde{O}$ - $\mathcal{J}$ -cld.

**Theorem 3.10**

If a subset  $H$  of an ideal topological space  $X$  is both  $\star$ -cld and  $\alpha$   $\mathcal{J}$ -cld, then it is  $w\tilde{O}$ - $\mathcal{J}$ -cld in  $X$ .

**Proof**

Let  $H$  be a  $\alpha$   $\mathcal{J}$ -cld set in  $X$  and  $V$  be any open set containing  $H$ . Then  $V \supseteq \alpha \text{ cl}(A) = H \cup (\text{int}(H^*))^*$ . Since  $H$  is  $\star$ -cld,  $V \supseteq (\text{int}(H))^*$  and hence  $w\tilde{O}$ - $\mathcal{J}$ -closed in  $X$ .

**Theorem 3.11**

If a subset  $H$  of an ideal topological space  $X$  is both open and  $w\tilde{O}$ - $\mathcal{J}$ -cld, then it is  $\star$ -cld.

**Proof**

Since  $H$  is both open and  $w\tilde{O}$ - $\mathcal{J}$ -cld,  $H \supseteq (\text{int}(H))^* = H^*$  and hence  $H$  is  $\star$ -cld in  $X$ .





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**Corollary 3.12**

If a subset  $H$  of an ideal topological space  $X$  is both open and  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$ , then it is both regular open and regular closed in  $X$ .

**Theorem 3.13**

Let  $X$  be an ideal topological space and  $H \subseteq X$  be open. Then,  $H$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  if and only if  $H$  is  $\ddot{O}\text{-}\mathcal{J}\text{-}cld$ .

**Proof**

Let  $H$  be  $\ddot{O}\text{-}\mathcal{J}\text{-}cld$ . By Proposition 3.2, it is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$ .

Conversely, let  $H$  be  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$ . Since  $H$  is open, by Theorem 3.11,  $H$  is  $\star\text{-}cld$ . Hence  $H$  is  $\ddot{O}\text{-}\mathcal{J}\text{-}cld$ .

**Theorem 3.14**

A set  $H$  is  $w\star\text{-}cld$  if and only if  $(int(H))^*\text{-}H$  contains no non-empty  $gs\text{-}cld$  set.

**Proof**

Necessity. Let  $G$  be a  $gs\text{-}cld$  set such that  $G \subseteq (int(H))^*\text{-}H$ . Since  $G^c$  is  $gs\text{-}open$  and  $H \subseteq G^c$ , from the definition of  $w\ddot{O}\text{-}\mathcal{J}\text{-}closedness$  it follows that  $(int(H))^* \subseteq G^c$ . i.e.,  $G \subseteq ((int(H))^*)^c$ . This implies that  $G \subseteq ((int(H))^*) \cap ((int(H))^*)^c = \phi$ .

Sufficiency. Let  $H \subseteq J$ , where  $J$  is  $\star\text{-}cld$  and  $gs\text{-}open$  set in  $X$ . If  $(int(H))^*$  is not contained in  $J$ , then  $(int(H))^* \cap J^c$  is a non-empty  $gs\text{-}cld$  subset of  $(int(H))^*\text{-}H$ , we obtain a contradiction. This proves the sufficiency and hence the theorem.

**Theorem 3.15**

Let  $X$  be an ideal topological space and  $H \subseteq Y \subseteq X$ . If  $H$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  in  $X$ , then  $H$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  relative to  $Y$ .

**Proof**

Let  $H \subseteq Y \cap J$  where  $J$  is  $gs\text{-}open$  in  $X$ . Since  $H$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  in  $X$ ,  $H \subseteq J$  implies  $(int(H))^* \subseteq J$ . That is  $Y \cap ((int(H))^*)^c \subseteq Y \cap J$  where  $Y \cap (int(H))^*$  is closure of interior of  $H$  in  $Y$ . Thus,  $H$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  relative to  $Y$ .

**Theorem 3.16**

If a subset  $H$  of an ideal topological space  $X$  is nowhere dense, then it is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$ .

**Proof**

Since  $int(H) \subseteq int(H^*)$  and  $H$  is nowhere dense,  $int(H) = \phi$ . Therefore  $(int(H))^* = \phi$  and hence  $H$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  in  $X$ .

The converse of Theorem 3.16 need not be true as seen in the following example.

**Example 3.17**

Let  $X = \{p, q, r\}$  and  $\tau = \{\phi, \{p\}, \{q, r\}, X\}$  with  $\mathcal{J} = \{\phi\}$ . Then the set  $\{p\}$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  set but not nowhere dense in  $X$ .

**Remark 3.18**

The following examples show that  $w\ddot{O}\text{-}\mathcal{J}\text{-}closedness$  and semi-closedness are independent.

**Example 3.19**

In Example 3.3, we have the set  $\{p, r\}$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  set but not semi-cld in  $X$ .

**Example 3.20**

Let  $X = \{p, q, r\}$  and  $\tau = \{\phi, \{p\}, \{q\}, \{p, q\}, X\}$  with  $\mathcal{J} = \{\phi\}$ . Then the set  $\{p\}$  is semi-cld set but not  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  in  $X$ .

**Remark 3.21**

From the above discussions and known results in [18]. We obtain the following diagram, where  $A \rightarrow B$  represents  $A$  implies  $B$  but not conversely.

**Diagram**

$\star\text{-}cld \rightarrow w\ddot{O}\text{-}\mathcal{J}\text{-}closed \rightarrow wg\text{-}closed \rightarrow w\pi g\text{-}closed \rightarrow rwg\text{-}closed$

**Definition 3.22**

A subset  $H$  of an ideal topological space  $X$  is called  $w\ddot{O}\text{-}\mathcal{J}\text{-}open$  set if  $H^c$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}cld$  in  $X$ .

**Proposition 3.23**

- (i) Every  $\ddot{O}\text{-}\mathcal{J}\text{-}open$  set is  $w\ddot{O}\text{-}\mathcal{J}\text{-}open$  but not conversely.
- (ii) Every  $g\text{-}open$  set is  $w\ddot{O}\text{-}\mathcal{J}\text{-}open$  but not conversely.

**Theorem 3.24**

A subset  $H$  of an ideal topological space  $X$  is  $w\ddot{O}\text{-}\mathcal{J}\text{-}open$  if  $J \subseteq int(H^*)$  whenever  $J \subseteq H$  and  $J$  is  $gs\text{-}cld$ .







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### Proof

Let  $H$  be any  $w\ddot{O}$ - $J$ -open. Then  $H^c$  is  $w\ddot{O}$ - $J$ -cld. Let  $J$  be a  $gs$ -cld set contained in  $H$ . Then  $J^c$  is a  $gs$ -open set containing  $H^c$ . Since  $H^c$  is  $w\ddot{O}$ - $J$ -cld, we have  $(\text{int}(H^c))^* \subseteq J^c$ . Therefore  $J \subseteq \text{int}(H^*)$ .

Conversely, we suppose that  $J \subseteq \text{int}(H^*)$  whenever  $J \subseteq H$  and  $J$  is  $gs$ -cld. Then  $J^c$  is a  $gs$ -open set containing  $H^c$  and  $J^c \supseteq (\text{int}(H^*))^c$ . It follows that  $J^c \supseteq (\text{int}(H^c))^*$ . Hence  $H^c$  is  $w\ddot{O}$ - $J$ -cld and so  $A$  is  $w\ddot{O}$ - $J$ -open.

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## Valuable Flora: A Relation between Medicinal Plants having Photoprotective and Antioxidant Property

Bhawana Bhatt<sup>1\*</sup>, Anupriya Sundriyal<sup>2</sup> and Sudhakar Kaushik<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Pharmacognosy, School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand India.

<sup>2</sup>PG Research Scholar, Department of Pharmacognosy, School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand India.

<sup>3</sup>Assistant Professor, Department of Pharmacology, School of Pharmaceutical Sciences Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand, India.

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### \*Address for Correspondence

#### Bhawana Bhatt

Assistant Professor,  
Department of Pharmacognosy,  
School of Pharmaceutical Sciences,  
Shri Guru Ram Rai University,  
Patel Nagar, Dehradun, Uttarakhand India.  
E-mail: bhawanabhatt729@gmail.com



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### ABSTRACT

Without plants, life would not flourish. The fundamental building block of medication is plants. Some significant medications used today are taken from conventionally used medicinal plants. Medicinal plants are also used in cosmetics such as creams, lotions, face wash, gels, toners and many more. These medicinal plant-based cosmetics are nontoxic and does not have any allergic reactions. Global warming has made the use of sunscreens more prevalent for the protection of the human skin from harmful rays of the sun. Medicinal plant can be used in the preparation of effective sunscreens which are helpful for the protection of our skin. The sunscreens prepared from the medicinal plants are more effective than the synthetic ones. These do not have any side effects and can be used for any skin type. A photoprotective plant must also have good antioxidant property for rejuvenating the skin. This article contains the information about certain medicinal plants possessing photoprotective as well as antioxidant properties as both these properties compliment each other in the protection of our skin.

**Keywords:** Medicinal, traditional, cosmetics, photoprotective, antioxidant, rejuvenating, SUNSCREEN





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## INTRODUCTION

Plants have existed as long as the human history. Since the beginning of time, people have employed plants for therapeutic purposes, and for thousands of years, knowledge of herbs has been passed down from one generation to another [1]. Plants have infinite number of uses. Until now many plants have not been explored for their medicinal properties. Plants possess many activities like antimicrobial, antifungal, antidiabetic etc. Plants are also used in cosmetics. The word "medicinal plants" refers to herbal treatments that are used to treat human illnesses. These healing plants can be regarded as a valuable supply of ingredients for the creation of pharmaceuticals. Since more than 3000 years ago, a large number of plants have been used in traditional medical practices, including Chinese Traditional Medicine, Ayurvedic Medicine, Unani Medicine, etc. The majority of these plants probably have therapeutic effects and would be proven as such if they were properly assessed by Western standards. Furthermore, ancient societies have used plants for centuries; however, the majority of these are less likely to hold up to the test of contemporary experimental verification of efficacy [2].

The survival of the human species without plants on Earth is inconceivable. Since the beginning of the human species, humans have been dependent on plants. Medicine is frequently obtained from medicinal vegetation. The use of herbs in traditional medical practises like Ayurveda, Unani, and Chinese traditional medicine for the treatment of illnesses as well as for regenerating and bolstering bodily systems is supported by substantial proof. To achieve a favourable interaction with body chemistry was the inherently desired goal of herb use [3,4]. An approximation states that 20–25% of all medications listed in the Pharmacopeia come from natural sources [5]. Pharmaceuticals are expensive, so 70–80% of the developing world relies on traditional plant-based remedies [6]. According to the World Health Organization, 80% of people worldwide used natural remedies to treat their major medical issues [7]. At least 119 compounds derived from 90 plant species are presently used in clinical practise, with 77% of these compounds coming from plants used in traditional medicines, according to scientists' reports [7]. More than 100 medications that are commonly used in many nations are derived from plants. Of these, 75% are directly derived from plants that are extensively used in traditional systems [8].

Food & Drug Agency statistics showed that during the period 1983-1994, 39% of 520 drugs registered were either from natural sources or their structurally modified derivatives [8]. About 25% of the prescriptions worldwide are filled with drugs which are obtained or extracted from plant sources [9]. Due to the fact that there are approximately 500,000 plants in the world and that the majority of them have not yet had their medicinal properties explored, medicinal plants have a bright future because they may play a significant role in the therapy of ongoing or upcoming research [10].

### A Relation between Photoprotective and Antioxidant Property

Green tea flavonoids, silymarin, vitamin C, and vitamin E are just a few phytochemical sunscreens that have antioxidant properties. Sunburn and erythema are caused by UV harm, which vitamin C guards against. Numerous additional beneficial effects of vitamin E include a reduction in immune suppression, photoaging, erythema, and photocarcinogenesis [11]. Polyphenols, antioxidant vitamins, carotenoids, minerals, and other antioxidant components are abundant in plant-based meals. Foods of plant origin, such as fruits, veggies, cereals, pulses, nuts, oilseeds, spices, tea, and others, are sources of antioxidants. Polyphenols like flavonoids, bioflavonoids, isoflavones, and tannins are some of the substances with antioxidant properties. Additionally, some vitamins, including vitamins C, A, and E, have antioxidative action [12]. Amla is a fruit extract that contains 1-O-Galloyl-D-glucose (also known as - Glucogallin), which has photoprotective effectiveness because it has an inhibitory impact on ultraviolet radiation [12]. It includes glucogallin, which is crucial for the effectiveness of photoprotection and has potent anti-aging and antioxidant properties [13]. The polyphenolic compounds that satisfy include resveratrol. It is a fat-soluble substance with anti-mutagenic, antioxidant, and anti-aging effects. Wine, grape skin, berry juice, and peanut products are the primary sources of it. It is found in great quantities in both the leaves of *Veratrum grandiflorum* and the stems of the



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weed *Polygonum cuspidatum*. Additionally, resveratrol slows the development of cutaneous tumours and reduces the frequency of UVB-induced tumours. Additionally, it promotes cell division in human promyelocytic leukaemia [14]. Vitamin C is also known as ascorbic acid. Ascorbic acid contributes to increased defence against severe Ultraviolet deterioration. As a result, it provides greater protection when used in sunscreen and is also marketed as a dietary supplement. serve as an antioxidant as well. In nutritional supplements, salt such as sodium ascorbate and ascorbate salt are required. Vitamin C deficiency can impede the synthesis of collagen [15]. Lycopene is an antioxidant-rich plant nutrient that is primarily present in red and pink foods such as tomatoes, pink grapefruit, and watermelons. A connection between lycopene and heart-healthy qualities. According to a test tube research, lycopene inhibits tumour growth, which slows the progression of breast cancer [16].

### Medicinal Plants Having Photoprotective and Antioxidant Properties

**Aloe vera (*Aloe barbadensis miller*):** Since *Aloe vera* serves as an astringent, emollient, humidifier, and cleaner, it is frequently used in dermatology. It softens the skin, reduces wrinkles, and treats skin irritation, psoriasis, dermatitis, mycosis, red spots, acne, and herpes. It also protects the skin from pollution. Additionally, it is excellent for removing and repairing dead skin cells and skin that is delicate or sunburned<sup>[17]</sup>. It produces excellent skin smoothing moisturiser, sunblock lotion, and a variety of other beauty goods when combined with chosen essential oils [18]. There have been claims that aloe vera gel can prevent skin harm from radiation [19,20]. Following the application of *Aloe vera* gel, the skin produces metallothionein, an antioxidant protein that scavenges hydroxyl radicals and stops the suppression of glutathione peroxidase and superoxide dismutase. Interleukin-10 (IL-10) and other immunosuppressive cytokines produced by skin keratinocytes are reduced, which inhibits UV-induced suppression of delayed type hypersensitivity [21].

**Papaya ( *Carica papaya*):** Papaya is a nutritional powerhouse. It serves as a softening agent and sunblock. The papaya fruit is used in makeup to lighten the colour of our skin, remove dead skin cells, and reduce the appearance of wrinkles and acne by rubbing the white pulp [22]. Papaya unripe fruit can be a component of facial goods like face creams. Overproduction of ROS results in oxidative stress and oxidative damage to organs. Occurrence of inflammation as a result of oxidative stress has been linked to the emergence of a number of medical conditions as well as aesthetic problems like wrinkle formation and skin suppleness loss [22,23,24]. The papaya fruit juice is used to clear up skin imperfections, soften it, and functions as an antioxidant in sunscreens.

**Pomegranate (*Punica granatum*):** Numerous therapeutic effects of pomegranates include antioxidant, antitumor, antibacterial, and antidiarrheal properties. These behaviours have been demonstrated using a variety of extracts from this plant's various sections, including fruit, cortex, etc. Pomegranate blossoms have also been linked to astringent, hemostatic, anti-diabetic, antioxidant, and hepatoprotective properties [25,26,27]. Pomegranate extracts and seed oil are widely used in skin care products, which promise rejuvenation, youth, and beauty [28].

**Tomato (*Solanum lycopersicum*):** By far, tomatoes are the primary source of lycopene. Strong antioxidant activity and the greatest physical quenching rate constant with singlet oxygen have both been demonstrated for lycopene [29]. Additionally, tomatoes contain phenolic substances, which are also highly antioxidant-active [30]. Tomatoes are excellent for skin care because they contain high levels of lycopene, a chemical that is present in many face cleansers [31]. Lycopene neutralises lipid radicals, lowers lipid peroxidation, and shields the epidermis from erythema brought on by UV rays. Lycopene may increase protection against both the immediate (sunburn) and long-term (accumulative) effects of sun exposure by reducing the damaging effects that UV light can have on the epidermis (cancer) [32,33].

Vitamin C and antioxidants are abundant in tomatoes. As a natural bleaching agent, tomato is frequently used to whiten the skin. It has an anti-aging impact, lessens oiliness and blackheads, and helps even the duller skin to look



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more youthful. It also reduces pimples and acne. The tomato may reduce skin inflammation, promote the creation of collagen, and aid in the removal of dead skin cells. Tomatoes contain salicylic acid, a popular ingredient in acne treatments, which serves to reduce large pores and brighten the skin's appearance. To get rid of dead skin cells that can block pores and cause white heads or black heads, it cleans and exfoliates the skin [34].

**Green tea (*Camellia sinensis*):** Green tea's constituent catechins, which are best known for their antioxidant qualities, have been studied in relation to a number of diseases like cancer that are caused by reactive oxygen species (ROS) [35]. Provides skin a healthy glow, reduces skin inflammation, and slows the ageing process. Green tea is a top skin protectant, whether applied topically or taken as a beverage or nutritional supplement. It moderates inflammation and guards against direct cell harm. Green tea contains catechins, which are 20 times more potent antioxidants than vitamin E [36]. The remarkable antioxidant qualities of green tea are typically attributed to polyphenols [37].

**Cucumber (*Cucumis sativus*):** Watermelon has a number of advantages for skin care and all-natural beauty. Cucumber is a great cosmetic to use on the skin to maintain it soft and white [38]. Lignans found in cucumbers help to reduce the itchiness and swelling brought on by sunburns [39]. Cucumbers contain two substances that stop water retention which are ascorbic acid and caffeic acid. This may be why cucumbers applied directly are frequently beneficial for swollen eyes, burns, and dermatitis. Additionally, it includes caffeine and ascorbic acid, two nutrients that help soothe skin irritations and reduce swelling [40].

**Amla (*Emblia officinalis*):** Low molecular weight hydrolysable polyphenols and vitamin C are both abundant in amla. Amla is an excellent source of antioxidants because of this. The tannins that are bonded to the vitamin C shield it from being ruined by heat or radiation [41]. Amla extract is thought to be helpful for natural dermal care because it has powerful antioxidant properties and protects human dermal fibroblasts from oxidative stress [42]. Human skin fibroblasts' mitochondrial activity is increased by amla extract, which also encourages the creation of procollagen. Therefore, amla has been used for skin treatment since ancient times due to its possible therapeutic, curative, and cosmetic applications [43].

**Saffron (*Crocus sativus*):** Safranol and the crocin-1, crocin-2, crocin-3, and crocin-4 esters of the carotenoid glycosides are the chemical components of sunblock that are actually active. Saffron blossom extracts are the primary ingredient in sunscreen formulations. Carotenoids are membrane-associated, lipid-soluble compounds that are highly effective free radical scavengers [44].

Saffron is well known for its anti-sun properties, which can shield the epidermis from dangerous UV rays. According to studies, homosalate may not be the best sunblock, but saffron lotion may be (an organic compound used in some sunscreens). Saffron can therefore be used as a natural Ultraviolet absorber [45,46]. Saffron's antioxidant qualities make it essential for the prevention of skin cancer in addition to its antisolar and moisturising benefits [47,48]. Crocin and crocetin are two examples of the carotenoids, which function as natural antioxidants and have a significant impact on health. They shield tissues and cells from reactive oxygen species' and free radicals' damaging impacts (ROS). Regarding the antioxidant qualities of saffron, crocin is the active component that has been the most researched [49].

**Turmeric (*Curcuma longa*):** Curcuminoids, potent phytonutrients (nutrients derived from plants) with strong antioxidant qualities, are present in turmeric [50]. The blood is cleansed and nourished, and the face becomes healthy and radiant. It is great for treating skin conditions like eczema, acne, skin cancer, etc. because of its anti-bacterial and antiseptic qualities, and it also delays the onset of premature ageing. Sunscreens and makeup products both contain turmeric [51,52].



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**Lemongrass (*Cymbopogon citratus*):** Because it includes primary compounds like neral, nerolic acid, geraniol, geranic acid, and geranial, lemongrass has a higher antioxidant capacity than many botanicals [53].

**Apple (*Malus domestica*):** Apple peels are a source of many phytochemicals, some of which may have antioxidant action *in vitro* but whose nutritional value is unknown. Quercetin, epicatechin, procyanidin B-2, and numerous other flavonoids are the main phenolic compounds found in apples. This demonstrates scavenging activity towards free radicals generated as a result of ultraviolet radiation [54].

### Oils Having Photoprotective and Antioxidant Property

**Soybean oil (*Glycine max*):** Protein, iron, lecithin, calcium, and vital fatty acids are all abundant in soybeans. Soybean oil is regarded as a healthy and affordable addition to sunscreen due to research showing that topical application to the skin has moisturising and sun protection action with an SPF of roughly 10 [55].

**Joboba oil (*Simmondsia chinensis*):** The desert shrub jojoba is useful for healing eczema, psoriasis, and dry skin. Myristic acid, a naturally occurring plant chemical, is present in jojoba oil and works well as a moisturiser for dry skin.

**Carrot seed oil (*Daucus carota*):** The essential oil from carrot seed has a lot of vitamin A and substantial antioxidant, antiseptic, antifungal, and fragrant qualities. Carrot seed oil also offers natural sun protection when applied topically to the epidermis in the form of a diluted carrier oil.

**Evening primrose oil (*Oenothera spp.*):** High levels of Linolenic acid found in evening primrose oil support healthy epidermis and skin repair. Typically, it is yellow in appearance. People with eczema, psoriasis, or any form of dermatitis should consider using it because it reduces skin irritation and inflammation. Evening primrose skin oil prevents dry skin and early skin degeneration [56].

**Castor oil (*Ricinus communis*):** It reduces various problems like sunburn, acne, dry skin, stretch marks etc. It penetrates deep into the skin and stimulates the production of collagen and elastin, which helps to soften and hydrate the skin [57].

**Sunflower Oil (*Helianthus annuus*):** It retains moisture in the skin and protects skin from harmful U.V. radiations. The sunflower oil also contains Alphatocopherol concentration of 609 mg/kg. Alpha tocopherol (Vitamin E) in cosmetics acts as an antioxidant and protect against UV radiation. Alphatocopherol is very effective against UV-B free radical damage. Vitamin E absorbs strongly in the UV-B region of 280-320 nm [58].

### Compounds Having Photoprotective and Antioxidant Properties

**Quercetin:** It is 3,5,7,3',4'-pentahydroxy flavones structurally. They have an anti-inflammatory and antioxidant impact, and they also offer UVA and UVB radiation protection. A meal high in quercetin has been shown to prevent oral carcinogenesis and carcinogen-induced rat mammary cancer. It can be found in a variety of popular fruits, vegetables, drinks, and herbs. Onion has the greatest concentrations [59,60].

**Apigenin Flavonoid:** Chemically, it is a 5,7-dihydroxy flavone. They discovered to be efficacious in preventing UV A and UV B-induced skin cancerogenesis and inhibiting UV-mediated induction of ornithine decarboxylase activity. *Calendula officinalis*, *Artemesia inculta*, and *Cuminum cyminum* are three plants that frequently contain it [59,61].



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**Resveratrol Polyphenol:** It is trans 3'4'5' trihydroxystilbene structurally. It is a fat-soluble stilbene that is a member of the polyphenolic compound family. They have anti-inflammatory, anti-mutagenic, and protective effects. When applied topically, it was discovered to prevent UV B-induced tumour. They are frequently found in plants like *Vitis vinifera*, *Polygonum cuspidatum*, and *Veratrum grandiflorum* [59,62].

**Tannins:** Gallic acid, epigallocatechin, epicatechin, epicatechin 3 gallate, and other catechins are present in it. They inhibit ROS, which lessens DNA damage and erythema frequency. They are frequently found in pomegranate, amla, and green tea [59,63].

**Anthocyanins:** It contains pelargonidin, nasunin, and cyanidin-3 glycosides. They serve as a strong antioxidant, preventing degradation of the lipids in cell membranes. Tyrosine is shielded from per oxy nitrite by pelargonidin. Additionally, they counteract the negative impacts of UV B exposure. They are frequently found in *Punica granatum*, cereal grains, and fruits and berries that range in hue from yellow to purple [59,64].

**Carotenoids:** They are phytoene and phytofluene compounds. Lycopene and beta carotene are both present. Strong singlet oxygen quenchers, carotenoids. They function as an antioxidant, photo-oxidant, and boost oxidative stress resilience. Additionally, it guards against retinal degeneration. They are frequently discovered in *Daucus carota* and *Solanum lycopersicum* [59,65].

#### **Advantages of Herbal Photoprotective and Antioxidant Cosmetics [66,67,68]**

1. They are easily accessible and preferentially absorbs radiation
2. Stable to heat, stable to light, stable to perspiration
3. Non-irritant and non-toxic
4. Quickly soluble in appropriate alcohol
5. No specific tools are required for preparation
6. They do not cause allergic reactions and have no adverse consequences
7. More potent and abundant with its consistency and purity
8. Cost-effective and heals the skin

## **CONCLUSION**

Humans are moving further and further away from nature and natural goods as their lifestyles become more technologically sophisticated. He is unaware that he cannot escape nature because he is an integral component of it. Being natural products, plants are eco-friendly, without side effects, readily accessible nearby, and generally safe. There are numerous plants that are used throughout the year for medicinal reasons and to treat the symptoms of different diseases. Therefore, it is important to encourage the use of medicinal herbs to save human lives. Sunscreen is increasingly being used as photoprotective substances to block ultra-violet rays. Sunscreens are used to support the body's defence systems against damaging ultra-violet radiation from the sun. So, there is a need to promote the use of medicinal plants to save the human lives. The use of sunscreen as photo protecting agents for ultra-violet protection is becoming very popular. Sunscreens are used to aid the body's natural defence mechanisms to protect against harmful radiation from the sun. hence, medicinal plants need to be explored for their photoprotective properties. Plants having the combination photoprotection as well as antioxidant are very useful for our skin and hence need to be explored.







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## A Review on *Tagetes erecta* (Marigold) with Reference to Its Pharmacological Importance

Nayan Talukdar<sup>1</sup>, Bhargav Kashyap<sup>2</sup>, Indrani Barman<sup>3</sup>, Jyotchna Gogoi<sup>4</sup> and Partha Pratim Kalita<sup>5\*</sup>

<sup>1</sup>Associate Professor of Biotechnology, Faculty of Science, Assam down town University, Guwahati, Assam, India-781026

<sup>2</sup>Student of Biotechnology, Faculty of Science, Assam down town University, Guwahati, Assam, India-781026

<sup>3</sup>Assistant Professor of Biochemistry, Faculty of Science, Assam down town University, Guwahati, Assam, India-781026

<sup>4</sup>Associate Professor of Biochemistry, Faculty of Science, Assam down town University, Guwahati, Assam, India-781026

<sup>5</sup>Assistant Professor, Faculty of Science, Assam down town University, Guwahati, Assam, India-781026

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### \*Address for Correspondence

**Partha Pratim Kalita**

Assistant Professor,

Faculty of Science,

Assam down town University,

Guwahati, Assam, India-781026

E.Mail: parthakalita@gmail.com



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### ABSTRACT

In traditional cultures all throughout the world, medicinal plants and their derivatives are widely used, and they are also gaining popularity in modern society as healthy substitutes for synthetic chemicals. This review is a step towards gaining more understanding of *Tagetes erecta*'s therapeutic effectiveness. Literature were searched in Google Scholar and PubMed using the term "*Tagetes erecta* AND biological activity" and a total of 38 references were selected for this study. Results have shown presence of different phytoconstituents which demonstrates a variety of pharmacological effects, including antimicrobial, anti-cancer, anti-inflammatory, antioxidant, insecticidal, wound healing, anti-diabetic, anti-depressant etc. The findings in this study recommend that *Tagetes erecta* species may be studied further for its anti-microbial and wound healing activity.

**Keywords:** *Tagetes erecta* review, phytoconstituents, pharmacological effects, anti-microbial, wound-healing .





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## INTRODUCTION

Throughout history, people have employed plants to treat various types of illnesses. The therapeutic properties and efficacy of these plants were largely based on public perceptions. Although their molecular or chemical compositions were barely known, these plants were prescribed for various diseases purely on the basis of popular opinions among the masses. (Salehi *et al.*, 2018) Natural products have traditionally made significant contributions to the advancement of modern medicine and they still play a huge role in drug discovery. Since the beginning of time, researchers have been looking for new novel therapeutic leads in natural resources. As a result of that, numerous important discoveries like antibiotics, anti-cancer drugs, anti-inflammatory compounds (analgesics) etc have become a reality. The enormous genetic diversity found in plants, animals and microorganisms offers a wide range of possibilities for improving quality of human life and its ability to produce food, materials and medicine. However only a small portion of the plant kingdom has thus far been examined for potential medical applications. (Sen & Samanta, 2014).

*Tagetes erecta* Linn known as "gendaphool" (Marigold) belong to the family *Astraceae* are indigenous to India, Mexico, Central America, Bolivia, Colombia etc. It has societal relevance due of its religious application. Because of its resilience, *Tagetes* is used to embellish Idols during festivals in India. (Kapil V Patil, 2011) Because of its high carotenoid content, *Tagetes erecta* is utilized as a food coloring in African countries. (D Jothi, 2008) The genus *Tagetes* (family Asteraceae) contains about 50 species of plants which are mainly annual or perennial herbaceous plants. Locally this plant is known as Genda Phool (Marigold). It is native to Central America, especially Mexico and later brought to Europe in the 16<sup>th</sup> century. (Lim, n.d.) In the past, marigold has been used as a spice and medicine in Indonesia, China, and India. Marigold is a flavor-enhancing spice that serves as the foundation of most Indian curries. It is a robust, branching herb that is indigenous to Mexico and other warmer regions of America. It has been seen in other tropical and subtropical regions, such as India and Bangladesh. These are annual flowering plants that grow quickly. Their heights range from dwarfs that are 6 to 8 inches tall to medium-sized, tall, and upright plants that are 10 to 3 feet tall. They bear large, pompon-like double flowers that can be up to 5 inches across, and they only flower for a short time, from midsummer to frost. It is well-liked as a garden plant and produces a potently scented essential oil (Tagetes oil), which is mostly used for creating premium perfumes. (Y. Singh & Gupta, 2020). Limonene, ocimene, tagetone, and valeric acid make up the majority of this oil's chemical make-up. (Dasgupta *et al.*, 2014) These days, it is grown all over the world both as an attractive plant and for its high concentration of carotenoids, which have a variety of applications in the food and pharmaceutical industries. (Lin *et al.*, 2015) *T. erecta* has a quick growth rate and strong roots, which enable it to thrive even in environments with insufficient plant nutrients. (Bastos *et al.*, 2009) The ability of the species to absorb heavy metals like chromium, copper, cadmium, and lead makes it a highly desirable species due to its phytoremediation abilities (Castillo *et al.*, 2011)

### Chemical Compositions

The sunflower family includes *Tagetes erecta*, sometimes referred to as Mexico marigold or Aztec marigold. Various researches have looked at its ability to produce metabolites, perform phytoremediation, and withstand stress. It has the same active ingredient used in the treatment of conditions like rheumatism, bronchitis, eye problems, and ulcers as the other two species. (Chowdhury Mohammad Shaheed Hossain, 2009) Lutein, which can be used as a food coloring and vitamin, is present in the flower extract. Depending on the portion of the plant is being studied and the extraction technique employed, *Tagetes erecta*' chemical makeup varies. Carotenoids, flavonoids, and essential oils are only a few of the bioactive substances found in *Tagetes erecta*'s flowers and leaves. Folk medicine utilizes numerous plant parts, including the flower, to treat a variety of illnesses. It has been said that the leaves are beneficial in treating wounds, ulcers, piles, kidney problems, and muscle pain. While treating boils and carbuncles on the outside, the pounded leaves are employed. With 18 active components found by GC-MS, several of which are terpenoids, it is said to have antioxidant, antimycotic, and analgesic properties. (GUTIÉRREZ *et al.*, 2006)



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Particularly abundant in lutein and zeaxanthin, which are critical for eye health, are the blossoms. Compounds with antibacterial and insecticidal effects, including as limonene, ocimene, and tagetone, are found in the essential oils that have been isolated from *Tagetes erecta* flowers and leaves. *Tagetes erecta* roots contain a variety of alkaloids, including tagetone, tagetol, and patulitri. The flowers of *Tagetes erecta* contain essential oils, which are responsible for their distinctive scent. These oils are composed of a variety of terpenes and terpenoids, including limonene,  $\beta$ -myrcene,  $\alpha$ -terpinene,  $\alpha$ -pinene, and linalool. Further research revealed that *Tagetes erecta* leaf oil included a total of forty-four components, with limonene, terpinolene, (Z)-myroxide, piperitone, and piperitenone serving as its main ingredients. (Gupta & Vasudeva, 2012).

*Tagetes erecta* is particularly rich in carotenoids, which give the flowers their bright orange and yellow colors. The flower contains carotenoids made up of lutein, zeaxanthin,  $\beta$ -carotene,  $\alpha$ -Cryptoxanthin, neoxanthin plus violaxanthin, phytoene and phytofluene. The main carotenoids identified in this plant are lutein and zeaxanthin. Lutein is an oxycarotenoid or xanthophyll that has the fundamental C-40 isoprenoid structure shared by all carotenoids as well as two cyclic end groups (one ionone ring). It is a key component and the plant's primary pigment, *Tagetes erecta*. (Ghani A, 1998). Flavonoids are a class of polyphenolic compounds that are found in many plants, including *Tagetes erecta*. The flowers of this plant contain flavonoids such as quercetagenin, patuletin, and isorhamnetin. Alkaloids are nitrogen-containing compounds that are often found in plants. *Tagetes erecta* contains several alkaloids, including tagetone, tagetol, and tagetone oxide. Triterpenoids are a class of compounds that are derived from isoprene units. *Tagetes erecta* contains triterpenoids such as  $\alpha$ -amyrin and  $\beta$ -amyrin.

**Pharmacological Actions**

*Tagetes erecta*, also known as Mexican marigold, has been traditionally used for its medicinal properties in various cultures. The plant contains several phytochemicals that are responsible for its pharmacological actions. Here are some of the known pharmacological actions of *Tagetes erecta* which are elaborated below

**Antimicrobial Activity**

Many researchers have investigated the presence of anti-microbial activity in different extracts of *Tagetes erecta*. Padalia and Chanda extracted *T. erecta* flowers with hexane, toluene, ethyl acetate, acetone, methanol and water. They investigated antimicrobial potentiality of the extracts against some 8 gram positive bacteria, 8 gram negative bacteria and 4 fungal strains. Aqueous extract showed efficacy against *E. aerogenes*, *P. pseudoalcaligenes*, and *P. morgani*. Polar solvents acetone and methanol inhibited almost all gram negative bacteria strains. Hexane extract produced highest activity against *K. pneumoniae*. In case of gram positive bacteria, acetone and ethyl acetate exhibited highest antibacterial activity against *L. monocytogenes* and *B. cereus*. Same goes for hexane extract against *C. rubrum* and *B. cereus*. Among all the 8 gram positive and 8 gram negative strains studied by Padalia & Chanda, *K. pneumoniae* and *B. cereus* were inhibited by all the solvent extracts except aqueous extract. (Padalia & Chanda, 2015)

By using a disc susceptibility assay, Ruddock et al. reported the antimicrobial activity of 19 plants utilized in Colombian traditional medicine for cutaneous diseases. Different parts of *T. erecta* flower exhibited maximum inhibitory action against NG strain. (Ruddock et al., 2011) In another study by Rhama and Madhavan, showed that presence of flavonoids like patulitri is one of the major factors responsible for the anti-bacterial activity of *T. erecta*. (Rhama S & Madhavan S, 2011) Insects are also poisoned by the flavonoids, which they further alter and incorporate into their own secretions of protection. (Hartman T, 1991)

Dasgupta et al studied the anti bacterial activity of leaf extract of *Tagetes erecta* and reported maximum antibacterial activity for *Acinetobacter baumannii* and minimum for *Streptococcus pneumoniae*. The capsulated structure of *Streptococcus pneumoniae* is the cause of its low activity index. The findings suggest that *Tagetes erecta*, has an antibacterial effect against gram positive and gram negative bacteria that cause airborne disease and primarily against bacteria that cause skin infections. As a result, it may be useful in the development of medications for conditions like dermatitis, acne, and skin rashes as well as an antiseptic. (Dasgupta, 2012) Citrus fruit pathogens



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*Penicillium digitatum*, *Diplodia natalensis*, *Penicillium italicum*, and *Alternaria tenuis* were significantly affected by a 0.2% concentration of marigold oil emulsion's considerable fungicidal effect. (Arora A & Alencer J.W, 1984)

**Anti-Oxidant Activity**

Antioxidants are compounds that can help protect cells from damage caused by harmful molecules called free radicals. The antioxidant properties of *Tagetes erecta* are mainly attributed to the presence of certain compounds such as flavonoids, carotenoids, and phenolic acids. These compounds work by scavenging free radicals and neutralizing their damaging effects. (Bhattacharjee KS, 2012) Three distinct assays, including DPPH, reducing power, and super oxide radical scavenging activity, were employed in Chivde et al's research on antioxidant tests on the ethanolic extract of *Tagetes erecta* flowers. In all three assays, *Tagetes erecta* demonstrated greater reducing power than the reference standard (ascorbic acid), whereas super oxide anion scavenging activity and DPPH antioxidant activity were less effective. Nevertheless, *Tagetes erecta* ethanolic extract showed antioxidant properties in all in vitro models. (Basavaraj Chivde V et al., 2009)

**Insecticidal Activity**

*Tagetes erecta*, has been reported to have insecticidal properties by many researchers. The plant contains a variety of compounds that have been shown to have insecticidal activity. According to the research done by Farzana et al., *Tagetes erecta* has strong insecticidal activity and can be utilized in integrated pest management systems to control the population of *Tribolium castaneum*. These systems appear to be both economically viable and environmentally sound. (Farjana Nikkon et al., 2009) Renu Sarin reported that there is a link between the generation of ascorbic acid and the tissues' pyrethrin concentration, suggesting that callus cultures of *T. erecta* are capable of producing both ascorbic acid and insecticidal pyrethrins. The rise in endogenous and exogenous ascorbic acid was accompanied by an increase in the concentration of pyrethrins in the callus tissue. It is permissible to utilize the pyrethrins recovered from the callus cultures as an insecticide on *Tribolium spp.* (Sarin, 2004)

A study by David Osvaldo Salinas-Sánchez demonstrated that *T. erecta* leaf extracts have toxic effects on *S. frugiperda* larvae that persist into the pupal stage. The death rate was greatest in the ethanol leaf extract group. Furthermore, *T. erecta* leaf extracts resulted in a significant death rate of 62–80% during the pupal stage. These extracts' anti-feedant and insecticidal effects were what led to these significant mortalities. (Salinas-Sánchez et al., 2012). The petroleum ether extract of the roots of *Tagetes erecta* exhibited toxicity against the third stage mosquito larvae of *Culex fatigans*. (R. P. Singh & Kataria. P.K, 1985). The second stage larvae of *Tylenchulus semipenetrans* and *Anguina tritici* were resistant to the aqueous and methanolic extract of *Tagetes erecta*'s leaves, stem, and buds. (Kumari et al., 1986)

**Mosquitocidal Activity**

Several studies have been conducted to investigate the efficacy of *T. erecta* extracts or essential oils against mosquitoes. Farzana et al investigated mosquitocidal effects of ethanolic extract of flowers of *T. erecta* and its chloroform and petroleum ether soluble fractions against the larvae of *Culex quinquefasciatus*. It was inferred that *T. erecta* flowers are a highly effective natural larvicide and may be beneficial against *Cx. quinquefasciatus*. (Nikkon Farzana et al., 2011)

**Wound Healing Activity**

Treatment with *Tagetes erecta* hydro alcoholic extract benefits numerous stages of wound healing, including collagen synthesis, wound contraction, and fibroplasias. This leads to quicker healing. When compared to the control group, the crude *Tagetes erecta* extract considerably raised the dry granulation weight while also significantly promoting wound contraction and breaking strength of the incision wound. (Chatterjee S et al., 2011) The ability of carbopol gels made from *Tagetes erecta* Linn. (TE) hydro alcoholic extracts to cure burn and excision wound models in albino mice. In excision and burn wound models, TE treated animals showed a considerable reduction in the time required for wound contraction and epithelization, while combined gel demonstrated faster wound healing activity, possibly as a result of synergism. The phytoconstituents (flavonoids) contained in hydro alcoholic extracts may have a free radical scavenging effect and accelerate the healing process as a result of their individual or cumulative effects, which may



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account for their improved wound healing activity. (Ibrahim MA *et al.*, 2011) Another study demonstrated that extract from ethyl acetate (EA) was chosen after the flowers of *Tagetes erecta* were extracted using that solvent. When the EA extract was subjected to GCMS analysis, it was discovered that it included sugars, siloxane derivatives, and acidic substances such phenolic and ascorbic acid derivatives, some of which are involved in the activity that promotes wound healing. It was obvious from the extract's presence of BHT, which had the largest peak, that its antioxidant activity could aid in wound healing. (U.K. Manisha *et al.*, 2022)

**Anti-Diabetic Activity**

Kusmiati *et al.* performed an experiment on White Sparague Dawley rats where they used Alloxan to treat diabetes induction. This experiment consisted of seven groups: the normal control (Group I), the negative control (Group II), the positive control for diabetics (Glibenclamide 5 mg/kg bw), the positive control for antioxidants (Vitamin E 10 mg/kg bw), and the experiment (Lutein extract at doses of 40, 80, and 160 mg/kg bw, respectively) (Group V, VI, VII). The outcome demonstrated that lutein extract from marigold flowers may lower blood sugar levels. (Kusmiati *et al.*, 2019) Rodda *et al.* investigated *Tagetes erecta* hydro-alcoholic extract for its anti-diabetic potential. Streptozotocin (60 mg/kg b.w.) was injected intraperitoneally once to cause diabetes. Blood glucose levels were elevated after taking the conventional medication glibenclamide for 30 minutes, then dropped during the following 120 minutes. When *Tagetes erecta* extracts were administered, it was found that the glucose levels rose after 30 minutes, but the hypoglycemic impact was not seen for 120 minutes. (Sharma *et al.*, 2019)

**Anti-Inflammatory Activity**

In an animal model of UC (ulcerative colitis), Meurer *et al.* studied the intestinal anti-inflammatory activities of *Tagetes erecta* dry hydroalcoholic extract (DHETE), which is rich in the carotenoid lutein. DHETE was found to lessen the severity of colitis by reducing the release of pro-inflammatory cytokines and enhancing the body's natural antioxidant defense in mice with UC brought on by DSS (Meurer *et al.*, 2019). Using acetic acid-induced writhing in mice and carrageenan-induced paw oedema in rats, the anti-inflammatory efficacy of the *Tagetes erecta* chloroform, methanol, and ether fraction was revealed. (Shinde *et al.*, 2009)

**Anti-Cancer Activity**

The ethanol extract of *Tagetes erecta* was subjected to an offline two-dimensional preparative high performance liquid chromatography method, which was directed by a real-time cell analysis system. This process was used to create syringic acid (1), quercetin (2), 6-hydroxykaempferol (3), protocatechuic 30 acid (4), and quercetagenin (5), all of which had high purity levels of above 95%. On HEPG2 and A549 cells, a real-time cell-analyzer assessed the compounds for their tumour cell growth inhibitory properties. At a dosage of 50 g/mL, four substances might stop the growth of human 35 carcinoma cells. Against A549 and HEPG2 cells, compound 2 and compound 3 significantly inhibited cancer growth. A549 cells responded favorably to compounds 4 and 5. (Lu *et al.*, 2016) Marigold flower extracts in ethanol and ethyl acetate were tested for their cytotoxic potential and their ability to inhibit the enzymes tyrosinase and elastase. The cytotoxicity of these two extracts was tested on the H460 lung cancer cell line and the CaCO2 colon cancer cell line which showed a very significant result. (Vallisuta *et al.*, 2013)

**Anti-Depressant Activity**

The marigold, *Tagetes erecta*, demonstrated some antidepressant properties. A study was done to determine the hydromethanolic flower extract of *T. erecta*'s antidepressant effects. Using a forced swim test on mice, the extract's potential for treating depression was examined. Serotonergic, nitrenergic pathway, and sigma receptors were found to be involved in mediating antidepressant action of *T. erecta* in mouse forced swim test. (Khulbeet *et al.*, 2013)

**CONCLUSION**

*Tagetes erecta*, marigold, is a plant that has been traditionally used for medicinal purposes. Its pharmacological properties are primarily attributed to the presence of phytochemicals such as flavonoids, terpenoids, and







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alkaloids. Studies have shown that it possesses various pharmacological activities such as anti-inflammatory, analgesic, antioxidant, antidiabetic, and antimicrobial effects. In one of the studies it was established that flavonoids like patulitrin plays a crucial role in exhibiting anti-bacterial response. The plant has also been found to have potential anticancer properties. Additionally, *Tagetes erecta* has been used in traditional medicine for the treatment of various ailments such as skin diseases, respiratory infections, and digestive disorders. However, more research is needed to validate the traditional uses of this plant. In conclusion, *Tagetes erecta* is a plant with promising pharmacological properties that can potentially be used for the development of new drugs for various diseases.

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## A Comprehensive Analysis of Breast Cancer Diagnosis Methods: A Survey

M.Subha<sup>1\*</sup> and P. Srimanchari <sup>2</sup>

<sup>1</sup>Research Scholar, Department of Computer Science, Erode Arts and Science College, Erode-09, Tamil Nadu, India.

<sup>2</sup>Research Guide and Assistant Professor of Computer Science, Erode Arts and Science College, Erode-09, Tamil Nadu, India.

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### \*Address for Correspondence

#### M.Subha

Research Scholar,  
Department of Computer Science,  
Erode Arts and Science College,  
Erode-09, Tamil Nadu, India.  
Email: subha.gmanoharan@gmail.com



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### ABSTRACT

One of the leading causes of cancer-related deaths throughout the globe is breast cancer. Lower mortality rates from breast cancer are achieved with early diagnosis. To discover abnormalities in breast tissue as quickly as possible, automatic cancer detection is crucial. Erroneous illness identification is a serious threat to human health because of background noise and distortion. Therefore, increasing the number of breast cancer diagnoses is challenging. Breast cancer is the leading cause of cancer mortality among women, accounting for about 2% of all cancer deaths each year and over 10,000 new diagnoses each year. Tobacco use, alcohol consumption, soft drink consumption, radiation exposure, work environment, dietary habits, advancing age, family history, obesity, and Diethylstilbestrol have all been linked to an increased risk of developing breast cancer, according to some academic and government studies. This study uses a synthesis of public data from a variety of sources to investigate and evaluate potential causes of breast cancer. This article reviews 45 research papers for breast cancer detection and explores the potential of computer-assisted methods for breast cancer and staging. These findings might inform future clinical studies and be shared with relevant medical organizations to raise breast cancer awareness and support preventative measures.

**Keywords:** breast cancer, Diagnosis, Survey, analysis

### INTRODUCTION

In response to the need for more openness, the government has made available information on areas like disease rates and consumer habits [1]. In the past, researchers studying breast cancer risk factors didn't attempt to combine



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their findings from other fields or databases [2]. The increased accessibility and transparency of government data have aided data collection; generalizing open data and investigating confidential information may help explain the influence of breast cancer risk factors [3-7]. With over two hundred and fifty known carcinogens in tobacco smoke, it's no surprise that tobacco use is linked to an increased chance of developing cancer and death from the disease [8]. Because women have a slower alcohol metabolism, men should limit their alcohol intake to two cups per day and women to one cup per day [9-16]. In tests and observations done by researchers over five years, women's breast cancer risk increased as their alcohol use increased [17]. In addition to alcohol and tobacco use, obesity is now understood to be a major contributor to the development of breast cancer in women [19-23]. A lack of physical activity, excessive alcohol use, tobacco use, and a high-fat, high-sugar diet are all risk factors for gaining weight [24-27]. Obesity and beverage use are both associated with a higher risk of breast cancer, and so are drinking beverages that are rich in fructose and, by extension, calories [28].

**Relationship between Noncancerous Breast Disease and Breast Cancer**

Since certain diseases do not raise cancer risk while others do, this is a major issue for patients, doctors, and health insurance providers [29-33]. Any lesion with non-proliferative alteration in a breast biopsy does not substantially raise cancer risk [34]. Duct ectasies and simple fibro adenomas are only two examples of the benign solid tumors that are made up of both glandular and fibrous tissue [35]. The latter might be singular or plural depending on context [36-39]. There is no increased risk of cancer in the future, even though solitary papillomas are often linked with sanguineous or serosanguineous nipple discharge [40]. There is no correlation between having a fibrocystic change (cysts and fibrous tissue without symptoms) and having the fibrocystic disease (cysts and fibrous tissue accompanied by discomfort, nipple discharge, or a degree of lumpiness sufficient to raise suspicion of malignancy) (other than the potential for missing a malignant mass) [41].

Breast cancer management in older women remains difficult for various reasons, including treatment tolerance, data distortion from senior women, and the administration of unsuitable medicines that may not be appropriate for the patient's health [42]. Psychological concerns such as melancholy, anxiety, a poor self-image, and the use of improper imitative tactics all influence the quality of a patient's life. Even though there are potent treatments available to cure breast cancer, the agony and suffering it causes are palpable [43]. A person already dealing with psychological, social, and physical pressures is stressed further by persistent, chronic pain [44]. The malignant progression of breast cancer starts with the uncontrolled multiplication of a subset of breast cells [45]. They multiply and accumulate at an accelerated rate, unlike typical cells, and eventually form a bulk or lump. These cells may spread to your lymph nodes and beyond if they were able to invade your breast tissue. The incidence of breast cancer declines with age, and it is quite uncommon in younger women (i.e., in their thirties). Women under the age of 50 are more likely to experience a more advanced form of breast cancer.

**Breast carcinoma evolution stages**

Stage 0 Abnormal cells are present but not grown in neighboring tissues

Stage 1: In situ: Cancer cells are confined only in the lobules and ducts of the breast

Stage 2: Localized: Some lymph nodes are involved, and the size of the tumor is confined between 20 and 50 mm

Stage 3: Regional: Tumor size is greater than 50 mm, and cancer grows in the skin or chest wall with more involvement of lymph nodes

Stage 4: Distant: The tumor can spread further to any part of the body and can be of any size

**Background Study**

al- sammarraie, L. H. A., & Ibrahim, A. A. [2] Many mammography reading methods, such as double reading and computer-assisted detection (CAD) approach, have been created in response to the necessity for a thorough medical diagnosis in the case of breast cancer to increase the patient's life expectancy. These authors' methods were inefficient because they needed many physicians and were limited to traits that were known ahead of time. Amkrane, Y. *et al.* [3] these authors' work offered a strategy for breast tumor diagnostics based on radiance feature extraction to identify the most crucial feature before training machines and deep learning models to predict breast tumor response



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to therapy. The complete pathological response (pCR) was used as the reference standard in this prediction. These authors believe that Radiomics could generate reliable results based on the present state of the art. However, this field did not have enough datasets to validate these authors' techniques. Aziz, A. *et al.* [5]. the design and modeling of a circular microstrip patch antenna operating in the ISM band presented in this paper. Because of its small size and ease of use, the antenna outperforms the competition. For the sake of evaluating the results, two types of breast phantoms were built. With and without the tumor, different simulated results were discovered. These data were used to identify whether or not malignant tumors were present. Basunia, M. *et al.* [6] Automatic breast cancer diagnosis was critical for limiting disease spread. The key to breast cancer therapy was an early diagnosis. The stacking classifier was built in these authors' research to predict breast cancer with an accuracy of 97.20 percent. The accuracy% indicates that malignant tumors may be identified ideally.

Bharat, A. *et al.* [7] However, the effectiveness of each algorithm varies widely depending on the parameters with which it was utilized. The results were better when the k Nearest Neighbours (KNN) algorithm was used. Breast cancer diagnosis using Naive Bayes and logistic regression has been successful. These authors conclude that Support Vector Machine (SVM) with a Gaussian kernel was the best strategy for predicting recurrence/non-recurrence of breast cancer since SVM was a reliable predictive analytic tool and because of the prior findings. Chu K *et al.* [9] Among various health-related activities, these authors revealed that as soft drink and alcoholic beverage sales climbed, so did the obesity incidence, affecting breast cancer risk. To reduce the risk of breast cancer caused by obesity, the author recommends women limit their consumption of soft drinks and increase their physical activity. Fu B. *et al.* [11], these authors' research focuses on using statistics and machine learning to predict recurrence and metastasis in patients with early breast cancer. Based on breast cancer clinical data provided by Clinical Research Center for Breast (CRCB) at Sichuan University's West China Hospital, the author reviewed and cleaned clinical data. The original number of features was decreased from 89 to 23 using Stratified Feature Selection, Statistical Feature Selection (SFS), and Ensemble Feature Selection (EFS). On the same dataset, comparing models before and after feature selection has no discernible effect on prediction model performance.

Hussain, M. *et al.* [12] a noninvasive, non-ionizing optical breast cancer screening method has been published. Utilizing a POM rod as a breast phantom and the recommended IR-based screening, a 3-cm<sup>3</sup> tumor at a 4-cm depth was identified using IR technology. The findings were consistent with earlier research. This one-of-a-kind noninvasive technology was helpful in the development of a portable scanner that might be used in large prescreening campaigns for early breast cancer diagnosis. Jacob, D. *et al.* [13] based on the above statistics, classification algorithms outperform clustering techniques in predicting breast cancer. Keatmanee, C. *et al.* [15] a novel automatic initialization for active contour model (ACM) in breast cancer segmentation has been proposed in the conventional US. Using a combination of conventional ultrasonic imaging modality (US) and Color Doppler, Several approaches have been used to these photographs to extract relevant attributes. Finally, these images were multiplied, and outliers were removed to extract the boundary of vascular flows in Color Doppler, which was the projected position for generating an initial contour. Khasana, U. *et al.* [16], if the malignant area was surrounded or constricted by a region that was colored at almost the same time as the segmentation process, these authors' research of breast segmentation utilizing the watershed transform approach includes multiple errors. KHOMSI, Z. *et al.* [17] Using COMSOL simulations, the author demonstrated that breast cancer might be diagnosed by measuring heat gradients on the breast's surface. The author built a phantom for testing the embedded components of the breast cancer detection system using a careful selection of organic materials. Tumors were simulated using deep-implanted temperature-controlled resistors. Khuriwal, N., & Mishra, N. [18] these authors offer an ensemble machine-learning strategy for detecting breast cancer

Li, M. [19] these authors' research was focused on the invention of a deep learning algorithm for benign and malignant tumor classification using 3D breast ultrasound data, and it examines the effect of modifying the topology of a convolutional neural network to integrate different inputs on classification performance. By combining the characteristics of different information with the malleability of the convolutional neural network (CNN) model, it



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was shown that using a convolutional neural network for multi-information fusion was an effective fusion method that eliminated the steps of artificially designing fusion methods and improved classification efficiency and accuracy. Liu, P. *et al.* [20], these authors' research was primarily concerned with optimizing the XGBoost survival analysis. It was used to predict the development of breast cancer. These authors' research EXSA technique was based on the XGBoost machine learning model and the Cox proportional hazard (CPH) survival analysis model. As the learning aim, the author chose a more accurate estimate of the partial likelihood function and developed the corresponding mathematical expression for XG Boost, which considerably improved and optimized XGBoost's ability to analyze survival data with many ties. Nagpure R. *et al.* [21] These authors researched some algorithms, including adaptive mean, Gaussian Mixture Model (GMM) segmentation, and Probability Neural Network (PNN) classifier, which were used to predict if a given mammography included benign or malignant cells, enabling the patient to detect the sickness and take appropriate action more promptly.

**Survey on breast cancer detection**

Nezhadian, F. K., & Rashidi, S. [22] Image processing was a critical topic in medicine and research. This strategy aimed to increase the relative quality of information that a physician must interpret. To increase diagnostic capabilities, attempts were undertaken to simplify preprocessing computations and extract the most beneficial attributes. Nguyen, P. *et al.* [23] these authors used the CNN technique to categorize breast cancer pictures from the BreakHis dataset. The classification of eight subtypes of breast cancer in the Break His dataset was a unique challenge that has not been addressed in the bulk of previous publications. Orel, V. *et al.* [24] Combination therapy for patients with locally advanced Breast cancer (BC) using personalized computer-assisted planning of neoadjuvant regional inductive moderate hyperthermia (RIMH) treatment delivered using the Mag Therm apparatus (Radmir, Ukraine) appeared safe and effective for improving both short-term and long-term treatment outcomes, according to these authors' research. Patients with breast cancer who responded well to Neoadjuvant chemotherapy (NAC) and RIMH were more likely to undergo breast-conserving and reconstruction.

Park, K. *et al.* [25] One such typical indicator was an increase in mechanical stiffness in breast cancer tissue. However, owing to differences in the quality of biological samples, single diagnostic decision criteria may not provide enough sensitivity and specificity, leading to false negatives and false positives. There was potential for more precise early-stage screening if a novel biomarker can be identified that distinguishes cancer cells from normal tissue. One of the most important reasons to look into the physical properties of human breast tissue was to see areas of interest by capturing the signature for clinical application, but the present experimental setup may serve as diagnostic criteria in a clinical environment.

Reis, S. *et al.* [26] these authors research show how Derivative-of-Gaussians (DtG) filtering and LBP may be used to determine the age of breast stroma on hematoxylin and eosin (H&E) stained slides. Compared to the direct application of the Local Binary Patterns (LBP) technique to greyscale luminance images, using the lighting DtG pre-filtering significantly improved the approach's discrimination. Saranya, S., & Sasikala, S. [27] There was a vast quantity of patient data in the medical field, and extracting relevant information from the dataset was very difficult and time-consuming. Data extraction may benefit from information mining. Numerous classification techniques were used in these authors' research to anticipate the answer; the three algorithms used here were Nave Bayes, Decision tree, and Deeping learning, all of which were generated from the original Wisconsin Breast Cancer dataset. These authors' research examines the evolution performance and efficiency of three different algorithms regarding accuracy, sensitivity, and AUC, demonstrating that the deep algorithm was the most successful in predicting breast cancer patients.

Sethi, A. [28] evolutionary algorithms were compared to machine learning techniques. To forecast breast cancer, the author created a classification system utilizing breast cancer records from Wisconsin. The four classifiers Genetic Algorithm for Neural Network (GANN), Particle Swam Optimization (PSO), KNN, and C4.5 were used. Sharma, S. *et al.* [29] the risk of this illness being detected in a randomly selected female population was 1 in 12. Therefore, there may be a great potential for life-saving benefits from early identification of breast cancer. The work of these authors



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evaluates many machine-learning strategies for detecting breast cancer and draws comparisons between them. Researchers analyzed many machine learning algorithm strategies in the Wisconsin Diagnosis Breast Cancer data collection. Singh, S. N., & Thakral, S [30] The author investigated different classifiers' accuracy and computational complexity, including Naive Bayes, Bayesian Logistic Regression, Simple CART, and J48, in these authors' work. These authors' research aimed to identify which classifier was the best. This classifier categorizes the Wisconsin breast cancer (WBCO) breast cancer dataset. For all of the testing, WEKA was utilized. When the data were compared, the Simple CART decision tree method was considered the best accurate classifier among those utilized in these authors' research. Singhal, P., & Pareek, S. [31], the backpropagation algorithm was applied to construct a faultless breast cancer diagnosis system. The dataset was trained and analyzed with the help of individual neurons in the hidden layer, the output of which was examined. The backpropagation approach was used to assess the model as an outcome categorizer. Song, H. *et al.* [33] showed the detectability of breast tumors in excised breast tissues of a total mastectomy using a portable impulse-radio-ultra-wideband (IR-UWB)-radar-based breast cancer detector and a co-focal imaging algorithm. The detector was proven capable of detecting many tumors in dense breast tissue. Song, H. *et al.* [34], Using a cross-shaped dome antenna array and complementary metal oxide semiconductor integrated circuits (CMOS) integrated circuits, researchers were creating a portable gadget for detecting breast cancer. The use of a dome antenna array and CMOS integrated circuits for breast cancer diagnosis has been verified by the successful detection of a target.

Suresh, V., & Kiran, R. [35] The inverse electromagnetic problem was addressed using a Deep Neural Network. The dataset produced by the moment technique was utilized for training neural networks. The scattered electric field was the neural network's input, and the permittivity values of benign, malignant, and skin tissue voxels were its output. Microwave imaging enables regular disease evaluation. Because it has the same dielectric properties as breast tissue, it must be recognized more precisely. Ting, F. F., & Sim, K. S. [39] a Grid Search-based AdaBoost and Random Forest integration model for detecting breast cancer. The model employed GridSearchCV to automatically search for hyperparameters that prevented over- and under-fitting throughout the parameter selection phase. Several studies have demonstrated that this integrated model beats traditional single-algorithm models in breast cancer diagnosis and prognosis.

## DISCUSSION

Despite an unstoppable rise in the frequency of breast cancer, new medicines, and screening have resulted in minor decreases in mortality. Local disease care impacts overall survival, and improved surgical margins and radiation techniques have reduced local recurrence after breast-conserving surgery. Oncoplastic surgical treatments were used sparingly to enhance cosmetic results while satisfying oncological needs. The presence and behavior of distant micrometastases must be appropriately managed for disease management, if not cured, to determine long-term prognosis. Molecular profiling may provide prognostic information on individual cancer responses, directing clinical usage of targeted biological therapies and rationalizing their integration with traditional systemic treatments.

## CONCLUSIONS

In this Survey, Understanding the illness at a fundamental level may occasionally allow for aggressive underwriting, even though breast cancer is a leading source of morbidity and death in women and a genuine worry for life insurers. However, more vigilance is warranted when insuring females who have the accumulated risk factors discussed in this treatise, as well as poor histology and, most importantly, the existence of axillaries metastases. There are 45 papers are surveyed breast cancer diagnosis using various algorithms like machine learning algorithms and deep learning algorithms. The various authors used KNN, GANN, CNN, BPNN, and PNN for detecting breast cancer. Further, we introduce the hybrid deep neural network model for detecting breast cancer as early and increasing the accuracy.







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Table 1 comparison table

S.No	Author	Problem Addressed	Model used	Method	Proposed Solution	Accuracy
1	Zhang <i>et al</i> (2018)	Segment lesions in entire mammograms; let the network acquire knowledge of distinguishing aspects	U-Net	Deep Supervision; Multitask Learning	Adapt architecture using ResNet modules and add supervision; Perform classification and segmentation simultaneously.	breast 0.85 Dice Score 89% Accuracy
2	Le <i>et al.</i> (2019)	Utilize the dataset's heterogeneous annotations to classify the mammography.	FCN	Multitask Learning	Perform classification and segmentation simultaneously; Fine-grained subdivision	DDSM 84.02 AUC





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3	Lin <i>et al.</i> (2019)	Detect mass on mammography; insufficient data and class imbalance	Mask R-CNN	Adversarial learning	Employ an adversarial network to produce artificial pictures.	breast 91% TPR @ 0.5 FPI
4	Li <i>et al.</i> (2019)	Learn to classify aberrant patches while keeping both structure and semantics.	U-Net, CNN	Multitask learning (learn image-mask correlations)	Utilizing depth-separable convolution blocks to retrieve semantics. The U-net with a graph-preserving layer retrieves structural data.	CBIS-DDSM 0.85 AUC breast 0.93 AUC
5	Shen <i>et al.</i> (2021)	Classify mammograms and identify problematic spots with little supervision.	CNN	Multi-Instance Learning	Utilizes a low-capacity network for aberrant patch detection and a high-capacity network for patch classification.	NYC 0.797AUC for Malignant class





## Buckwheat and Its Health Benefits- A Review

Simran Parikh<sup>1\*</sup>, Soumya Shubham<sup>1</sup> and Yamee Shah<sup>2</sup>

<sup>1</sup>M.Sc., Student (Nutrition and Dietetics), Department of Nutrition and Dietetics, Parul Institute of Applied Sciences, Parul University, Post Limda, Waghodia, Gujarat, India

<sup>2</sup>Head of Department, Department of Nutrition and Dietetics, Parul Institute of Applied Sciences, Parul University, Post Limda, Waghodia, Gujarat, India.

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### \*Address for Correspondence

#### Simran Parikh

M.Sc., Student (Nutrition and Dietetics),  
Department of Nutrition and Dietetics,  
Parul Institute of Applied Sciences,  
Parul University, Post Limda,  
Waghodia, Gujarat, India.  
E. Mail: simranp1010@gmail.com



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### ABSTRACT

It has been established that buckwheat is a significant source of a variety of nutritive and bioactive components with a range of therapeutic and physiological benefits. As a functional food, the findings showed that it has potent antioxidant, cardio protective, anti-cancer, hepatoprotective, prevents hypertension, anti-tumour, anti-inflammatory, and anti-diabetic properties. It also lowers cholesterol and improves cognition. It contains various types of nutrients both macro and micronutrients. There are mainly two type of buckwheat- common and Tartary buckwheat. Reviewing and outlining some of the beneficial effects of buckwheat on numerous diseases is the main aim of this article.

**Keywords:** Buckwheat, Diabetes, Hypertension, Anti-oxidant, Anti-cancer

## INTRODUCTION

A primeval pseudo cereal crop belonging to the *Polygonaceae* class and genera *Fagopyrum*, buckwheat is a staple of the global foods of humans [1,2,3]. The most extensively harvested and utilized species globally are common buckwheat and tartaric buckwheat [1,4]. Additionally, buckwheat is increasingly favoured in the United States, Canada, and Europe these days [5]. It is primarily consumed as noodles, pancakes, and muffins in a number of countries, including China, Ukraine, Japan, Canada, India, and Nepal [6]. Because it has been demonstrated to be a great source of several nutritional and functional components with varying physiological and pharmacological effects, buckwheat has attracted considerable attention as a potential staple food [7,8]. Due to its highly comparable chemical constitution and great efficacy as a therapeutic food with antioxidant, cardioprotective, anti-cancer,



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hepatoprotective, hypertension, diabetes preventing, anti-tumor, anti-inflammatory, neuro-protective, cholesterol-lowering, and cognition-improving properties and so on, buckwheat has expanded the market and drawn research attention from food scientists in last few years [1, 9,10]. A variety of buckwheat's bioactive ingredients have been linked, either completely or partially, to certain health effects. Flavonoids, polyphenols, carbs, dietary fibre, proteins and amino acids, fatty acids, vitamins, and minerals are just a few of the many substances that make up these bioactive components [11,12,13,14]. The B vitamins thiamine, riboflavin, and pyridoxine [15] as well as few macro- and trace elements including sodium, potassium, copper, zinc, magnesium, iron, calcium, and manganese, are abundant in buckwheat [16,17]. Buckwheat is an excellent substitute for other grains when making a variety of dishes, such as loaves, pastries, casseroles, cookies, crepe, gruel, pancakes, pasta-noodle soups, and other confectionery items [18, 19].

Buckwheat flour is a significant dietary source of protein due to its high quantities of protein. The protein in buckwheat flour has a well-balanced amino acid composition, scoring 100 on the amino acid index. One of the plant foods with the highest amino acid scores is buckwheat protein. While prolamin and glutelin levels are low in buckwheat flour, albumin and globulin levels are high [20,21]. There might be minimal or no gluten in buckwheat flour. Little cross-reactivity has been seen in immunological research between buckwheat proteins and cereal prolamins [22] and have demonstrated that the amount of gliadin-like polypeptide is extremely low [23]. Hence, just as bread and cereal are essential to a normal person's diet, buckwheat is also essential to a gluten-free diet for people who have celiac disease [24]. Buckwheat has a high starch content equivalent to various other cereal grains [25,26,27]. Increased amounts of dietary fiber can be found in buckwheat flour [28,29, 30]. Buckwheat flour has a moderate lipid content [31, 32] Magnesium, zinc, copper, manganese, and other trace minerals are abundant in buckwheat flour [31,34,35,36,37,38]. Numerous vitamins, including vitamins B1, B2, and niacin, are present in buckwheat flour in rather high concentrations [31,39].

Tartary buckwheat, a plant belonging to the Polygonum class, has a substantial nutritious value and a balanced nutritional composition of protein, vitamins, and flavonoids [40]. The main components of tartary buckwheat flavonoids (TBFs) are quercetin and rutin. TBFs have blood cholesterol lowering, oxygen radicals scavenging, anti-aging, anti-inflammatory, and antioxidant effects. Many flavonoids have been linked to these biological characteristics, including rutin, quercetin, and kaempferol [41-46]. Reviewing and outlining some of the beneficial effects of buckwheat on numerous diseases is the main aim of this article.

### **Effects of Buckwheat on Diabetes**

When compared to other traditional cereals like rice, wheat, and maize, buckwheat has a lower glycemic index. It contains antinutritional components such polyphenols and enzyme inhibitors that slow down digestion, helping to maintain blood sugar levels [47]. Due to their capacity to boost the action of liver antioxidant enzymes, buckwheat's rutin and quercetin lower insulin resistance [48]. Also, it is indicated that D-chiro-inositol, a chemically generated insulin-regulating substance known as an antidiabetic drug, is used to lower blood glucose levels in diabetic individuals. Buckwheat is a good source of this substance due to its availability in relatively high amounts [49].

In a research on healthy individuals with type 2 diabetes, white flour and buckwheat flour-based diets were provided to participants for the duration of a week. As a consequence, no variations in insulin or glucose levels were seen. Yet, upon consuming foods prepared with buckwheat flour, healthy and type 2 diabetes participants showed an alteration of the gastrointestinal satiety hormones such as glucagon-like peptide-1 (potentiator of insulin production) and glucagon-dependent insulinotropic peptide [50]. A research on people with type 2 diabetes evaluated at how adding Tartary buckwheat to the food affected risk variables for the disease like fasting blood sugar levels, insulin resistance, and lipid profiles. Subjects were split into two groups arbitrarily: a control group and a group that consumed buckwheat. Following up on the food and blood results for 4 weeks, it was found that the group eating buckwheat showed significantly lower fasting levels of insulin, total cholesterol, and LDL cholesterol. In summation, it was discovered that Tartary buckwheat improved the lipid profiles and insulin resistance of type 2 diabetic individuals [51].



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10 healthy participants in a study consumed boiled buckwheat grouts, bread enriched with 50% buckwheat flour, and white bread. According to the study, people who consumed buckwheat foodstuffs, particularly buckwheat groats, produced less postprandial plasma glucose and insulin compared to those who ate white wheat bread [52]. Su-Que *et al.* (2013). 10 diabetes patients were chosen at random and found to consume buckwheat bread, which resulted in a 51% decrease in plasma glucose after two hours than white bread [53]. According to community-based research, individuals who consume buckwheat bread showed lower postprandial blood glucose and insulin response than those who use wheat flour that is readily available in the area [54]. Buckwheat is utilized as a nutritional supplement in some nations, like Taiwan, to manage type 2 diabetes.

Buckwheat is high in resistant starch [53]. Resistant starch-containing foods typically have a low glycemic index. Because low glycemic index diets control blood sugar, buckwheat can be utilized in the treatment of various chronic conditions [56,57]. In a study on rats, it was found that buckwheat decreased the rise in blood glucose and insulin levels brought on by high glucose and fructose diets [48]. A research on diabetic rats found that buckwheat consumption reduced serum glucose concentrations by 12-19% at the 90th and 120th minutes after ingestion and was successful in reducing the rise in blood glucose [58]. Buckwheat was observed to lessen the rise in blood glucose levels after 60 min of oral sucrose consumption in another study on rats. Also, mice given buckwheat had considerably lower blood glucose levels after consuming sucrose for 30 minutes [59].

#### **Effects of Buckwheat on Hypertension**

Rutin and quercetin-rich buckwheat is a superfood that is used to prepare a wide range of beneficial meals. Buckwheat's high polyphenol content is hypothesized to have an antihypertensive effect via changing the renin-angiotensin system. Moreover, compared to other grain sprouts, buckwheat sprouts have better antioxidant activity and more phenolic chemicals [60]. In an experiment, the impact of high-salt diets on the blood pressure of hypertensive rats was investigated. Two groups of rats were differentiated: those who did not eat buckwheat and those who did. The findings from the research demonstrated that the high salt diet significantly increased serum Na<sup>+</sup> levels and blood pressure in the control group. It has been demonstrated that buckwheat lowers blood pressure, guards against oxidative damage, and boosts Na<sup>+</sup>/K<sup>+</sup> ATPase [61,62].

Buckwheat reduces oxidative stress in artery endothelial cells and systolic blood pressure, which both contribute to its antihypertensive effects [63,64,65]. A different study on hypertensive rats discovered that buckwheat sprout feeding boosted endogenous vasodilators such bradykinin and nitric oxide, as well as low blood pressure and substantial antioxidant capacity, in comparison to rats consuming other grains. A similar study examined the impact of immune reactivity on mice's aortic endothelial cells and systolic blood pressure after they consumed buckwheat for five weeks. According to the study, eating buckwheat reduces immune reactivity in aortic endothelial cells, which reduces systolic blood pressure and oxidative stress [63]. It has been discovered that giving hypertensive rats Tartary buckwheat digest orally lowers their blood pressure [66].

#### **Effect of Buckwheat on Cardiovascular Diseases and Lipid Levels**

A regular metabolic function requires cholesterol, which is synthesized in the liver and ingested through food. Yet, observational epidemiologic research shows that the risk of a heart attack is three times higher in hyperlipidemic people than it is in the overall population with normal lipid status, and a 1% decrease in blood total cholesterol is significantly linked to a 3% decrease in the risk of CVD [67,68]. According to this meta-analysis of RCT trials, increasing consumption of buckwheat-based products from seven days to 27 weeks significantly improved a person's lipid profile, lowering total cholesterol by an average of 0.50 mmol/L and triglycerides by 0.25 mmol/L [69]. It is commonly recognized that Tartary buckwheat seeds are an excellent source of the antioxidants rutin and quercetin [70]. Rutin has been shown to prevent the increase in plasma total cholesterol and non-HDL cholesterol in mice or rats who are fed a high cholesterol or high fat diet [71-75]. Buckwheat's nutritional profile, which includes soluble fiber, protein, rutin, and quercetin, has been connected to its capacity to lower cholesterol [76]. Although the average blood total cholesterol level in the study population was low, He and colleagues' cross-sectional investigation revealed that buckwheat's water-soluble fiber and total dietary fiber were each significantly and

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individually associated with reduced serum total cholesterol levels [77]. Given that buckwheat has a low glycemic index in humans and contains resistant starch, the grain may have cholesterol-lowering properties [78,79]. In an experiment, the impacts of buckwheat protein on hypercholesterolemic mice were investigated. According to the research, buckwheat vastly reduced protein plasma cholesterol levels when compared to other grains, enhanced sterol excretion from the body, and helped regulate the function of the hepatic cells that create increased cholesterol [80]. In a related study, the correlation between blood myeloperoxidase, cholesterol levels, and inflammatory markers in common and Tartary buckwheat was examined. According to the study's findings, both varieties of buckwheat severely reduced myeloperoxidase levels as well as total and HDL cholesterol [81]. The research looked at how buckwheat (tartary) affected the genetic expression of proteins and sterol transporters in cholesterol absorption. According to the study's findings, buckwheat lowers the levels of hepatic cholesterol, non-HDL lipoproteins, and plasma total cholesterol. Moreover, buckwheat has been found to increase sterol elimination and reduce cholesterol absorption from the intestinal tract. Buckwheat is viewed as a hypocholesterolemic food due to its capacity to decrease cholesterol absorption in the intestine [82].

A high-quality polysaccharide that contains resistant starch is found in tartary buckwheat starch. In this study, tartaric-resistant starch was discovered to be a dietary element that significantly lowers cholesterol levels [83,84]. Prior research have shown that tartary-resistant starch's ability to decrease cholesterol is linked to a large fecal excretion of neutral sterols as a result of its poor digestion [85]. One study found that buckwheat resistant starch consumption significantly reduced serum levels of TC, TG, and LDL-C induced by a high-fat diet. Nevertheless, supplementing with buckwheat resistant starch raised the HDL-C serum levels. Also, this study demonstrated that buckwheat resistant starch possessed anti-insulin resistance and anti-hyperlipidemia properties [86].

#### **Role of Buckwheat in Gastrointestinal System**

Lower gastrointestinal inflammation has been associated to buckwheat bioactive substances. Six in vivo animal studies investigated buckwheat's potential to minimize GI mucosa lesions and inflammation. Two in vivo mice studies studied on whether the anti-inflammatory properties of buckwheat sprout extract and buckwheat-derived pollen improved the intestinal barrier in ceftriaxone-treated mice [87,88]. In comparison to other foods examined (wheat, rice, soybean, peanuts, and maize), buckwheat bran significantly reduced indomethacin-induced stomach mucosal lesions [89]. When compared to rats on a standard American diet, animals fed a high-fat diet for four weeks together with fermented milk or a high-fat diet along with buckwheat had fewer pro-inflammatory biomarkers in the colon [90]. Kim *et al.* created extracts from buckwheat hull and evaluated them on several cancer types (human gastric carcinoma, human hepatocellular carcinoma, human lung carcinoma, human breast adenocarcinoma, and human cervical adenocarcinoma) using fractions of numerous solvents (ethanol, ethyl acetate, hexane, butanol, chloroform, and water). With the exception of water, all buckwheat hull extract fractions showed greater than 80% suppression of human gastric cancer, however only hexane and butanol components suppressed hepatocellular carcinoma to the same degree [91]. In the study by Li *et al.* human hepatoma HepG2 cells were examined against buckwheat flavonoid extracts. Quercetin was revealed to be the most powerful flavonoid antioxidant. They also discovered that the flavonoids have a dose- and time-dependent ability to suppress HepG2 cell proliferation [92]. When buckwheat was fed instead of casein, there was a noticeably decreased incidence of bloody stools and colonic epithelial proliferation. Rats given common buckwheat flour exhibited acetate, butyrate, and total SCFA concentrations that were noticeably greater than those in the casein and soy protein isolate groups [93]. According to Zhou *et al.*, mice given a high-fat diet containing Tartary buckwheat-resistant starch had much higher levels of Bifidobacterium, Lactobacillus, Enterococcus, and Clostridium and much lower levels of Escherichia and Bacteroides [94]. Due to its ability to repair ruptured villi and crypts, lessen necrotic regions, and reverse vacuolar changes in colon tissues in diabetic mice, TBF therapy may minimize the risk of colon cancer. Hartstra *et al.* underlined the importance of SCFAs, particularly acetate, propionate, and butyrate, in lowering chronic inflammatory diseases and promoting colonic cellular integrity. The gut bacteria Roseburia, Rikenella, and Odoribacter produce butyrate, propionic acid, and butyrate [95-97]. In addition to improving the colon's acidic environment, the SCFAs produced by these microbiotas may also be able to repair mucosal inflammation, suppress the synthesis of inflammatory factors, and supply energy for the host [98].







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A fundamental mechanism behind the development of obesity, diabetes, and nonalcoholic fatty liver disease is shown by the significance of the gut microbiota in regulating the host's energy metabolism and immunological homeostasis [99]. Resistant starch has been discovered to be capable of nourishing and shield Bifidobacterium [100]. Also, the inclusion of resistant starch greatly reduced the amount of dangerous bacteria including *E. coli* and bacillus while substantially increasing the amount of Lactobacillus [101]. It has been hypothesized that the ability to control gut redox state may be connected to the shift in gut microbiota brought on by BRS. Previous studies showed that intake of resistant starch may affect changes in gut flora because the digestive enzymes in the small intestine have trouble hydrolyzing resistant starch [102,103]. Subsequently, the main products of resistant starch fermentation by intestinal microbiota in the large intestine are SCFAs (like acetic acid, propionic acid, butyric acid, and isovaleric acid) and gases (H<sub>2</sub>, CO<sub>2</sub>, and CH<sub>4</sub>) [104,105]. SCFAs can reduce intestinal pH to inhibit the development of pathogenic bacteria and promote the survival and growth of probiotics [104].

Two human clinical trials and one observational study both examined the effects of buckwheat intervention/habitual consumption on gastrointestinal tolerance. Dinu *et al.* arbitrarily assigned persons with non-celiac disease gluten sensitivities to either their regular gluten-free diet or a gluten-free diet in which approved commercial buckwheat items were substituted for the first 12 weeks. Following each of the trial's two six-week phases—the intervention phase and the control phase—there was a cross-over. At the end of the intervention period, participants in this cross-over study who ingested buckwheat items had significantly higher Symptom Severity Scale (SSS) values than those who avoided gluten. The intervention group had less severe bloating and less severe abdominal pain during this timeframe. The majority of participants said they were content with the consistency of their stools during the control period, but there was no noticeable difference in non-CeD gluten intolerance symptoms such nausea, joint/muscle discomfort, headaches, or attention problems throughout the intervention period [106]. On the other hand, a cross-sectional study discovered that eating more buckwheat noodles every day was associated with a higher frequency of IBS in Japanese people, irrespective of their sociodemographic characteristics, anthropometric measurements, lifestyles, or other dietary habits, such as rice, noodles, bread, and pasta [107]. When SIBO patients were administered with anti-protozoan medications (tiliquinol and tilbroquinol), those who ingested more buckwheat had noticeably higher rates of treatment resistance than those who consumed other grains [108,109]

#### Other Benefits

According to in vitro studies, buckwheat has a high concentration of phenolic compounds, which are known to have antioxidant effects [110]. Several flavonoids, particularly rutin, orientin, isorientin, vitexin, and quercetin, are present in breeding buckwheat, whereas Tartary buckwheat is a different species and solely contains rutin. A higher flavonoid level of buckwheat enhances its antioxidant activity. Moreover, buckwheat has elevated amounts of polyphenolic chemicals and flavonoids. Buckwheat is recognized to have a positive influence on human wellbeing because to its high levels of flavonoid and polyphenol, which function as antioxidants [111]. Buckwheat contains substantial antioxidant characteristics, including the capacity to remove super-oxide anion and the capacity for binding iron ions. Moreover, it scavenges with greater power clearance and free radical activity. Buckwheat compared to conventional buckwheat, tartary sprouts exhibit greater free radical scavenging, superoxide capacity, diminishing power, and anion clearing properties. They also exhibit less iron ion binding. Buckwheat cleanses cellular superoxide anions and reduces intracellular peroxide generation, according to studies on liver cells. It has been found that quercetin significantly lowers cellular oxidative stress in tartary buckwheat [112]. In an experiment with 37 participants, the blood plasma samples were taken from healthy people who used to consume 1.5 g of buckwheat per kilogram all at once [113]. According to in vitro research, the antioxidant properties of buckwheat are due to the grain's high phenolic component level [114-116]. In their study, Zieliski and Kozłowska (2000) classified several grains according to their antioxidant capacity as buckwheat > barley > oats > rye [117]. Buckwheat's ability to act as an antioxidant is enhanced by its high flavonoid concentration [118]. Buckwheat that has been sprouted also contains significant amounts of polyphenolic chemicals and flavonoids. The elevated flavonoid and polyphenol content of buckwheat is thought to have a positive impact on human health through its antioxidant function [119].

A Chinese study published in 2018 found a link between regular consumption of buckwheat and a lower risk of developing lung cancer [120]. Oxidative DNA damage is a major factor in the genesis of cancer. According to a study,



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ethanol buckwheat extracts shields DNA from hydroxyl radical damage. The methanolic extracts of buckwheat, rutin, and quercetin not only decreased tert-butyl hydroperoxide-induced DNA damage in the HepG2 cell line but also showed significant antioxidant function (DPPH scavenging activity). In another research, it was found that certain ethanol buckwheat extract portions prevented the proliferation of numerous cancer cell lines and decreased tumor formation in mice exposed to sarcoma cells. In HeLa cancer cells, BW extracts high in polyphenols displayed antioxidants and growth-inhibitory action [121]. A research on the cytotoxic effects of buckwheat extract on cancerous cells was conducted. SK-cytotoxic MEL-2's activity was enhanced by buckwheat extract depending on the dosage and duration of the treatment. The growth of human immune cell lines (RA) was stimulated at concentrations of 50, 100, and 200 g/ml extract. Human brain cellular lines Hs 683 and U-87MG did not exhibit cytotoxic activity when exposed to the majority of buckwheat and mulberry mushroom extracts in Buckwheat Media (MMBM), but extracts at 50 g/ml did. When glutamate at a concentration of 100 g/ml and H<sub>2</sub>O<sub>2</sub> at a concentration of 10 g/ml were used in the intervention, the cytotoxic actions of U-87MG were 88.1 and 80.2%. The results of this research showed that H<sub>2</sub>O<sub>2</sub> 10 g/ml-treated buckwheat and MMBM extract boosted U-87MG growth, however treatment with glutamate did not make U-87MG cytotoxic [122]. Buckwheat's antioxidant qualities have been connected to its anticancer activity.

Moreover, buckwheat protects the nervous system from a number of neurodegenerative disorders. Cognitive and mental deterioration is connected to the Alzheimer's disease. Inflammatory mediators, such as nitric oxide, prostaglandin E<sub>2</sub>, and TNF, amyloid-beta peptide aggregation, reactive oxygen species (ROS), and induction, are responsible for a number of important neuropathological symptoms of Alzheimer's disease [123]. According to one study, eating buckwheat stopped the decline of neurological capabilities in animal trials. In rats subjected to repeated brain ischemia, glutamate release was inhibited by 600 mg/kg buckwheat ingestion for 21 days. This prevented the necrosis and death of hippocampal cells, which decreased the level of nitric oxide and alleviated memory deficits [124].

In vitro studies have shown that ethanol and ethyl acetate extract of buckwheat seeds and roots have suppressive action on neurological illnesses by acting as antioxidants and by inhibiting the enzymes acetylcholinesterase, butyl cholinesterase, and tyrosinase [125]. Oral treatment of methanol extracts of common and Tartary buckwheat to rats for 14 days at a dose of 100 mg/kg improved both cognitive and memory functioning in an in vivo research model of Alzheimer's disease in rats. Nitric oxide and lipid peroxidation levels also decreased in both types of rats. Moreover, Tartary buckwheat has been discovered to have a better protective action than buckwheat that is typically used [126]. Poor animal cognition and memory were enhanced by oral treatment of an n-butanol fraction and rutin extracted from Tartary buckwheat [127]. Rutin, which was suggested as a protective agent, was considered to prevent the motor disease orofacial dyskinesia induced by the extended neuroleptic therapy of schizophrenia, haloperidol [128]

## CONCLUSION

In order to establish the concept of treating human ailments with nutrition, this article examines the value of buckwheat as a nutrient-dense grain crop for enhancing human health. There are numerous studies that suggest eating buckwheat may be healthy. Although buckwheat has been proven to have antioxidative properties, it also has cytotoxic and anti-genotoxic effects. It has been suggested to lower hyperlipidemia, lower blood pressure, and regulate blood sugar. Rutin may possibly be used therapeutically to treat Alzheimer's disease, according to some research. It can be noted from the literature that buckwheat is safe to consume and may have a variety of health benefits.

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## Control of Air Pollutants – Sulphur Dioxide Analysers

T.Mohandas<sup>1</sup>, M.Veeralakshmi<sup>2\*</sup>, K.Vinoth<sup>3</sup>, M.Santhi<sup>3</sup> and A.Iruthayaseelan<sup>3</sup>

<sup>1</sup>Associate Professor, Department of Physics, J.J.College of Engineering and Technology, Trichy, Tamil Nadu, India.

<sup>2</sup>Assistant Professor of Botany, Sree Sevugan Annamalai College, Devakottai, Sivaganga, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, Department of Physics, J.J.College of Engineering and Technology, Trichy, Tamilnadu India.

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### \*Address for Correspondence

#### M.Veeralakshmi

Assistant Professor of Botany,  
Sree Sevugan Annamalai College,  
Devakottai, Sivaganga, Tamil Nadu, India.  
Email: mksudiksha2012@gmail.com.



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### ABSTRACT

Conversion, diffusion, and chemical reactions control how pollutants move through the atmosphere over time. The main goal of studies on air pollution is to quickly anticipate pollution levels under specific meteorological circumstances. The evaluation of control systems and the assessment of the impact of new sources. To achieve these goals, it is necessary to solve the pollution concentration equations, which call for knowledge of convective diffusion and chemical synthesis or depletion. Natural and human-made pollution make it impossible to find clean air in the wild. Natural processes including volcanic activity, vegetation deterioration, and forest fires continuously emit gases into the atmosphere, including CO, SO<sub>2</sub>, and H<sub>2</sub>S. Winds also spread minute liquid or solid particles across the air, and volcanic outbursts.

**Keywords:** chemical, pollution, Natural, clean, circumstances.

### INTRODUCTION

Different terms have been used to define air pollution. In a certain sense, it is the addition of any material to our atmosphere that would negatively impact life on our planets. In other words, air pollution will only occur in circumstances when the concentration of pollutants in the atmosphere poses a risk to human health or the environment. Air contaminants can be ingested without being inhaled. Just by existing in the atmosphere, it becomes a pollution. Large amounts of gases and particle materials make up smog [1]. Indicators of air pollution include reduced visibility, damage to plants, deterioration of materials, and more, strange or strong scents, visible grit deposits, an acidic or disagreeable flavor in. Natural pollutants, such as natural fog, pollen grains, bacteria, and

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volcanic eruption products, aerosols, such as smoke, dust, mist, and fumes, and vapours and gases. H<sub>2</sub>S, SO<sub>2</sub>, and NO<sub>2</sub>. Sulphur dioxide is one of the main components of air pollutants, among others. The burning of fuels, mainly coal, is the main source of SO<sub>2</sub>. Less than 1% of most crude petroleum products have sulphur, however some have as much as 5%. Approximately 80% of the sulphur in coal and almost all of that in liquid and gaseous fuels are present as SO<sub>2</sub> in fuel gases. The residual sulphate in coal is inorganic sulphate, which is why it is still present in the ash. Metalworking processes are a common source of SO<sub>2</sub> in the environment. Many others like Zinc, copper and lead are primarily sulphides. During the smelting of these ores, SO<sub>2</sub> is evolved in stack concentrations of 5-10%. But this can be recovered in the form of sulphuric acid.

**Sources of SO<sub>2</sub>**

According to Table 1, this SO<sub>2</sub> accounted for 73% of all SO<sub>2</sub> emissions, making it the greatest source of emissions.

**METHOD OF MEASUREMENT****SO<sub>2</sub> analyzer**

Different types of analyzers, including infrared, thermal conductivity, and ambient air analyzers, are used to measure SO<sub>2</sub>.

**Infrared analyzer**

The IR portions of the spectrum are among the wide range of wavelengths that SO<sub>2</sub> can absorb. As the dividing lines between the UV, Visible, and IR spectrum areas. An effective method for continuous chemical analysis of a process is IR absorption (or reflection for solids). The wavelengths for the electromagnetic spectrum range from 0.8 to 1000. The near IR (12,500–4000 cm<sup>-1</sup>) and the mid IR (4000–650 cm<sup>-1</sup>) are the two regions of the infrared spectrum that process analyzers employ the most. Sources and detectors required for the near IR will not function in the mid IR, and vice versa, with the exception of a small overlap region [2]. The IR analyzer operates between 650 and 200 cm<sup>-1</sup> and 4000 cm<sup>-1</sup>. When many stack gases and opacity are monitored at once in stack analyzer packages, these instruments are most frequently utilized. Fig. 1 depicts the IR analyzer in this manner.

**Thermal conductivity analyzer**

The simplest and earliest form of process analytical instrumentation is composition measurement using the thermal conductivity properties of gases. The method makes use of the different materials' differing abilities to transfer heat energy from a heat source. As a result, capacity, also known as thermal conductivity, varies depending on the gas and can be stated using several unit systems [3]. The thermal conductivity of SO<sub>2</sub> is 0.344, while the thermal conductivity of air is assumed to be 1.0. This difference is significant enough to enable the detection of air in SO<sub>2</sub> at a range of 0 to 1% of full scale or the measurement of sulphur dioxide in air down to a range of approximately 0 to 3%.

**Ambient air analyzer**

The SO<sub>2</sub> from the air sample is absorbed in a solution of sodium tetrachloromercurate to determine the SO<sub>2</sub> concentration of ambient air. Forming a powerful purple dye complex after the addition of formaldehyde and pararosaniline dye [4]. Due to the intricate plumbing and propensity of the dye complex to plate out on the cell windows, which lowers its sensitivity, this class of analyzers needs frequent maintenance. They are based on a chemical reaction that is unique to SO<sub>2</sub> and when properly maintained, they provide an excellent record of SO<sub>2</sub> concentrations in the air. The ultimate SO<sub>2</sub> air quality goals are a yearly arithmetic average of 60 micrograms per cubic metre, a maximum 24-hour concentration of 260 micrograms, and a maximum 3-hour concentration of 1300 micrograms, which must not be surpassed more than once annually. Except in cases where higher levels are anticipated, the instrument range is typically chosen for a 0 to 1ppm whole scale range. Few devices can accurately read at levels as low as 0.01 ppm, hence there is a sensitivity issue. The SO<sub>2</sub> from the air sample is absorbed in a solution of sodium tetrachloromercurate to determine the SO<sub>2</sub> content of ambient air. Upon addition of formaldehyde and pararosaniline dye, a strong purple dye complex is formed. This family of analyzers requires frequent maintenance



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because of the complexity of the plumbing and tendency of the dye complex to plate out on the cell windows, thus reducing its sensitivity. Fig. 2 shows the SO<sub>2</sub> content of the air stream.

### Flame Photometric Analyzers

Radiation in a band with a wavelength centred at 394 is produced when a hydrogen-rich flame burns a stream of air containing sulphur. In air sampling equipment, this phenomena is used to detect sulphur gases at concentrations as low as 0.01 ppm. The output electric signal has a logarithmic shape. This device counts all sulphur molecules in the sample stream. Additional hardware is provided to offer discriminating at different sulphur compounds. Sulphur compounds are separated quantitatively using a gas chromatographic column made entirely of Teflon that comes before the flame photometric analyzer. This has shown to be quite helpful for measuring reduced sulphur compounds in the air, such as hydrogen sulphide and dimethyl sulphide. [5].

### Electrochemical Analyzers

Certain gases move selectively across the membrane and produce a signal in the electrolyte when air is passed over an element made up of a semipermeable membrane, an electrolyte, and a voltage sensitive pick up. Many gases, such as SO<sub>2</sub>, have been measured using this theory. Although the field of the electrochemical principle for the measurement of air pollutants is not very large, it is utilised as the sensor in small portable alarms and indicators. Because of the movement of H<sub>2</sub>O vapour, operational issues can arise in maintaining the proper electrolyte strength and moisture content of the membrane.

### IR Spectroscopy

The IR absorption spectroscopy is based on the molecules' ability to absorb IR radiation. The most frequent application of IR spectroscopy is the detection of chemical molecules. Both qualitative and quantitative analyses have been done using IR spectrometry, however the quantitative applications are less important than the qualitative ones. The electromagnetic theory states that the relationship between wavelength and frequency is given by the formula  $c = \lambda \nu$ , where  $c$  is the speed of light [6].

### Visible region

The area between 400 and 800 nm that may be seen with the unaided eye, on photographic plates, in photographic cells, etc.,

### IR region

The area that lies between 8000 and 35000 °A. Thermopiles, which record the heat they produce, can be used to measure these radiations. Large crystals of NaCl or CaF are used to make the optical components.

### UV region

The region which lies below 400 °A and can be detected with photographic plates and photographic cells. The optical parts prisms and lenses are made of quartz. The wave number which may be defined as the number of wavelengths per cm, is related to wavelength  $\lambda$  by the expression  $\lambda = c/\nu$

The essential components of an IR spectrometer are

### Light source

Hot bodies that generate heat constantly throughout the IR are called IR sources. The following frequently utilised radiation sources in IR spectroscopy are Nernst, glower, and globar. The Nernst glower can work in air because it is not subject to oxidation and is kept at a high temperature by using electrical heating. The Globar source has the benefit of a positive coefficient of resistance and is heated electrically. Both of these sources offer a great source that is simple to manage for the wavelength bands that are most frequently utilised in analysis. A basic nichrome wire coil with a tungsten filament light made of rhodium wire [7].





### Monochromator and Optical Material

In IR work, monochromators of the prism or grating type are used. Prism instruments, however, are preferred due to their simplicity and wider range. Optical components have been made from crystals of specific halogen salts that freely transmit infrared light. For the creation of prisms, quartz is used close to the IR area [8]. For the far IR, crystalline potassium bromide and cerium bromide work well. As dispersing elements for the IR area, reflecting gratings also offer a number of benefits.

1. With these greater resolution is obtained than the prism, because of less loss of radiant energy.
2. They provide more nearly linear dispersion.
3. They resist the attack by water.

### Sample handling

#### Gaseous samples

After being cleaned of water vapour, it is analysed in an IR spectrophotometer. Commercially available accessory gas cells with mirrors enable the radiation to repeatedly pass over the sample. The gaseous sample is passed through a stop cock, an appropriate gas handling device, and, in most situations, a partial pressure range of 5 to 50 n of Hg, which results in a reasonable amount of absorption. Eluates from gas chromatographs can also be handled using heated cells.

#### Liquid samples

In restricted wavelength ranges and in very thin layers, alcohol, acetone, water, chloroform, cyclohexane, and other liquids. Two solvents with complementary absorption region have also been used so that two successive spectra may cover the entire wavelength of interest. One pair that has been widely used is  $\text{CCl}_4$  and  $\text{CS}_2$ .

#### Solid samples

They can also be used after being dissolved in the proper solvent. It has also been studied in the form of a thin coating that was applied to a salt plate's surface via sublimation or solvent evaporation. It has also been created to combine a little amount of heavy paraffin oil with the powdered sample to create a paste, a process known as mulling. For measurement, the mull is positioned between salt plates.

### Detectors

Thermal detectors which depend on the integrated energy of a large number of incident photons to produce a measurable response via, their heating effects. Photo detectors in which the electron can be caused to move to a higher level by the energy of a single photon of IR radiation.

### Amplifiers

It is vital to utilize alternating current amplification because all bodies emit IR radiation when they are at ambient temperature. For the detector's ac signal, the radiation beam is chopped at an appropriate constant frequency. The signal is rectified after being amplified and used to power the recorder. A chopper is used in all commercial designs to regulate the source's output.

The structural diagnosis field is where IR spectra are most useful. In order to explore molecular structure, spectra are examined for the presence or lack of bands that are distinctive of different chemical groupings. In order to cope with the unidentified structure of natural products as well as to verify the synthesis, IR spectra are quite valuable.

### Removal of $\text{SO}_2$

There are different kinds of processes which can be enhanced for to remove the  $\text{SO}_2$ .



**Mohandas et al.,****Absorption Processes**

Carbonaceous adsorbents are used in three physical absorption processes (Reinluft, sulfacid, and BF). Two of these either create sulphur or sulphuric acid. With a capacity of 33000 mn<sup>3</sup>/h, the reinluft process was tested. Both operate at temperatures up to 120 °C for reinluft and 210 °C for BF and thermal regeneration and recycling, using a moving bed of adsorbents. The sulfacid method, in contrast, employs fixed layers at 60–80 °C and wet extraction of adsorbed H<sub>2</sub>SO<sub>4</sub>. The regenerated adsorbent peat coke or lignite low temperature coke is mechanically transported to adsorption part II, passes through part I, and is subsequently desorbed by hot gases in the smaller part at the installation's base at temperatures between 350 and 400 °C. An efficiency of 70% was achieved in the tested unit, with up to 2 g of dust/Mn<sub>3</sub> and 4 g of SO<sub>2</sub>/Mn<sub>3</sub> in the flue gas. [9].

**Catalytic Absorption**

In a trial plant with a fuel gas capacity of roughly 1000 mn<sup>3</sup>/h, Shell developed this technique. Waste gases are passed over CuO on an activated alumina carrier at 400° c, where they react with oxygen to create cuso<sub>4</sub>. A reducing gas switches the reactor to regeneration at a breakthrough of 10% SO<sub>2</sub>. By first converting 2/3 of the SO<sub>2</sub> to hydrogen sulphide and then processing the entire mixture in a clans-unit, the SO<sub>2</sub> rich gas can be further processed to become sulphur. It is necessary to construct a double reactor capacity based on the unique regeneration process.

**Effects of sulphur dioxide**

Plants are harmed by SO<sub>2</sub>. High levels of the gas exposure injure the areas between the leaf veins and the edges of the leaves as well as the leaf tissue itself. Chlorosis, or the bleaching or yellowing of the typically green sections of leaves, results from prolonged exposure to SO<sub>2</sub>. Plant damage is increased as the relative humidity rises. The severity of this injury increases during the daytime when the stomata, or microscopic holes in surface tissue that allow for gas exchange with the atmosphere, are open. It is well established that short-term high dose SO<sub>2</sub> exposures are less harmful to crops than long-term low dose exposures. In addition to harming aquatic life in rivers and lakes, SO<sub>2</sub> creates acid rains that also harm plants.

**Effects of human**

When exposed to an atmosphere with a concentration of SO<sub>2</sub> over acceptable limits, the main effect of SO<sub>2</sub> is on the respiratory tract, producing irritation and increasing airway resistance, and their visibility is impacted when exposed to higher temperatures. Public health officials consider SO<sub>2</sub> to be the most dangerous air pollutant. Elderly people are disproportionately affected, especially those with respiratory and cardiovascular disorders. These elderly adults are particularly vulnerable to extended exposure to increased amounts of SO<sub>2</sub> that are typical of air pollution crises. [10].

**Effects on material**

As demonstrated in Table 2, air pollution damages materials in the following ways and results in financial losses. Abrasion, material deposition, and corrosion, a direct chemical attack, and an indirect chemical attack.

**CONCLUSION**

The concerns with pollution and other substances coming from industry are covered in this presentation, along with the controlling measures used. The impact of air pollution on the environment has been widely explored. deals with both the affects of people and plants. The use of man-made sources like coal-fired power plants and fuel combustion will be drastically reduced in order to tackle these challenges. However, it is impossible to accomplish in real life. To sum up, in the present, for a better working environment and for the cleanliness of the surrounding areas, through the industry which has some pollution control equipments a few mere at vulnerable regions.





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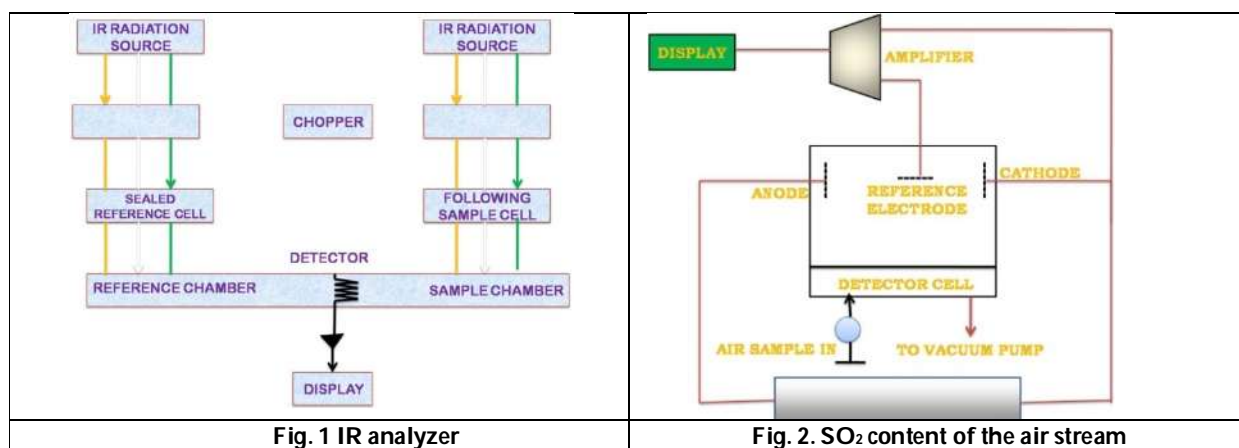
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**Table 1. Sources of SO<sub>2</sub> emission**

Source	Emissions – 10 <sup>6</sup> ton/hr
Transportation	1.1
Coal	19.8
Fuel oil	4.6
Industrial processes	7.5
Solid waste disposal	0.2
Coal effuse banks	0.2

**Table 2. Air pollution affects the materials**

Material	Air Pollutants	Effects
Metals	SO <sub>2</sub> , acids	Tarnishing of surface, loss of metal etc.
Paints, ceramics	SO <sub>2</sub> , H <sub>2</sub> S	Discolouration
Textiles	SO <sub>2</sub> , acid	Reduction in tensile strength





## Characterization and Estimation of Area Biased Shanker Distribution with Applications

Malathi.S<sup>1\*</sup> and Parthasarathi.S<sup>2</sup> and S.Sasikala<sup>3</sup>

<sup>1</sup>Research Scholar, Annamalai University, Chidambaram, Tamil Nadu, India.

<sup>2</sup>Professor, Department of Statistics, Annamalai University, Chidambaram, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, Thanthai Periyar Government Arts and Science College, Affiliated to Bharathidasan University, Trichy, Tamil Nadu, India.

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### \*Address for Correspondence

#### Malathi.S

Research Scholar,  
Annamalai University,  
Chidambaram, Tamil Nadu, India.  
E. Mail: malathisanmugam1988@gmail.com



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### ABSTRACT

In this paper, we have proposed a new study of Shanker distribution called as area biased Shanker distribution. The proposed distribution has been addressed with several statistical properties which include moments, survival function, failure rate function, reverse hazard rate function, order statistics, entropy, bonferroni and Lorenz curves and the model parameters are estimated through the technique of maximum likelihood estimation. Finally, the proposed new distribution has been examined with real life data set to discuss its goodness of fit.

**Keywords:** Shanker distribution, Area biased distribution, Survival analysis, Order statistics, Entropy, Maximum likelihood estimation.

## INTRODUCTION

The weighted distributions arise when the observation generated from a stochastic process are not given equal chances of being recorded, instead they are recorded according to some weight function. The weighted distribution gives a unified approach to deal with model specification and data interpretation problems. Fisher (1934) introduced the concept of weighted distribution to model the ascertainment bias, which was later formalized by Rao (1965) in a unifying theory for problems where the observations fall in non-experimental, non-replicated and non-random. When an investigator records an observation in nature according to certain stochastic model, the distribution of recorded observation will not have the original distribution unless every observation is given an equal chance of being recorded. The weighted distributions are applied in various research areas related to reliability, biomedical







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science, engineering, finance, insurance, survival analysis, analysis of family data, ecology and several other areas. The weighted distributions are used as a tool in selection of appropriate models for observed data, especially when samples are drawn without a proper frame. The weighted distributions are utilised to modulate the probabilities of events as observed and transcribed. The weighted distributions play an important role in handling lifetime data from various applied sciences. The weighted distributions occur in modeling clustered sampling, heterogeneity and extraneous variation in the data set. The weighted distribution reduces to length biased distribution especially when the weight function considers only the length of units of interest. The concept of length biased sampling was introduced by Cox (1969) and Zelen (1974).

The statistical interpretation of length biased sampling was originally introduced by Cox (1962) in renewal theory. More generally, when the sampling mechanism selects units with probability proportional to measure of the unit size, resulting distribution is called size biased. Various newly introduced distributions along with the weighted version exist in literature whose statistical behavior is extensively studied during decades. Modi and Gill (2015) discussed the length biased weighted Maxwell distribution. Kersey and Oluyede (2012) studied the theoretical properties of length biased inverse Weibull distribution. Saghir *et al.* (2016) discussed on the length biased weighted exponentiated inverted weibull distribution. Almutiry (2021) proposed the inverted length biased exponential model with statistical inference and modeling. Reyad *et al.* (2017) studies the length biased weighted erlang distribution with applications. Das and Roy (2011) introduces the length biased weighted generalized Rayleigh distribution with applications. Silambarasan and Elangovan (2020) discussed on the length biased weighted two parameter quasi Akash distribution and its applications to blood cancer data. Rather and Subramanian (2018) proposed the length biased sushila distribution with properties and applications. Hassan *et al.* (2021) discussed the weighted power Lomax distribution and its length biased version with properties and estimation based on censored samples.

Mir *et al.* (2013) studies the structural properties of length biased beta distribution of first kind. Subramanian and Shenbagaraja (2020) presented the length biased quasi Sujatha distribution with properties and applications. Vijayakumar *et al.* (2020) obtained the length biased Rani distribution with survival data analysis. Shanker and Shukla (2017) presented the weighted Shanker distribution and its applications to model lifetime data. Fazal (2018) obtained the area-biased poisson exponential distribution with applications. Oluwafemi and Olalekan (2017) obtained the length and area biased exponentiated weibull distribution based on forest inventories. Recently, Ganaie and Rajagopalan (2021) studies the length biased weighted new quasi Lindley distribution with statistical properties and applications which shows more flexible than the classical distribution. Shanker distribution and its applications proposed by Shanker (2015) is a newly introduced one parametric lifetime distribution. Its various mathematical and statistical properties which include moments, hazard rate and mean residual life functions, stochastic ordering, order statistics, Renyi entropy measures, mean deviation, stress-strength reliability, bonferroni and Lorenz curves have been discussed. The method of moment and the method of maximum likelihood estimation have been used for estimating the parameters of proposed distribution.

#### Area Biased Shanker (ABS) Distribution

The probability density function of Shanker distribution is given by

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

and the cumulative distribution function of Shanker distribution is given by

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

Let  $X$  be the non-negative random variable has probability density function  $f(x)$ . Let its non-negative weight function be  $w(x)$ , then the probability density function of weighted random variable  $X_w$  is given by





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

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

In this paper, we have considered the weight function  $w(x)$  gave different weighted distributions. We have to obtain the area biased version of Shanker distribution, so we will take consequently at  $w(x) = x^2$ , the resulting distribution is called area biased distribution with probability density function given by

$$f_a(x) = \frac{x^2 f(x)}{E(x^2)} \tag{3}$$

Where  $E(x^2) = \int_0^{\infty} x^2 f(x; \theta) dx$

$$E(x^2) = \frac{2\theta^2 + 6}{\theta^2(\theta^2 + 1)} \tag{4}$$

By using the equations (1) and (4) in equation (3), we will obtain the probability density function of area biased Shanker distribution as

$$f_a(x) = \frac{x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} \tag{5}$$

and the cumulative distribution function of area biased Shanker distribution can be obtained as

$$F_a(x) = \int_0^x f_a(x) dx$$

$$F_a(x) = \int_0^x \frac{x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} dx$$

$$F_a(x) = \frac{1}{(2\theta^2 + 6)} \int_0^x x^2 \theta^4 (\theta + x) e^{-\theta x} dx$$

$$F_a(x) = \frac{1}{(2\theta^2 + 6)} \left( \theta^5 \int_0^x x^2 e^{-\theta x} dx + \theta^4 \int_0^x x^3 e^{-\theta x} dx \right) \tag{6}$$

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

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 area biased Shanker distribution as

$$F_a(x) = \frac{1}{(2\theta^2 + 6)} (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x)) \tag{7}$$





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**Survival Analysis**

In this section, we will discuss the survival function, failure rate function, reverse hazard rate function and Mills ratio of the proposed area biased Shanker distribution.

**Survival Function**

The survival function of proposed area biased Shanker distribution can be obtained as

$$S(x) = 1 - F_a(x)$$

$$S(x) = 1 - \frac{1}{(2\theta^2 + 6)} (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x))$$

**Hazard Function**

The hazard function is also known as hazard rate or failure rate or force of mortality and is given by

$$h(x) = \frac{f_a(x)}{1 - F_a(x)}$$

$$h(x) = \frac{x^2 \theta^4 (\theta + x) e^{-\theta x}}{(2\theta^2 + 6) - (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x))}$$

**Reverse Hazard Function**

The reverse hazard rate function is given by

$$h_r(x) = \frac{f_a(x)}{F_a(x)}$$

$$h_r(x) = \frac{x^2 \theta^4 (\theta + x) e^{-\theta x}}{(\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x))}$$

**Mills Ratio**

$$\text{Mills Ratio} = \frac{1}{h_r(x)} = \frac{(\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x))}{x^2 \theta^4 (\theta + x) e^{-\theta x}}$$

**Statistical Properties**

In this section, we will discuss the different statistical properties of area biased Shanker distribution which include moments, harmonic mean, MGF and characteristic function.

**Moments**

Let  $X$  be the random variable following area biased Shanker distribution with parameter  $\theta$ , then the  $r^{th}$  order moment  $E(X^r)$  of area biased Shanker distribution can be obtained as

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

$$E(X^r) = \mu_r' = \int_0^\infty x^r \frac{x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} dx$$

$$E(X^r) = \mu_r' = \int_0^\infty \frac{x^{r+2} \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} dx$$





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$$E(X^r) = \mu_r' = \frac{\theta^4}{(2\theta^2 + 6)} \int_0^\infty x^{r+2} (\theta + x) e^{-\theta x} dx$$

$$E(X^r) = \mu_r' = \frac{\theta^4}{(2\theta^2 + 6)} \left( \theta \int_0^\infty x^{r+2} e^{-\theta x} dx + \int_0^\infty x^{r+3} e^{-\theta x} dx \right)$$

$$E(X^r) = \mu_r' = \frac{\theta^4}{(2\theta^2 + 6)} \left( \theta \int_0^\infty x^{(r+3)-1} e^{-\theta x} dx + \int_0^\infty x^{(r+4)-1} e^{-\theta x} dx \right) \tag{8}$$

After the simplification of equation (8), we obtain

$$E(X^r) = \mu_r' = \frac{\theta^2 \Gamma(r+3) + \Gamma(r+4)}{\theta^r (2\theta^2 + 6)} \tag{9}$$

By putting  $r = 1, 2, 3$  and  $4$  in equation (9), we will obtain the first four moments of area biased Shanker distribution.

$$E(X) = \mu_1' = \frac{6\theta^2 + 24}{\theta(2\theta^2 + 6)}$$

$$E(X^2) = \mu_2' = \frac{24\theta^2 + 120}{\theta^2(2\theta^2 + 6)}$$

$$E(X^3) = \mu_3' = \frac{120\theta^2 + 720}{\theta^3(2\theta^2 + 6)}$$

$$E(X^4) = \mu_4' = \frac{720\theta^2 + 5040}{\theta^4(2\theta^2 + 6)}$$

$$\text{Variance} = \frac{24\theta^2 + 120}{\theta^2(2\theta^2 + 6)} - \left( \frac{6\theta^2 + 24}{\theta(2\theta^2 + 6)} \right)^2$$

$$S.D(\sigma) = \sqrt{\frac{24\theta^2 + 120}{\theta^2(2\theta^2 + 6)} - \left( \frac{6\theta^2 + 24}{\theta(2\theta^2 + 6)} \right)^2}$$

**Harmonic Mean**

The harmonic mean for the proposed area biased Shanker distribution can be obtained as

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

$$H.M = \int_0^\infty \frac{x\theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} dx$$

$$H.M = \frac{\theta^4}{(2\theta^2 + 6)} \int_0^\infty x(\theta + x) e^{-\theta x} dx$$

$$H.M = \frac{\theta^4}{(2\theta^2 + 6)} \left( \theta \int_0^\infty x e^{-\theta x} dx + \int_0^\infty x^2 e^{-\theta x} dx \right)$$





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$$H.M = \frac{\theta^4}{(2\theta^2 + 6)} \left( \theta \int_0^\infty x^{2-1} e^{-\theta x} dx + \int_0^\infty x^{3-1} e^{-\theta x} dx \right) \tag{10}$$

After the simplification of equation (10), we obtain

$$H.M = \frac{\theta(\theta^2 + 2)}{(2\theta^2 + 6)}$$

**Moment Generating Function and Characteristic Function**

Let the random variable X following area biased Shanker distribution with parameter  $\theta$ , then the moment generating function of proposed distribution can be obtained as

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

Using Taylor’s series, we get

$$M_X(t) = \int_0^\infty \left( 1 + tx + \frac{(tx)^2}{2!} + \dots \right) f_a(x) dx$$

$$M_X(t) = \int_0^\infty \sum_{j=0}^\infty \frac{t^j}{j!} x^j f_a(x) dx$$

$$M_X(t) = \sum_{j=0}^\infty \frac{t^j}{j!} \mu_j'$$

$$M_X(t) = \sum_{j=0}^\infty \frac{t^j}{j!} \left( \frac{\theta^2 \Gamma(j+3) + \Gamma(j+4)}{\theta^j (2\theta^2 + 6)} \right)$$

$$M_X(t) = \frac{1}{(2\theta^2 + 6)} \sum_{j=0}^\infty \frac{t^j}{j! \theta^j} (\theta^2 \Gamma(j+3) + \Gamma(j+4))$$

Similarly, the characteristic function of area biased Shanker distribution can be obtained as

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

$$M_X(it) = \frac{1}{(2\theta^2 + 6)} \sum_{j=0}^\infty \frac{it^j}{j! \theta^j} (\theta^2 \Gamma(j+3) + \Gamma(j+4))$$

**Order Statistics**

The concept of order statistics has a large number of applications in statistical sciences and has wide range of applications in the field of reliability and life testing. Consider  $X_{(1)}, X_{(2)}, \dots, X_{(n)}$  denotes the order statistics of a random sample  $X_1, X_2, \dots, X_n$  from a continuous population with probability density function  $f_X(x)$  and cumulative distribution function  $F_X(x)$ , then the probability density function of  $r^{th}$  order statistics  $X_{(r)}$  is given by

$$f_{X_{(r)}}(x) = \frac{n!}{(r-1)!(n-r)!} f_X(x) (F_X(x))^{r-1} (1-F_X(x))^{n-r} \tag{11}$$





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By using the equations (5) and (7) in equation (11), we will obtain the probability density function of  $r^{\text{th}}$  order statistics of area biased Shanker distribution as

$$f_{x(r)}(x) = \frac{n!}{(r-1)!(n-r)!} \left( \frac{x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} \right) \times \left( \frac{1}{(2\theta^2 + 6)} (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x)) \right)^{r-1} \times \left( 1 - \frac{1}{(2\theta^2 + 6)} (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x)) \right)^{n-r}$$

Therefore, the probability density function of higher order statistic  $X_{(n)}$  of area biased Shanker distribution can be obtained as

$$f_{x(n)}(x) = \frac{n x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} \times \left( \frac{1}{(2\theta^2 + 6)} (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x)) \right)^{n-1}$$

and the probability density function of first order statistic  $X_{(1)}$  of area biased Shanker distribution can be obtained as

$$f_{x(1)}(x) = \frac{n x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} \times \left( 1 - \frac{1}{(2\theta^2 + 6)} (\theta^2 \gamma(3, \theta x) + \gamma(4, \theta x)) \right)^{n-1}$$

**Likelihood Ratio Test**

Let the random sample  $X_1, X_2, \dots, X_n$  of size  $n$  from the area biased Shanker distribution. To test we use the hypothesis  $H_0 : f(x) = f(x; \theta)$  against  $H_1 : f(x) = f_a(x; \theta)$

For examining, whether the random sample of size  $n$  comes from the Shanker distribution or area biased Shanker distribution, the following test statistic is used.

$$\Delta = \frac{L_1}{L_0} = \prod_{i=1}^n \frac{f_a(x_i; \theta)}{f(x_i; \theta)}$$

$$\Delta = \frac{L_1}{L_0} = \prod_{i=1}^n \left( \frac{x_i^2 \theta^2 (\theta^2 + 1)}{(2\theta^2 + 6)} \right)$$





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$$\Delta = \frac{L_1}{L_o} = \left( \frac{\theta^2(\theta^2 + 1)}{(2\theta^2 + 6)} \right)^n \prod_{i=1}^n x_i^2$$

We should refuse to accept the null hypothesis, if

$$\Delta = \left( \frac{\theta^2(\theta^2 + 1)}{(2\theta^2 + 6)} \right)^n \prod_{i=1}^n x_i^2 > k$$

Or we should also refused to accept the null hypothesis, where

$$\Delta^* = \prod_{i=1}^n x_i^2 > k \left( \frac{(2\theta^2 + 6)}{\theta^2(\theta^2 + 1)} \right)^n$$

$$\Delta^* = \prod_{i=1}^n x_i^2 > k^*, \text{ Where } k^* = k \left( \frac{(2\theta^2 + 6)}{\theta^2(\theta^2 + 1)} \right)^n$$

Whether for the large sample of size  $n$ ,  $2\log \Delta$  is distributed as chi-square distribution with one degree of freedom and also  $p$  value is obtained from the chi-square distribution. Thus we refuse to accept the null hypothesis, when the probability value is given by

$$p(\Delta^* > \alpha^*) \text{ Where } \alpha^* = \prod_{i=1}^n x_i^2 \text{ is less than a specified level of significance and } \prod_{i=1}^n x_i^2 \text{ is the observed value}$$

of the statistic  $\Delta^*$ .

**Income Distribution Curves**

The bonferroni and Lorenz curves are known as classical or income distribution curves are mostly being used in economics to study the distribution of inequality in income or poverty. The bonferroni and Lorenz curves are given by

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

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

Where  $\mu_1' = \frac{6\theta^2 + 24}{\theta(2\theta^2 + 6)}$  and  $q = F^{-1}(p)$

$$B(p) = \frac{\theta(2\theta^2 + 6)}{p(6\theta^2 + 24)} \int_0^q \frac{x^3\theta^4}{(2\theta^2 + 6)} (\theta + x)e^{-\theta x} dx$$

$$B(p) = \frac{\theta^5}{p(6\theta^2 + 24)} \int_0^q x^3(\theta + x)e^{-\theta x} dx$$

$$B(p) = \frac{\theta^5}{p(6\theta^2 + 24)} \left( \theta \int_0^q x^3 e^{-\theta x} dx + \int_0^q x^4 e^{-\theta x} dx \right)$$





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$$B(p) = \frac{\theta^5}{p(6\theta^2 + 24)} \left( \theta \int_0^q x^{4-1} e^{-\theta x} dx + \int_0^q x^{5-1} e^{-\theta x} dx \right) \tag{12}$$

After the simplification of equation (12), we obtain

$$B(p) = \frac{\theta^5}{p(6\theta^2 + 24)} (\theta \gamma(4, \theta q) + \gamma(5, \theta q))$$

$$L(p) = \frac{\theta^5}{(6\theta^2 + 24)} (\theta \gamma(4, \theta q) + \gamma(5, \theta q))$$

**Entropy**

In probability, the term entropy is defined as the measure of degree of uncertainty in a random variable. Entropy is a scientific concept as well as measurable physical property that is most commonly associated with state of disorder, randomness or uncertainty. Entropy quantify the diversity, uncertainty or randomness of a system.

**Renyi Entropy**

The Renyi entropy is named after Alfred Renyi in the context of fractal dimension estimation, the Renyi entropy forms the basis of the concept of generalized dimensions. The Renyi entropy is important in ecology and statistics as index of diversity. For a given probability distribution, Renyi entropy is given by

$$e(\beta) = \frac{1}{1-\beta} \log \left( \int f^\beta(x) dx \right)$$

Where  $\beta > 0$  and  $\beta \neq 1$

$$e(\beta) = \frac{1}{1-\beta} \log \int_0^\infty \left( \frac{x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} \right)^\beta dx$$

$$e(\beta) = \frac{1}{1-\beta} \log \left( \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\beta \int_0^\infty x^{2\beta} e^{-\theta \beta x} (\theta + x)^\beta dx \right) \tag{13}$$

Using binomial expansion in equation (13), we obtain

$$e(\beta) = \frac{1}{1-\beta} \log \left( \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\beta \sum_{j=0}^\infty \binom{\beta}{j} \theta^{\beta-j} x^j \int_0^\infty x^{2\beta} e^{-\theta \beta x} dx \right)$$

$$e(\beta) = \frac{1}{1-\beta} \log \left( \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\beta \sum_{j=0}^\infty \binom{\beta}{j} \theta^{\beta-j} \int_0^\infty x^{(2\beta + j + 1) - 1} e^{-\theta \beta x} dx \right)$$

$$e(\beta) = \frac{1}{1-\beta} \log \left( \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\beta \sum_{j=0}^\infty \binom{\beta}{j} \theta^{\beta-j} \frac{\Gamma(2\beta + j + 1)}{(\theta \beta)^{2\beta + j + 1}} \right)$$







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**Tsallis Entropy**

The generalization of Boltzmann-Gibbs (B.G) statistical properties initiated by Tsallis has focused a great deal to attention. This generalization of B-G statistics was proposed firstly by introducing the mathematical expression of Tsallis entropy (Tsallis, 1988) for a continuous random variable is defined as follows

$$S_\lambda = \frac{1}{\lambda - 1} \left( 1 - \int_0^\infty f^\lambda(x) dx \right)$$

$$S_\lambda = \frac{1}{\lambda - 1} \left( 1 - \int_0^\infty \left( \frac{x^2 \theta^4}{(2\theta^2 + 6)} (\theta + x) e^{-\theta x} \right)^\lambda dx \right)$$

$$S_\lambda = \frac{1}{\lambda - 1} \left( 1 - \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\lambda \int_0^\infty x^{2\lambda} e^{-\lambda \theta x} (\theta + x)^\lambda dx \right) \tag{14}$$

Using binomial expansion in equation (14), we obtain

$$S_\lambda = \frac{1}{\lambda - 1} \left( 1 - \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\lambda \sum_{j=0}^\infty \binom{\lambda}{j} \theta^{\lambda - j} x^j \int_0^\infty x^{2\lambda} e^{-\lambda \theta x} dx \right)$$

$$S_\lambda = \frac{1}{\lambda - 1} \left( 1 - \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\lambda \sum_{j=0}^\infty \binom{\lambda}{j} \theta^{\lambda - j} \int_0^\infty x^{(2\lambda + j + 1) - 1} e^{-\lambda \theta x} dx \right)$$

$$S_\lambda = \frac{1}{\lambda - 1} \left( 1 - \left( \frac{\theta^4}{(2\theta^2 + 6)} \right)^\lambda \sum_{j=0}^\infty \binom{\lambda}{j} \theta^{\lambda - j} \frac{\Gamma(2\lambda + j + 1)}{(\lambda \theta)^{2\lambda + j + 1}} \right)$$

**Maximum Likelihood Estimation and Fisher's Information Matrix**

In this section, we will discuss the method of maximum likelihood estimation to estimate the parameters of area biased Shanker distribution. Let  $X_1, X_2, \dots, X_n$  be a random sample of size  $n$  from the area biased Shanker distribution, then the likelihood function can be written as

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

$$L(x) = \prod_{i=1}^n \left( \frac{x_i^2 \theta^4}{(2\theta^2 + 6)} (\theta + x_i) e^{-\theta x_i} \right)$$

$$L(x) = \frac{\theta^{4n}}{(2\theta^2 + 6)^n} \prod_{i=1}^n (x_i^2 (\theta + x_i) e^{-\theta x_i})$$

The log likelihood function is given by

$$\log L = 4n \log \theta - n \log(2\theta^2 + 6) + 2 \sum_{i=1}^n \log x_i + \sum_{i=1}^n \log(\theta + x_i) - \theta \sum_{i=1}^n x_i \tag{15}$$





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Now differentiating the log likelihood equation (15) with respect to parameter  $\theta$  and must satisfy the normal

equation as

$$\frac{\partial \log L}{\partial \theta} = \frac{4n}{\theta} - n \left( \frac{4\theta}{(2\theta^2 + 6)} \right) + \sum_{i=1}^n \left( \frac{1}{(\theta + x_i)} \right) - \sum_{i=1}^n x_i = 0$$

The above likelihood equation is too complicated to solve it algebraically. Therefore, we use R and wolfram mathematics for estimating the required parameters of the proposed distribution.

To obtain the confidence interval, we use the asymptotic normality results. We have that if  $\hat{\beta} = \hat{\theta}$  denotes the MLE of  $\beta = \theta$ . We can execute the result as follows

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

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

$$I(\beta) = -\frac{1}{n} \left( E \left( \frac{\partial^2 \log L}{\partial \theta^2} \right) \right)$$

Here we can see

$$E \left( \frac{\partial^2 \log L}{\partial \theta^2} \right) = -\frac{4n}{\theta^2} - n \left( \frac{4(2\theta^2 + 6) - (4\theta)^2}{(2\theta^2 + 6)^2} \right) - \sum_{i=1}^n \left( \frac{1}{(\theta + x_i)^2} \right)$$

Since  $\beta$  being unknown, we estimate  $I^{-1}(\beta)$  by  $I^{-1}(\hat{\beta})$  and this can be used to obtain asymptotic confidence interval for  $\theta$ .

**Application**

In this section, we have fitted a real life time data set in area biased Shanker distribution to discuss its goodness of fit and the fit has been compared over Shanker, exponential and Lindley distributions. The following real life time data set is given below as The following real lifetime data set relating to times (in months) of 105 patients who were diagnosed with hypertension and received at least one treatment related to hypertension in the hospital where death is the event of interest and the real life data set is given below in table 1 as In order to estimate the unknown parameters along with the model comparison criterion values, the R software application is used. In order to compare the area biased Shanker distribution with Shanker, exponential and Lindley distributions, we are using the criterions *AIC* (Akaike Information Criterion), *BIC* (Bayesian Information Criterion), *AICC* (Akaike Information Criterion Corrected) and  $-2\log L$ . The better distribution is which corresponds to the lesser values of *AIC*, *BIC*, *AICC* and  $-2\log L$ . For calculating the criterion values *AIC*, *BIC*, *AICC* and  $-2\log L$  can be evaluated by using the formulas as follows.

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

Where  $k$  is the number of parameters in statistical model,  $n$  is the sample size and  $-2\log L$  is the maximized value of log-likelihood function under the considered model.

From table 2 given above, it can be easily seen from the results that the area biased Shanker distribution have the lesser *AIC*, *BIC*, *AICC* and  $-2\log L$  values as compared to the Shanker, exponential and Lindley distributions. Hence, it





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can be concluded that the area biased Shanker distribution leads to a better fit over Shanker, exponential and Lindley distributions.

## CONCLUSION

The present study deals with a new distribution called as area biased Shanker distribution has been proposed. The proposed new distribution is generated by using the area biased technique to the baseline distribution. Its various statistical properties along with some survival measures have been discussed. The model parameters of the proposed new distribution are estimated by using the method of maximum likelihood estimation. Finally, a real life time data set has been fitted in proposed new distribution to investigate its usefulness and it is found from the result that the area biased Shanker distribution fits quite satisfactory over Shanker, exponential and Lindley distributions.

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**Table 1: Data regarding the patients diagnosed with hypertension relating to times (in months) by G. Mancia et al. (2013)**

45	37	14	64	67	58	67	55	64	62
9	65	65	43	13	8	31	30	66	9
10	31	31	31	46	37	46	44	45	30
26	28	45	40	47	53	47	41	39	33
38	26	22	31	46	47	66	61	54	28
9	63	56	9	49	52	58	49	53	63
16	67	61	67	28	17	31	46	52	50
30	33	13	63	54	63	56	32	33	37
7	56	1	67	38	33	22	25	30	34
53	53	41	45	59	59	60	62	14	57
56	57	40	44	63					

**Table 2: Comparison and Performance of the fitted Distributions**

Distributions	MLE	S.E	-2logL	AIC	BIC	AICC
<b>Area Biased Shanker</b>	$\hat{\theta} = 0.09482519$	$\hat{\theta} = 0.00462300$	929.3957	931.3957	934.0496	931.4345
<b>Shanker</b>	$\hat{\theta} = 0.047382990$	$\hat{\theta} = 0.003264626$	945.3519	947.3519	950.0059	947.3907
<b>Exponential</b>	$\hat{\theta} = 0.023728534$	$\hat{\theta} = 0.002311547$	995.7186	997.7186	1000.373	997.7574
<b>Lindley</b>	$\hat{\theta} = 0.046391990$	$\hat{\theta} = 0.003201435$	946.9942	948.9942	951.6481	949.0330





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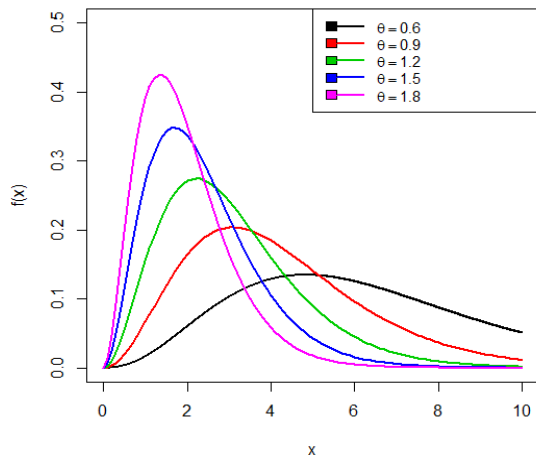


Fig.1:Pdf plot of Area Biased Shanker Distribution

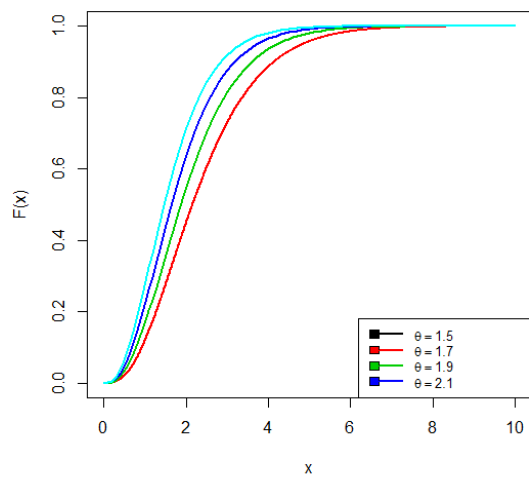


Fig.2:Cdf plot of Area Biased Shanker Distribution

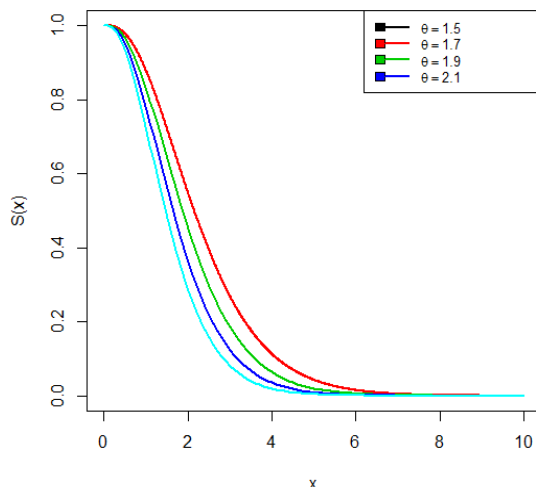


Fig.3:Survival plot of Area Biased Shanker Distribution

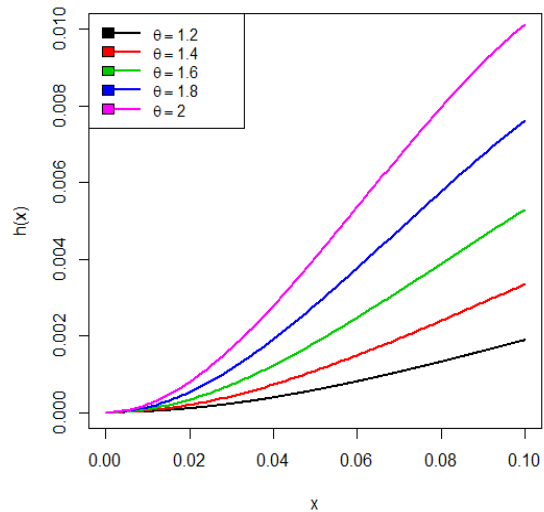


Fig.4:Hazard function of Area Biased Shanker Distribution





## Surface Roughness Investigation of Machined X-750 Nickel Alloy by Coated WC Tool using RSM

Manjeet Bohat<sup>1</sup> and Neeraj Sharma<sup>2\*</sup>

<sup>1</sup>Research Scholar, Department of Mechanical Engineering, Maharishi Markandeshwar Engineering College, Maharishi Markandeshwar (Deemed to be University), Mullana - Ambala 133207, Haryana, India.

<sup>2</sup>Professor, Department of Mechanical Engineering, Maharishi Markandeshwar Engineering College, Maharishi Markandeshwar (Deemed to be University), Mullana - Ambala 133207, Haryana, India.

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### \*Address for Correspondence

**Neeraj Sharma**

Professor,

Department of Mechanical Engineering,

Maharishi Markandeshwar Engineering College,

Maharishi Markandeshwar (Deemed to be University),

Mullana - Ambala 133207, Haryana, India.

E. Mail: neerajsharma@mmumullana.org



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### ABSTRACT

In the current work, coated carbide tools have been used to process X-750 nickel alloy. Depth of cut (DoC), feed (F) and Tool rotational speed (TRS) are the input variables, and mean roughness value (Ra) is the output variable. The tests were conducted using a box-Behnken model of the response surface approach. A total of seventeen experiments were conducted and Ra was measured on all seventeen specimens. Ra has been seen to rise when TRS, F, and DoC values increased. Hence, small values of TRS, F, and DoC favor better surface quality. The optimized setting for minimum Ra value is TRS: 978rpm; DoC: 16mm and F: 0.06mm/rev. The predicted value of Ra corresponds to the optimized setting is 0.7043  $\mu\text{m}$ . The validation experiments were carried out in the suggested setting, and it was revealed that the predicted and experimental findings exhibit a strong correlation.

**Keywords:** Conventional machining, X-750, nickel alloy, surface roughness, optimization.

### INTRODUCTION

Nickel (Ni) based super alloys are very popular to manufacture some parts that need excellent oxidation, corrosion, creep, and excellent rupture strength characteristics [1]. Because of constant yield strength, higher fatigue life at pressure (approximately 600 °C and 103 MPa), and at elevated temperatures these super alloys have been widely

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used in heavy industry, turbine components, nuclear reactors, and aircraft engines, which are utilized under cyclic loads, and greater temperature. Because they are thermally robust under extreme temperatures, Ni-based super alloys have recently been widely employed in the aerospace engine production sectors [2]. These alloys retain their ductility at extremely low temperatures due to the dominating face-centered cubic structure, which property led to the invention of uses like space rocket bodies, cryogenic tanks, and superconducting materials. Inconel-800, FGH-95, Inconel-718, Inconel-100, and ME-16 are a few of the Ni-based super alloys that are often utilized for high-temperature applications[1]. Inconel-800 can withstand oxidation and carburization while maintaining adequate yield strength at higher temperatures. Moreover, it is also useful to manufacture those devices which are used at elevated temperature and prohibits cracks due to chloride stress corrosion [3]. Inconel-800 demonstrates excellent rupture and creep strength at 500-985 °C temperature. Inconel-800 has been used in various applications and also possesses several advantages; however, cutting such alloys is a challenging task because of the high hot-hardness, low capability to transfer heat, and chemical affinity for the materials insert for cutting. These limitations accelerated tool wear and lead to an impact on the surface quality which result in carbon emission and consumes more power by the cutting tool in the process. In the process of cutting Ni-based alloys, increased stresses at the cutting interface lead to welding or adhesion of work materials on the inserts, which further causes excessive notch wear and also alters the shape of the rake face due to pull-out of material coating and tool [4-5]. In the action of plastic deformation, the energy released during cutting is converted into heat, which affects the newly created surface and speeds up the wearing of the tool [6]. Industries are compelled to reduce their energy use due to rising electricity costs and EPA regulations targeted at decreasing global warming. It is crucial to limit the amount of tool wear and the machining forces put on the cutting tool to lower the amount of energy used. Hence, applications that use distinct cooling methods are introduced such as N<sub>2</sub>[7], NMQL [8], and MQL [9], and also to decrease the total energy consumed and cutting forces related to the cutting tools.

Additionally, by influencing other machining factors like machining temperature[10], surface quality[11], and wear of tool [12], such cooling approaches also result in effective machining qualities. In contrast to carbide tools (both uncoated and coated) used at various cutting speeds and rates of feed, Devillez *et al.* examined the wear of tools for Ni-based super alloys during dry machining [13]. When analyzing the wearing of tool behavior, the authors revealed the built-up layer (BUL), adhesion, and welding of the machined material built-up edge (BUE) on inserted rake face at the prior cutting step. Under extremely difficult machining circumstances, the adherence of BUE and BUL on the tool surface and subsequent tool particles contributed to tool notching. To examine the life of the tool and surface condition of the work piece, Zhang *et al.* machined Ni super alloys in MQL and dry-cutting environments[14].The authors concluded that MQL produced better surfaces and enhanced tool life by 1.5 times compared to dry machining. Due to the thin pressured mist that penetrates the tool-chip interface, the increase in tool life is associated with a decrease in friction. The micro-droplets in contact with the cutting zone reduced friction, which in turn reduced chip adhesion and cutting forces, which ultimately resulted in power savings. Similarly, Tamang *et al.* have identified the power cutting and wearing of the tool during the cutting of Inconel-825 material using both MQL and dry machining strategies[15].To investigate the impact of machining on social and ecological elements, turning was done at various depths of cut, feed rates, and cutting velocities. According to the testing results, employing MQL for machining reduces surface roughness, power for cutting, and wearing of the tool by 10.41%, 8.47%, and 16.51%, respectively, compared to dry cutting. From the published research, it was found that there is a good research published on machining and optimization [16-22]. But a limited work published on the processing of X-750 Nickel alloy using carbide inserts. Thus, in the present work, X-750 nickel alloy was machined using coated carbide inserts at different settings of F, DoC, and TRS. The experiments were planned using a box-Behnken design. Using mean roughness measures, the samples' surface quality was evaluated. To determine the impact of each parameter on the response variable, an analysis of variance was conducted.

**Experimental Details**

The tool made of coated carbide was used to process the X-750 nickel alloy. In the current study, machining was done on a standard, semi-automatic lathe. The cutting of the nickel-based super alloy (X-750) was done with the coated carbide tool inserts of MiTech's (TNMG 160408 CQ 5090). The machine tool configuration employed in the



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current work is shown in Fig. 1. Ra (Mean surface roughness) is the response variable in the current work, while TRS (rotational speed of tool), DoC (cutting depth), and F (feed rate) are the input variables. After the initial trials, the range of process parameters is chosen. Ra was calculated at three separate locations during the tests, which were all organized using a "box-Behnken design" based on the RSM. For analysis purposes, the three-way average is taken into account.

## FINDINGS AND DISCUSSION

Table 1 shows the experimental range of various input parameters. The Ra values corresponding to the experimental array are also given in Table 1.

### Analysis of Ra

Tables 1 and 2 illustrate the results of the analysis of Ra with the input variables. In Table 1, all the input variables are considered, while in Table 2, the insignificant parameters (at 95% confidence interval, 0.05 alpha out with backward elimination) are pooled and only significant parameters are considered. The significance of the model, with a P-value of 0.0025, and the insignificance of the lack of fit, with a P-value of 0.5321, are both clear from Table 1.

The model exhibits a strong ANOVA and the values of R<sup>2</sup>, Adj-R<sup>2</sup>, and Adeq Prec. are observed inside the limit. The results of the pooled ANOVA for Ra are shown in Table 2, where P-values of 0.002 and 0.244, respectively, indicate a significant model and an insignificant lack of fit. It is clear from Table 2 that DoC, followed by F and TRS, is a key player in the research of Ra. Similar trends are observed from the values of SS, MS, and tabulated F-values. The empirical model formed after the analysis of Ra is given in Eq. 1

$$Ra = +1.06133 - 17.99153 * DoC + 14.49167 * F + 64.38194 * DoC^2 \quad (1)$$

Fig. 2 presents the graphical plots for Ra, which include a normality plot, predicted versus actual, single factor variation plot, and counterplots concerning different parameters. The normal distribution plot, which is depicted in Fig. 2a, demonstrates that all of the residuals are in a straight line. This is required for the normal distribution of the residual and verifies the good ANOVA. In the predicted versus residual plot, all the residuals must be randomly distributed for a good ANOVA, which is true in the present work. The fluctuation of Ra with TRS is shown in Fig. 2c, and it has been shown that the value of Ra slightly rises as the TRS value goes up. Similarly, an increase in Ra value has been observed with the increase in DoC (Fig. 2d) and F (Fig. 2e) respectively. Counter plots show the variation of the Ra value with the combination of two parameters along with the color coding. As given in Fig. 2f, the lower value of Ra is presented by blue color and the higher value of Ra is given by red color. The counter lines show an increase in the Ra value with the color change. The variation of Ra concerning F and TRS is presented in Fig. 2g with the help of counter lines. The value of Ra varies from 1.36 μm to 2.10 μm with the change in color from red to green. Similar variation has been observed during the variation of Ra with F and DoC in Fig. 2h. The procedure variables for setting the minimum value of Ra are shown in Table 3. Validation experiments are performed on the suggested optimized setting and the experimental values are observed within the limit. Fig. 3 shows the ramp curve of the process parameters, response variables, and desirability. The dots on the ramp presents the value of the input variable within the range and the blue dot shows the minimum Ra value. Fig. 4 presents the bar chart of the desirability of input parameters, output variables, and combined values. All the values in the bar chart are equal to one and the desirability value nearby one is assumed to be good for a good model.

## CONCLUSIONS

The X-750 nickel alloy was processed using coated carbide tool and the following conclusions are drawn:

1. ANOVA of Ra presents that DoC has a major influence on Ra followed by F, while TRS has negligible influence on Ra. The values of R<sup>2</sup>, Adj-R<sup>2</sup> and Adeq-Prec. are observed to be found within the limit and show a good ANOVA.







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2. The Ra value was observed to rise together with the DoC value. The primary cause is the increased rate of material removal, which increases the crater and, consequently, Ra values.
3. The Ra value rises when the F value increases because more material is removed after each revolution, raising the Ra value.

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**Table 1: Design Matrix and corresponding Ra**

Run	A: TRS (RPM)	B: DoC (mm)	C: F (mm/rev)	Ra
1	1250	0.3	0.12	3.879
2	1250	0.2	0.09	1.407
3	1250	0.2	0.09	0.826
4	900	0.3	0.09	2.076
5	900	0.1	0.09	1.118
6	1250	0.1	0.12	1.444
7	1600	0.2	0.06	1.516
8	1250	0.1	0.06	0.966
9	900	0.2	0.06	1.168
10	1600	0.3	0.09	3.107
11	1250	0.2	0.09	0.892
12	1600	0.1	0.09	1.313
13	900	0.2	0.12	1.66
14	1600	0.2	0.12	2.133
15	1250	0.2	0.09	0.934
16	1250	0.2	0.09	1.547
17	1250	0.3	0.06	1.988

**Table 2: Ra (from "ANOVA")**

Source	SS	df	MS	F-Value	Prob> F	
Model	9.89	9	1.1	10.71	0.0025	significant
A-TRS	0.52	1	0.52	5.1	0.0585	
B-DoC	4.82	1	4.82	46.93	0.0002	
C-F	1.51	1	1.51	14.73	0.0064	
AB	0.17	1	0.17	1.7	0.2333	
AC	3.91E-03	1	3.91E-03	0.038	0.8509	
BC	0.5	1	0.5	4.86	0.0633	
A^2	0.12	1	0.12	1.13	0.3227	
B^2	1.6	1	1.6	15.57	0.0056	
C^2	0.46	1	0.46	4.52	0.0712	





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<b>Residual</b>	0.72	7	0.1			
<b>Fit Lack</b>	0.28	3	0.094	0.86	0.5321	<b>Non-significant</b>
<b>Error (Pure)</b>	0.44	4	0.11			
<b>TotalCor</b>	10.61	16				
<b>R-Squared</b>	0.932273	<b>Adjof R-Squared</b>		0.845196	<b>Adeq Precision</b>	10.87810496

**Table 2: Ra (from "Pooled ANOVA")**

Source	SS	df	MS	F-Value	Prob> F	
<b>Model</b>	8.09	3	2.7	13.87	0.0002	<b>significant</b>
<b>B-DoC</b>	4.82	1	4.82	24.8	0.0003	
<b>C-F</b>	1.51	1	1.51	7.78	0.0153	
<b>B^2</b>	1.76	1	1.76	9.03	0.0101	
<b>Residual</b>	2.53	13	0.19			
<b>Lack of Fit</b>	2.09	9	0.23	2.12	0.244	<b>not significant</b>
<b>Error (Pure)</b>	0.44	4	0.11			
<b>TotalCor</b>	10.61	16				

**Table 3: Validation experiments of the Predicted values**

Experimental Run	F	DoC	TRS	Predicted Ra	Experimental Ra
1	0.06	0.16	978.7	0.7043	0.741
2	0.06	0.17	907.8	0.7543	0.723
3	0.06	0.14	954.46	0.7291	0.757

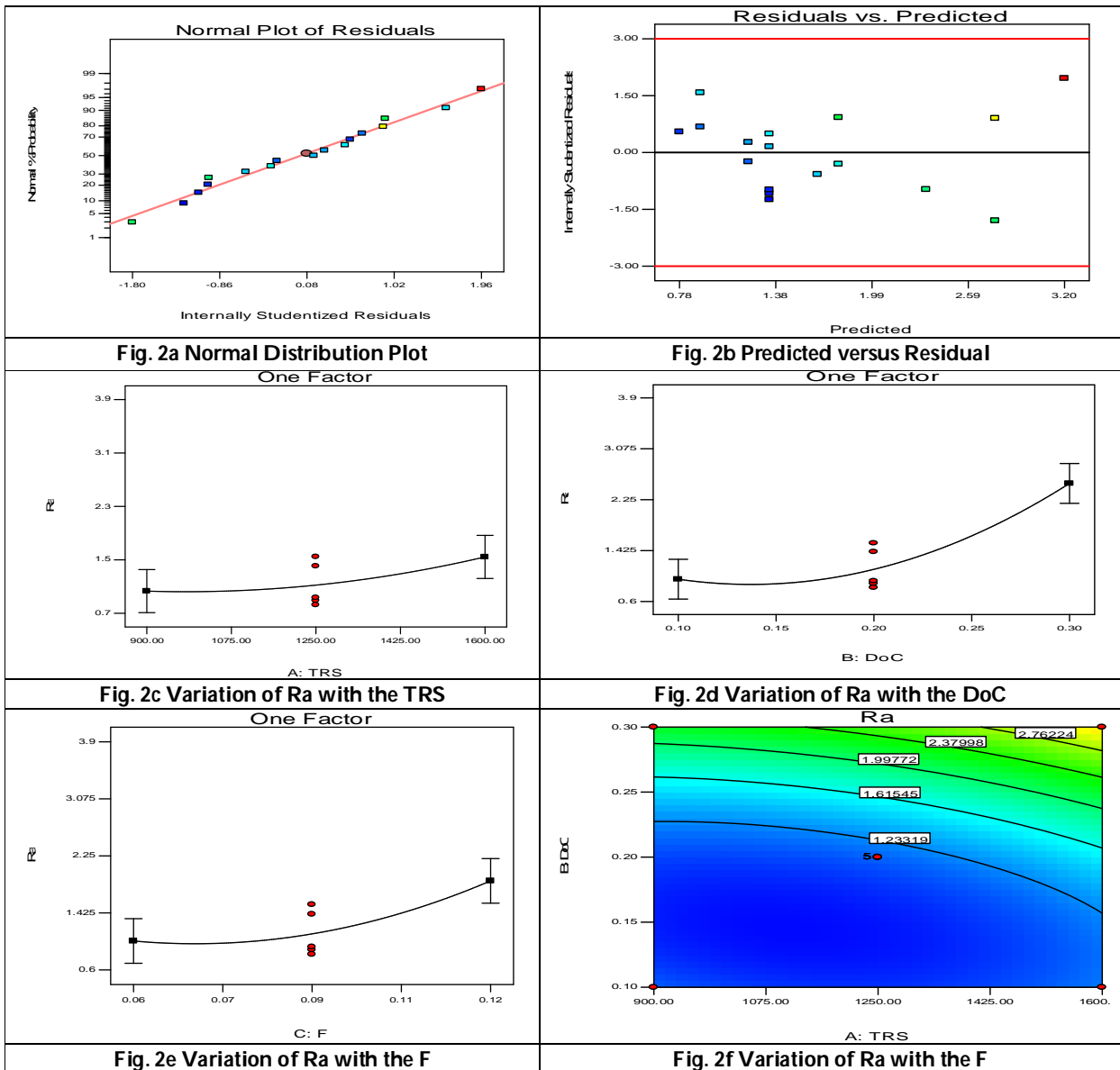


**Fig. 1 Machine tool set-up**



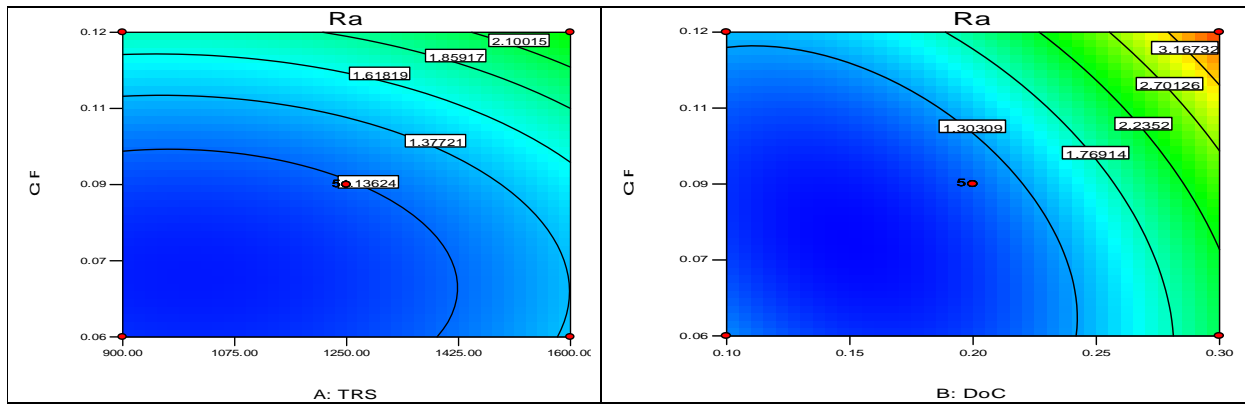


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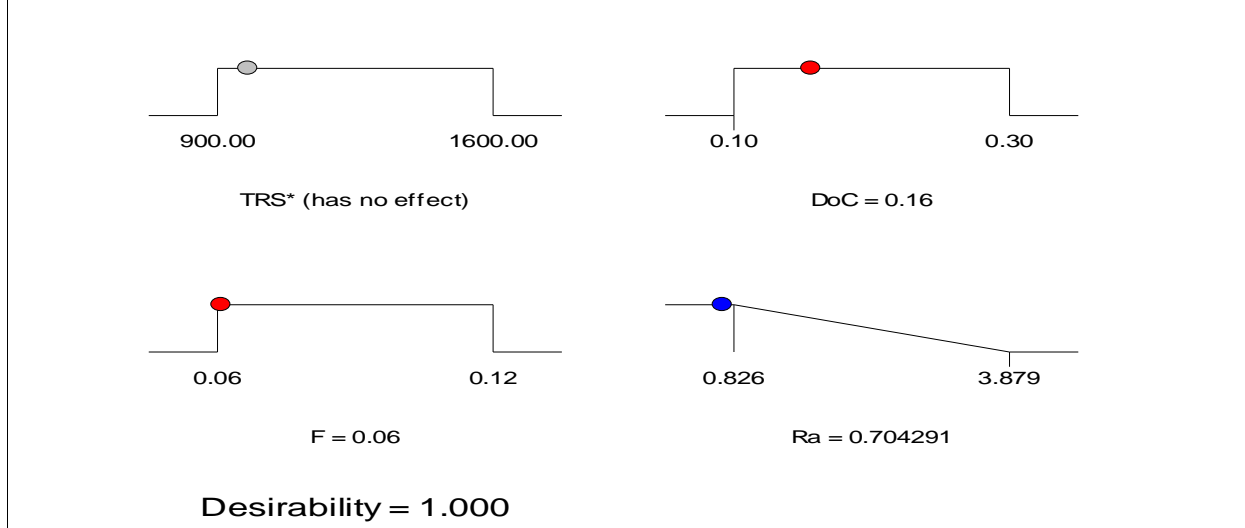
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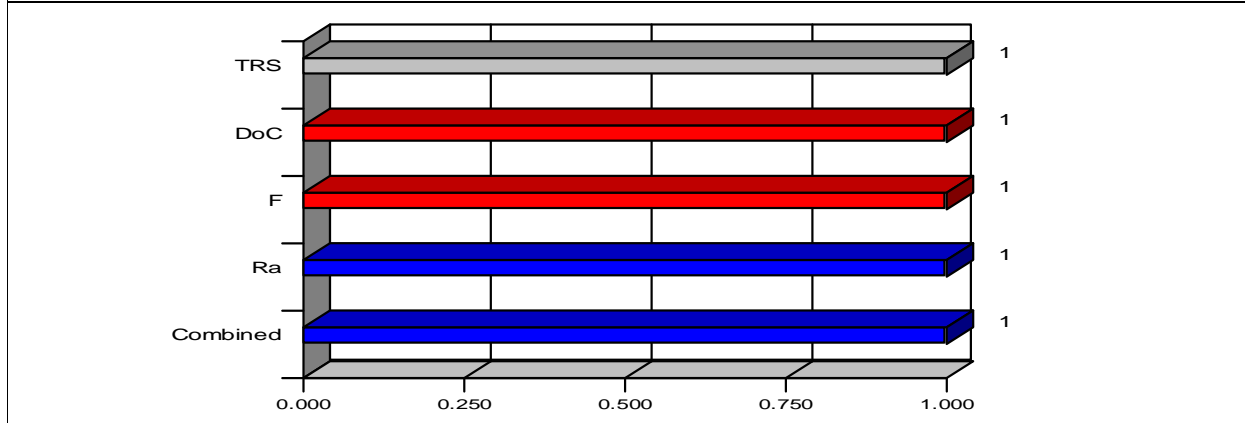
**Fig. 2g** Variation of Ra with the F and TRS

**Fig. 2h** Variation of Ra with the F and DoC

**Fig. 2** Graphical Plots for Ra



**Fig. 3** Ramp plot for input and output variables



**Fig. 3.** Bar plot for input and output variables





## A Study on User's Perceptions on Mobile Banking In Handwara, Kashmir

Showkat Ahmad Dar<sup>1\*</sup> and P.Sakthivel<sup>2</sup>

<sup>1</sup>Research Scholar of Public Administration, Department of Political Science and Public Administration, Annamalai University, Tamil Nadu, India.

<sup>2</sup>Professor, Department of Political Science and Public Administration, Annamalai University, Tamil Nadu, India.

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### \*Address for Correspondence

#### Showkat Ahmad Dar

Research Scholar of Public Administration,  
Department of Political Science and Public Administration,  
Annamalai University, Tamil Nadu, India.  
E. Mail: darshowkat41@gmail.com



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### ABSTRACT

The Indian banking system is computerising, and financial reforms have been enacted. The Indian banking system's large structure and strong foundation can be utilised to digitalize the financial industry. Some aspects impact technology, while others prevent improvements. In 2017, Jammu and Kashmir introduced the Mobile Banking App to satisfy client needs. J&K Bank's Mobile Banking App lets customers make NEFT/IMPS and mobile-to-mobile transfers. This programme also allows mobile bill payments. The app checks account balances, mini statements, transaction history, cheque status, and stops cheque payment. Jammu & Kashmir residents use mobile banking. It's important to understand the current situation and progress of Mobile Banking, a technical drive toward cashless transition in Kashmir, so that solutions can be proposed. It's the paper's research topic. The study combines documentary research and semi-structured interviews. According to the survey, Jammu and Kashmir Bank changed from traditional to innovative mobile banking.

**Keywords:** Banking, Transitions, Privacy, Apps, Technology etc.

### INTRODUCTION

Mobile banking lets individuals make financial transactions using mobile devices. This 24-hour, 7-day-a-week system lets clients pay bills, buy things, and transfer payments from anywhere. Smart phones gained WAP capabilities in 1999, providing mobile web browsing. Smart phones incorporated WAP technology in 1999 to support mobile banking. Mobile banking was first used by European banks. Wachovia started mobile banking in 2006. India launched mobile banking in 2002. Mobile banking is convenient, thus all banks are implementing it. Mobile devices

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include phones, PDAs, wireless tablets, and anything else that can connect to a mobile network and accept payments (Goyal, 2012). Mobile payments take cash, checks, credit, and debit cards. Bills can be paid through NEFT, Internet banking, direct debit, and e-bill (particularly utilities and insurance premiums).

Mobile banking lets users access their accounts anywhere, but it's insecure. Some banks utilise third-party security services, but we shouldn't give them personal information. Mobile banking security and consumer trust are our top priorities (Aditya Kumar Tiwari et, 2014). Second, make it user-friendly so clients can easily use it. These characteristics can help mobile banking gain acceptance. Mobile banking can also be used to pay bills and shop. Mobile banking is handy. Mobile banking, or mobile payment, will extend its functionality (Aditya Kumar Tiwari et, 2014). Customers won't use mobile banking if it's dangerous and they don't grasp how it works. Mobile banking security and client trust must be ensured. Second, make it easy to use without training. Mobile banking lets customer's access bank accounts from their phones. SMS lets us check account info (Goyal, 2012). Mobile banking allows you to check account information and make transactions and payments from the comfort of your home or office. Two mobile banking categories exist: When you use an ATM or shop, you'll get an SMS (Aditya Kumar Tiwari et, 2014). First, SMS banking sends you an SMS message whenever you use your account (Goyal, 2012). These suppliers provide us the amount, time, and location of fraudulent transactions. Downloading a banking app on your phone lets you access your account. Mobile banking gives us full account access and control. Mobile banking can be classed as an SMS or application service based on the preceding facts (Goyal, 2012). India will have 748 million smartphone users by 2020 and 1.5 billion worldwide by 2040. J&K will have 1,180,904 mobile users by December 2021, up from 1,042,635 in September 2017. 60% of J&K's clients are in Kashmir (S.A Dar, 2021). In this study, we examine user's perceptions on mobile banking in Handwara, Kashmir

**LITERATURE REVIEW**

With the widespread use of mobile phones in India, banks may now offer services via mobile phones. Researchers began studying mobile banking's numerous elements and characteristics. Many research documents were studied for this work, but only the most relevant are listed. Banking and telecommunications have been the industries with the most dramatically expanding growth rates in India during the past two decades.(Leeladhar, 2006). It has been stated that the mobile as a channel provides consumers with convenience, immediacy, and choice; yet, there is a significant variety of various mobile devices, which poses a big problem to banks in offering mobile banking solutions on any sort of device (Sofi, 2019). It has come to our attention that people who utilise mobile banking in India are concerned about security-related issues.(Bamoriya, 2012). Author has proposed that regulatory bodies for banks should guarantee sufficient protection for customers, as this is the primary obstacle preventing widespread adoption of mobile banking (Hayat, 2009). Author claims that younger people have a greater propensity to accept mobile banking since it is more compatible with their lifestyle.(Koenig-Lewis, 2010). Traditional branch banking is losing ground to e-banking and mobile banking due to technology, changing demographics, and lifestyles (m-banking). Data show low technology adoption. 64 banks in India have started mobile banking, and 22 million people utilise it (5 percent of bank accounts) (Report of the Technical Committee on Mobile Banking, 2014). Lack of understanding, security concerns, and technical challenges are major barriers to mobile banking.(Krishnaswamy R. &., 2015). ICICI bank dominates mobile banking transactions in India, followed by HDFC and AXIS. In India, private banks have the greatest mobile banking share. 71% of banks are private, 26% are public, and 3% are foreign (Sharma, 2018)

**Research Objective**

This study aims to elucidate the development of Mobile Banking and explore user perceptions regarding its usage in Handwara, Kashmir. Through comprehensive research, an in-depth analysis will be conducted to understand the progression of Mobile Banking in this region. Additionally, this study aims to investigate the perceptions of users towards mobile banking services, examining factors such as convenience, security, accessibility, and user experience. By gathering primary data through surveys and interviews, the research will provide valuable insights into the adoption and acceptance of Mobile Banking in Handwara, Kashmir. The findings of this study will contribute to the



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existing knowledge base and assist financial institutions and policymakers in enhancing Mobile Banking services to meet the evolving needs and expectations of users in this specific geographical context.

**The Study Area**

To research mobile banking's environment, cashless transaction prospects, and obstacles. Kashmir is our study area. Kashmir Valley is to the Himalayas what Switzerland is to the Alps, regarded as "Paradise on Earth" or "Kerala of the north." Jammu & Kashmir has 1.25 Million people, up from 1.01 Million in 2001. Male literacy is 78.26% while female literacy is 58.1% in Jammu and Kashmir. Jammu and Kashmir has 7,245,053 literates, 4,370,604 men and 2,874,449 women. Islam dominates the town. The study solely covers Kashmir, not Jammu. The study only covers Kashmir.

**MATERIALS AND METHODS**

Two research methodologies were used to collect data in order to meet the study's goals and objectives. The first technique included a survey as well as analytical and documentary methods, as well as the acquisition of secondary data from the Jammu and Kashmir Bank Pvt Ltd. Purposive sampling was used to acquire primary data in April and May 2022. Purposive sampling depends on the researcher's judgement of who can provide the best facts and statistics to meet the study's aims. To meet the study's aims, 180 participants were asked close-ended, semi-structured questions. 15-45 minute interviews. Some were near stores, some at participants' houses. The interviewees at home gave informed consent. Before house interviews, attention was taken to know how to knock, open, and start a dialogue. Data gathering comprised field notes, audio recordings with interviewees' permission, and personal observation. Repeated interviews were used to clarify data gathering ambiguities. The study utilized the tools like SPSS 23.0 package and MS Excel for the analyses of data. The techniques utilized were frequency and t-test.

**Approach and participants**

A phenomenological method was utilised to examine participants' perceptions on mobile banking's potential and challenges (Cova, 2008). Small numbers of respondents are usually enough for saturation in phenomenological research (Guest, 2006). We recruited and interviewed participants using purposive sampling to acquire primary data. To understand mobile banking, In Kashmir Valley, researchers focused on Mobile Banking, a technological approach toward cashless transformation. Researchers analysed primary survey data from 180 individuals and extracted important statements to generate themes. Before data collection, all participants were told of the study's purpose and ensured that the data would be used academically.

**Data interpretation Analysis and Questionnaire schedule**

The study surveyed 180 respondents in Hindi and English using a questionnaire. Male and female J&K Bank customers largely responded. The respondents' responses were rated Y-Yes, N-No, and NI-No Idea. The Three point scale is mentioned below:

The above table 1 reveals that the dominant majority of the respondents i.e. 60.55 per cent of the respondents belong to the age group of 18 to 23 years while the 39.44 per cent belong to the age group of 24 to 29 years, Further the distribution of respondents with respect to their gender. It is revealed that of the total respondents in the sample, 180 i.e. (56.66%) respondents were male and 72 (43.33%) respondents were female. Further, the majority of the respondents were literate 109, i.e. (60.55 %) while the illiterate respondents were only 71 i.e. (39.44%). Further the details of marital status of the respondents. Out of the total 180 respondents, reveals that a majority of the respondents are unmarried 97 i.e. (53.88%). While the married respondents were only 83 i.e. (46.11) .The findings of the study regarding the Mobile Banking, a technological step toward Cashless Transition in the Handwara sub district of Jammu and Kashmir enquired from the respondents are given below in the tabulated form.





**Showkat Ahmad Dar and Sakthivel****Data Interpretation**

When asked about whether mobile banking provides quick and error free services, respondents feel that financial transactions through mobile banking is the greatest innovative move towards cashless transactions and has increased the customer base of Jammu and Kashmir Bank to a large extent. Males made up 58.3% of the people who said they knew a lot about the reach and extent of mobile banking. When the same questions were asked of both genders, the same result was varying. Question was asked to educate the respondents; the majority of them chose the yes option, as mobile banking is an effective and speedy way to carry out financial transitions. While few, if any, of them were aware of the posed question, in addition to married and unmarried respondents, it's found that 98% of respondents were aware that mobile banking provides quickly and hassle free financial services. While the majority of respondents were unmarried, 23% shared that they had no idea. Furthermore, 59% stated unequivocally that they had not encountered such a problem.

From Variable 2: The following results have been carried out by the respondents. Relating to the reaction of the respondents while asking whether mobile banking results in traditional manual systems being reduced, the majority of the respondents from all three categories said that mobile banking has changed the working culture of banks. The traditional financial transitions have also taken the back seat due to automation and digitalisation. The study also found that customers don't have to wait as long at banks now that they can use mobile banking. From all three categories of respondents, miscellaneous percentages opined that they don't come across such a problem.

From Variable 3: The respondents achieved the following result, which relates to their reaction when asked whether mobile banking leads to banking anywhere, at any time. The majority of respondents said mobile banking makes their life easier since it provides customers with a secure and convenient way to bank and shop from anywhere at any time. A small fraction indicated they had no ideas, and those were mostly elderly and illiterate persons who had never heard of mobile banking. Furthermore, the educated respondents, the majority of them stated that uneducated, impoverished, and elderly people are unaware of the latest advancements and hence are unable to benefit from technology services. They claim that this is due to a lack of digital literacy as well as other concerns such as privacy, security, a lack of information, a conservative worldview, and so on.

From Variable 4: The variable displays the replies of participants when asked if they had any problems while utilising mobile banking. The majority of respondents said they have problems using mobile banking on a regular basis. The majority of respondents stated that mobile banking is extremely valuable for all segments of society throughout the pandemic. A minor proportion of responders stated that they have never encountered such a situation. All three categories of respondents agreed that privacy and security are important challenges that impede mobile banking in Jammu and Kashmir. They do not use mobile banking in the financial system due to a lack of security and fear of future dangers.

Table 4 indicates the variations in the level awareness of mobile banking between the age group of 18-23 and 24-29 respondents, as an outcome of t-test. The results of this t-test show that the t- value of  $-0.361$  corresponding to the awareness about mobile banking awareness is found to be significant at 5 percent level. Hence, null hypothesis is accepted at 5 percent level of significance. The results thus suggest that the level of awareness about mobile banking governance awareness is not varying significantly with the Age of respondents.

Table: 3. shows the variations in the level of "Technological benefit of mobile banking" between male and female respondents, as an outcome of Independent Samples t-test. From the results of this test, it can be opined that the t- value of  $6.68$  corresponding to the "progress and benefits of mobile banking" is found to be significant at 0.01 percent level. Hence, null hypothesis is rejected at 0.01 percent level of significance the results thus suggest that the level of Technological benefit is varying significantly with the Gender of respondents.



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Table: 5. shows the variations in the level of “Technological benefit of mobile banking” between married and unmarried respondents, as an outcome of Independent Samples t-test. From the results of this test, it can be opined that the t-value of 2.98 corresponding to the “Technological benefit of mobile banking” is found to be significant at 0.01 percent level. Hence, null hypothesis is rejected at 0.01 percent level of significance the results thus suggest that the level of Technological benefit of mobile banking is varying significantly with the education status of respondents.

Table: 5. shows the variations in the level of “Technological benefit of mobile banking” between married and unmarried respondents, as an outcome of Independent Samples t-test. From the results of this test, it can be opined that the t-value of 2.89 corresponding to the “Technological benefit of mobile banking” is found to be significant at 0.01 percent level. Hence, null hypothesis is rejected at 0.01 percent level of significance the results thus suggest that the level of Technological benefit of mobile banking is varying significantly with the marital status of respondents.

Table 4 indicates the variations in the level awareness of mobile banking between the age group of 18-23 and 24-29 respondents, as an outcome of t-test. The results of this t-test show that the t-value of -.361 corresponding to the awareness about mobile banking awareness is found to be significant at 5 percent level. Hence, null hypothesis is accepted at 5 percent level of significance. The results thus suggest that the level of awareness about mobile banking governance awareness is not varying significantly with the Age of respondents.

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**DISCUSSION AND RESULT**

In India, the commercial banking industry has developed several financial innovations to suit consumer needs and gain a competitive edge. Mobile banking lets clients transfer funds in real time utilising mobile networks. This capability frees banking transitions from space and time constraints. This has made banking convenient and affected client transactions. It enables banks engage with customers and generates income through mobile banking. Banks, clients, and Telecom Company collaborated to make this possible. (Singh, 2018). Mobile banking is the delivery of banking services via cell phones and PDAs (PDA). It enables an effective payment and accounting system, speeding up banking services. Mobile phones as a banking channel have gained importance recently. With 950 million mobile phone consumers in India (as of February 2013), mobile banking has a lot of promise. (Wadhe1, 2013). Mobile banking SMS alerts improve service. SMS tells the account owner when money is purchased or transferred. Credit card theft is prevented. SMS can be used to request mini-statements, deposits, and withdrawals. To improve



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customer service, banks send SMS loan reminders, payment dates, and offers. Mobile banking improves financial services by allowing bill payments and purchases. We can access our account details for payments and money transfers without visiting the bank. Mobile banking saves time and provides easy services anytime, anywhere. (Aditya Kumar Tiwari et, 2014)

The survey indicated that 18–23-year-olds are aware of mobile banking and use it for financial transactions without visiting the bank. A majority of all four groups using cell phones for mobile banking stated such innovations help them and support a green economy. Mobile banking is faster, but some respondents said it's not error-free. Technical error is part of any innovation, and we can't avoid it, but we can solve it with technical players. Electronic banking facilitates digital financing, which is crucial for emerging nations' development. Success of electronic banking service developments depends on customer perceptions and consumption habits. As e-banking adoption is minimal, banks can benefit by spreading the technology. Banks should not disregard the role of staff as manual and computerised banking are complementary. To fully rely on electronic media, electronic banking must be made simpler and more secure. (Supreet Sandhu, 2020)

Mobile banking allows companies to build new service design ideas and models. This reduces bank manual and paper effort. With globalisation and fiercer competition, using the Internet as an alternate channel for financial services distribution has become a competitive imperative. Internet banking has altered commercial banking by overcoming geographical, industrial, and regulatory boundaries and enabling innovative products, services, and market opportunities for banks and clients. M-banking services are customised forms of Internet banking, which consumer's value for their time and place independence. Telecom carriers are offering m-banking to attract, retain, and protect subscribers. It's crucial to improve e-banking by meeting customers' needs. (Rasha Abd, 2014). Mobile banking has changed the financial industry's mentality and diminished the manual system, the study showed. Mobile banking has transformed the working culture of banks, according to most respondents. Automation and digitalization have slowed conventional financial transformations. Mobile banking reduces client wait times, according to the study. Various percentages of all three groups of respondents said they don't encounter this difficulty. Mobile banking focuses on client needs for anytime, anywhere banking. (Saini, 2014). Mobile and wireless are fast-growing sectors. This helps value-added banking. Mobile banking lets customers transfer money and trade stocks while travelling. Mobile devices are the best way to reach and retain customers. Mobile banking uses phones. Smartphone's boost mobile banking in India. India has ICICI, HDFC, SBI, etc. mobile banking. A corporation may only acquire loyal clients by providing exceptional services. (Geeta Sharma, 2011)

M-banking revolutionises e-banking (mobile banking). Combining internet with mobile phones creates mobile data service, and banks perform the first commercial wireless internet transaction. M-banking will provide a remote banking channel. (S.M. Sohel Ahmed, 2011). Middle-aged folks who grew life pre-smartphone find digital payments and banking difficult. Banks and private companies have developed mobile payment systems to enable cashless banking, but they seem to target young, tech-savvy consumers. These solutions aren't beginner-friendly. (Joglekar, 2019). The new mobile banking services combine intangible service with high-tech service delivery. Thus, innovation and spread are more complex as technology and service issues affect mobile banking services. Improving 2.5G and 3G devices and networks will boost mobile banking. In Finland, 20% of the population owns an Internet-enabled device, despite high fixed and mobile connection densities. Men have more advanced model access than women. Younger people have advanced mobile phones more regularly than older people; in reality, only 3-9 percent of 60-year-olds and retirees have access. Higher education increases the likelihood of having an Internet-enabled mobile phone, although not as much as age. (Mattila, 1970). Mobile banking allows banking anywhere, anytime, according to the study. Mobile banking offers clients a secure and convenient way to bank and shop from anywhere, at any time, according to most respondents. Various numbers indicated they didn't know, usually the elderly and illiterate. Educated respondents claimed ignorant, impoverished, and elderly individuals don't know about the latest advances and can't use mobile banking. They said this problem is due to digital literacy, privacy, security, lack of understanding, and conservative mind-sets, etc.



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Over a billion people in underdeveloped regions don't have bank accounts but use mobile phones. New businesses use mobile phones to serve these customers. These solutions extend banks' reach to remote locations in a convenient and often cheaper method for consumers. Mobile phones as banking instruments are a fascinating notion with numerous benefits, but implementation is difficult. Preventing fraud is crucial. Every bank that offers mobile banking wants to ensure that transaction requests come from the phone's owner. In several nations, mobile banking requires strict government authentication. (Saurabh Panjwani, 2010) Kashmiris had trouble using mobile banking, according to the study. In cases like internet blackouts or 2G connectivity in Kashmir, most respondents face issues using mobile banking. Most respondents believed mobile banking was useful for everyone throughout the pandemic. Few respondents reported having this issue. All three groups of respondents indicated privacy and security issues impede mobile banking in Jammu & Kashmir. Armed conflict, lack of security, and fear of threats prevent them from using mobile banking.

There are multiple challenges on the way of mobile banking. Some are definitely technical, but with reference to Jammu and Kashmir, some are unique and regionally based. Let's have a look at them:

- Existing Account Holders: Only those with a valid bank account will be allowed to use mobile banking, according to the instructions this restricts the full potential of mobile banking to expand micro-credit and introduce banking to the enormous number of unbanked people in India. (Tiwari, 2014)
- Demographic Challenges: India has 18 official languages. Official state communications must also be in regional languages. Two-thirds of India's population is illiterate, complicating mobile banking deployment. This will be difficult for pan-Indian mobile banking. (Krishna, 2021)
- Customer awareness: Lack of knowledge and awareness about mobile banking is also a reason for distrust in mobile banking services, as well as another reason for risk and security issues in mobile banking. Because mobile banking is a new technology in the banking and financial system, all banking customers are unaware of it and are hesitant to adopt it, posing a significant challenge to mobile banking services in India. (Tiwari, 2014)
- Security issues & privacy: There is a big problem and challenge with the security of mobile banking services. For security, PIN or PASSWORD is used in mobile banking. If the mobile device is lost or stolen, an attacker or unauthorised user could steal the PIN or PASSWORD. The user should be aware of this. Customers use sensitive data and information on their phones, so there is a risk if they don't use a legitimate application. This is because application services are provided by a third party, which means that the application could steal our information and send it to another third party. Because of this, we need to be careful about the applications we use for WAP mobile banking services and only use applications that have been approved by the bank. (Tiwari, 2014)
- Virus & malware attack: There is also the chance of a virus or malware attack accessing your account information such as login, password, and other information, just as there is on a computer system. There is also the possibility of a virus or malware attack on mobile banking services. Some malicious code is written to compromise mobile banking, such as Zeus's attack on SMS banking and Zeus's theft of mobile transaction authentication such as password and pin number. As a result, there is a significant security risk and challenge in mobile banking services. (Tiwari, 2014)
- Wireless network: All mobile banking services are wireless, therefore mobile device component contact with cell site and dedicated circuit or microwave for communication services poses a security risk. Any weakness in our network raises the chance of attack, so we must safeguard all network devices. SMS risk: Text-only SMS. Unavailable end-to-end encryption. Base station transceiver and SMS server encrypt transmissions. SMS banking dangers include SMS spoofing, where an attacker sends a message by modifying a user's phone. (Aditya Kumar Tiwari et, 2014)
- Authentication issue: In mobile banking, there is an authentication risk during login or when we access our account through the mobile system since PINS numbers are used for authentication. PINS authentication is an ancient method, and obtaining the password and id can lead to various security difficulties. If a phone is stolen, an attacker can get the password and access your account. (Aditya Kumar Tiwari et, 2014)
- Digital divide: A digital gap is unequal access, use, or influence of information and communications technology between groups based on social, geographical, international, or other characteristics. Internet media make



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political strengthening and assembly difficult without a computer network. Networks are transparent and accountable. Separation hinders e-administration. Web access affects a country's economy. Separation hinders a country's social progress. Computer partitioning causes data need. Neediness, sorrow, and backwardness are reinforced. Digital divide hinders kids' learning and creativity. Without Internet, students can't learn IT. (S.A Dar, 2021)

- Cybercrime: There is a digital danger everywhere on the globe and digitalization won't be any special case. Subsequently it needs a solid team of experts of that keeps up the data set and secures nonstop. (S.A Dar, 2021)
- Administration culture: Deficiencies in the administration is one of the greatest business digitalization challenges. The most well-known misinterpretation is that digitalization is done if an organization updates its devices and advances. Nonetheless, actually digitalization isn't just about advances. It's about organizations capacity to adjust these changes. Consequently it is fundamental to empower representatives and other partners to get acquainted with the digital culture. (S.A Dar, 2021)
- Lack of IT resource and Management: Absence of IT asset and the board: Helpless asset the executives arranging and absence of IT assets are a portion of the basic difficulties with digitalization. Regarding IT assets, absence of labour and ability war are two angles that goes about as an obstacle to a fruitful digitalization measure.
- Conflict: Kashmir is called the land of conflicts from decades. Every day is a day mourns, stone pelting, boycotts etc is a persistent culture, which hampers the technological advancement in Jammu and Kashmir. (S.A Dar, 2021)
- Internet and Network barring: Mobile banking lets users do financial transactions using a laptop, smartphone, or internet-connected PC. Internet offers financial and nonfinancial banking services. Internet and mobile networks are crucial in modern times for obtaining services. Due to armed conflict and security concerns in Jammu and Kashmir, internet and network access are cut off during every escalation of violence. (S.A Dar, 2021)
- The study found that Launched to "delight" customers and make their transactions "safer and easier", the mobile application of Jammu and Kashmir Bank is not working, leaving customers of the bank aghast. Reports received from across Jammu and Kashmir reveal that the online mobile banking application is down now and then. The snag is more noticeable as the customers out for shopping ahead of festivals were embarrassed at the payment counters and many had to leave shops empty-handed. The crisis coupled with the malfunctioning of several ATMs led to chaos and severe criticism of the bank and its claim of being innovative in digital banking. The system breakdown of the bank is seen as a "complete failure" of the people at the helm of affairs. Jammu Kashmir Bank, it may be recalled here, is the main financial backbone of Kashmir society as it manages almost two-thirds of the entire banking sector. (Network, 2022) (Rasha Abd El.Aziz.et, 2014)

**Problems and ways to fix them**

**Problem solvers** Using solutions and suggestions, we can overcome mobile banking's obstacles and risks. **Customer education:** It's crucial for us to educate and familiarise our consumers with the benefits and risks of mobile banking to overcome these worries and impediments. (Tiwari, 2014)

**Privacy issues:** Privacy concerns need users to be aware of the mobile banking system's security and their own. Make sure privacy-related programmes are downloaded from a trusted source and tested before installation. When you use these apps, third-party providers may steal your personal data from your phone or during a transaction. (Tiwari, 2014).

**Wireless network:** Mobile banking uses wireless technology for transactions, transfers, and other activities. We must give a high infrastructure and solid security for banking to protect consumer services. (Tiwari, 2014)

**Trust:** To gain clients' trust, we must provide safe mobile banking services. Educating clients about financial services and security helps develop trust. This protects their privacy and allows them to use secure services. (Tiwari, 2014) Mobile Banking relies on trust. MB technology can improve people's lives and banks' efficiency. (F.MalaquiasaYujongHwang, 2106)



**Showkat Ahmad Dar and Sakhthivel****Major Findings**

Mobile banking is a quick and convenient way for customers to conduct banking activities. Mobile banking is a rising internet banking app. Banks that use mobile banking has created a specialised app. Most banks use smartphone apps for mobile banking. Mobile banking can be used to invest in mutual funds and manage portfolios.

**Limitation of study**

The study's limitations prevent generalising its conclusions and findings. When interpreting the results, consider the study's limitations. First, Kashmir was surveyed. A greater sample size would have improved the survey's results. Clients, not bankers, are surveyed. Several constraints prevented us from completing the investigation. Young researchers may lack expertise, knowledge, or experience, making research challenging. Personal motives, time limits, and others contributed. Insufficient books, periodicals, and records in libraries have caused more problems. Respondents were occasionally unwilling to offer needed information due to mobile banking ignorance. Authority approval took a long time. I followed processes to obtain data from administration and respondents.

**Implications of the study**

The study on user's perceptions on mobile banking in Handwara, Kashmir has several implications that can be considered. Here are some of the implications that arise from the study:

**Access to financial services:** The study sheds light on the potential of mobile banking to expand access to financial services in Handwara, Kashmir. It highlights the role of mobile technology in bridging the gap between traditional banking services and remote areas. This implies that mobile banking has the potential to provide financial services to previously underserved populations, thereby promoting financial inclusion.

**Convenience and efficiency:** The study likely reveals that mobile banking offers convenience and efficiency to users in Handwara. By enabling users to perform banking transactions through their mobile devices, it eliminates the need for physical visits to banks or ATMs. This convenience saves time and effort for users, especially those residing in remote areas where physical banking infrastructure may be limited.

**Trust and security concerns:** The study may uncover users' perceptions regarding trust and security in mobile banking. It can provide insights into the level of trust users have in mobile banking systems and their concerns about the security of their financial information. Understanding these perceptions is crucial for service providers to address any gaps in security measures and enhance users' trust in mobile banking services.

**Financial literacy and awareness:** The study can shed light on the level of financial literacy and awareness among mobile banking users in Handwara. It can identify any gaps in knowledge and help design appropriate educational initiatives to enhance users' understanding of mobile banking features, benefits, and potential risks. Increasing financial literacy can lead to better decision-making and more effective utilization of mobile banking services.

**Socio-economic impact:** The study's findings can contribute to an understanding of the socio-economic impact of mobile banking in Handwara, Kashmir. It can assess how mobile banking affects individuals, businesses, and the overall economy by analyzing factors such as increased savings, access to credit, cost savings, and economic growth. This information can be used by policymakers and financial institutions to formulate strategies that leverage the positive socio-economic outcomes of mobile banking.

**Technology infrastructure:** The study may reveal insights into the existing technology infrastructure in Handwara, including mobile network coverage and internet connectivity. It can identify potential challenges and limitations faced by users in accessing mobile banking services. These findings can guide policymakers and service providers in improving the technological infrastructure and connectivity in the region, ensuring a seamless mobile banking experience for users.





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**Future adoption and innovation:** The study's results can provide valuable insights into the factors influencing the adoption of mobile banking in Handwara, Kashmir. It can identify the drivers and barriers to adoption and highlight areas for improvement. Additionally, the study can serve as a foundation for further research and innovation in mobile banking, encouraging the development of new features and services that cater to the specific needs of users in the region.

The study on user's perceptions on mobile banking in Handwara, Kashmir has implications for financial inclusion, convenience, trust and security, financial literacy, socio-economic impact, technology infrastructure, and future adoption. It offers valuable insights that can inform policies, strategies, and improvements in mobile banking services in the region and beyond.

## RECOMMENDATIONS

Based on the implications derived from the study on user's perceptions on mobile banking in Handwara, Kashmir, the following recommendations can be made:

**Enhance accessibility:** To further promote financial inclusion, it is recommended to expand mobile network coverage and improve internet connectivity in Handwara. This will ensure that users in remote areas have reliable access to mobile banking services. Collaboration between telecommunication companies and financial institutions can help bridge the infrastructure gap.

**Strengthen security measures:** Addressing users' concerns about trust and security is crucial. Financial institutions should prioritize robust security measures, including strong encryption protocols, multi-factor authentication, and regular security audits. Educating users about security best practices and implementing proactive measures to detect and prevent fraud will help build trust in mobile banking services.

**Promote financial literacy:** To maximize the benefits of mobile banking, it is essential to improve financial literacy among users. Financial institutions can collaborate with local organizations, community leaders, and schools to provide financial education programs tailored to the needs of the population in Handwara. These programs should focus on educating users about mobile banking features, safe financial practices, and responsible money management.

**Tailor services to local needs:** Understanding the specific requirements and preferences of users in Handwara is crucial for the success of mobile banking services. Financial institutions should conduct regular user surveys, focus groups, and feedback sessions to gather insights and adapt their services accordingly. This includes offering vernacular language support, simplified user interfaces, and customized features that cater to the unique socio-cultural context of Handwara.

**Foster partnerships:** Collaboration between financial institutions, local government bodies, and community organizations can accelerate the adoption and impact of mobile banking. Such partnerships can facilitate joint initiatives to raise awareness, provide training, and offer incentives for mobile banking usage. Government support in terms of policy frameworks, regulations, and incentives can also play a vital role in encouraging mobile banking adoption in the region.

**Continuous innovation:** Financial institutions should continuously invest in research and development to enhance mobile banking services. This includes leveraging emerging technologies such as artificial intelligence, biometrics, and blockchain to enhance security, streamline processes, and offer new functionalities. Regular updates and feature enhancements based on user feedback will ensure that mobile banking remains relevant and meets evolving customer needs.



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**Monitor and evaluate impact:** It is essential to establish monitoring and evaluation mechanisms to assess the impact of mobile banking in Handwara. This involves tracking key indicators such as increased access to financial services, improved financial inclusion, enhanced economic activity, and user satisfaction. The findings from these evaluations can guide future interventions, policy decisions, and resource allocation to further optimize the benefits of mobile banking. By implementing these recommendations, stakeholders can work towards maximizing the potential of mobile banking in Handwara, Kashmir. This will contribute to financial inclusion, economic growth, and improved livelihoods for the population in the region.

**Conflict of interest and Funding**

The authors state unequivocally that they do not have any known financial conflicts of interest or personal ties that could have given the appearance of influencing the work that is disclosed in this paper.

**CONCLUSION**

The study conducted on user perceptions of mobile banking in Handwara, Kashmir reveals some significant conclusions. The findings indicate a growing adoption of mobile banking services among the residents of Handwara. Convenience and accessibility are identified as the primary drivers behind the positive perception of mobile banking. Users appreciate the ability to perform banking transactions anytime and anywhere using their mobile devices, eliminating the need to visit a physical bank branch. Trust and security are also crucial factors in users' perception of mobile banking services. The study suggests that users generally trust the mobile banking platforms, although there are some concerns about security. Overall, the study highlights the increasing acceptance and benefits of mobile banking in Handwara, Kashmir.

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**Table1. : Demographic profile of the Respondents**

S.NO	Variables	Frequency	Percentage
01	<b>AGE :</b>		
	18-23 Years	109	60.55%
	24-29 Years	71	39.44%
02	<b>Gender:</b>		
	Male	102	56.66%
	Female	78	43.33%
03	<b>Educational:</b>		
	Illiterate	71	39.44%
	Literate	109	60.55%
04	<b>Marital status:</b>		
	Married	83	46.11%
	Unmarried	97	53.88%

Source: Primary Data





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**Table 2. Mobile Baking, a Technological step toward Cashless Transition its Prospects And Lucanas in Kashmir**

S.No	Technical Benefit	Yes	%age	No	%age	No Idea	%age
1	Getting quick and error free service.	121	67.22	30	16.66	29	16.11
2	Through mobile banking traditional manual system reduced.	107	59.44	53	29.44	23	12.77
3	Customer can use mobile banking any time anywhere.	123	68.33	27	15	30	16.66
4	Mobile banking lacks privacy, security, and internet connectivity.	104	57.77	23	12.77	53	29.44

Variable: 1 Getting quick and error free service													
Age			Gender			Education			Marital Status				
Yes	No	NI	Yes	No	NI	Yes	No	NI	Yes	No	NI	Total	
121	29	30	105	34	41	123	09	48	104	41	37	180	
67%	16.1%	16.9%	58.33%	19%	22.7%	68.3%	5%	27%	57.7%	22.7%	20.5%	99.9%	

Variable 2: Through mobile banking traditional manual system reduced													
Age			Gender			Education			Marital Status				
Yes	No	NI	Yes	No	NI	Yes	No	NI	Yes	No	NI	Total	
90	55	35	105	40	35	107	44	29	98	23	59	180	
50%	30.5%	19.4%	58.3%	13%	19.4%	59.4%	24.4%	16%	54.4%	12.7%	32.7%	99.9%	

Variable 3: Customer can use mobile banking any time anywhere													
Age			Gender			Education			Marital Status				
Yes	No	NI	Yes	No	NI	Yes	No	NI	Yes	No	NI	Total	
95	59	26	105	54	21	111	36	33	101	33	46	180	
53%	32.7%	14.5%	58.33%	30%	19.44%	11.7%	20%	18%	56.11%	18.3%	25.55%	100%	

Variable 4: Mobile banking lacks Privacy, Security, and internet connectivity													
Age			Gender			Education			Marital Status				
Yes	No	NI	Yes	No	NI	Yes	No	NI	Yes	No	NI	Total	
104	21	55	97	54	29	141	11	30	106	27	47	180	
58%	12%	31%	54%	30%	16%	78%	6%	17%	59%	15%	26%	100%	

**Table 3 Shows The Frequency Of Prospects And Challenges Of Mobile Banking Problems Faced By The Respondents At Handwara In Kashmir Valley.**

Dependent Variable	Age	N	Mean	Std. Deviation	t-value	Sig.
Technological Benefit	18-23	109	33.5710	4.435322	-.361	0.63
	24-29	71	31.1212	4.41315		

Source: Primary Data Level of Significance=0.05





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**Table 4: Mean Difference in the Technological Benefit of Mobile Banking With Regard To Age Background of the Respondents**

Dependent Variable	Gender	N	Mean	SD	t-value	p
Technological Benefit	Male	102	27.24	4.27	6.68**	.000
	Female	78	23.04	4.13		

Source: Primary data

\* Significant at 0.01 level of confidence (2- Tailed).

**Table 5: Mean Difference in the Technological benefit of mobile banking with regard to Educational Status Background of the Respondents**

Dependent Variable	Education	N	Mean	Std. Deviation	t-value	Sig.
Technological Benefit	Illiterate	71	21.50	3.51	2.98**	.005
	Literate	109	27.35	5.71		

Source: Primary Data

\*\* Significant at 0.01 level of confidence (2- Tailed).

**Table 5: Mean Difference in the Technological benefit of mobile banking with regard to Marital Status of the Respondents**

Dependent Variable	Marital Status	N	Mean	SD	t-value	p
Technological benefit	Married	83	26.35	4.57	2.89**	.004
	Unmarried	97	24.32	4.61		

Source: Primary data

\*\* Significant at 0.01 level of confidence (2- Tailed).

**Table 6. Mean Difference in the progress and benefits of mobile banking with regard to Age Background of the Respondents**

Dependent Variable	Age	N	Mean	Std.Deviation	t-value	Sig.
Technological Benefit	18-23	109	33.5710	4.435322	-.361	0.63
	24-29	71	31.1212	4.41315		

Source: Primary Data Level of Significance=0.05

**Table 7: Mean Difference in the Technological Benefit of Mobile Banking With Regard To Age Background of the Respondents**

Dependent Variable	Gender	N	Mean	SD	t-value	p
Technological Benefit	Male	102	27.24	4.27	6.68**	.000
	Female	78	23.04	4.13		

Source: Primary data

\* Significant at 0.01 level of confidence (2- Tailed).

**Table 8: Mean Difference in the Technological benefit of mobile banking with regard to Educational Status Background of the Respondents**

Dependent Variable	Education	N	Mean	Std. Deviation	t-value	Sig.
Technological Benefit	Illiterate	71	21.50	3.51	2.98**	.005
	Literate	109	27.35	5.71		

Source: Primary Data

\*\* Significant at 0.01 level of confidence (2- Tailed).





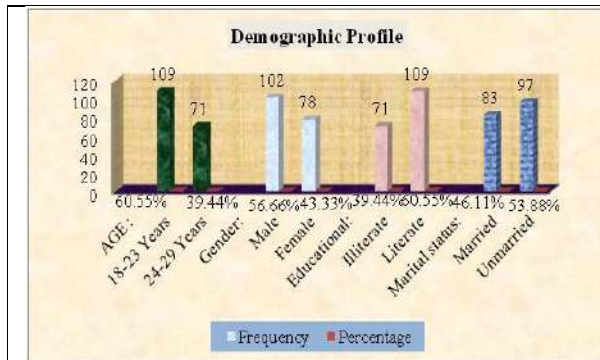
**Showkat Ahmad Dar and Sakthivel**

**Table 9: Mean Difference in the Technological benefit of mobile banking with regard to Marital Status of the Respondents**

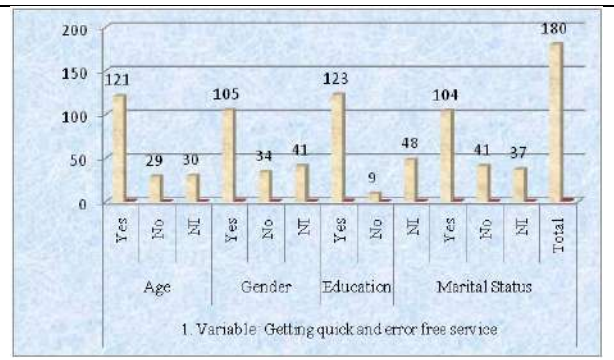
Dependent Variable	Marital Status	N	Mean	SD	t-value	p
Technological benefit	Married	83	26.35	4.57	2.89**	.004
	Unmarried	97	24.32	4.61		

Source: Primary data

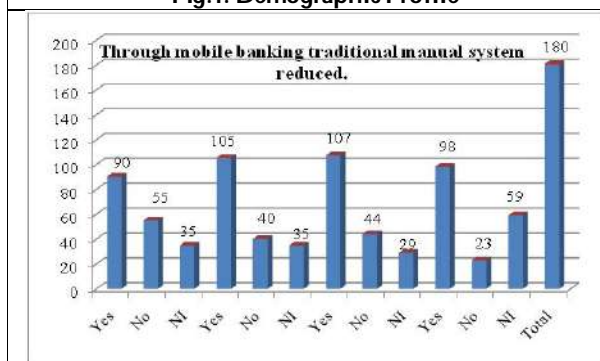
\*\* Significant at 0.01 level of confidence (2- Tailed).



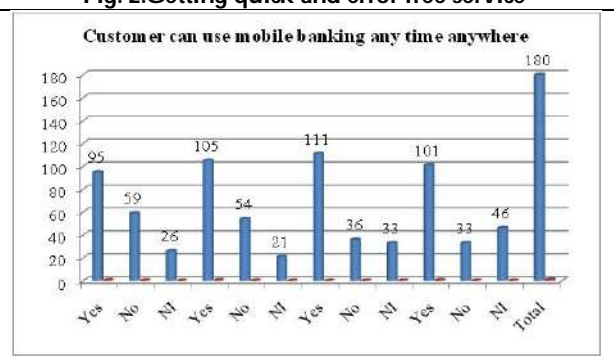
**Fig.1. Demographic Profile**



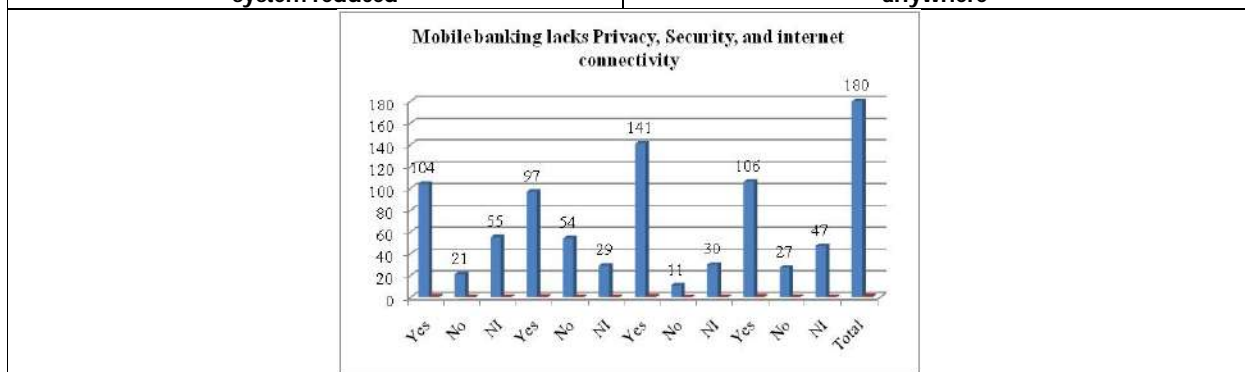
**Fig. 2. Getting quick and error free service**



**Fig. 3. Through mobile banking traditional manual system reduced**



**Fig. 4. Customer can use mobile banking any time anywhere**



**Fig. 5. Mobile banking lacks Privacy, Security, and internet connectivity**





## Empowering Mizo Sportsmen through Motivational Training: an Examination of Its Impact on Self-Efficacy and Performance

Rebecca Vanlalruati<sup>1\*</sup> and C.Lalfamkima Varte<sup>2</sup>

<sup>1</sup>Ph.D Research Scholar, Department of Psychology, Mizoram University, Mizoram, India.

<sup>2</sup>Professor, Department of Psychology, Mizoram University, Mizoram, India.

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### \*Address for Correspondence

**Rebecca Vanlalruati,**

Ph.D Research Scholar,

Department of Psychology,

Mizoram University,

Mizoram, India.

Email: bekiecaca@gmail.com



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### ABSTRACT

This paper discusses the role of motivation and self-efficacy in sports performance, as well as how motivational skills training can help to improve them. Athletes with high levels of intrinsic motivation and self-efficacy perform better in sports competitions, according to research. Self-efficacy beliefs can influence motivation and in turn affect performance in a variety of ways, such as the activities people choose to pursue or the amount of effort they put into them. Motivational training is a well-known approach to improving athletes' performance by providing them with the cognitive and behavioural skills necessary to stay focused, upbeat, and motivated during practise and competition. The paper describes a quasi-experimental study with pre and post-tests with a control group that used a general self-efficacy scale to assess the effectiveness of motivational training on athletes' self-efficacy and performance.

**Keywords:** Motivation, self-efficacy, motivational skills training, athletic performance, cognitive abilities

### INTRODUCTION

Motivation and self-efficacy are two key psychological constructs that have been extensively researched in the context of sports performance. The internal and external factors that drive an athlete to engage in a specific behaviour, such as training or competition, are referred to as motivation. Sport psychology recognises motivation as a crucial aspect of sports performance (Gould, Dieffenbach, & Moffett, 2002), but it is also observed to be linked to athletes' persistence throughout practises and competitions (Wilson & Rodgers, 2004, according to Vallerand, 2007). According to both athletes and coaches, motivation is one of the most crucial psychological factors for success in

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athletics (Gould, 1982). Numerous studies have explored the relationship between motivation, self-efficacy, and sports performance. For example, a study by Chen et al. (2017) found that athletes with high levels of intrinsic motivation and self-efficacy performed better in sports competitions than those with low levels. Similarly, a study by Johnson et al. (2018) showed that athletes with high self-efficacy were more likely to persist in the face of challenges and setbacks, leading to greater success in sports. Other studies have also demonstrated the importance of motivation and self-efficacy in sports, highlighting their role in improving athletic performance, enhancing well-being, and promoting physical activity (Hagger & Chatzisarantis, 2016; Bandura, 1997).

Self-efficacy is described as a person's belief in his or her capacity to do a task successfully (Gore, 2006). Self-efficacy is a social cognitive theory concept that defines one's perception of one's ability to complete a given activity and achieve a specific result (Bandura, 1997). It is not concerned with a person's abilities, but rather with a personal evaluation of what an individual can do with the abilities that he or she possesses. Self-efficacy beliefs may impact motivation in a variety of ways, including the activities people choose to pursue or the effort they put into them, as well as emotional reactions to failure or unpleasant stimuli (Bandura, 1997). High self-efficacy is a belief in one's ability to do a task at a high level, with certainty, and over time. Athletes with high self-efficacy strive harder, persevere longer, select stronger challenges, have a more pleasant experience with effort, and are less nervous. Martin and Gill (1991) demonstrated the link between self-efficacy, state sport confidence, and performance in runners in their research. Athletes who were incredibly sport confident and had high self-efficacy result expectancies raced quicker in their races than athletes who were less self-efficacious and less sport confident.

The importance of using mental skills training as a strategy to improve performance is supported by a growing amount of scientific research (Greenspan & Feltz, 1989; Murphy & Martin, 2002; Weinberg & Comar, 1994). According to several studies, visualizing previously acquired skills causes greater activity in the brain regions responsible for such skills. Mental training also helps in the execution and planning of previously practiced and new activities (Cross, Hamilton & Grafton, 2006). Motivational training is a well-known approach to enhancing athletes' athletic performance. By equipping them with a variety of cognitive and behavioural abilities to stay focused, upbeat, and motivated during practise and competition, this form of training tries to enhance athletes' intrinsic motivation. The effectiveness of motivational training in enhancing athletes' performance has been shown in numerous researches. For instance, Hardy et al. (2015) developed and validated a thorough assessment of athletes' psychological skills and discovered that the application of performance strategies is positively correlated with athletic performance. Overall, the evidence points to motivational training as a promising technique for raising sportspeople's performance, but further investigation is required to pinpoint the specific components of training that enhance performance.

## METHODOLOGY

### Samples

121 Professional Sportsmen and 222 non-sportsmen participants from Mizoram were randomly selected for *Phase-1 (Baseline Phase)* of the present study. The non-sportsmen group were selected to match the professional sportsmen based on consideration for other demographic profile, age and other inclusion criteria. All the participants were required to complete the background demographic profiles and the psychological measures of Self-efficacy. For *Phase-2 (Intervention-Phase)* the sportsmen and non-sportsmen were randomly assigned to two groups, namely 'Training' and 'Non-Training'. The participants in Phase-2 were required to complete psychological measures of Self-efficacy after receiving the intervention. Besides, the sportsmen were required to undergo pre and post-test on 'Sport Performance Index', specially prepared for the study.

### Inclusion criteria for the groups:

#### Sportsmen Group

1. Participants should be sportsmen from the state and district level sport clubs and sport academies
2. The sportsmen should have at least one year of experience in competitive sports



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3. Age:18-30 years

**Non-sportsmen Group**

1. Participants should not be under any sports club
2. They may or may not play sports, but should be limited to being recreational players
3. Age: 18- 30 years

**Design**

To assess the effectiveness of motivational training on sportsmen's self-efficacy and performance, a quantitative research approach and a quasi-experimental study with pre and posttests with a control group were used.

**Psychological Tool**

General Self efficacy scale (Swchwarzer & Jerusalem, 1995) was used for the study.

**Intervention**

During intervention, participants were given Motivational training. The training comprised of eight sessions. All participants were given the training program twice a week, for 60 min. The training program was the same for all participants. After the training program the participants were measured again on the selected psychological variable, i.e., Self-efficacy. The sportsmen's performances were also measured again using the sport performance index after the training by their respective coaches.

**RESULT**

As shown in table 1, Wilcoxon Signed Rank Test revealed a statistically significant difference following intervention in the Performance  $Z=-6.19$ ,  $p=.00$  and General Self-efficacy  $Z=-2.86$ ,  $p=.00$  of the sportsmen from Training group. However, no significant difference was found for non-sportsmen from Training group. In Table 2, significant difference was found in the performance of sport from Non-training group  $Z=-2.53$ ,  $p=.01$ .

**DISCUSSION AND CONCLUSION**

The results of the Wilcoxon Signed Rank Test (see table 1) indicated that there was a statistically significant difference in the performance and general self-efficacy of sportsmen in the training group following the intervention. This may imply that the intervention was successful in enhancing these aspects of athletic performance. This is in line with earlier studies that revealed interventions targeting self-efficacy and self-regulation could enhance athletic performance (Zimmerman, 2000; Feltz et al., 2008). Non-sportsmen in the training group, however, showed no significant difference, suggesting that the intervention may not have been successful for those who do not routinely participate in sports.

Lack of motivation and unclear goals may be to blame for the lack of a meaningful difference in the non-sportsmen who received training. Previous studies have revealed that motivation is a vital component in athletic performance, and individuals with clearly defined goals are more likely to be motivated and perform better (Locke & Latham, 2002; Weinberg & Gould, 2015). It's probable that the non-sportsmen in the training group did not have concrete objectives or clear expectations for what they hoped to accomplish with the intervention, which could have resulted in lower motivation and lesser favourable results. This highlights the importance of establishing clear, attainable goals when developing interventions for those who do not routinely participate in sports. There are a number of reasons why sportsmen in the present study who did not receive psychological intervention still improved in their performance ( see table 2). One possibility is that they might have experienced a natural intervention that helped them improve, such as increased motivation or self-reflection (MacDonald, Button, & Collins, 2016). Another possible explanation is that individual factors such as talent, experience, and training influenced their performance (Balyi & Hamilton, 2004; Hambrick et al., 2014).



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Overall, the results have important implications for coaches, sports psychologists, and athletes who seek to improve performance. Motivational training may be an effective way to enhance the cognitive and behavioral skills of athletes, thereby improving their performance. The findings also suggest that motivation may play a crucial role in athletic performance, and that strategies designed to improve motivation may lead to improvements in performance. Future research may be needed to identify the specific components of the motivational training that led to improvements in performance and self-efficacy. Overall, the findings suggest that motivational training may be an effective strategy for enhancing the performance of athletes.

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**Table 1. Results of Wilcoxon-Signed Rank test for Self-efficacy and Performance of Sportsmen and Non-sportsmen under Training Group**

TRAINEE		Sport				Non-Sport					
		N	Mean Rank	Sum of Ranks	Z	P	N	Mean Rank	Sum of Ranks	Z	P
GSEP-GSE	Negative	16	18.50	296.00	-2.86	.00	26	29.25	760.50	-1.33	.18
	Positive	31	26.84	832.00			35	32.30	1130.50		
	Ties	6					42				
PERP-PER	Negative	1	9.00	9.00	-6.19	.00					
	Positive	51	26.84	1369.00							
	Ties	1									

Note. GSEP= General Self-efficacy Post, GSE= General Self-efficacy, PERP= Performance Post, PER= Performance





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**Table 2 Results of Wilcoxon Signed Rank test for Self-efficacy and Performance of Sportsmen and Non-sportsmen under Non-Training Group**

NON-TRAINEE		Sport				Non-Sport					
		N	Mean Rank	Sum of Ranks	Z	P	N	Mean Rank	Sum of Ranks	Z	P
GSEP- GSE	Negative	28	23.48	657.50	-1.00	.32	44	46.51	2046.50	-1.81	.07
	Positive	19	24.76	470.50			57	54.46	3104.50		
	Ties	21					18				
PERP- PER	Negative	19	30.08	571.50	-2.53	.01					
	Positive	41	30.70	1258.50							
	Ties	8									

Note. GSEP= General Self-efficacy Post, GSE= General Self-efficacy, PERP= Performance Post, PER= Performance





## Efficacy in Chemistry Laboratory Pedagogy VIS- À-VIS the Academic Achievement of under Graduate Students

P. Kalyani<sup>1</sup>, T.R.Banuprabha<sup>2\*</sup>, C.Sudharsana<sup>1</sup>, T.Jeyagowri<sup>3</sup> and M. Vasimalairaja<sup>3</sup>

<sup>1</sup>Department of Chemistry, DDE, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

<sup>2</sup>Department of Chemistry, Mary Matha College of Arts and Science, Periyakulam, Tamil Nadu, India.

<sup>3</sup>Department of Education, DDE, Alagappa University, Karaikudi, Tamil Nadu, India.

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### \*Address for Correspondence

**T.R.Banuprabha**

Department of Chemistry,  
Mary Matha College of Arts and Science,  
Periyakulam, Tamil Nadu, India  
Email: banuprabha1975@gmail.com



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### ABSTRACT

The present study aimed to investigate the roles and functions of the chemistry laboratory in accomplishing chemistry-related academic achievement and elevation among the students at under graduate level. The investigator/researchers/authors employed an experimental research design and also used a parallel-group procedure. The sample was randomly selected and it consisted of 100 students of under graduate I year chemistry students. The experiment was conducted in a chemistry laboratory enhancing data collection, mainly focusing volumetric analysis (e. g. acidimetry and alkalimetry) procedure and academic achievement tests. The statistical tools used for data analysis in the study were mean and standard deviation for research questions and t-ratio for testing the null hypothesis at a 0.01 significant level. The findings of the study showed that the laboratory teaching methods had much more effects on science students' academic achievement. The study showed that the boys and girls slightly differ in their performance when taught with the laboratory methods. It means the experimental group is found to be nearly superior to both girls as well as boys in learning chemistry. It also concludes that the effectiveness is also not limited by gender.

**Keywords:** Chemistry education, Laboratory teaching method, Academic achievement

### INTRODUCTION

The development and progress of any nation depends on the level of technological achievements of the people made through the learning of science by understanding and exploring its applications. It is viewed generally as a systematic study of nature. Bradford (2015) defined "Science" as a systematic and logical approach in discovering of



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how things in the Universe work. Thus, the knowledge of science has indispensable link with technology. The authors of the present research stress that the acquisitions of scientific and technological knowledge enhance the student's mental development and achievement in academics. The laboratory in schools and colleges has been defined by several authors in different ways. Mduabum (1992) sees a laboratory as a place where scientific exercises are conducted by the science teachers for the benefit of the students (learners). The laboratory exercises include; conduct of experiments and other activities like demonstrating new experiments, group discussions, conducting science quizzes, one minute presentation on elements, identifying scientists' names by actions and miming, scientific essay writing, creating science-based cartoons etc., which help the students in understanding scientific concepts more effectively. Further, Ezeliiora (2001) has defined a science laboratory as a workshop where science is done or where scientific activities are carried out in a conducive environment. She also sees the laboratory as a place where scientific equipments, materials or instruments are housed for security and safety. Interestingly, Igwe (2003) explains that a chemical laboratory can be indoor, such as the sufficiently designed and equipped room found in most schools and colleges or outdoor involving such places as riverside, workshops, fields and even markets for carrying out scientific studies. He further states that whatever the type of laboratory employed in science teaching, the same laboratory experience should be attained, that is participation in the series of experimental, observational and demonstrating activities, which provide an opportunity for the students to develop an understanding of practical and theoretical concepts through solutions of problems.

In focusing chemistry laboratory, students are able to see chemistry hands-on and they have the opportunity to act as scientists and personally observe chemical reactions taking place. It has long been a belief in chemistry education that the science laboratories have the potential to be a place where theory and practice can coalesce for students. All the activities in chemistry laboratory are connected with chemicals and also chemistry laboratory equipment. Chemistry laboratory equipment means the various tools and equipment used by scientists in the chemistry laboratory. For both experiment and research in chemistry, the laboratory equipments are used. Kinds of chemistry laboratory equipment are laboratory glassware (such as conical flask, beaker, reagent bottle, etc) and analytical device (pH meter, spectrophotometer, magnetic stirrer etc.) [Priymbodo 2017]

#### **Advantages of chemistry laboratory pedagogy**

Since school education forms the basic, the main advantages in chemistry laboratory method at school level are discussed below. Undoubtedly, this may extend to college students also.

- Very effective in middle and senior classes
- All students enjoy doing chemistry experiments
- Learning becomes easy
- Students like chemistry labs for the colours of different chemicals.
- All students have fondness for experiments
- Performance of students increases when they learn through labs
- Students learn recording, tabulating and observation skills in lab experiments
- Students enjoy and learn skills
- Students avoid taking leave on practical days
- Students develop scientific temperament
- Girls work neatly in labs compared to boys

#### **Disadvantages in chemistry laboratory pedagogy**

The main disadvantages in laboratory method are discussed below.

- The problems faced in schools and colleges by the students are handling of chemicals
- Students forget to bring lab coats
- Though goggles are provided students don't like to wear them, they just keep it aside
- Many schools and colleges do not purchase important apparatus like distillation apparatus, Kipps apparatus for H<sub>2</sub>S gas, enough burners and appropriate apparatus for doing organic based experiments
- School labs should improve a lot, then only teachers can show many more experiments



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- Only very dilute acids can be used for experiments
- Many schools do not procure chemicals on time
- In school labs, for metals like sodium, no safety provision is given
- Many schools do not follow lab curriculum prescribed by the Government system They are now making it simple and easy for students
- Many students do practical without learning the names of apparatus
- Conceptually, they do not bother to learn the experiments
- Sometimes schools and colleges do not have lab assistants for different labs. This creates pressure on the only available lab assistant and the teachers too
- Without basics, students perform very badly in Viva-voce examinations

At school level, laboratory approach is liked by all students and chemistry becomes easy and interesting when learnt through laboratory methods. They learn analytical skills also which pave way for higher education, especially research etc.

**Need of the laboratory work in chemistry**

The need of the laboratory work in chemistry especially in higher education can be divided into three broad areas as given below:

1. **Practical skills** – includes safety hazards, risk assessment, procedures, instruments, observation methods.
2. **Transferable skills** – includes team working, organization, time management, communication, presentation, information retrieval, data processing, numeracy, designing strategies, problem solving.
3. **Intellectual simulation** – connections with the 'real world', raising enthusiasm for chemistry.

The above-mentioned skills are closely interconnected and basically required for a chemistry laboratory pedagogy.

A set of possible reasons for the inclusion of practical work in undergraduate courses in chemistry course is listed below (Reid 2006):

- Illustration of key concepts
- Seeing things for 'real'
- Teaching experimental design
- Reporting, presenting, data analysis and discussion
- Developing deducing and interpreting skills
- Developing time management skills
- Training in specific practical skills and safety
- Developing team working skills
- Enhancing motivation and building confidence
- Showing how theory arises from experimentation
- Developing observational skills
- Introducing equipment

**Significance of the study**

The most recent concept of teaching pedagogy is to teach the students how to learn, how to discover, how to think and how to inquire. In the fact, every good teacher in the classroom always tries to prepare pedagogy of teaching then he or she wants to follow at all times, when he or she gains more and more experience through the laboratory experiments teaching strategy to the students. The laboratory has been identified as the heart of a good scientific programme which allows students in the school to have experiences that are consistent with the goals of scientific literacy. Therefore, schools and colleges require properly equipped and functional laboratories. The prevalent negative trends in academic output and dispositions of students towards science subjects in general and chemistry in particular have been the concern of science educators and all those who care about the subjects. Several attempts have been made to find out some science teaching methods that can stimulate the students' interest to learn and achieve better in chemistry. In this regard, many researchers have noted that science teachers predominantly make use of ineffective teaching methods in teaching under graduate college chemistry which might have led to



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deteriorating students' achievement in chemistry. Therefore, there is every need to involve the use of other teaching methods and approaches which have been found effective in some subject areas. One of such is the laboratory teaching method which has proved to be effective in improving students' achievement and interest in chemistry. Therefore, this study sought to find out the efficacy in chemistry laboratory pedagogy on the academic achievement of under graduate college students.

**Statement of the problem**

Efficacy in chemistry laboratory pedagogy vis-à-vis the academic achievement of under graduate students.

**Delimitation of the study**

1. The present study will be confined to only under graduate chemistry major students.
2. The study was confined on the topic Volumetric Analysis (ACIDIMETRY AND ALKALIMETRY) Experiment.
3. In this study boys and girls of I year chemistry students were only taken.

**Objectives of the study**

1. To compare the mean pre-test scores of experimental and control groups.
2. To compare the mean post-test score of experimental and control groups to see the efficacy in chemistry laboratory pedagogy vis-à-vis the academic achievement of under graduate students.
3. To compare the mean post-test scores of boys and girls of experimental groups.

**Hypothesis of the study**

1. There will no significant difference in the mean pretest scores of experimental and control groups.
2. There will be no significant difference in the mean post-test score of experimental and control groups.
3. There will be no significant difference in the mean post-test score of boys and girls in experimental groups.

**METHODS AND PROCEDURE****Design**

In the present study, the investigators used an experimental research design and also used a parallel-group procedure.

**Sample**

The sample was selected randomly from the following 5 Arts & Science Colleges (Co-Education system) in Madurai district Tamilnadu, India. They are

1. Arul Anandar College
2. M.S.S. Wakf Board College
3. S. Vellaichamy Nadar College
4. Sourashtra College
5. Thiagarajar College

It consisted of 100 students in I year under graduate chemistry course.

**Tools**

1. Volumetric Analysis (ACIDIMETRY AND ALKALIMETRY) procedure was prepared by the investigators.
2. Academic achievement tests were prepared by the investigators.

**Statistical analysis**

1. Descriptive statistics such as mean and standard deviation (S. D.) was used.
2. 't' ratio was employed.



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## RESULTS AND DISCUSSION

In order to test that “There will no significant difference in the mean pretest scores of experimental and control groups” raw scores obtained from pre-test and post-test were tabulated and analyzed. ‘N’ denotes the number of students and ‘t’ value was computed to study the significant difference between mean pre-test scores of experimental and control groups. The results so obtained have been entered in table 1. Table 1 reveals that the mean pre-test scores of control and experimental groups are 11.28 and 11.14 respectively. The obtained ‘t’ value ( $t = 0.233$ ) is not significant at 0.01 level, which shows that there exists no significant difference in the achievement of students in the chemistry of experimental and control groups.

The mean pre-test scores of experimental and control groups are 11.28 and 11.14 respectively and their mean difference (D) is 0.14, which reveals that the performance of students in both the groups i. e., experimental and control groups do not differ in the pre-test scores. Thus, the first hypothesis namely “There will no significant difference in the mean pretest scores of experimental and control groups” is accepted. In order to test that, “There will be a significant difference in the mean post-test score of experimental and control groups” the following analysis is done. Table 2 reveals that the mean post-test scores of the control and experimental groups are 15.86 and 20.56 respectively. The obtained ‘t’ value ( $t = 5.815$ ) is significant at 0.01 level, which shows that there is a significant difference (S) in the achievement of students in the chemistry of the experimental and control groups.

The mean post-test scores of the experimental and control groups are 15.86 and 20.56 respectively and their mean difference (D) is 4.70, which reveals that the group taught with the laboratory method has higher mean post-test scores as compared to the group taught with the conventional method. It means that students taught with the laboratory methods showed better performance than the students taught with the conventional method. Thus, the second hypothesis namely “There is no significant difference in the mean post-test scores of experimental and control groups” is not accepted.

In order to test that, “There will be no significant difference in the mean post-test score of boys and girls in experimental groups” the following analysis is done. Table 3 reveals that the mean post-test scores of boys and girls are 20.12 and 21.00 respectively and the mean difference (D) is 0.88. Calculated ‘t’ value ( $t = 0.639$ ) is not significant at 0.01 level, which clearly shows that boys and girls do not differ significantly in their mean post-test scores when taught through the laboratory method. It means that the experimental group is found to be nearly equally superior for both boys and girls in learning chemistry. Therefore, the third hypothesis “There will be no significant difference in the mean post-test score of boys and girls in experimental groups” is accepted.

## FINDINGS

In the light of the above-mentioned interpretation and discussion, the following conclusions have been drawn:

1. The performance of students in both the groups i.e., experimental and control groups do not differ in their pre-test.
2. The performance of students in mean post-test scores of experimental groups i.e., with the laboratory method is higher than the mean post-test scores of control group i.e., with the conventional method.
3. The boys and girls slightly differ in their performance when taught with the laboratory method. It means experimental group is found to be nearly superior to both girls as well as boys in learning chemistry.
4. The students of the experimental group were looking well motivated and ready to learn students of the control group.





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### Final thoughts

All of the practical chemistry courses should be taught in the laboratory, with all of the appropriate equipment and reagents. The pupils would gain knowledge using the chemicals/reagents. Handling harmful substances necessitates a set of abilities and skills. In their teaching and learning processes, both teachers and students are involved. This will assist them in learning new concepts, approaches, and abilities in challenging chemistry. The study shows that the laboratory method approach plays an important role in improving the academic achievement of students. So, the teacher should use the laboratory method approach in teaching in the classroom which can make his/her task easier and students can achieve better.

Students may even find themselves participating in novel research exercises during scheduled laboratory teaching. This study identifies and highlights a good and innovative trend that ensures student engagement and an improved learning experience in the chemistry laboratory pedagogy.

We should not forget the saying “*what I hear I forget, what I see I remember, what I practice I understand*” may be the key for students for a successful outcome of their efforts.

Despite all the technological advancements, we shouldn't forget traditional lab training entirely:

*“Not because that is the way we want to continue to do chemistry rather because we want to build a better way of doing chemistry in the future.”*

*“We want our students who want to learn a particular technique to do it in the authentic setting.”*

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**Table 1 Showing 't' value of mean pre-test scores of experimental and control groups**

Group	N	Mean	S.D.	Mean difference (D)	df	t - ratio	Remarks @ 5% level
Control Group	50	11.28	3.169	0.14	98	0.233	NS*
Experimental Group	50	11.14	2.836				

\*NS denotes non significance @ 5% level

**Table 2 Showing 't' value of mean post-test scores of experimental and control groups**

Group	N	Mean	S.D.	Mean difference (D)	df	t - ratio	Remarks @ 5% level
Control Group	50	15.86	3.044	4.70	98	5.815	S*
Experimental Group	50	20.56	4.837				

\*S denotes significance @ 5%level







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**Table 3 Showing 't' value of mean post-test scores of experimental groups**

Gender	N	Mean	S.D.	Mean Difference (D)	df	t- ratio	Remarks @ 5% level
Boys	25	20.12	5.028	0.88	48	0.639	NS*
Girls	25	21.00	4.699				





## Analysing the Attitude of MBA Students towards Writing Skills

Abhishek Verma<sup>1\*</sup> and Rabindra Kumar Verma<sup>2</sup>

<sup>1</sup>Ph.D Research Scholar (English), Department of Languages, Literatures and Cultural Studies, Manipal University Jaipur, Rajasthan, India.

<sup>2</sup>Assistant Professor (English), Department of Languages, Literatures and Cultural Studies, Manipal University Jaipur, Rajasthan, India.

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### \*Address for Correspondence

#### Abhishek Verma

Ph.D Research Scholar (English),  
Department of Languages,  
Literatures and Cultural Studies,  
Manipal University Jaipur, Rajasthan, India.  
E. Mail: mpabhishek16@gmail.com



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### ABSTRACT

One of the most challenging problems in India nowadays is to provide employment opportunities to the youth showcasing poor communication skills, particularly writing. So, the experts and researchers of English Language Teaching (ELT) are trying to enhance the opportunities for employment of the youth by facilitating the communicative competence of the learners pursuing their MBA programme. The meritorious students from different streams who want to contribute to the development of society, emerge as leaders, and elicit their skills while pursuing their under graduate programmes. After completion of their undergraduate programmes, these aspirants lead to the MBA programmes to fulfil their desires and achieve their targets. However, they are good at academic achievements in their respective fields, but their writing skills are weak when they write in English. There are various factors responsible for their poor writing skills. One of the major factors is attitude. The purpose of this paper is, therefore, to analyse the attitude of MBA students towards writing skills. This research paper also explores the reasons behind the poor writing skills of MBA students with the help of the demographic and socio-economic factors.

**Keywords:** Attitude, Business Administration, Second Language Learning, Writing Skills, Written Communication.



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## INTRODUCTION

Psychology is viewed as an interdisciplinary contribution to the understanding of education and language development of learners, in particular (Nadjette, 2016). Therefore, the psychology of learners is crucial in the learning and teaching of a foreign or second language. Further, the understanding of the psychology of the second language learners depends on the understanding of the role of psycholinguistic variables like attitude, motivation and anxiety that affect learning of a foreign language. These psycholinguistic variables can foster learners' language skills or hinder the process of developing competence among them. In this study, attitude as one of the psycholinguistic variables has been taken for analysis of the writing skills of MBA students while the remaining other variables are beyond the scope of the study.

To begin with discussion, it can be said that for enhancement of the writing skills, a course instructor or a teacher needs to understand the attitude of learners towards writing because attitude of a learner plays an important role in learning or enhancing writing skills, therefore, the attitude is to be addressed contextually and meaningfully. Analysing attitude is the first step in the process of enhancement of writing skills. This paper aims to draw attention to the attitude of learners and how it can affect a second language learner in learning writing skills in English. The study also explores and suggests ways and means to enhance writing skills.

In the last few decades, there has been a sudden upsurge in the number of institutions offering MBA programmes in India. This rapid growth also marks the challenges to be faced by the aspiring MBA students. However, the various reports and surveys showcase a gradual decrease in the number of employable incumbents. The analysis of their communication skills particularly writing skills reveal that they need to improve their linguistic competence and hone their writing skills at different levels. Communication is an important aspect of employability, and written communication plays an important role in business administration education. The importance of written communication lies in the fact that documenting evidence is done majorly in writing. Also, wherever occurs any ambiguity in statements, the written communication is referred to. So, it is evident that enhancement of writing skills is required to support and strengthen the students of business administration programmes.

## METHODOLOGY

This study is based on information gathered from both primary and secondary sources. The participants of this study comprise students of MBA programmes of two different groups of institutions at Bhopal, a district in Madhya Pradesh, India. The number of students in the second semester of the two years MBA degree programme who responded to this questionnaire is 70. The data collection instrument used in this study is a set of questionnaires adopted from Lilly Golda, 2014. It has been observed that several psycholinguistic variables influence business administration students' English language learning in general, and writing skills in particular. Attitude is one of the main variables. Apart from attitude, self-esteem, emotional intelligence, motivation, and anxiety are the other variables. Nadjette (2016) argued that all of these psychological factors could either help or hinder success, resulting in an obvious failure to acquire the necessary skills to achieve competence in English.

At the commonplace, the scientific study of attitudes falls under the discipline of social psychology. Gordon Allport is considered one of the pioneers in this field. According to Allport (1935) attitude is "a mental and neural state of readiness, organised through experience, exerting a directive and dynamic influence upon the individual's responses to all objects and situations with which it is related" (p. 810). Similarly, Schwarz and Bohner (2001) state, "Attitudes are a hypothetical construct, invented by researchers to account for a body of phenomena. We cannot observe attitudes directly but infer them from individuals' self-reports and behaviour" (p. 5). A vast majority of researchers agree that the chances of success in the life of people are influenced by their attitudes. A positive attitude towards language learning creates interest among learners and makes the process of learning enjoyable and fruitful, on the contrary, a negative attitude results in boredom and failure.



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Writing attitude was operationally defined by Graham, Berninger, and Fan (2007) "as an affective disposition involving how the act of writing makes the author feel, ranging from happy to unhappy" (p. 4). Through its impact on cognitive engagement, attitude can have an impact on writing ability (Graham, Berninger and Fan, 2007). Likewise, the students who have a positive attitude towards writing, are aware of their writing efficiency. Consequently, they are encouraged to take part in written assignments to put forth an extra effort to develop their writing skills.

Paker and Erarslan (2015) explored the attitude of Turkish students towards writing. The results of this study include the investigation of the relationship between the attitudes of students and their proficiency in writing in English. Results show that the attitude of the students towards writing had a positive effect on their proficiency in writing. Further, Caldwell and Al-Ajmi (2017) applied and developed their study to assist less effective students' writing for business school students. The researchers also identified that the business students are confronted with the challenges of becoming effective writer.

Kondal (2019) conducted a study to find out the various challenges and difficulties faced by management students. The subjects of the study comprised 50 second-year MBA students from 5 different professional colleges in Hyderabad. These 50 students include 18 females and 32 males. Survey methodology is used in this study. The study revealed that different factors contribute to overcoming various students' problems in developing business writing skills. It was found that many students were not aware of the appropriate use of sentence structures in their writing. The investigator suggested adopting an appropriate teaching strategy to improve learners' writing skills. Umar *et.al.* (2019) in a case study followed the survey research method to find out the current English language proficiency and the target English language proficiency for the MBA students of Pakistan. The study shows that the current writing proficiency of MBA students does not match the target situation. The students' assessment of their abilities and the teachers' assessment of the students' abilities do not match with each other.

**Aspects of Writing**

Out of the four language skills, writing is one of the most complex skills to develop. It is the core of any language and the capacity to write effectively in a second language is perceived as the sign of significant expertise. Nadjette (2016) opines that for achievement of writing skills in English in school and college, scholarly or academic writing is essential since it mirrors the scholastic or academic level through assignments, tests, and dissertations. However, the following challenges are faced by the MBA students during their attempts at academic writing, which is also true to the case of MBA students of two different groups of institutions at Bhopal, from which the data is collected.

- Linguistic challenges
- Organizational challenges
- Challenges related to academic writing conventions
- Content-related challenges
- Social and cultural challenges

Nadjette (2016) argued that a postgraduate student forces the utilization of academic writing in all viewpoints and phases of instruction because academic writing is a particular kind of composition that investigates, explores, questions breaks down, clarifies and translates the gathered information. According to Nadjette (2016), "To write academically, there are some conventions which the learner should be committed to; these conventions represent the main features which characterise the academic writing from other types of writing" (p.14). However, the learners should inculcate the following characteristics in their writing skills to overcome the challenges of writing:

- Logical organization
- Conciseness
- Formality
- Clarity and relevance
- Objectivity
- Usage of correct grammar



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## FINDINGS AND DISCUSSION

The data was collected from the two different groups of institutions at Bhopal, in the academic year 2021-22. The purpose of this data collection is to analyse the attitude of business administration students towards writing skills and to explore the different aspects of writing. The purpose of this question was to identify the perception of the MBA students towards writing. The data reveals that there is a majority of students who are positive towards writing. It is about 64.03%. The purpose of this question is to know about the interest of the students towards writing exercises and writing as an activity. Out of the total number of students, 63.89% prefer to write down their thoughts always, which shows their interest in writing as an activity.

This question requires a response from the students about their self-analysis of the linguistic aspects of writing. The percentage of students who thought that they used correct grammar in their writing is 40.96%. This question probes to know about the willingness of students towards the challenges they faced in writing. The results clearly show that a majority of students which is 61.03% were always ready to take on the challenges of writing. This question was aimed to probe if the students had an understanding about the importance of good writing skills in their academic career. The responses show that the majority of students know the importance of writing skills in their academic career.

The purpose of this question was to know the understanding of the students about their competence in writing as compared to an average MBA student. The results show that the students experienced themselves quite competitive in writing skills in comparison to an average MBA student. The demographic details are one of the important aspects of any study conducted on the human subjects. It is always desirable to collect demographic details of the population for enrichment of the study. To fulfil this purpose, following demographic details were also obtained in addition to the data related to attitude of learners towards writing skills.

### Demographic Detail

The data displayed above is interpreted and the characteristics of the population of the study are drawn. The characteristics of the participants are as follows:

1. The number of males (40) in the study was more than the females (30).
2. The number of students who studied in English medium schools (41) is more than the number of students who studied in Hindi medium (29).
3. The number of schools located in the urban area is more than the number of schools located in the rural area. It is (48) twofold in comparison to the schools located in the rural area (22).
4. The study reveals that the number of students of English medium colleges is higher than the number of the students of Hindi medium colleges. The number of students of English medium colleges (50) is more than twice the number of students who studied in Hindi medium (20).
5. The number of students in colleges located in urban areas is more than the number of students in colleges located in rural areas. The study reveals that the number of students from colleges located in urban areas (63) is nine times the number of students from colleges located in rural areas (7).
6. The number of students whose fathers received education upto elementary school education (41) is more than the number of students whose fathers completed higher education (29). The number of students whose mothers received education upto elementary school education is more than the number of students whose mothers completed higher education. It is (56) four times the number of students whose mothers completed higher education (14).
7. The number of students with an annual family income upto 2 lacs is more than the number of students whose annual family income lies in the range of 2-4 lacs, 4-5 lacs and above 5 lacs respectively.

The analysis of the data shows that the attitude of MBA students can broadly be divided into three categories:

1. Learners with a positive attitude towards writing skills.





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2. Learners with a neutral attitude towards writing skills.
3. Learners with a negative attitude towards writing skills.

To enhance the writing skills of MBA students their negative and neutral attitudes should be converted into positive attitudes and positive attitudes should be retained skillfully. The experts in the field of writing suggested that the use of motivational exposure material in the form of interplay between theoretical and operational frameworks can enhance writing skills. The interplay of the theoretical and operational framework is the use of a combination of one of the different models of communicative competence along with Krashen's theory of comprehensible inputs in language learning. Out of the five hypotheses proposed by Krashen, the input hypothesis is crucial in the field of writing. This combination in the form of interplay exposure will be useful in enhancing writing skills among business administration students.

## CONCLUSION

The study concludes that the attitude plays a crucial role in the enhancement of writing skills. The findings of this study show that the attitude of MBA students towards writing varies from positive to negative. However, the attitude of the students must be addressed to boost their confidence and enhance their writing skills. It is also evident from the above analysis that the negative and neutral attitude of MBA student can be converted into positive attitudes with the help of interplay exposure contents.

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**Table 1: You feel happy while doing writing tasks.**

Never	Rarely	Sometimes	Often	Always
0.83%	1.07%	3.01%	31.06%	64.03%





**Abhishek Verma and Rabindra Kumar Verma**

Never	Rarely	Sometimes	Often	Always
2.31%	3.21%	10.04%	20.18%	63.89%

Never	Rarely	Sometimes	Often	Always
0.00%	2.38%	18.43%	38.23%	40.96%

Never	Rarely	Sometimes	Often	Always
0.73%	2.17%	2.01%	34.06%	61.03%

Never	Rarely	Sometimes	Often	Always
0.00%	0.07%	4.01%	27.06%	67.03%

Never	Rarely	Sometimes	Often	Always
1.41%	2.12%	12.67%	24.78%	59.02%

**Table 7 Demographic Detail**

Characteristics	Frequency	Percentage
1. Gender		
Male	40	57.14
Female	30	42.85
2. Medium of education in school		
English	41	58.57
Regional (Hindi)	29	41.41
3. Location of school		
Urban	48	68.58
Rural	22	31.42
4. Medium of education in college		
English	50	73.43
Regional (Hindi)	20	28.57
5. Location of college		
Urban	63	90
Rural	7	10
6. Parents' education		
(a) Father		
Upto school (Hr.Sec.)	41	58.59
Above school (Hr.Sec.)	29	41.41
(b) Mother		
Upto school (Hr.Sec.)	56	80
Above school (Hr.Sec.)	14	20
7. Yearly income (Family)		
Upto 2 Lacs	47	67.14
2- 4 Lacs	13	18.57
4- 5 Lacs	7	10
Above 5 Lacs	3	4.29





## Role of Insulin Resistance in Type I Diabetes Mellitus

Shriya Sujit Deshpande<sup>1</sup>, Janakidevi Velmurugan<sup>2</sup>, Kasthuri Sundaramoorthy<sup>3</sup> and Senthil Janarathan<sup>4\*</sup>

<sup>1</sup>M.Sc. Biotechnology, Department of Microbiology and Biotechnology, Faculty of Arts and Science, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

<sup>2</sup>Associate Professor, Department of Microbiology and Biotechnology, Faculty of Arts and Science, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

<sup>3</sup>Research Fellow, PSG Center for Molecular Medicine and Therapeutics, PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India.

<sup>4</sup>Assistant Professor, Department of Biotechnology, Sharmila Institute of Medicinal Products Research Academy, Thanjavur, Tamil Nadu, India.

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### \*Address for Correspondence

#### Senthil Janarathan

Assistant Professor,

Department of Biotechnology,

Sharmila Institute of Medicinal Products Research Academy,

Thanjavur, Tamil Nadu, India.

Email: senjana25@gmail.com



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### ABSTRACT

In recent times, many scientific reports shows that the individuals having type 1 Diabetes Mellitus develops insulin resistance which is considered to be a feature of type 2 Diabetes. The reason behind this metabolic impairment is type 1 which causes insulin resistance and many other liver diseases etc. Understanding insulin resistance requires knowledge about insulin action. Insulin resistance is a somehow underappreciated term for type 1 diabetes that is always having remarkable consistency. This term is associated commonly with cardiovascular risk, individuals with type 1 diabetes. Although during puberty, there is an increased risk of cardiovascular risk due to insulin resistance. Modifying insulin therapy for restoring insulin balance between a hepatic portal and peripheral circulation can avoid lifelong complications due to insulin resistance. As there are so many complications, we urgently need to develop a treatment for type 1 diabetes. This article is an overview of previously reported studies, which includes a few mechanisms, treatment, causes, etc are studied in context with insulin resistance in type 1 Diabetes Mellitus.

**Keywords:** Insulin Resistance, Metformin, Obesity, Cardiovascular disease, Insulin Sensitivity.

### INTRODUCTION

Diabetes Mellitus, a non-communicable disease is the seventh leading cause of death and was recognized as pandemic problem by the UN in the 21<sup>st</sup> century [1]. The majority of the population affected is found in the western pacific (131million) and south pacific Asian regions (91 million). This distribution may be because of an increase in





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overweighed and obese people in a particular area or part of this world. The comorbidities include heart attack, kidney failure, blindness, and lower limb problems [1]. Among two types of diabetes, Type 1 diabetes (T1DM) also known as insulin dependent is a chronic immune disease that destructs pancreatic cells leading to insulinopenia and hyperglycemia [2]. Though there are many significant advancements in insulin development, continuous exogenous insulin infusion and maintenance of glycemic levels remain formidable challenge in T1DM. According to some scientific reports, people with T1DM are also associated with insulin resistance [3] and this can be a potential intervention in addition to insulin therapy.

Insulin Resistance is considered to be the feature of Type 2 Diabetes Mellitus [1]. Insulin is said to be the cornerstone of treatment and insulin therapy for Type 1 Diabetes individuals to increase their life expectancy [2]. Untimely and inappropriate treatment of Type 1 Diabetes patients results in excess complications [4]. In recent years there are increased prevalence of obesity, over body weight and certain development of insulin resistance among those Type 1 Diabetes patients who have poor glycemic control [5]. Therefore, in this review, we will focus on the efficacy of metformin as adjuvant therapy to insulin and the role of Insulin Resistance in Type 1 Diabetes Mellitus. This article revolves around previously conducted studies and does not involve any new studies along with some basic terms such as Insulin Resistance, its mechanism, some complications, and preventions as well if there is in the case of Type 1 Diabetes.

## WHAT IS INSULIN RESISTANCE?

Insulin is a highly anabolic endocrine hormone that is secreted by  $\beta$ -cells of the Islets of Langerhans in the pancreas. It plays a pivotal role in stimulating transmembrane, transport of glucose, drives glycolysis process, glycogen synthesis as well as abolishes its breakdown [6]. In 1930, Sir Harold Himsworth was first to propose that diabetes could be differentiated by injection of glucose and insulin as insulin sensitive and insulin insensitive. This was later supported by Yalow and Berson [6, 7]. Decreased biological response to a certain concentration of insulin is called Insulin Resistance [8, 9]. Impaired insulin action has been described in poor glycemic control which is associated with hepatic insulin resistance, though whole-body glucose was reported to be lower even in the controlled stage [2]. Insulin Resistance is observed during the aging process, puberty, and pregnancy [10]. Insulin Resistance required increased insulin secretion and to compensate for it, plasma insulin levels increases. The degree of insulin resistance keeps varying among patients with Type 1 Diabetes [11, 13]. Clinically speaking, insulin resistance is characterized by hyperinsulinemia and a decreased responsiveness of the target tissues to insulin stimulation. The physiology of insulin resistance is interrelated with insulin action at target cells [14]. Reversible effects of insulin action are weight loss and hypocaloric regimens etc. Hyperinsulinemia and insulin resistance eventually result in  $\beta$ -cell failure due to glucose and lipid toxicity which leads to Type 2 Diabetes [15, 16]. The most important fact is that Insulin Resistance is not a binary switching off for insulin signaling [17]. Therefore, because hyperinsulinemia demonstrates tissue-specific function, it demonstrates a compensatory mechanism that maintains insulin action in mild and moderate insulin resistance. But particularly it is considered to show its nature in skeletal muscles, liver, and WAT which is further associated with physiological functions impaired in obesity-related insulin resistance [14]. Insulin Resistance correlates with sedentary lifestyle, obese conditions, weight gain and family history associated with intensive insulin therapy [2]. Type 1 Diabetes patient with insulin resistance is at greater risk of developing micro and macro vascular complications [18, 13]. The below list includes factors causing insulin resistance in T1DM.

- (1) Physiological - Increasing age  
Puberty and Adolescence
- (2) Genetic/Familial - Overweight or Obesity  
High Risk Ethnic Groups  
Family History of Type 2 Diabetes  
Double Diabetes
- (3) Lifestyle - Eating Disorders  
Sedentary Lifestyle



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- (4) Treatment Related - Hypoglycemia  
Intensive Insulin Therapy  
Weight Gain  
Chronic Hyperglycemia / Glucotoxicity
- (5) Others - Drugs and Intercurrent Illness

The individuals having T1DM autoantibody positivity but develops significant insulin resistance were described by the term double diabetes. They have greater association with type 2 diabetes contributing genes and lower frequency of high-risk MHC alleles [2]. Based on clinical risk factors in individuals with type 1 diabetes, the insulin resistance syndrome (IRS) was created. Euglycemic hyperinsulinemia clamp trials were used to verify the IRS. This syndrome shows clinical characteristics such as hypertension, abdominal obesity, high triglycerides, and low HDL levels [19]. In Type 1 Diabetes elevated insulin levels produce an adaptive membrane receptor for hormones [21]. Consequently, a greater dose of insulin is needed to show physiological effect, and finally the Insulin Resistance begins.

#### Mechanisms of Insulin Resistance in T1DM

Identification of some clinical factors of Insulin Resistance Syndrome associated with Insulin Resistance has applications in epidemiological studies, just to assess the link between risk factors and outcomes. Several studies have examined the pattern and mechanism of insulin resistance but no studies had identified the ability of clinical factors of Insulin Resistance Syndrome to predict insulin resistance in the population [19]. In T1DM, macrophages are the source of pro-inflammatory cytokines which migrate to pancreatic islet cells. Chronic inflammation can be associated with the factor contributing to the development of Insulin Resistance in Type 1 Diabetes [1]. Since the 1960s, the Application of Insulin in Type 1 Diabetes always leads to insulin resistance. A mechanism such as Oxidative stress which is associated with hyperglycemia, lipotoxicity, and glucotoxicity plays a vital role in the development of Insulin Resistance in Type 1 Diabetes Mellitus [1]. The mechanism associated with cardiovascular disorders and insulin resistance in T1DM has been explored but there is a need to understand the role of insulin for improved results [19]. In adolescents, reduced insulin sensitivity correlates with elevated risk of cardiovascular risk factors which includes blood pressure, elevated waist circumference, cholesterol levels and much more. Alteration in plasma triglycerides composition increases cardiovascular disease risk, which is related to people with insulin resistance in type 1 diabetes [22]. For clinical trials and management of cardiovascular disease risk, we need to understand the tissue distribution of insulin resistance as early as possible [23].

#### Previous studies

explains that byproducts such as glucosamine from high glucose level play important role in developing insulin resistance. But it is not clear that this glucose and glucosamine would develop insulin resistance in absence of insulin. Detemir, an Insulin extracted from Novo Nordisk (NOD) Mice have similar applications to conventional treatment of human with T1DM. Detemir doses vary with various animals to achieve euglycemia. According to previous reports, Insulin Tolerance Test (ITT) was performed after 14 hours or overnight fast after the last dose of detemir. In this test, initial blood glucose levels are tested by intraperitoneal injection of human insulin (0.75 unit/kg). This blood glucose level is noted or checked via tail vein blood by 15,30,60,90 and 120 min after injection. As a result, we may conclude from treating NOD T1DM mice with the insulin reagent Detemir that induces insulin resistance that hyperglycemia and the administration of insulin are the main causes of inducers of insulin resistance in T1DM. The outcomes were obtained by studying the mechanism behind insulin resistance after treatment with detemir by IRS-1 phosphorylation levels at serines 636 and 639 [24].

Studies performed with constructed insulin resistant models and rats, after metformin treatment showed the underlying molecular mechanism of Insulin Resistance in T1DM with P53 and RAP2A. This study showed that metformin increased inflammatory response during P53 down-regulation and RAP2A up-regulation, and it also reduced insulin resistance while P53 induces apoptosis and inhibits RAP2A to cause insulin resistance in cells [4]. Metformin treatment also hinders complex 1 of respiratory chain and triggers the activation of AMP-activated



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protein kinase (AMPK) by altering cellular energy state in liver and skeletal muscle. This also lowers intestinal glucose absorptions resulting in glucose lowering effect. Metformin also hinders the formation of AGE by binding and inactivating methylglyoxal through an AMPK independent pathway contributing to cardioprotective effects [2]. The molecular mechanism of insulin resistance and the onset of diabetes was described by the researchers [25] where this mechanism functions as an anabolic hormone that increases the production of glycogen in the muscle and liver. The accumulation and mobilisation of fat is one of the key processes contributing to insulin resistance [27]. A large body of work on insulin resistance described the cellular mechanism, which may not be dependent on lipotoxicity. The biological mechanism also includes unfolded protein response and endoplasmic reticulum stress [14]. Reactive oxygen, an intermediary between glucose and fatty acids, affects numerous subcellular compartments and substrate competition [28].

**Complications of Insulin Resistance in T1DM**

In 1999, the "ticking clock" theory showed that individuals with hyperglycemia were more likely to experience macrovascular problems at the time that insulin resistance first appeared [29]. According to that fact in another report, the overweighted people develop type 1 diabetes who are predisposed genetically to diabetes [27]. Type 1 diabetic person would show a decrease in adipocyte insulin sensitivity, greater plasma triglyceride saturation, and a decrease in plasma concentration of palmitoleic acid as compared to the non-diabetic control group. Various factors such as reduced skeletal muscle blood flow, reduced skeletal muscle glucose transport, and excessive hepatic glucose production, etc. contribute to insulin resistance in type 1 diabetes [27]. In hyperinsulinemia, we can observe weight gain, for that overdose of insulin results in hypoglycemia and polyphagia (excessive eating) [30]. According to Conway in the Pittsburgh Epidemiology of Diabetes complications study, there was an increase from 29% to 42% and from 3% to 23% respectively of overweight and obese individuals with Type 1 Diabetes. Chronic inflammation due to Macrophages are also included in factors contributing to the development of Insulin Resistance in Type 1 Diabetes. Gender can also relate to the development of Insulin Resistant in T1DM patients, as per research it was observed that T1DM affected adipose and skeletal muscle insulin sensitivity is more in women than in men [38]. The presence of Autoantibodies i.e., the antibodies against endogenous insulin may increase Insulin Resistance. During insulin therapy, there is a higher risk of allergic reactions, large fluctuations in blood glucose levels, and decreased insulin requirements [1].

**CONCLUSION**

As there are no exact or specified drug treatments for people having Type 1 Diabetes, the situation and time requires to find proper treatment. To lessen the requirement for insulin in Type 1 Diabetes, a perfect medicine would decrease Insulin Resistance and safeguard  $\beta$ -cells. Additionally, it ought to lower hyperglycemia, weight, cardiovascular disease, and other things. Additionally, the perfect medication should have a reasonable price, be very safe, and most importantly, enhance the quality of the patient's life [27]. For patients with T1DM, Vitamin B<sub>12</sub> plays a vital role because of the reduction in the level of homocysteine, which can be a major risk factor of causing atherosclerotic plaque [33]. Various factors such as exercise, weight loss, and improved glycemic control, and insulin-sensitizing medications help in improving Insulin Resistance [19]. As per previous reports the exact nature of insulin resistance in T1DM is unclear and not just the result of glucose toxicity. As many unnoticed facts could play role in insulin resistance. In contrast to problems, no specific treatment has been established. To find effective treatment or prevention we need organized action at all levels, that should be both at a national and international level of organization as well the involvement of people with Type 1 Diabetes Mellitus.



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## Conditional Relationship between Risk and Returns in the Context of Bombay Stock Exchange

Akash Asthana<sup>1</sup> and Syed Shafi Ahmed<sup>2\*</sup>

<sup>1</sup>Assistant Professor, Department of Statistics, University of Lucknow, Lucknow –226007, Uttar Pradesh, India

<sup>2</sup>Research Scholar, Department of Statistics, University of Lucknow, Lucknow –226007, Uttar Pradesh, India.

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### \*Address for Correspondence

**Syed Shafi Ahmed**

Research Scholar,

Department of Statistics,

University of Lucknow,

Lucknow –226007,

Uttar Pradesh, India.

E. Mail: syedshafi011@gmail.com



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### ABSTRACT

The Capital Asset Pricing Model, being one of the most widely used finance literature model, assumes that the relationship between the return and risk is linear and this risk is measured by beta. One of the major reasons given for the failure of CAPM is that the sole measure of systematic risk is not beta. The present study attempts to examine the conditional relationship between the returns and risk in the Indian stock market using Pettengill *et al.* (1995) methodology. The conditional betas were estimated using the GARCH (1,1) specification adopted from Bollerslev *et al.* (1988). The results of the study indicated that the conditional CAPM does not hold true in the Indian stock market. Since the conditional beta obtained was positive but insignificant (up market) and negative but insignificant (down market), it could not explain the risk and return relationship.

**Keywords:** GARCH(1,1), conditional beta, conditional CAPM, Indian stock market.

### INTRODUCTION

The decisive step in improving the modern portfolio theory was the discovery by Sharpe and Lintner which states that a functional relationship exists between the returns of individual securities and the market return. The outcome was presented in the form of Capital Asset Pricing Model (CAPM) by Sharpe (1964) and Lintner (1965). CAPM, a key tool known for providing the framework that analyses the return and risk relationship, proved to be very useful for



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investors. It stated that the required rate of return on an asset is given by its sensitivity to the non diversifiable risk, also known as the systematic risk or market risk, represented by beta ( $\beta$ ). Levy (1974) suggested computing the betas separately for bull and bear markets, which was first carried out by Fabozzi and Francis (1977). No evidence supporting the beta instability was found. Since the unconditional CAPM was unable to explain the cross section of average returns on stocks, the researchers tested the model conditionally. Even if the stocks were mispriced by the unconditional CAPM, the conditional CAPM could hold period by period. The conditional CAPM is more justifiable as the capital markets have both positive and negative periods of risk premium. The testing and modeling of time varying volatility of stock market returns gained attention since the introduction of ARCH/GARCH models by Engle (1982). The conditional models proved to be better models than the unconditional models as it provided strong evidence of the risk-return relationship.

Various researchers examined the validity of the CAPM throughout the world and they obtained different conclusions, some researchers' study found the applicability of CAPM while others study found evidence against the CAPM and rejected the model. Fletcher (2000) and Theriou *et al.* (2010) examined the unconditional and conditional CAPM. Using the unconditional CAPM, they found no significant relationship between the risk and return while the conditional CAPM showed significant positive (negative) relationship between risk and return in up (down) markets. Morelli (2011) examined the conditional risk and return relationship using the ARCH/GARCH process and found the importance of recognizing sign of the excess market return while testing the risk return relationship. Khalid *et al.* (2013) studied the dual nature of betas in the bull and bear markets in the Karachi Stock Exchange and found that for nine stocks beta was higher in the bear market than in the bull market while for other six stocks, the reverse result was obtained. Akbar (2013) examined the different versions of CAPM including the conditional CAPM in the Karachi Stock Exchange and obtained that the intercept terms were mostly insignificant and supported the theory of CAPM but the systematic covariance risk i.e. market risk was insignificant in both conditional and unconditional CAPM. Thus, both the models cannot be validated empirically in the context of Karachi Stock Exchange. Bilgin and Basti (2014) and Stancic *et al.* (2015) examined the validity of CAPM using both unconditional and conditional model and found that unconditional CAPM was rejected for the sample period while the conditional CAPM showed significant conditional relationship for some periods. Further findings of the studies showed that CAPM cannot be a reliable model to be applied to the respective stock exchange. Xiao (2016) examined the conditional relationship between risk and return using the ARCH process.

The results obtained supported the study of Morelli (2011) and showed the importance of recognizing the sign of excess market returns while testing the risk-return relationship. The study obtained that when the excess market return is positive (negative), a significant positive (negative) relationship was found between the risk and returns. Ignoring the sign of excess market returns, beta was found to be an insignificant risk factor. Vendrame *et al.* (2018) examined the performance of conditional CAPM and obtained that beta from conditional CAPM explains both the bull and bear markets. Osamah (2019) examined the relationship between conditional beta and returns by applying the Pettengill *et al.* (1995) methodology. It was obtained that the relationship between beta and returns is positive (negative) in bullish (bearish) market. The conditional CAPM was supported in the study showing the market excess returns were positive and the risk-return relationship was symmetrical in both bullish and bearish markets. Thus, it can be said that beta is still a valuable risk measure. Hollstein *et al.* (2020) examined the conditional CAPM with betas based on the daily and high frequency data. Using the daily data, it was obtained that the model cannot explain the size anomaly and out of 6, 3 main anomalies of the component returns. While using the high frequency data, the conditional CAPM explains the size, value and momentum anomalies and also out of 6, 5 component portfolio return. The high frequency betas provided more accurate predictions of future betas than the daily data. Fernando and Samarakoon (2021) examined the unconditional and conditional CAPM in the Colombo Stock Exchange and obtained that using the unconditional CAPM, the risk-return relationship is positive but insignificant in both individual and portfolio stock returns while using the conditional CAPM, no significant positive (negative) risk-return relationship in portfolio stock returns and individual returns during up (down) markets. A positive risk-relationship was obtained in individual stock returns in up market but significant inverse risk-return relationship was not obtained in the down market. Filho *et al.* (2022) examined the unconditional and conditional CAPM in







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Brazilian Stock Exchange by including the human capital. The results of unconditional CAPM without Human Capital could not satisfactorily explain the cross sectional returns. Even after the inclusion of size variable, the model remained inconsistent. The conditional CAPM proved to be more effective in explaining the cross sectional returns than the non conditional CAPM. Thus the conditional CAPM proposed by Jagannathan and Wang (1996) is perfectly applicable to the Brazilian Stock Exchange. The main objective of the current study is to establish a conditional relationship between risk and returns, in context of Bombay Stock Exchange (BSE), using conditional CAPM model with the help of GARCH (1, 1) specification.

## MATERIALS AND METHODS

The present study was based on the monthly data of 10 sectoral indices namely S&P Auto, Bankex, Capital Goods, Consumer Durables, Metal, Oil & Gas, Power, Public Sector Undertaking (Psu), Realty and Teck), listed in S&P BSE 500 Index, for a period of 10 years from April 2011 to March 2021 collected from the website of BSE and data of Treasury bill (T-bill) rates, used as proxy for risk free rate, collected from the website of Reserve Bank of India (RBI). The sector's monthly returns ( $R_{it}$ ) were calculated using the given formula:

$$R_{it} = \frac{P_{1t} - P_{0t}}{P_{0t}} \quad (1)$$

where  $P_{0t}$  = last day closing price of stock,  $P_{1t}$  = current day closing price of stock. Similarly the market returns ( $R_{mt}$ ) was calculated using the given formula:

$$R_{mt} = \frac{P_{1t} - P_{0t}}{P_{0t}} \quad (2)$$

Most of the previous studies tested conditional and unconditional risk-return relationship using the two main methodologies i.e. Pettengill *et al.* (1995) or Fama-MacBeth (FM) (1973) methodology, respectively. The present study has been conducted using the approach used by Pettengill *et al.* (1995). The econometric specifications for the conditional CAPM are adopted from Bollerslev *et al.* (1988). The conditional betas for each indices were obtained using the following GARCH(1,1) model:

$$R_{it} = \hat{\alpha} + \hat{\beta}^{c_{imt}} (R_{mt}) + \mu_t \quad (3)$$

For obtaining the conditional betas, using the results of Asthana and Ahmed (2021), the above equation was estimated using the 60 months rolling window with step size 1 over the entire sample period. For the conditional CAPM to hold, the intercept term i.e.  $\hat{\gamma}_0$  should be statistically zero and  $\hat{\gamma}_1$  i.e. market risk premium should be positive and statistically significant.

As per CAPM, there exists a linear relationship between the systematic risk and the return on an asset, the Pearson correlation coefficient was used to measure the degree and direction of linear relationship between the given two variables i.e. risk and return. To test whether the beta factor has any validity in the Indian stock market, the relevancy of beta factor was examined using the given equation:

$$Z_{pt} = \gamma_0 + \gamma_1 (\beta_p) + e_{pt} \quad (4)$$

Where  $Z_{pt}$  denotes average excess return of portfolios,  $\gamma_0$  denotes the intercept term,  $\gamma_1$  denotes the risk premium (beta) coefficient for this equation and  $e_{pt}$  denotes the residual or error term.





## RESULTS

Following the Pettengill *et al.* (1995) approach for testing the conditional CAPM in the Indian stock market, the total sample was divided into two groups i.e. up markets when the monthly excess returns were positive and down markets when the monthly excess returns were negative. The average excess returns were -0.0244 in the down market and 0.0236 in the up market. The weak positive linear relationship (0.1099) was obtained between the monthly returns and up market betas while moderate positive linear relationship (0.3178) was obtained between the monthly returns and down market betas. The results conditional tests (up and down markets) are given in the table below. After the estimation of conditional betas, the second pass cross sectional regression was used to test the conditional CAPM. The results revealed that the intercept value ( $\hat{\gamma}_0$ ) was obtained as 1.229 which is different from zero and the corresponding p-value was obtained as 0.133 which indicates that it is statistically insignificant. The value of market risk premium ( $\hat{\gamma}_1$ ) was obtained as 0.745 which is positive and corresponding p-value was obtained as 0.270 which was also statistically insignificant. These findings suggest that the hypothesis of conditional CAPM (up market) mentioned is not empirically supported. Our findings are consistent with the study of Akbar M. (2013), Bilgin and Basti (2014) and Stancic *et al.* (2015). (Table 1).

The results for down market revealed that the intercept value ( $\hat{\gamma}_0$ ) was obtained as 0.049 which is different from zero and the corresponding p-value was obtained as 0.979 which indicates that it is statistically insignificant. The value of market risk premium ( $\hat{\gamma}_1$ ) was obtained as -0.038 which is positive and corresponding p-value was obtained as 0.980 which was also statistically insignificant. These findings suggest that the conditional CAPM is not a reliable model in case of BSE. (Table 2). In order to find whether the beta value has any effectiveness in the Indian stock market, the relevance of beta was tested. The theory states that the intercept term should be zero and the slope term should be positive and significant. The results revealed that the intercept term obtained is -1.228 (up market) and -1.2455 (down market) which is significantly different from zero and the slope term obtained is 0.0197 (up market) and 0.0029 (down market) which is positive but insignificant. Also the R square and adjusted R square values are too low to explain the beta value. Hence it can be said that the beta is not a relevant factor as it cannot explain the cross-sectional differences in the returns in the Indian stock market. Our findings are consistent with the study of Rabha D. (2014) and Stancic *et al.* (2015). (Table 3)

## CONCLUSION

The present study evaluated the conditional relationship between the beta and returns using the data of selected sectoral indices listed in S&P BSE 500 index for the period from April 2011 to March 2021. The conditional relationship between the portfolio returns and portfolio beta obtained was positive but insignificant. Since the conditional beta is insignificant, it is not a reasonable factor in the Indian stock market. The conditional CAPM does not hold true in the Indian stock market as revealed from the results of the cross sectional regression.

### Funding

Not applicable.

### Availability of Data and Materials

The data used in the study that support the findings of this study have downloaded from BSE (<https://www.bseindia.com/indices/IndexArchiveData.html>) and RBI ([https://www.rbi.org.in/Scripts/BS\\_NSDDPDisplay.aspx?param=4](https://www.rbi.org.in/Scripts/BS_NSDDPDisplay.aspx?param=4)) websites which is publically accessible.

### Declaration of Interest

The authors declare no conflict of interests.





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**Table 1: Coefficients of alpha and beta for conditional CAPM (up market)**

Coefficients	alpha	Beta	R square	adjusted R square
Value	1.229	0.745	0.006	0.001
t statistic	1.509	1.509		
p-value	0.133	0.270		

**Table 2: Coefficients of alpha and beta for conditional CAPM (down market)**

Coefficients	Alpha	Beta	R square	adjusted R square
Value	0.049	-0.038	0.001	-0.005
t statistic	0.025	-0.024		
p-value	0.979	0.980		



**Akash Asthana and Syed Shafi Ahmed****Table 3: Result of Relevance of beta (up and down market)**

	up market			down market		
	Coefficient	t Statistic	p-value	Coefficient	t Statistic	p-value
$\gamma_0$	-1.2283	-5.867	<0.001	-1.2455	-6.5117	<0.01
$\gamma_1$	0.0197	1.47234	0.1425	0.0029	0.7203	0.472
<b>R Square</b>	0.0107			0.0026		
<b>Adjusted R Square</b>	0.0058			-0.0024		





## Issues and Challenges Faced by ASHA Worker during COVID-19 Pandemic: a Review Study

Bijoy Das<sup>1\*</sup> and Asha Sarma<sup>2</sup>

<sup>1</sup>Assistant Professor, Programme of Social Work, Faculty of Humanities and Social Sciences, Assam down town University, Guwahati, Assam, India.

<sup>2</sup>Assistant Professor, Programme of Psychology, Faculty of Humanities and Social Sciences, Assam down town University, Guwahati, Assam, India.

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### \*Address for Correspondence

#### Bijoy Das

Assistant Professor,  
Programme of Social Work,  
Faculty of Humanities and Social Sciences,  
Assam down town University,  
Guwahati, Assam, India.  
E.Mail: bijoydas@adtu.in



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### ABSTRACT

The goal of the current review study is to comprehend and investigate the various issues that ASHA workers had to deal with during COVID-19. Studies on their weaknesses and the difficulties they encountered in providing their services have been observed. The ASHA workers were especially vulnerable as frontline personnel during the COVID-19 situation and continually feared contracting the illness. They have been tasked with carrying out door-to-door surveys as part of their duties, specifically to inform the populace. Additionally, they have suffered many acts of violence, abuse, and torture at the hands of other groups of individuals throughout the nation. There have been numerous incidents recorded in the states of Bihar, Bangalore, Karnataka, and others. Therefore, out of 45 reviewed articles, 7 articles were selected as they met the purpose of the review in particular these studies highlighted the challenges faced by the ASHA workers during the pandemic.

**Keywords:** ASHA Workers, Issues & Challenges, COVID-19 Pandemic

## INTRODUCTION

In the current scenario, when doctors, nurses, and other medical staff are engaged in providing different health services, ASHA workers are also not behind the situation. Instead, they were expected to assume and take lead as

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front-line healthcare workers. One of the most difficult tasks they had to complete during the COVID-19 pandemic included making outdoor visits, household surveys, health check-ups of expectant mothers, and people in isolation, and collection of data on health issues of the community and so on. The nature of their contribution towards health by reaching out to people in rural areas and educating them about preventative measures like wearing a mask, routinely washing one's hands with water and soap, maintaining social distancing in public places, and other things, ASHA workers were playing a very significant role during the COVID-19 pandemic. Additionally, they have helped the Panchayati Raj Department establish community quarantine facilities, provide reproductive, maternal, fetal, and neonatal care, and child health services, assuring the safe delivery of expectant mothers.

Numerous studies have been conducted across the nation to comprehend the function of ASHA employees and their psychological wellness during COVID-19. For instance, a study found that ASHAs are one of the most crucial components of the institutional healthcare framework since they work at the most basic levels to provide access to fundamental healthcare services [3]. Significantly, her research revealed that ASHA employees are providing their services to the management of the pandemic scenario with the utmost integrity. On the other hand, an article about the difficulties ASHA employees encountered while providing services during the COVID-19 Pandemic [1]. The states of Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, and Kerala were the main subjects of his piece. As they provided door-to-door services, raised awareness about the coronavirus, and took temperatures of those living in containment zones, there was a danger of infection. Further Niyati and Mandela did a study on the effects of the epidemic on Indian ASHA employees. The secondary materials were particularly used as the basis for the investigation [5]. Their study highlighted the number of issues that ASHA employees encountered during the epidemic, such as neglect, over time, a lack of assistance, etc., which highlights how vulnerable ASHA employees were. Thus, the fear of COVID-19 among the common people during the lockdown created several challenges in front of healthcare workers.

**Statement of the Problem**

ASHA workers of the state of Assam are not falling behind in dealing with difficulties while providing their services throughout the epidemic; they are doing so alongside the other states and their allocated tasks. They are more vulnerable to pandemic situations due to several factors, including the following: a) they are underpaid and overburdened with their job duties; b) they must work from morning until evening without breaks and away from their families; c) they must wear PPE kits, masks, and globes the entire day; d) they must cover more than 25 homes per day; and e) In addition to all of these issues, they also had to deal with problems with the general public, assault victims, verbal abusers, and a lack of safety and security in their services. All of these issues have made them mentally weak to the point where they are unable to communicate with their family and children. Hence, the primary psychosocial vulnerability of AHSA workers, specifically in the state of Assam, is the focus of this review paper.

**MATERIALS AND METHODS**

The review highlights the issues that affect the ASHA workers in their response to COVID-19. This paper primarily focuses on the papers published in 2020 after the advent of COVID-19 and includes all studies which are published in English across the world. For carrying out the review work the keywords "ASHA", "pandemic", "COVID-19", "coronavirus" and "psycho-social" in the following databases: Google Scholar, Science Direct, Pro-Quest. The criteria for selecting the papers for review involve all studies which are published in English in journals from December 2019 to the Present and focussed on the issues and challenges faced by the ASHA workers during their response to the COVID-19 pandemic. A total of 45 articles were reviewed and around 20 articles were removed as they were not found relevant to the topic under study. The remaining 25 articles were screened for their eligibility to check if they were consistent with the purpose of the review. Further, 19 articles were found to be outside the scope of the review. Finally, 7 articles were selected as they met the purpose of the review; in particular, these studies highlighted the challenges faced by ASHA workers during the pandemic.



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## FINDINGS AND DISCUSSIONS

The data extracted through these 8 studies drawing upon some common themes are presented in the table 1

### Issues in financial matters

One of the serious issues faced by ASHA workers in their work is low incentives, and low and irregular payment because of which they face certain serious issues to manage and support their families [4] It is a very serious matter in India where those female front-line healthcare workers are paid very less also which is not recognized by government employees. On the other hand, we see those are the women who implement India's health and nutritional services at the grassroots level and are merely giving such honorary [6].

### Transportation

There was a problem during the lockdown period of COVID-19 as no proper transport facilities were provided to ASHA workers because of that they had to face challenges in visiting the village and the areas that are far away from their households. Few studies witnessed the problems of extensive traveling, door-to-door visits, and hospital visits with the patients remain challenging factors due to the lack of proper transport facilities [4]. Similar factors are also contributing challenges for ASHA workers like distance from the residence, from a health facility or center, and uneven distribution of population.

### Social Stigma and Fear

According to Devarajappa, S. et al. and a few other researches, ASHA employees confront a severe hazard when providing their services during the COVID period: a fear of social status, which includes domestic violence and adverse effects on children's upbringing [2]. Niyati and Mandela (2020) mention long hours and insufficient safety precautions as reasons why their predicament is stigmatised. Such services require a personal touch, and widespread knowledge is crucial at the grassroots level.

## CONCLUSIONS AND SUGGESTIONS

Review of various papers also revealed the issues related to supervision, issues with job security, low incentives, and poor transport remain major challenges in the field which is similar to those reported by Sharma et al (2014). The pandemic of COVID-19 evidence has shown certain responsibilities of a group on the other hand how a group is also witnessed certain forms of vulnerability. Witnessed the challenges like excess working hours [7][5] of ASHA a worker was a serious concern during COVID-19 because they had to devote much time to their service rather than family. Similarly when we look into a problem that is surrounded by other similar challenges. to give long strenuous services sometimes they do not get proper transportation to come back their home due to lock down across the country. Thus, the study by Salim (2020) found that lack of transportation was also a serious threat to ASHA workers during COVID Pandemic [9]. Discussions of some of the papers are not confined only to limited areas. As the study of Devarajappa, S. et al (2021) reflected other crucial forms of issues like; domestic violence, the social and economic status of ASHA workers are also significantly responsible for facing challenges [2]. Besides, no proper care and responsibilities from the government have been reflected in terms of lack of poor transportation facilities, lack of recognition from the government, and insufficient training are also major challenges for ASHA workers.

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**Table 1. Common Themes are Presented**

Ref No	Authors ,date	Title	Findings
1	Awasthi,P (2020)	The life of ASHA workers in the time of COVID-19	i) More working hours & personal risk of infection ii) Not being able to provide immunizations to pregnant women i.e. other duties have taken a backseat
	Salim, A (2020)	Performance of ASHA Workers during the Time of COVID-19: A Case Study of RajakkadGramaPanchayat	i) Lack of transportation affected the day to day activities of ASHA (they have to work for hours and do not get any travel incentives) ii) Long strenuous hours of work
2	Devarajappa, S et al (2021)	Impact of Covid-19 Pandemic on Accredited Social Health Activists (ASHA) in Karnataka: A Empirical Analysis	I) The adverse effect of COVID-19 on the social status which includes cases of domestic violence, negative impact on the upbringing of the children of the ASHA workers. II) The adverse effect upon the economic status indicating their difficulty in fulfilling their basic needs, it had impacted their savings, regular expenditure and jobs of their family members.
5	S. Niyati* and S. Nelson Mandelat	Impact of the Pandemic on Accredited Social Health Activists	i) Intensification of working hours during the pandemic and lockdown. ii) During the pandemic, the suspension of many incentive-based tasks, such as working in immunisation drives and village health awareness campaigns, lowered the earnings. iii) Thirdly, ASHAs face unsafe working conditions because of inadequate protective gear, insufficient training, and lack of recognition as government health workers. Insufficient training and lack of recognition as government health workers.
	Report Release (2020)	Global in Women's Health series (Down to Earth, 2020)	i. Many workers are paying from their own pocket for purchasing gloves, masks, and sanitizers ii. Fear of getting infected. They are not from







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			privileged backgrounds where they can afford to self-isolate themselves in their homes. The pandemic has led to a cut in their incentive for attending to a smaller number of cases.
4.	Meena, S (2020)	Challenges faced by ASHA Workers during their Field Works: A Cross Sectional Observational Study in Rural Areas of Jaipur, Rajasthan	Inadequate Payment, overburden of work, poor transport and conflict between ICDS and Health Staff.





## A Novel Chemically and Mechanically Stable Terpolymer for Acyl and Retro Acyl Carrier Protein Fragment Synthesis: A Comparative Study with Merrifield Resin

Nissy Ann Harry<sup>1</sup>, Sunil Jacob<sup>1\*</sup>, Ujwaldev S M<sup>2</sup>, T. R. Satyakeerthy<sup>3</sup> and Sosamma John<sup>4</sup>

<sup>1</sup>Department of Chemistry, Catholicate College, Pathanamthitta, Kerala 689645, India

<sup>2</sup>Department of Chemistry, Sree Kerala Varma College, Thrissur, Kerala, 680011, India

<sup>3</sup>Indira Gandhi National Open University Rajadhani Complex, Karamana, Thiruvananthapuram, Kerala, India.

<sup>4</sup>Department of Physical Education, Catholicate College, Pathanamthitta, Kerala 689645, India.

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### \*Address for Correspondence

**Sunil Jacob**

Department of Chemistry,

Catholicate College,

Pathanamthitta,

Kerala 689645, India.

E. Mail: suniljacob07@gmail.com



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### ABSTRACT

Aterpolymer- polystyrene, N-vinylpyrrolidone, 1,6-hexanediol diacrylate resin (PS-NVP-HDDA) developed by the radical aqueous suspension polymerization. The resin exhibited high swelling capacity in different solvents. This challenging sequence-ACP 65-74 fragment (acyl carrier protein) and the retro acyl protein fragment (ACP74-65) were synthesized with novel support. When comparing with Merrifield resin, the novel support produced peptides with a greater yield and purity.

**Keywords:** Peptide, Merrifield resin, polystyrene, N-vinylpyrrolidone, 1,6-hexanediol diacrylate

### INTRODUCTION

The crucial factor that controls the homogeneity and purity of biomolecules synthesized on it is the choice of polymer support, including polypeptides and oligonucleotides. Merrifield made a scientific discovery in 1963 that helped spark a boom in polymer-supported organic synthesis decades later [1]. A pendant chloromethyl group serves as the attachment site in the divinyl benzene and polystyrene polymer known as Merrifield resin. Truncated and deletion sequences were produced as a result of the rigid nature of the polymer, insufficient solvation in polar organic solvents, non-uniform distribution-induced nonlinear kinetic behavior, inaccessibility of the functioning sites hidden in the hydrophobic core to substrates, and other issues related to heterogeneous reaction conditions [2, 3]



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To further the area of peptide synthesis, various attempts have been made for developing new polymeric supports with increased polarity compared to the actual Merrifield resin [4, 5]. This article compares Merrifield resin to a recently produced terpolymer polystyrene, N-vinylpyrrolidone, 1,6-hexanediol diacrylate resin (PS-NVP-HDDA), which was created using the radical aqueous suspension styrene polymerization, NVP ("N-vinylpyrrolidone"), and HDDA ("1,6-hexanediol diacrylate"). The resin displayed excellent mechanical stability, swelling characteristics, and a hydrophobic-hydrophilic balance. Evaluating the new polymer's potential for the stepwise ACP fragment 65-74 synthesis [6] and the retro acyl protein fragment was evaluated by the synthesis of a few test peptides (ACP74-65) [7]. Then, using the same parameters for evaluation, a similar peptide sequence was produced on widely available supports like Sheppard as well as Merrifield resins to evaluate the efficacy of the novel polymer [8]. The HDDA crosslinker and hydrophilic NVP monomer present in the polymer gave rise to exceptionally high swelling characteristics in diverse solvents. By increasing the effectiveness of the reaction between the resin-bound and the solvent-medium reagents, the peptide chain was expanded. It is clear from the HPLC profile of the crude peptide that all of the peptides were synthesised to a high degree of purity in the new resin, which was used for all of the reaction steps.

## MATERIALS AND METHODS

### Synthesis of PS-NVP-HDDA Support

By first washing with a 1 percent NaOH mixture (2x30ml) and then with distilled water, we were able to remove inhibitors from styrene (3x30ml). This is then dried over anhydrous calcium chloride. Vacuum distillation ensured the purification of NVP. An N<sub>2</sub> inlet, water condenser, thermostat, and a stirrer were all part of the set-up in the four-necked reaction vessel. Styrene (10.54ml), HDDA (0.67ml), NVP (0.54ml), and AIBN (200mg) were included into a mixture of magnesium hydroxide (1g), sodium sulphate (10g), and disodium hydrogen phosphate (10mg) in water (100ml) while the mixture was being stirred at 1600rpm. As long as a steady supply of nitrogen was present, the temperature of reaction solvent was maintained at 70°C. After 6h, the copolymer was produced as beads between 200 and 400µ. The stabilizing agent, acetone (3x50ml), and methanol (3x50ml) were removed from the polymer using hot water before it was again filtered using a Soxhlet extraction process with the aforementioned solvents and dried in vacuum.

### Swelling Behavior

A sintered Teflon filter was inserted inside a syringe along with 1g of resin, and the syringe's cap was emptied to release the solvent. By applying steady suction at the syringe's discharge point, a flow of solution was produced. One milliliter per minute of flow was achieved by controlling the suction. The resin was exposed to the solvent for thirty minutes. This resin was dissolved into solution for one hour with the syringe exit closed. The syringe's piston compressed the swelled resin, and then the pressure was gradually released. To assess the resin's capacity for swelling, the resin volume at the stage was measured and compared to the weighted sample. PS-DVB resin underwent the same testing. Solvent-swollen resin bead weight gain was compared to that of dry resin.

### PS-NVP-HDDA-HMPA and PS-NVP-HDDA-HMPB Support

PS-NVP-HDDA-HMPA and PS-NVP-HDDA-HMPB support was synthesized using 4-HMPA and HMPB acid (1.89g, 10mmol) respectively by reacting with DCC (2g, 10mmol) and HOBt (2.2g, 20mmol) dissolving in DCM (10ml) and stirred for 1h. It was possible to remove the DCU that had settled to the bottom by filtering it. Filtering a solution of 4-hydroxymethyl phenoxy acetic acid yielded the HOBt active ester containing DCM and then drying the filtrate under a vacuum. In 100ml of NMP solvent, aminomethyl resin (5g, 0.24mmol NH/g) was swollen for 1h before the excess NMP was filtered out. The swollen aminomethyl resin was then processed with HMPA/HMPB HOBt active ester. The filtered resin was then rinsed using NMP (30ml each time) dioxane: H<sub>2</sub>O (1:1) (3x30ml), MeOH (3x30ml), dioxane (3x30ml), and vacuum dried. 0.16mmol OH/g of hydroxyl was present in the resin. IR (KBr): 3400cm<sup>-1</sup>(NH), 3380cm<sup>-1</sup>(OH), 1164cm<sup>-1</sup> (ether), 1643cm<sup>-1</sup> (NHCO).



**Nissy Ann Harry et al.,****General Steps for Synthesizing Peptides with Fmoc-Amino Acids**

A manual peptide synthesizer was used to synthesize various peptides on matching swelling HMPA and HMPB resins that had C-terminal amino acids attached. The DMF (3x25ml) was used to clean the resin after the Fmoc protection was eliminated using a 20 percent piperidine solution (25ml x 20min). The specific amino acids were used in coupling processes (3.5meq more than the amino acid potential of the HMPB resin's C-terminal amino acid) with a solution of HOBt (7meq), DIEA (3.5meq), and HBTU (3.5meq) in DMF for 50 minutes, then rinsed with DMF (3x20ml). The degree of coupling in each cycle and the cleavage of the Fmoc protection were monitored using the "Kaiser semi-quantitative ninhydrin test". These following steps were used to introduce each amino acid residue: (a) using DMF (4x25ml) to wash, (b) 20% piperidine in DMF for washing (1x25ml), (c) 20 percent piperidine deprotection in DMF (1 x 25ml x 20min), (d) using DMF to wash (4x25ml). 3.5mmol additional Fmoc-amino acid, DIEA, HBTU, and 7mmol of HOBt were added to the reaction to acylate the C-terminal amino acid contained in HMPB resin. As a result, peptide resin no longer has the Fmoc shield protecting its N-terminal amino acid, following the inclusion of all amino acids (25ml x 20 min) using a 20% piperidine solution. After washing the peptidyl resin with DMF, isopropanol, and ether at (5 x 25ml) each, then it was vacuum dried.

**Acyl Protein Fragment (65-74) Synthesis**

For the production of PS-NVP-HDDA-HMPA-Gly-Fmoc resin (100mg, 0.01mmol Gly), Sheppard resin (105mg, 0.01mmol Gly) and PS-DVB-HMPA-Gly-Fmoc resin (58g, 0.01mmol Gly) for this comparative analysis of ACP 65-74. These resins were removed out of a peptide synthesizer manually, and DMF was used to swell them for an hour (50ml). The Fmoc protection was eliminated from the resins after 20min of treatment with a 20 percent piperidine/DMF solution in 10ml, followed by a thorough DMF (6x10ml) wash. The corresponding Fmoc-amino acids (0.1mmol each), Gln (61.1mg), Val (33.9mg), Ile (35.3mg), Ala (31.1mg), Tyr (45.96mg), Asp (41.15mg), Gly (29.7mg), Asn (59.7mg), HBTU (30.76mg), HOBt (13.5mg), and DIEA (17.41µl), in minimal quantity of DMF, were included into Fmoc-deprotected resins for each acylation cycle. The three synthesizers were used to which an equal amount of coupling solutions, were prepared in triples. The coupling processes took place at room temperature for a whole hour. The ninhydrin test was used to track the coupling and deprotection processes. After incorporating all of the amino acids, the target peptidyl resins' Fmoc-protection was eliminated, and the resins were extensively cleaned with ether (5x5ml), DMF (5x5ml), methanol (5x5ml), before being dried in vacuum. For HPLC analysis, a small peptide solution volume was injected into the C-18 RPC and then eluted with Buffer A gradient: water consist TFA (0.5%), and Buffer B: MeCN in water consist TFA (0.5%).

**Retro ACP Fragment (74-65) Synthesis**

The retro ACP sequence H-GNIYDIAAQV-OH was synthesized on PS-NVP-HDDA and PS-HDDA resins using the same reaction conditions. The resins were pre-treated with HMPB linker before the synthesis. C-terminal Fmoc-Val was added to the resins and then synthesized utilizing the HOBt active ester method. It was decided to take the PS-NVP-HDDA-HMPB-Val-Fmoc (100mg, 0.01mmol Val) and PS-HDDA-HMPB-Val-Fmoc (75mg, 0.01mmol Val) resin. Using the appropriate Fmoc-amino acids and activating agents, the remaining retro ACP was included. Following the ACP synthesis instructions, the peptide was then isolated from the resin. A little amount of the peptide solution was injected into the C-18 RPC for HPLC analysis, and the solution was then eluted with Buffer A gradient: water consisting of TFA (0.5 %), and Buffer B: MeCN in water consisting of TFA (0.5%).

**Peptide Removal from the Polymer Support- General Method**

The following techniques were used to isolate the peptides from the resin. The polymer supports allowed the target peptides to be released after being suspended in Reagent K [TFA (3ml), ethanedithiol (150ml), thioanisole (150ml), water (150ml), and phenol (200ml) at room temperature for 4h. Filtering the solutions resulted in a filtrate that was concentrated at low pressure. Adding ice-cold ether helped precipitate the peptides. The scavengers were then eliminated and the precipitate dried after being rinsed with ether. The peptide was lyophilized after it had been frozen after being dissolved in water.





## RESULTS AND DISCUSSION

### The Polymer Synthesis

The 1,6-hexanediol diacrylate, monomers styrene, and N-vinylpyrrolidone were free radical copolymerized to create the cross linked polymer in an aqueous solution using the radical initiator AIBN.

IR and  $^{13}\text{C}$  NMR techniques were used to characterize the polymer PS-NVP-HDDA. The IR (KBr) spectra of the powdered polymer also showed strong peaks at  $1724\text{cm}^{-1}$ , which corresponded to the ester carbonyl of the crosslinker, and  $1686\text{cm}^{-1}$ , which corresponded to the NVP carbonyl peak, in addition to the normal polystyrene peaks. The solid-state  $^{13}\text{C}$  NMR spectra revealed a high peak at  $130.435\text{ppm}$ , equivalent to the aromatic polystyrene carbons, and a weak signal at  $148.403\text{ppm}$ , equivalent to the styrene C-3. The PVP carbonyl carbon is seen at a peak at  $178.584\text{ppm}$ , while the crosslinker's methylene carbon is visible at a peak at  $66.437\text{ppm}$ . The peak at  $43.548\text{ppm}$  is due to the methylene carbon in the polymer's backbone, whereas the peak at  $34.465\text{ppm}$  is the result of the ring superimposing itself on the main chain carbon. The SEM image of the functionalized bead demonstrates that the addition of CMME and the other chemicals used to functionalize the polymer had no discernible effect on the morphological nature of the polymer (Figure 3). It was observed that the smoothness of the polymer surface was unchanged.

### Polymer Stability

They remain stabilize during the whole polypeptide production process. It was found that the crosslinker's ester linkages were robust to resist the powerful nucleophilic attack of the acids or bases. To examine it, the polymer was suspended at  $40^\circ\text{C}$  in a variety of chemicals, including piperidine: DMF (1:4) combination, 2M  $\text{NH}_4\text{OH}$ , 2M aqueous NaOH, neat TFA, and liquid ammonia in aqueous MeOH. After the individual resins were cleaned, dried, and the polymer's chemical stability was evaluated, the IR resin spectra was measured both before and after the processing with the suitable chemicals. In comparison to the initial spectrum, the spectrum showed no change in their chemical composition, demonstrating that the support is strong enough to withstand all the harsh circumstances required for the synthesis of peptides (Fig. 4). The resin stability was then assessed after the production of short peptide sequences on it and its cleavage. The resin was cleaned using different solvents after being removed from the cleavage solution and then used KBr to pelletize, powder, and dry the material. Results from the infrared spectrum matched those from the original resin exactly.

### Resin Functionalization- Chloromethylation and Aminomethylation of the Resin

Chloromethyl functionalization [9] and aminomethyl functionalization was employed in the early stages of the creation of the new resin [10]. Chloromethyl resin's IR (KBr) spectra revealed a band at  $670\text{cm}^{-1}$ ,  $1250\text{cm}^{-1}$  as well as  $1420\text{cm}^{-1}$  for C-Cl stretch as well as H-C-Cl vibration, respectively.

The polymer's infrared spectra revealed an amino group-corresponding absorption at  $3400\text{cm}^{-1}$ . The functionalized supports were then ideal for polypeptide production.

### Resin Swelling Characteristics

We examined and compared the polymer's swelling with PS-DVB resin in different solutions (Fig.6). It was observed that PS-NVP-HDDA resin had higher swelling characteristics in all solvents while comparing it with PS-DVB resin. The porosity measurements of the new PS-NVP-HDDA resin revealed that it is very microporous, resulting in a huge surface area (Table 1). Solid phase reactions depend on the pace at which chemicals diffuse into the resin since they are heterogeneous processes. The effects of aminomethylation, as well as chloromethylation on the swelling of polymers in different solvents, were also studied [11]. PS-DVB resin was used for comparison (Merrifield resin). These swelling properties of the functionalized and unfunctionalized resins did not differ noticeably. But it was discovered that the nature of the solvent affected the peptidyl-tendency resin to swell. Due to the altered polarity of the polymer matrix, peptidyl resin exhibited relatively better swelling characteristics in DMF than in DCM.





### Linker Incorporate into Resin

The ultimate cleavage of the target peptide in PS-NVP-HDDA resin might be aided by the addition of particular linkers or handles between the resin activity and the carboxyl group of the C-terminal amino acid. By combining the HMPA or HMPB HOBt active ester with H<sub>2</sub>N-CH<sub>2</sub>-PS-NVP-HDDA resin, the linkers HMPA and HMPB were used in PS-NVP-HDDA resin.

### Comparative Investigation of the Stepwise Polypeptide ACP Fragment Synthesis (65-74)

Under the similar experimental settings, ACP fragment H-VQAAIDYING-OH was synthesized using Fmoc chemistry in comparison to Sheppard and PS-DVB-HMPA-OH resins (Novasyn® KA 125) that are commercially available, and the novel PS-NVP-HDDA-HMPA-OH resin's suitability as a stable support for polypeptide synthesis was also examined. Each HBTU, Fmoc-amino acid, DIEA, and HOBt was utilized in three equivalent excesses (with respect to Gly load) for the coupling processes. All the chemicals needed to include an amino acid into all the resins were added together, weighed, mixed in DMF, and then divided evenly across the synthesizers. After the removal of N-terminal Fmoc protection following the synthesis, under the same cleavage conditions, the peptide was isolated from the corresponded resin. By applying the resulting ACP fragment to a reverse phase HPLC Sephasil Peptide C-18 column, its purity was determined after it had been diluted in a comparable amount of HPLC buffer A. HPLC examination of crude ACP-peptides synthesised using various resins is depicted in Figures a, b, and c.

The efficiency of the innovative PS-NVP-HDDA resin in synthesis of solid-supported polypeptide may be shown by comparing the average purity of ACP produced using PS-NVP-HDDA, Sheppard, and Merrifield resins. The eluting segments from the various resins that corresponded to the various peaks of each peptide were collected and subjected to an amino acid analysis. Under the identical synthesis conditions, the pure peptide output was over 90% for PS-NVP-HDDA resin, compared to over 59 percent for PS-DVB resin and around 80 % for Sheppard resin, according to the peak area in the HPLC profile corresponds to the ACP fraction. PS-DVB resin exhibited poor swelling in the reaction medium and peptide chain aggregation during synthesis caused insufficient acylation and deprotection processes, which contaminated the target peptide with peptide sequences of deletion as well as truncation. PS-NVP-HDDA resin yielded 40.1mg of crude peptide (90%). Tyr, 0.68 (1); Asp, 2.03 (2); Gly, 1.06 (1); Ile, 1.98 (2); Glu, 0.96 (1); Ala, 2.07 (2); Val, 1.0 are the amino acids that make up the protein. Tyr has a low value since it has partially degraded. The hydrolysis of Gln and Asn produced Glu and Asp. PS-DVB resin produced a crude peptide yield of 27 mg (59%) whereas Sheppard resin had a yield of 33.2mg (80 %).

### Comparative Retro Acyl Carrier Protein Fragment Synthesis (74-65)

The hydrophobicity of the novel resin is favorably impacted by the NVP content. The ability of resin to swell in different solvents proves this. The PS-NVP-HDDA and PS-HDDA (in brackets) swelling volume were 2.62ml/g (2.7ml/g) in methanol, 34.5ml/gm(4.45ml/g) in dioxane, .75ml/g (3.8ml/g) in acetone, 5.5ml/g (5.0ml/g) in pyridine, 6.2gml/gm (6.2ml/g) in toluene, 7.5ml/g (7.0ml/g) in DCM, 6.7 ml/g (6.15ml/g) in THF, 6.3ml/g (5.9ml/g) in DMF, and 7.4ml/gm (6.9ml/g) in NMP. The polymer's high degree of swelling might facilitate free reagent interaction with resin-bound functional sites, resulting in an increased rate of amide bond production. The retro ACP fragment H-GNIYDIAAQV-OH was competitively synthesized in PS-NVP and PS-HDDA-HMPB-OH resins under the same experimental conditions to assess the effect of NVP in the polymer on the synthesis of peptides. When PS-NVP-HDDA-HMPB-OH was used in its synthesis, the HPLC profile exhibited a single, dominant peak, with a few smaller peaks spaced apart from it. The HPLC profile under the aforementioned eluting settings revealed the existence of highly difficult-to-distinguish deletion/truncated peptide sequences when the identical peptide was synthesized with PS-HDDA-HMPB-OH resin. 9.30 mg of the crude peptide were produced (theoretically computed at 94 percent based on the resin's inclusion of the C-terminal Val). Gly, 1.00 (1); Val, 1.11 (1); Ile, 1.98 (2); Ala, 2.18 (2); Glu, 0.93 (1); Tyr, 0.67 (1); Asp, 2.13 are the amino acids that were analysed (2). Hydrolyzed Glu and Asp made up one Gln and one Asn, respectively. Tyr's low value might be the result of incomplete degradation. MALDI-TOF-MS was used to further characterize the peptide: m/z 1064.29Da [(M+H)<sup>+</sup>, 100%], C<sub>47</sub>H<sub>74</sub>N<sub>12</sub>O<sub>16</sub> needs M<sup>+</sup> 1063.14Da (Fig. 9).



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## CONCLUSION

Thus, the terpolymer of polystyrene, N-vinylpyrrolidone, and 1,6-hexanediol diacrylate resin (PS-NVP-HDDA) was developed by radical aqueous suspension styrene polymerization, NVP, and 1,6-hexanediol diacrylate. Its utility in synthesis of solid-phase peptide was compared to Merrifield resin. The resin displayed excellent mechanical stability, swelling characteristics, and a hydrophobic-hydrophilic balance. Acyl and retro acyl carrier protein fragments were prepared using the same experimental procedures on widely available supports including Sheppard as well as Merrifield resin, the performance of the new polymer was then assessed. The polymer's high degree of swelling might facilitate free reagent interaction with resin-bound functional sites, resulting in an increased rate of amide bond production. When compared to Merrifield resin, the novel support produced peptides with greater purity and yield.

## ACKNOWLEDGEMENTS

Declared none.

### Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

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Table 1:BJH Adsorption pore volume distribution of 200-400µ PS-NVP-HDDA resin

Diameter range (nm)	Average diameter (nm)	d(Vp)/d (Dp) (ml/g*nm)	Cumulative Vol.(ml/g)	IncrementalVol. (ml/g)	Volume %
159.13-136.94	148.13	0	0.00007	0.00007	0.47
136.94-120.13	128.53	0	0.00014	0.00007	0.47
120.13-107.05	113.59	0.00001	0.00002	0.00007	0.47
107.05-96.57	101.81	0.00001	0.00027	0.00006	0.44
96.57-77.70	87.14	0.00001	0.00044	0.00017	1.18
77.70-65.10	71.4	0.00001	0.00061	0.00017	1.15
65.10-44.01	54.55	0.00002	0.0011	0.00049	3.36
44.01-33.38	38.69	0.00005	0.00159	0.00049	3.37
33.38-26.96	30.17	0.00008	0.00208	0.0005	3.42
26.96-22.65	24.8	0.00012	0.00258	0.0005	3.44
22.65-19.54	21.09	0.00016	0.00308	0.00049	3.38
19.54-17.19	18.36	0.00021	0.00356	0.00049	3.35
17.19-14.82	16.01	0.00027	0.0042	0.00064	4.41
14.82-13.03	13.93	0.00035	0.00483	0.00063	4.31
13.03-11.62	12.33	0.00044	0.00544	0.00061	4.23
11.62-10.48	11.05	0.00053	0.00605	0.00061	4.18
10.48-9.54	10.01	0.00064	0.00665	0.0006	4.11
9.54-8.75	9.15	0.00074	0.00723	0.00058	4.02
8.75-8.08	8.42	0.00084	0.0078	0.00056	3.89
8.08-7.50	7.79	0.00096	0.00836	0.00056	3.86
7.50-6.99	7.24	0.00107	0.00891	0.00055	3.76
6.99-6.54	6.76	0.00118	0.00944	0.00053	3.67
6.54-6.14	6.34	0.0013	0.00996	0.00052	3.58
6.14-5.45	5.79	0.00144	0.01094	0.00098	6.77
5.45-4.89	5.17	0.0016	0.01185	0.0009	6.21
4.89-4.41	4.65	0.0018	0.0127	0.00086	5.89
4.41-4.20	4.3	0.00191	0.01311	0.0004	2.77
4.20-3.82	4.01	0.00195	0.01385	0.00074	5.09
3.82-3.48	3.65	0.00207	0.01454	0.00069	4.75

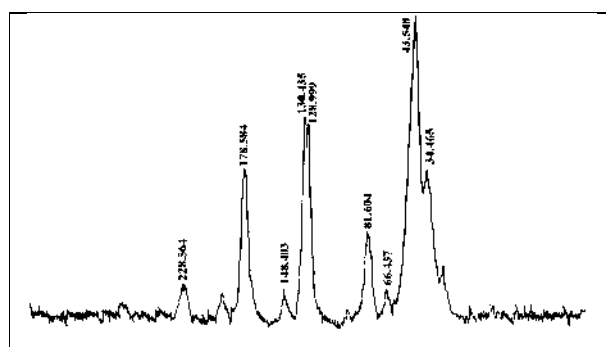


Figure 1:<sup>13</sup>C NMR of PS-NVP-HDDA polymer support

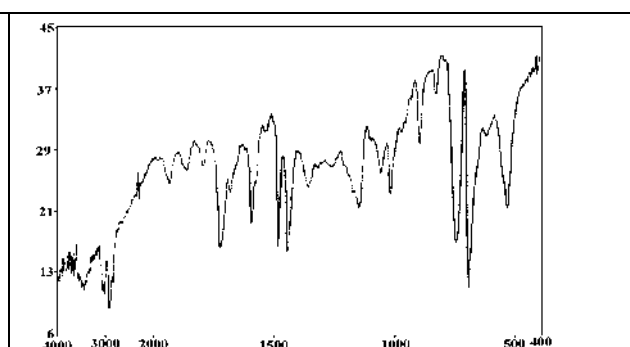


Figure 2:PS-NVP-HDDA polymer support IR (KBr) spectrum







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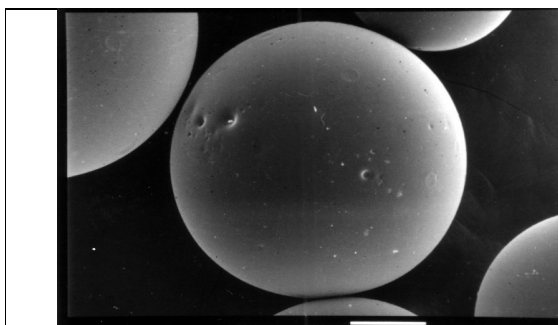


Figure 3: SEM image of PS-NVP-HDDA polymer

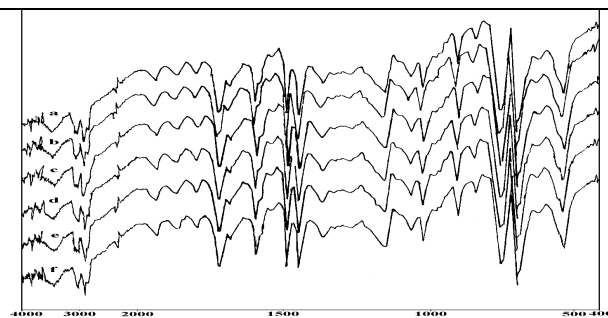


Figure 4.A spectrum of PS-NVP-HDDA support in the infrared (KBr), (a) original,b-f after 48hresin treatment with following agents, (b) piperidine: DMF mixture of (1:4); (c) 2M NaOH aqueous; (d) 2M NH<sub>2</sub>OH in MeOH aqueous; (e) liquor ammonia; (f) neat TFA.

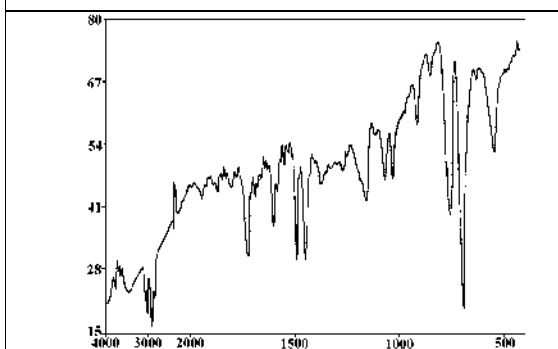


Figure 5:Chloromethylated PS-NVP-HDDA polymer support IR (KBr) spectrum

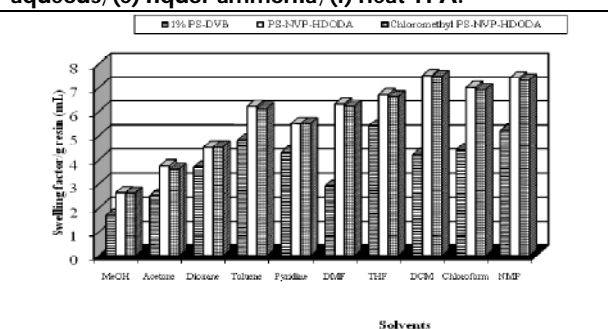


Figure 6: Swelling comparison of PS-NVP-HDDA &Chloromethyl-PS-NVP-HDDA resins with PS-DVB in different solutions

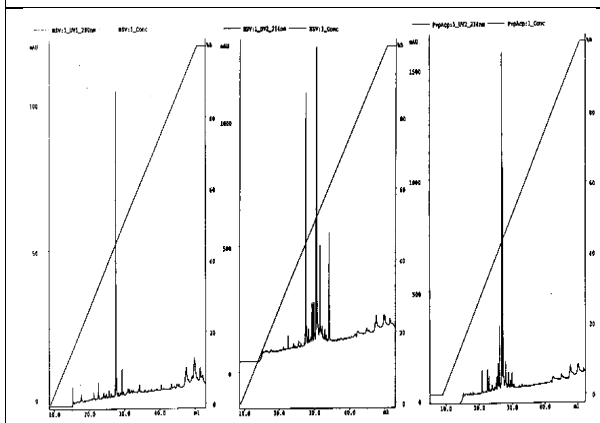


Figure 7:ACP fragment peptide HPLC elution profile.Different resins like (a) PS-NVP-HDDA-HMPA-OH, (b) PS-DVB-HMPA-OH (c) Sheppard resin Buffer A: TFA of 0.5ml in 100ml water; Buffer B: TFA of 0.5ml in 100ml acetonitrile: water (3:1). Flow rate: 1ml/min. Gradient: 0%-100% B in 40min

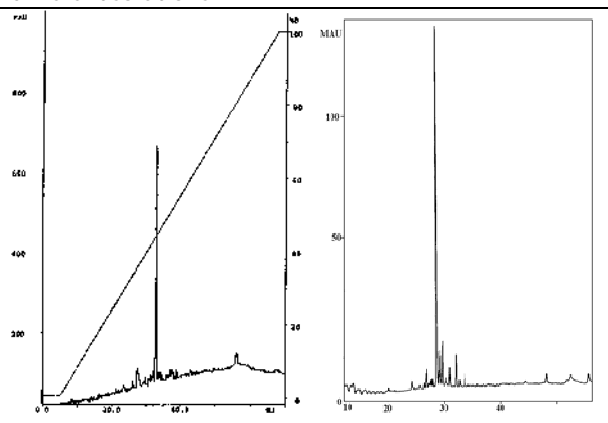
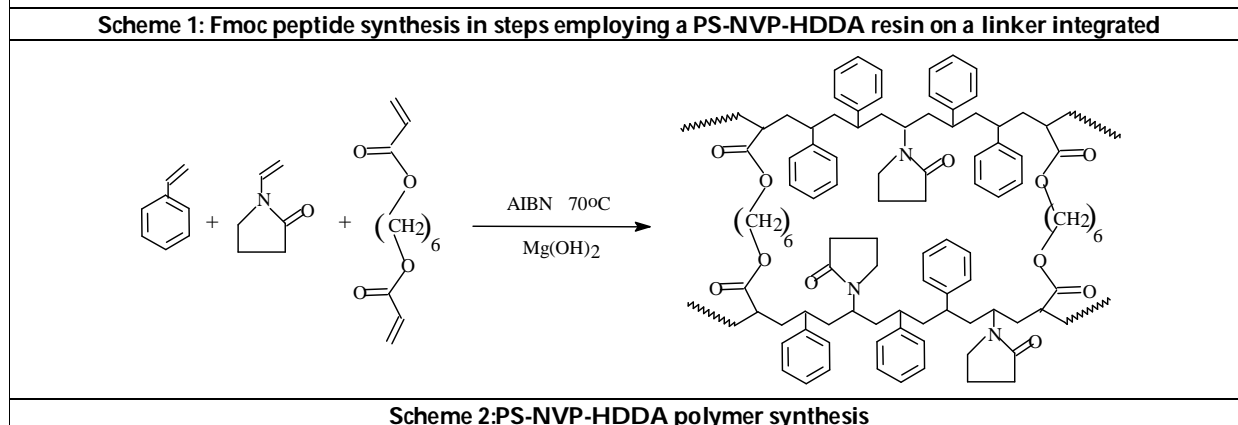
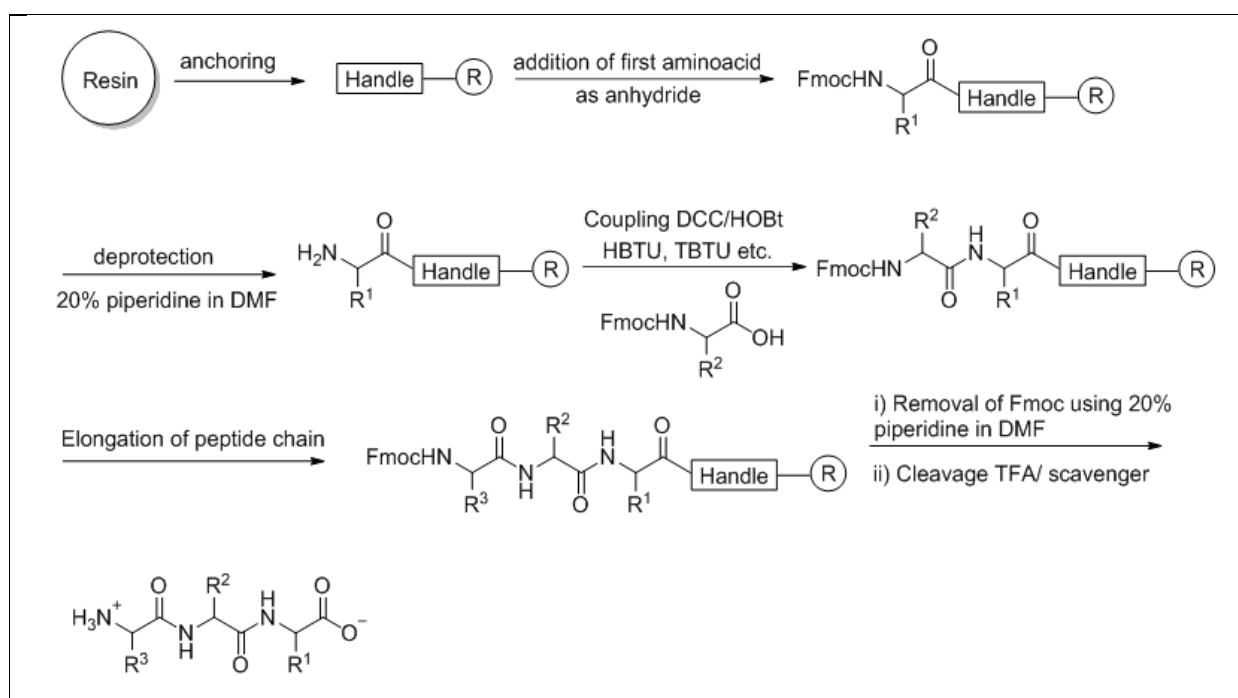
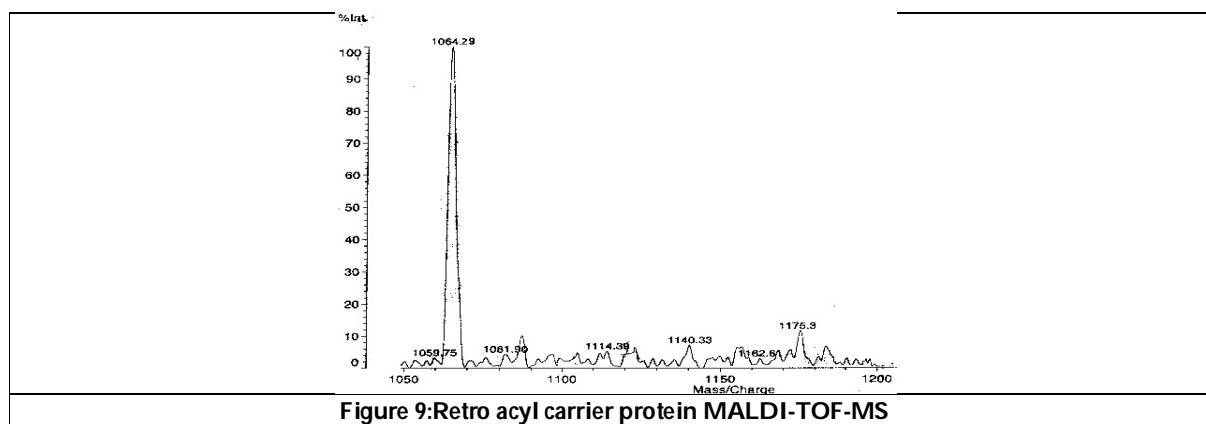


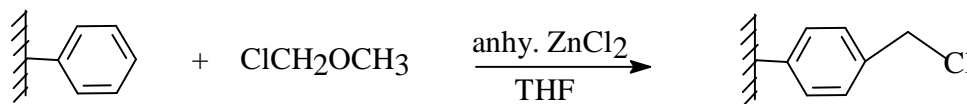
Figure 8:HPLC elution profile of synthesized retro-ACP fragment on resins i.e., (a) PS-NVP-HDDA-HMPB-OH (b) PS-HDDA-HMPB-OH. Buffer A: TFA of 0.5% in 100ml water; Buffer B: TFA of 0.5ml in 100ml acetonitrile: water (3:1). Gradient: 0%-100% B in 40min. Flow rate: 1ml/min.



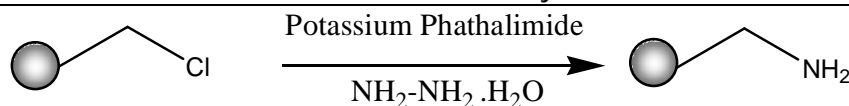


Nissy Ann Harry et al.,

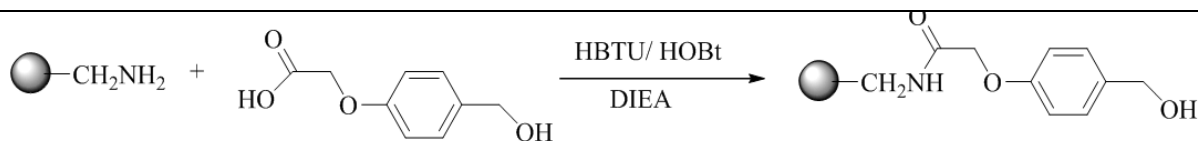


Nissy Ann Harry *et al.*,

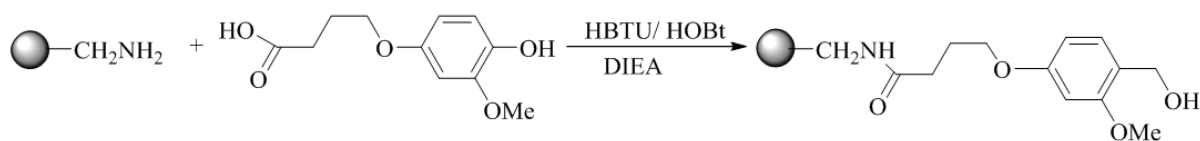
Scheme 3: Resin chloromethylation



Scheme 4: Resin Aminomethylation



Scheme 5: Preparation of HMPA-PS-NVP-HDDA Resin



Scheme 6: Preparation of HMPB-PS-NVP-HDDA resin





## Analysis of Social Responsibility of Educational Institutions during Covid-19

Veenus Gehlot<sup>1</sup> and Himani Sharma<sup>2\*</sup>

<sup>1</sup>Assistant Professor, Dept. of Business Administration, Manipal University Jaipur, Jaipur, Rajasthan, India

<sup>2</sup>Assistant Professor, Dept. of Commerce, Manipal University Jaipur, Jaipur, Rajasthan, India

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### \*Address for Correspondence

#### Himani Sharma

Assistant Professor,  
Dept. of Commerce,  
Manipal University Jaipur,  
Jaipur, Rajasthan, India .  
E. Mail: himani.sharma@jaipur.manipal.edu



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### ABSTRACT

The Corona Virus Disease (COVID-19) has threatened the entire world. Millions of deaths were caused due to this disease. The entire world was shut down; people were locked inside their homes to prevent the spread of this disease. The education sector has also seen great losses drastically as all the educational institutions were also closed due to this situation. Millions of students worldwide have been affected by this. Many discontinued their education due to the non-availability of required resources. With everything gradually opening, the educational institutions were kept closed. So, it became even more important for these institutions to fulfil their duties and impart education to their students. This research has been done to analyse the social responsibilities of the universities during such a pandemic and how they fulfilled these responsibilities. This research followed a cross-sectional design with the qualitative method and collected the data through the interview method. A total of 5 participants were interviewed for this process. This data was then analysed using the thematic analysis technique of data analysis. The research concluded that the universities in Jaipur city of Rajasthan state were aware of their university social responsibilities, and they did fulfil these responsibilities with effort. These educational institutions not only took the duties of imparting timely and proper education to their students but also provided their campuses and hostels to the government for quarantine centres and vaccination camps. These universities also took necessary precautions to keep their professors and staff safe from the disease and provided them training to use advanced methods of providing education facilities to their students.

**Keywords:** Covid 19 Pandemic, University Social Responsibilities, Higher Education System, Online Education, Lockdown.





## INTRODUCTION

Indian education or schooling system is the second largest in the world after China (Rawal, 2021). Millions of students every year get their desired qualifications from India. Being such a vast platform, it has many duties aligned to it. These duties include social obligations as well. The social responsibility of the education sector is more significant as it not only has to work for the present condition but also must train and impart social awareness to the future of the country as well (Jankal & Jankalova, 2017). But this chain got drastic changes when the global pandemic hit the world. The pandemic of COVID-19 spread throughout the world and the governments of different countries announced massive lockdowns as a logical solution to social distancing. The educational institutions also were closed (Gupta & Goplani, 2020). This impacted the process of imparting knowledge drastically and on the other hand, the institutions were expected to fulfil their social duties to help control this situation. This research would disclose the various attempts done and measures adopted by the institutions of Jaipur, a city in Rajasthan, India, in fulfilling their social responsibilities during a such pandemic and ensuring fluency in providing knowledge.

### Aim of the Research

This research aims to figure out the ways by which the universities of Jaipur fulfilled their duties regarding their social responsibilities and find out about the measures adopted by them to make the education imparting during the pandemic possible and smooth.

### Objectives of the Research

This research would fulfil the following objectives.

1. To study the social responsibilities of the educational institutions of India.
2. To know about the ways, these responsibilities were fulfilled by the institutions.
3. To figure out how these institutions also took care of providing education fluently during the pandemic and how the professors and lecturers were safeguarded while providing the education.

## LITERATURE REVIEW

The literature review section would present the past literatures about various concepts related to this research. In this section, the theories, concepts, and conclusions presented by scholars previously would be presented to know about the education system of the country and their social responsibilities, and in what ways they fulfilled these responsibilities.

### Education in India

The education system in India is vast. It falls under the concurrent list of the constitution and both the central and the state government has rights to take necessary actions and command regarding the upliftment of the system (Tilak, 1989). The educational institutions in the country are managed by both the public sector as well as the private sector. Higher education in India is the duty of both, the central government, and the state government in share. Universities in India can be established under any state law, central law or the provincial act. The concerned university must be recognized by the University grants commission (UGC) and other statutory regulator body (Department of Higher Education, 2022). In India, Rajasthan has secured top rank when considered for the number of universities. The pink city of Rajasthan, Jaipur has been ranked second in the country when considered about the number of higher education institution (TOI, 2018).

### The Situation in India during Covid-19

The Novel CORONA Virus started to spread in the late December 2019 from the Wuhan city of China. Gradually this virus spread all over the world and caused a huge loss of lives on the planet. Till January 2020 this virus affected more than 115 countries, soon after this, the virus was declared as a pandemic by World Health Organization (WHO) (Mohan & Vinod, 2020). In India, the spread of this virus started in late January 2020 in Kerala. Soon after this the



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lockdown was announced in the city and the rest of the country as more than 56000 cases were found till the month of May that year (Kumar *et al.*, 2020). The first lockdown continued for 21 days. Simultaneously the lockdown was announced many times in different part of the country. This caused almost all the types of businesses and sectors to shut for many months. The education sector was also affected the same way and the process of imparting education fluently was interrupted. Till date India recorded more than 44.58 million corona cases and over 5.28 million deaths due to this virus as per the WHO (Trading Economics, 2022).

**The Impact of Lockdown on Educational Institutions**

With the announcement of first lockdown in the month of March 2020, all the educational institutions, irrespective of their levels, were forced to shut down causing huge damage to the learning. This shutdown continued for almost for a year for higher classes and for more than this tenure for lower classes (HT, 2022). A survey concluded that over 250 million students in India suffered the loss of education due to this pandemic. Seeing this huge loss, the government tried to adopt alternative ways to smoothen the flow of education. These measures included changing the mode of education form offline to online. Universities started to adopt online mode to teach their students. E-learning portals were developed to support this decision (Jena, 2020). This transition also had some drawbacks which include lack of facilities, teaching aids, proper guidance and internet accessibility (Lakshman Naik *et al.*, 2021). Professors were provided with flexible timing for taking classes (Ghali-Zinoubiet *al.*, 2021). These drawbacks were though tried to settle off by the education institution, still in many cases it was seen that it is not up to the desired mark (Wadhwa *et al.*, 2020). In spite of these, the universities used to focus more on advancing the education and imparting knowledge in the students (Hasan & Bao, 2020).

**The Social Responsibilities of Educational Institutions**

Social responsibilities are to be fulfilled by every organization that is a part of the society and universities and educational institutions are not different from it. The social responsibility of a university is defined as an ethical quality of the services provided and its impact on development (Jankal&Jankalova, 2017). This USR (University Social Responsibility) was also to be followed during the time of COVID-19. As when the corona virus was getting mild, the educational institutions were opening as per government guidelines. The universities were also allowing students to come for offline studies, but were strictly following the guidelines and also making students to follow them. Online lectures were provided simultaneously to those who were not able to attend offline classes (Bhandari *et al.*, 2020). College campuses were used for vaccination campaign in Jaipur (The Times of India, 2022). Moreover, the universities also used to help students by sharing health tips via mails (UoW, 2022).

**Research Gap**

The spread of corona had had a huge impact on the education system. The government and the faculties had done a lot to combat its negative impact on the education and the health of the society. The previous research have stated many facts about this but still there is a gap in these researches which would be tries to be bridged in this research. There are not many research that sate facts about universities in India, specifically in Jaipur. Also, the past literatures are not highlighting the way by which universities in Jaipur have followed their USR.

**RESEARCH METHODOLOGY**

Research methodology describes the principles that help defining the designs and plans to conduct research (Mohajan, 2017). This section would describe the complete and detailed information about the idea the researchers have in their minds and the methods and techniques used in this research from collecting the data till reaching the conclusion.

**Research Philosophy**

This section describes the assumptions that researchers believe are essential for developing the knowledge. These assumptions could be related to human knowledge or the facts that are encountered (Saunders, Lewis & Thornhill,



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2009). This research would adopt realism and interpretivism. The researchers would accept and interpret the reality rather than concerning the expectations.

**Research Approach**

Research approach is a general plan, or in other words, is a direction of the procedure of the research (Dudovskiy, 2015). This direction goes either inductive way or deductive way. This research will follow an inductive approach as the data that would be collected is non-numeric in nature which could be interpreted using inductive approach.

**Research Method**

Research method refers to the methodological expression of the research. In simple words, the methods that can be used to research about a particular knowledge can be termed as research methods. These methods could be either qualitative or quantitative (Almeida, 2017). This research will adopt the qualitative method as it helps to provide better description of this complex phenomena.

**Research Strategy**

Research strategy describes the strategic framework of data collection. It basically bifurcates the sources of data collection. These sources could either be primary or secondary (Ajayi, 2017). For the purpose of this research, the data would be collected from primary source as primary data would help collect the actual and timely information of the pandemic, which is a present issue, any past data could not help get the idea of the present in this regard.

**Research Design**

The design of any research considers its duration. A research design defines the period considered to collect the data for any research (Robinson, Schmidt & Teti, 2008). This research would follow cross-sectional research design as collecting real time data directly from participants would suit cross-sectional time horizon.

**Technique and Procedure**

This section describes the process of collecting the data the techniques of analysing the data to reach the conclusion. For this research, the data would be collected from the primary source using an interview technique. A total of 8 samples would be selected using the non-probability convenient sampling technique. Deans of 8 different colleges would be contacted for the interview. The data thus collected would then be analysed using the thematic analysis technique.

**Research Ethics**

The ethical considerations related to research scholar would be followed which performing this research and complete anonymity of identity would be taken care of which doing this research.

**ANALYSIS AND DISCUSSION**

This section would analyse the collected data using the thematic analysis method. Thematic analysis is the method used to analyse qualitative data. The collected qualitative data is raw data which is required to analyse to draw the conclusion of the research. Thematic analysis method is a step-by-step process in which the researcher firstly reads all the collected information; then various themes according to the requirement of the research are formed. These themes are then divided into various codes. At last, the collected data is arranged in these codes to draw conclusions. The following table will present different themes and codes along with their rationales for this research. The collected data for this research would then be codified to draw the conclusion.



**Veenus Gehlot and Himani Sharma****Theme 1 Mode of Education****Code 1: Mode of Providing Education**

During lockdown when educational institutions were closed, the teachers were asked to take classes from their homes. But when gradually when orders were passed to open everything, universities were also opening and at some places teachers were asked to come to the universities to take online classes as still it was not permitted to open educational institutions as stated by HT, (2022). Some problems were faced by the lecturers and students as they all were adopting a new way for learning, but these were sorted out by both students and universities. When respondents of this interview were asked about the time of opening their university after the lockdown; many of them responded the opening data as April or May 2020. Respondent 3 responded,

*Classes were resumed immediately after the first lockdown i.e. from April 2020.*

While respondent 5 said that classes were resumed in May 2020. When these interviewees were asked about the place from where they used to take classes the responses were mixed. 2 interviewees out of 8 said that they were called to the university on the alternate days while 1 said that they were called for 5 days a week; rest every one of them said that they had flexibility to do so. It was their own choice if they want to take classes from their homes. Respondent 1 stated some problems while taking online lectures which were also discussed by Lakshman Naik *et al.*, (2021).

**Theme 2: University Social Responsibility****Code 2: University Social Responsibility**

The professors were asked about their views on the social responsibilities of the university during such a hard time and whether their university was playing the role for fulfilling this responsibility responsibly. The responses of the interviewees were satisfying as 5 out of 8 respondents described the role that their university played were satisfying and socially responsible. Respondent 2 stated:

*Our institution played a great role in this because the hostels were given to the government to be used for the quarantine of the patients. Even the vaccination camps were held in the university itself for the faculties and their families.*

Same way respondent 3 also claimed that their college campus was used for vaccination program. This was also stated by The Times of India, (2022). Respondent 4 said that their university focused on quality education through online as it was still not possible to take offline classes as stated by Bhandari *et al.*, (2020) and respondent 5 stated that students and lecturers at their university experienced that screen time was irritating, but proper guidance and training made it easy but still it was not good as compared to offline classes. This fact was also stated by Wadhwa *et al.*, (2020). Respondents 6, 7 and 8 said that providing education is the most important social responsibility.

**Code 3: Social Message**

The time of pandemic was hard for all as everything was shut and lethal disease was spreading all over. Everyone was afraid and at such times it was also necessary to continue with regular chores in all the fields including education. During such a time it was expected for these institutions to raise confidence in common people regarding their strategies of continuing education procedures. The professors of universities were asked about how their universities helped in such a situation. The responses were satisfying as interviewees stated that universities used to send messages at regular intervals to take required precautions. Interviewee 1 responded:

*Regular messages and bulk e-mails were being sent that there is no need to panic, and basic precautions are being observed for safety.*

Respondent 2 did not give satisfactory response and said the university mainly focused on levelling up the education; while other respondents agreed upon sending emails and messages regarding keeping precautions and necessity of continuing education in online mode as stated by UoW, (2022). Respondent 3 agreed upon sending various messages regarding the pandemic. Respondents 4 and 5 said that their university used to send messages regarding health camps to the students and guardians. Respondents 6 and 7 said that no such activity was performed while respondent 8 said that they regularly used to talk about precautionary measures.





**Veenus Gehlot and Himani Sharma****Theme 3: Students' and Teachers' Growth****Code 4: Students' Growth**

During the pandemic, the loss of education was tried to be settled by taking online classes. But lots of screen time was also having negative impacts on the students. So, it was expected for the teachers to also teach students about their health to safeguard them from pandemic and screen timings. When the interviewees were asked about how they taught health tips to their students, the answers were satisfying enough as many of them focused on their health and not only on the level of receiving education and growing on this basis. 4 out of 5 respondents said that their university focused on the health as well; while one claimed for providing better level of education as stated by Hasan & Bao, (2020). Respondent 1 said online education is a better option that leads to the growth of the students. But this option works only when the student himself is sincere. While in the contrast, respondent 2 said that imparting proper knowledge in the responsibility of the university and the university played this role well. Respondent 5 said: *Online education is comparatively good for students as it provides the same level of education but saves times. Also taking online classes helps students to stay away from diseases outside.* Respondents 7 and 8 said that they used to teach about staying safe and online education is not as good as offline teachings are.

**Code 5: Teachers' Growth**

During the pandemic the growth of the students was significant, but same way teachers' growth was also equally significant. So, to know about how universities tried to take care of their faculties as well, the interviewees were asked about how they were treated. The responses were good enough as almost all of them agreed and praised the efforts of the universities. Respondents 1 and 2 said that their universities helped them to understand the new regime and work accordingly and thus provided training to adopt new technique. Respondent 2 also said:

*Salaries were provided timely, and no deductions were made from the salary in spite of lower income. Vaccination campaigns were held for the faculties as well as their family members in the university campus.*

The response of respondent 2 was also discussed by The Times of India, (2022). Respondent 3 said that their university provided flexible working hours with alternate days to come to the university to avoid gathering and taking care of social distancing. This fact was also discussed by Ghali-Zinoubiet al., (2021). Respondents 4 and 5 also stated that their university took all the precautionary measures to avoid the spread of disease. Respondents 6,7 and 8 did not state much as no special activity was performed by their university for professors rather everything was the same as it used to be prior to the pandemic.

**CONCLUSION**

The spread of Corona Virus Disease hit the whole world drastically. Everything all over the world was impacted negatively. The education sector also had been impacted badly causing huge damage to the studies and careers of students worldwide. Universities in the country tried their best to cope with this damage by adopting various methods. This research focused on such attempts done by the universities in Jaipur. This research aimed to study about the ways these universities fulfilled their social duties during Covid pandemic along with providing smooth and flawless education. These aims were fulfilled as this research concluded that the universities in Jaipur worked with government to provide facilities to the Covid patients by providing quarantine rooms and arranged camps for vaccination. Moreover, these universities also held training for the professors and students so that they can learn new digital ways of studying so that the education process does not get disturbed.

This research provided deep insights about the attempts done by the university in Jaipur during the time of pandemic. But still there are a few loopholes present in this research. Firstly, the research is based on a small sample size. The conclusions based on such a small sample can be deceptive. Moreover, these samples were only based on a small geographic division. So, this conclusion cannot be used accurately at the state level or national level. Samples were collected by interviewing only professors; if data generation could have included the participation of the





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students also then this would have helped to generate more accurate results. This research also has many further scopes. Other researchers can use this research as a base to find out the facts about a bigger region or say a state. This research can also be furthered to know about the facts related to the vaccination campaigns, or other COVID related facts.

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**Table-1 Themes and Codes**

Theme 1: Mode of education	Code 1: mode of providing education	This code would help to find out about how the universities continued to provide education to the students during the lockdown.
Theme 2: University Social Responsibility	Code 2: University Social Responsibility	Through this code it would be analysed about whether the universities are aware of their responsibilities and are they fulfilling it.
	Code 3: Social Message	It would be tried to figure out that did the universities tend to spread some social message regarding the awareness and precautions to be taken during the pandemic.
Theme 3: Students' and Teachers' Growth	Code 4: Students' Growth	This code would help to know about how universities worked for the growth of the students.
	Code 5: Teachers' Growth	Through this code the work of the universities for the growth of the professors would be analysed.





## Importance of Camel Milk as a Probiotic on Human Health

Komalben Hirani<sup>1\*</sup>, Sandeep Shrivastava<sup>2</sup> and Amar Garg<sup>3</sup>

<sup>1</sup>Research Scholar, School of Biological Engineering and Life Sciences, Shobhit Institute of Engineering and Technology (Deemed-to-be-University), Meerut, Uttar Pradesh, India.

<sup>2</sup>Head, Department of Allergy and Molecular Diagnostics, Centre of Innovation, Research and Development, Dr.B.Lal Clinical Laboratory Pvt. Ltd., Jaipur, Rajasthan, India.

<sup>3</sup>Vice Chancellor, Shobhit Institute of Engineering and Technology, Deemed-to-be-University, Meerut, Uttar Pradesh, India.

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Accepted: 27 Apr 2023

### \*Address for Correspondence

#### Komalben Hirani

Research Scholar,

School of Biological Engineering and Life Sciences,

Shobhit Institute of Engineering and Technology (Deemed-to-be-University),

Meerut, Uttar Pradesh, India.



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### ABSTRACT

Milk is the best ideal diet for humans as it contains all the necessary requirements of body such as carbohydrates, proteins, vitamins, lipids, water and other minerals. Milk and milk products are consumed in regular diet throughout the world due to its several health benefits. Majority of the world population consume cow, buffalo, goat, sheep and yak milk due to its easy availability. Very few human populations consume camel milk due to lesser availability of camels. Camel milk is also considered to be the white gold of dessert as it comprises of large number nutrients and minerals which shows many beneficial effects on humans such as anti-diabetic, anti-ageing, anti-bacteria and anti-viral activities. Camel milk also contains large number of abundant proteins which helps in improving the immunity functions. Apart from all the nutritional aspects, camel milk also contains large number of probiotic bacteria which helps the host in regulating several body functions. The entire review will highlight the importance of camel milk as probiotics on human health.

**Keywords:** Camel milk, Probiotics, Human health, Health benefits.

### INTRODUCTION

Camel is an even toed ungulate animal of genus *Camelus* that habitats in the arid regions of the earth. *Camelus dromedaries* and *Camelus bactrianus* are the two species of camels found throughout the world (Kamal et al; 2007). Camels have been used since centuries for transportation, milk and meat (Agrawal et al; 2018). Camel milk has been a very important source of nutrition for people living in arid and semi arid zones of the world. Due to its high

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therapeutic effects and nutritional value, camel milk has turned into a growing interest for researchers (Khalesi *et al*; 2017). In Quran camel is declared as wonder of god (Attia *et al*; 2001). Dromedary camels usually habitat in desert area and are generally used for transportation for small distance. Besides it, their milk is also used as dietary supplement by some communities residing in desserts namely raikas and rabaris since many decades (Al Haj *et al*; 2010). Camel milk has been used as medicine for treating several infections by many communities of dessert in Asia and Africa since centuries (Konuspayeva *et al*; 2009). Camel milk is quite different than milk of other animals and somewhat more relevant to human milk as its composition contains very small amount of sugars and cholesterol and large amount of minerals such as potassium, copper, zinc, iron, magnesium and calcium in greater quantity (Kumar *et al*; 2016). Camel milk has been also used in treating and curing several diseases such as asthma, anti-hypersensitivity, jaundice, Leishmaniasis and dropsy (Al-Shamsi *et al*; 2018). In 1990s, the medicinal properties of camel milk were investigated. According to the researchers, camel milk contains reactive proteins in its composition which boosts the immunological defense mechanism (Devendra *et al*; 2016). A study also reported that these proteins have antibacterial and antiviral properties (Hernández-Ledesma *et al*; 2014). Besides this, camel milk also has a hypoglycemic effect while treatment due to which combination of insulin and insulin like proteins shows good result in treating diabetes. In past, camel milk was used in curing crohn's infection and food allergies (Chatterton *et al*; 2006). We have compiled all the updated literature describing the composition and probiotic effects of camel milk on human health. Therefore, the entire review will briefly illuminate the advantageous impacts of camel milk on human health.

**Medicinal Values of Camel Milk**

Camel milk has been used in the treatment of number of clinical infections and diseases since ancient times. Camel milk is not just a good source of nutrients but it also has large number of medicinal properties as it contains high concentration of vitamin C and also contains good proportion of antibacterial substances in comparison to cow milk (Abushelaibi *et al*; 2017). Camel milk contains large number of bioactive compounds such as peptides and proteins which are naturally found in its compositions and have also been reported to have beneficial effects of immunity, growth and digestion. Apart from this, camel milk has also been reported to have beneficial effects on diabetic patients and patients with high cholesterol (Al-Shamsi *et al*; 2018).

**Anti-Diabetic Effects of Camel Milk**

Diabetes mellitus is a medical complication caused due to high increase in blood sugar levels. There are two types of diabetes: Type I and Type II. Type I is more severe which insulin dependent is that is also called juvenile diabetes. Approximately 10% of people suffer from type I diabetes which is fatal unless treated with insulin. Type II diabetes is caused due to insufficient production or improper functioning of insulin in the body. Approximately 90% of the patients suffer from type II diabetes throughout the world. According to the previous studies, consumption of camel milk on regular basis has provided effective management for patients suffering from type I as well as type II diabetes.

Researchers in the past have assumed the following possibilities for anti-diabetic effect of camel milk on humans that is 1) Presence of good concentration of insulin/insulin like substances in the composition of camel milk. The whey protein found in camel milk is rich in half-cystine which is similar to insulin; 2) Immuno-modulatory effect of camel milk on beta cell function; 3) the human, goat, bovine milk contains insulin in their composition but the insulin found in camel milk is resistant to low pH or the acidic environment of gut and avoids coagulum. It is assumed to be encapsulated in nanoparticles that make it possible to survive at low pH in stomach. Studies of Sbouis demonstrated the effect of heat treatment on the anti-diabetic property of camel milk in Alloxan induced diabetic dogs. In his study, he reported that pasteurized and raw milk of camel can be used as treatment for treating diabetic dogs. The technique of pasteurization not only helps to preserve the milk for long time but it also saves the therapeutic particularity if camel milk.



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Natural inhibitory systems are found in camel milk that is considered to be much better than cow's milk. Studies in the past showed that camel milk contains various lysozymes (LZ), peptidoglycan recognition protein (PGRP), protective proteins, lactoferrin (LF) and immunoglobulins (Ig's) which exhibits immunological properties and antibacterial responses. The concentration of lysozyme and lactoferrin in camel milk is reported to be higher than cow's milk (Khalesi et al; 2017). Lysozyme plays an important role in showing broad spectrum of antimicrobial responses. It mainly targets the cell wall of bacteria containing peptidoglycan layer which is the main specific site for lysozyme action. It shows muramidase activity against Streptococcus and other Gram positive bacteria. Lactoferrin is a protein that binds with iron and divests the microorganism from iron by binding to it and through this bacteriostatic effect is observed against both Gram negative as well as Gram positive bacteria. However, a study in the past has also reported that few strains of *E. coli* produce siderophores which helps them to bind with Fe. The Lactoperoxidase found in camel milk is highly bacteriostatic against Gram positive bacteria and it is bactericidal against Gram negative bacteria. According to previous studies, presence of immunoglobulins in camel milk is found throughout the entire period of lactation which greatly improves the human immune system on regular consumption of milk in regular diet. For diagnosing mastitis, N-acetyl -  $\beta$  - D - glucosaminidase (NAGase) is one of the most reliable lysosomal enzyme which is found in camel milk. Though milk of camel is rich in NAGase, it is established to have antibacterial activity.

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## A Review on Medicinal Values of the Super Fruit: *Psidium guajava* (Guava)

Abdul Hadi Umam<sup>1</sup>, Nongmaithem Randhoni Chanu<sup>2</sup>, Manjit Mishra<sup>1</sup>, Digbijoy Nath<sup>1</sup>, Ankur Chutia<sup>1</sup>, Josef Yakin<sup>2\*</sup>, Ananta Choudhury<sup>3</sup> and BiplabKr.Dey<sup>3</sup>

<sup>1</sup>M.Pharm Student, Faculty of Pharmaceutical Science, Assam down town University, Panikhaiti, Narengi, Guwahati, Assam-781026, India

<sup>2</sup>Assistant Professor, Faculty of Pharmaceutical Science, Assam down town University, Panikhaiti, Narengi, Guwahati, Assam-781026, India.

<sup>3</sup>Professor, Faculty of Pharmaceutical Science, Assam down town University, Panikhaiti, Narengi, Guwahati, Assam-781026, India.

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### \*Address for Correspondence

#### Josef Yakin

Assistant Professor,

Faculty of Pharmaceutical Science,

Assam down town University,

Panikhaiti, Narengi, Guwahati, Assam-781026, India

E. Mail: joseph123yakin@gmail.com



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### ABSTRACT

Guava (*Psidium guajava* Linn.), a member of the Myrtaceae family, has been used as a food for centuries which is grown extensively in many tropical regions like India, Bangladesh, Florida and West Indies. Different pharmacological characteristics such as antibacterial, hypoglycemic, anti-inflammatory, antipyretic, spasmolytic, anti-hyperglycemic, hepatoprotective, anticancer and gastro protective effects have been found due to the presence of different phytochemical constituents like saponins, alkaloids, tannins, cardiac-glycosides in the different parts of plant, including the root, bark, leaves, and fruits, which are used to treat a wide range of diseases as a traditional medicine also. Guavas' nutritional worth is sometimes compared to that of super fruits because of its abundance in dietary fiber, vitamins A and C, folic acid, and dietary minerals including potassium, copper, and manganese. Guava is a plant with enormous broad use now and with amazing potential for the future, even though there are gaps in the studies completed so far that need to be filled in order to realize the full therapeutic potential of guava. The low toxicity of guava extracts and their derived phytochemicals, as well as their use as nutraceutical (fruit) and medicinal (leaves, bark, seeds, and roots) agents, are supported by studies that demonstrate the efficacy of both traditional and their derived phytochemicals, *Psidium guajava* will only become more





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widely recognized as an essential component of our biodiversity that must be protected and used sustainably for future generations through additional study, clinical trials, and commercial development.

**Keywords:** *Psidium guajava* Linn, Guava, Anti-Hyperglycemic, Wound Healing, Diarrhoea, Gastrointestinal

## INTRODUCTION

Due to its nutritional importance, the guava plant (*Psidium guajava* Linn.), a member of the Myrtaceae family, has been used in food for centuries. In many tropical regions, including India, Bangladesh, Florida, and West Indies, guava is grown extensively. There are reports that certain *Psidium guajava* components are used in traditional medicine. Different pharmacological characteristics have been found in the plant's many components, including the root, bark, leaves, and fruits, which are used to treat a wide range of diseases.[1] This is a genus containing roughly 133 genera, 3,800+ species of tropical shrubs, and a 10-meter-tall spreading tree that can grow in a variety of soil types. It is one of the most sociable fruit trees, and its common English name is well-known (guava). It is known as guava (Hausa), gurfa (Yoruba), and Gwaibwa (Igbo) in Nigeria.[2] The traditional uses of *P. guajava*, commonly referred to as the "poor man's apple" of the tropical, can have lengthy tradition and were largely supported by scientific research.[3] Guava leaves' aqueous extract has been found to be effective in treating a variety of gastrointestinal (GIT) disorders, including diarrhoea, peristaltic reflex inhibition, and gastroenteritis.[5] Additionally, the entire plant is used as a skin cleanser and in the treatment of illnesses that affect women, such as dysmenorrhea, miscarriages, uterine haemorrhage, and premature labour. Recent research on the medicinal effects of the bark, fruit, and leaves has shown that they have antibacterial, hypoglycemic, anti-inflammatory, antipyretic, spasmolytic, and central nervous system depressant properties [1]. *Psidium guajava* is used around the world as a treatment for a number of illnesses, including diabetes, hypertension, caries, inflammation, wound care, pain reduction, and lowering fever. In Mexico, *P. guajava* is frequently used as an anti-inflammatory drug and to treat digestive and respiratory issues. [6] Leaves are chewed to treat toothaches and are applied to wounds, ulcers, and rheumatic pain. [7] It is used as a gargle in Peru to cure diarrhoea, dysentery, stomach ache, indigestion, and throat and mouth inflammations. [8] Guava leaves include triterpenic acids and flavonoids, including avicularin and its powerful antibacterial 3-l-4-pyranoside. [9] Diabetes mellitus (DM) is a long-term metabolic condition. [10] *P. guajava* is a well-liked medication for the treatment of type II diabetes. The nutritional and medicinal benefits of guava include anti-hyperglycemic, anti-hyperlipidemic, antioxidant, hepatoprotective, anti-allergy, and anti-nociceptive properties. [11-14] Nearly every region in the world has diarrhoea on a regular basis. [15] Traditional remedies are typically given out by a group of people within a Society using various plant roots. [16] In certain nations, treating diarrhoea the old way is still practiced. [17] The primary biologically active components are flavonoids, which have a variety of biological effects, such as antioxidant activity, hypoglycemic effects, and hypertensive effects. [18-19] In many countries, preparations of the leaves have been used traditionally in folk medicine, mostly as an anti-diarrheal treatment. [20]

According to the Indian Horticulture Data Base, 2009–10, the total area in India under guava cultivation was around 219,700 hectares, with an anticipated annual production of 2,572 lakh tonnes. In India, particularly in the conditions of Karnataka, Madhya Pradesh, Maharashtra, Nagaland, Orissa, Pondicherry, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Jharkhand, and West Bengal, Allahabad safeda and Taiwan guava organic ingredients are outstanding assortments filled. HDP innovation leads to an increase in unit zone yield and early availability of the natural products to the market, which results in lower cost. It is understood that this produce blooms three times during the year: obviously in the spring (AmbeBahar), the stormy season (MrigBahar), and the fall (Hasta Bahar). Dietary advantage: Guava is abundant in vitamin A and vitamin C. Riboflavin and minerals including iron, calcium, and phosphorus are among the varied components. When compared to other citrus natural items, guava includes 4-5 times more Vitamin C component. Guava is 82% water, 2.45% acid, 4.45% decreasing sugar, 5.23% on



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decreasing sugar, 9.73% TSS, 0.48% debris, and 260 mg vitamin C per 100 g of organic product when it becomes mature. Soil and Environment: Since guava is a tropical and subtropical product, it can be successfully grown up to an elevation of 1000–1500 m mol. Its growth and development are best facilitated by dry, mild winter and summer conditions as well as a yearly precipitation of 1000 mm. Being a hardy harvest, it may fill well in a variety of soils. The pH should remain between 6.5 and 8.5. Guava is sensitive to water logging conditions yet has good resistance to salt. Harvest Control: The growth of this produce may be threatened by a variety of factors, including pest attacks and natural disasters including windy breezes, tornadoes, floods, and heavy precipitation. These common enemies could cause ranchers great injury and suffering. Therefore, ranchers want crop protection to increase production. In any event, the lack of earlier information on harvest protection presents ranchers with another challenge.

### Common Names

There are several names for guava used around the world. The common names of *Psidium guajava* are given in the table no: 1

## RESULTS AND DISCUSSION

### Ethno medicinal Uses

The guava fruit, *Psidium guajava*, is used as a folk medicine for the treatment. It holds a specific place in the standard medicine system. It is thought to be an important natural supplement in Ayurveda for diarrhoea and dysentery. It is used to treat a variety of diseases in the system of Traditional Chinese Medicine. It has been used for centuries to improve human health [1].

### Nutrient or Food Value of Guava Fruit [37]

Guavas' nutritional worth is sometimes compared to that of super fruits because of its abundance in dietary fiber, vitamins A and C, folic acid, and dietary minerals including potassium, copper, and manganese. A single common guava fruit has almost four times as much vitamin C as an orange and has a generally broad, low-calorie profile of key elements. In Table 3, the nutritional value and composition of guava fruit are mentioned. However, different guava cultivars have different nutrient contents.

### Microscopy

Numerous unicellular trichomes, paracytic stomata, xylem arteries, calcium crystals, and few crystal sheaths are visible under the microscope. [38,39,40] For mature leaves, the average stomatal index is higher on the upper epidermis than it is on the lower epidermis, and the opposite is true for immature leaves.[39] Younger leaves have greater moisture, and both young and adult leaves have approximately the same amounts of chemicals that are soluble in alcohol and water. The transverse section of the midribs reveals gutter-shaped xylem and phloem, as well as a pericycle that contains collenchymatous cells beneath the phloem.[40]

### Physico-Chemical Studies

The powdered sample of *P. guajava* leaves conducted proximate analysis, which revealed low moisture content of 1.0% and low ash value of 2.80%. A low number means that the powdered leaves of *P. guajava* contain more organic ingredients. The ash value measures the number of inorganic components in the plant. It contains fat, protein, and carbohydrates in large quantities, making it a source of energy. The magnesium, manganese, zinc, calcium, iron, sodium, and potassium that were tested for in the metal analysis of the powdered sample of *P. guajava* were all present. The amount of these metals showed that they were within the suggested daily consumption for healthy adults set by the Dietary Reference Intakes and well below the acceptable upper intake threshold [41]. The presence of bio-active elements in the leaves and roots was also checked in the plant extracts. [42,43,44] According to the results of the phytochemical investigation, *P. guajava's* crude hydro-ethanolic leaf extract contains a variety of bioactive elements from diverse classes, including saponins, alkaloids, tannins, cardiac-glycosides, terpenes,





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flavonoids, and sterols. The findings revealed that cardiac-glycosides are present in low concentrations, while saponins, tannins, and alkaloids are present in significant concentrations [45].

### Phytochemical Constituents

The fruit also has iron, calcium, phosphorus, vitamin C, and vitamin A. The plant also contains manganese along with the acids phosphoric, oxalic, and malic. The fruit has saponin, oleanolic acid, guaijavarin, and quercetin in combination [46]. Alfa-pinene, beta-pinene, limonene, menthol, terpenyl acetate, isopropyl alcohol, caryophyllene oxide, curcumene, crategolic, and guayavolicacids are the primary constituents of the essential oil found in the leaves [47]. The tannin in the bark ranges from 12 to 30%, and one source claims it contains 27.4% tannin (also known as polyphenols), resin, and calcium oxalate crystals [46]. The roots contain a lot of tannin as well. Salts, sterols, and leukocyanidins are also present in the plants. Tannic acid can be found in considerable amounts in the root, stem, bark, and leaves. There are significant amounts of salt and carbs [48].

### Pharmacological Activity

#### Anti-Inflammatory / Analgesic

Around the world, rheumatism and other inflammatory conditions are treated by boiling fruit tree leaves. Additionally, the leaf extract (50-800 mg/kg, i.p.) resulted in significant and dose-dependent analgesic effects.[49] Researchers also investigated the 70% ethanolic extract of *Psidium guajava* leaf's anti-inflammatory and analgesic properties. The dosage of the extracts was 300 mg/kg, p.o. Aspirin was used as the reference medication (300 mg/kg, p.o.). With a 58% inhibition, *Psidium guajava* leaves demonstrated substantial anti-inflammatory action.[50] Carrageenan-induced oedema formation was greatly reduced by the essential oil (0.8 mg/kg), and granuloma formation caused by cotton pellets was similarly significantly reduced (0.4 mg/kg and 0.8 mg/kg).[51]

#### Antimicrobial

Using the in vitro agar well diffusion method, the inhibitory effects of liquid and alcoholic extracts of the guava bush (root as well as leaves) on the growth of *Cocci aureus*, *Eubacteria mutans*, *Bacteria genus Aeruginosa*, *Salmonella enteritidis*, *Bacillus cereus*, *Proteus spp.*, *Shigella spp.*, and *Escherichia coli*, the causative [52.] The leaves have been shown to contain three Quercetin-derived antimicrobial compounds.[53] *Arthrimum sacchari* M001 and *Chaetomium funicola* M002 strains are susceptible to the fungicidal effects of methanolic extract from ripe fruit.[54] The bark tincture shown fungicidal action at various concentrations, however in the case of *Candida albicans*, it only demonstrated fungistatic properties.[55]

#### Acne Lesion

*Psidium guajava* leaf extracts have strong antimicrobial effects against *Propioni bacterium* skin disease and should be effective in treating acne, especially now that they are more widely recognized for their medicinal properties. [56]

#### Antitussive Effects

Another research indicated that after 10 minutes of injecting the extract, a water infusion made from *Psidium guajava* leaves reduced the frequency of coughing brought on by capsaicin aerosol as compared to the control. [57]

#### Anti-Hyperglycemic

In many parts of the world, the fast-rising incidence of diabetes mellitus is starting to seriously damage human health. Traditional medicine offers good clinical potential and predicts a bright future in the treatment of diabetes mellitus and its consequences thanks to its unique traditional medical viewpoints and natural medicines that are primarily derived from herbs. Numerous authors have investigated the potential anti-diabetic properties of guava fruit, leaves, and bark. [58] Evaluation of the ethanol extract from the guava stem bark's anti-hyperglycemic efficacy on normal, alloxan-induced hyperglycemic, and normal glucose-loaded rats. Significant reduction of LDL glycation was seen following treatment with *Psidium guajava* aqueous leaf extract (0.01-0.625 mg/ml) in a dose-dependent manner. [59-60] It was shown that *Psidium guajava* leaves extracted with methanol had a substantial inhibitory



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impact on PTP1B. (protein tyrosine phosphatase 1B). [61] Using aqueous decoctions of ripe *Psidium guajava* fruit at doses of 0.01-0.625 mg/ml, anti-LDL (low density lipoprotein) glycativ compounds were studied. [62]

#### **Antimalarial Effects**

Guava fruit and stem-bark extracts are used in the parasite lactate dehydrogenase (PLDH) assay technique, which is used to assess antimalarial drugs. [63-64] *Psidium guajava* leaves and stem bark inhibited *Entamoeba histolytica* growth with MAC 10g/ml. [65]

#### **Effect on Dental Plaque**

The early settlers of plaque adhering to the tooth's surface play a part in the development of plaque. Plaque buildup is thought to be reduced more effectively by brushing your teeth. Plaque deposition on tooth surfaces is reduced using chemical treatments. *Staphylococcus sanguinis*, *Staphylococcus mitis*, and *Actinomyces* sp. had their cell-surface hydrophobicity reduced when they were exposed to 1 mg/ml aqueous extract of leaf of guava. respectively, by 54.1%, 49.9%, and 40.6%. [66]

#### **Hepatoprotective Effects**

Researchers examined at the hepatoprotective potential of an aqueous leaf extract of *Psidium guajava*. At 500 mg/kg, the leaf extract significantly protected the liver. [67] Radiation protection, free radical scavenger, and antioxidant functions Numerous human neurological illnesses, diabetes, inflammation, viral infections, autoimmune pathologies, and digestive system disorders are caused by cellular damage or oxidative injury caused by free radicals or reactive oxygen. [68] Hot water was used to extract the dried leaves of *Psidium guajava*; ascorbic acid was a significantly stronger antioxidant than the guava leaf extracts. [69] Its phenolic components, including protocatechuic acid, ferulic acid, quercetin, ascorbic acid, gallic acid, guavin B, and caffeic acid, are linked to these antioxidant effects. [70]

#### **Wound Healing**

Using the excision wound model, it was possible to determine the guava leaf extract's ability to heal wounds. After 14 days postoperatively, more than 90% of the wound had healed, compared to 72% in the group treated with distilled water. [71]

#### **The Action of Anti-Allergic**

Studies on the effects of guava extracts on mice's T cell immunity and methanol and aqueous extracts of *Psidium guajava* leaves were conducted. The production of histamine from mast cells is potently inhibited by these extracts, and IL-10-mediated effects are stopped [72].

#### **Anticancer / Anti-tumor Effects**

The cancer cell line DU-145 was suppressed by an aqueous extract of *Psidium guajava* leaves in a dose-dependent manner. After 48 and 72 hours of incubation, the extract decreased PCa DU-145's viability to 36.1% and 3.6%, respectively, at 1.0 mg/ml. [73] The anti-proliferative action of guava leaf oil was the strongest, with an IC50 value of 0.0379 mg/ml on P388 cell lines. [74] Aqueous leaf extracts from *Psidium guajava* are effective at preventing the growth of tumors by suppressing Tr cells, which then convert to Th1 cells. [72] To stop or slow the growth of tumors, *Psidium guajava* extracts have the potential to be developed as novel chemotherapeutic drugs.

#### **Cardiovascular, Hypotensive Effects**

The effects of *Psidium guajava* liquid leaf extract on cardiac muscle damage were investigated. The plant extract dramatically decreased malondialdehyde and high-energy phosphates in the reperfused hearts. [75] In an isolated rat, *Psidium guajava* leaf extract demonstrated cardioprotective properties against cardiac ischemia-reperfusion injury. [76] Therefore, guava leaf extracts may help avoid cardiovascular disorders, which also demonstrates that their long-standing use for treating hypertension.



**Abdul Hadi Umam et al.,****Antistress Activity**

Using Swiss mice in anoxia stress tolerance tests and swimming endurance tests, an ethanol extract of *Psidium guajava* L. demonstrated considerable adaptogenic action against the stress paradigms [77].

**Antiviral Activity**

Guava extracts were tested for their antiviral activity against A/Narita/1/2009 (amantadine-resistant pandemic 2009 strain) is getting bigger A/Yamaguchi/20/06 strain) at an IC<sub>50</sub> of 0.05% and its growth oseltamivir-resistant strain) and A/Kitakyushu/10/06 (sensitive strain). These strains' development was severely constrained by the extracts from guava. Guava tea has been shown to promote viral resistance in the body and to be effective against the influenza virus [78].

**Inotropic Activity**

The substances known as inotropics are what cause muscular action. It has been demonstrated that guava extracts produced in hexane, water, and methanol reduce the contractile force of smooth muscle. Additionally, they inhibit the release of acetylcholine at neuromuscular junctions by interfering with the calcium channels on presynaptic membranes [79].

**Immunomodulatory Activity**

The chemical substances known as immunomodulators alter how the human immune system reacts to foreign substances. The use of natural compounds as immunomodulators is widespread. Immunomodulatory properties have been found in guava extracts [80].

**Antiparasitic Activity**

In order to treat parasitic disorders brought on by ectoparasites, protozoa, parasitic fungi, ameba, and helminths, among other things, antiparasitic substances are utilised. Guava leaf essential oil demonstrated noteworthy effects as a host for *Toxoplasma gondii* in an in vitro antiparasitic experiment. Guava leaf essential oil's possible therapeutic effects may have helped to reduce the pathology-related free radicals associated with toxoplasmosis in vitro.[81]

**Gastroprotective Activity**

Rats were used to evaluate the guava extracts for various ulcer types. Guava extract had a similar impact as omeprazole. After using guava extract, secretory volume, elevated gastric pH, and stomach acid secretion were decreased.[82]

**Antigenotoxic and Antimutagenic Activity**

The creation of DNA damage is thought to be a crucial early stage in the development of cancer. For the identification of various genotoxic effects of substances in experimental systems or for research into exposure to genotoxic agents in environmental or occupational situations, a sizable battery of tests is available. *Psidium guajava*'s aqueous whole plant extracts provided protection (anti-genotoxic activity) against the genotoxins mitomycin C, nalidixic acid, and hydrogen peroxide [83]. In a different investigation, it was discovered that pre-treating tester strains of *Salmonella typhimurium* with an aqueous guava leaf extract effectively reduced the mutagenicity of the direct-acting mutagens 4-nitro-o-phenylenediamine and 2-aminofluorene. As a result, *Psidium guajava* leaf extracts in aqueous form exhibit encouraging antigenotoxic / antimutagenic action.[84]

**Activity on Muscular System**

Regenerative cell treatment has been used to treat degenerative muscle illnesses like muscular dystrophy. Although satellite cells are essential for the skeletal muscle regeneration that naturally follows muscular damage, using them in cell therapy poses challenges [85]. Both water and methanolic leaf extracts from *Psidium guajava* had evident calcium-antagonistic effects on the caffeine-induced calcium release from rat skeletal muscle cells' sarcoplasmic reticulum in a dose-dependent manner [86]. *Psidium guajava* leaf infusions in aqueous form may inhibit L-type calcium membrane channels [87]. Therefore, guava may be advantageous for those who have muscular dystrophy [88].



**Abdul Hadi Umam et al.,****Toxicology**

The leaves of *Psidium guajava* L. were the subject of a toxicology investigation that calculated the mean lethal dose in Swiss mice and alternative toxicology in Wistar rats. The toxicological outcomes of the two experimental models in the dose range employing up to 2g/kg body weight did not show any fatalities. Guava leaf extracts' LD50 was established to be greater than 5g/kg by acute toxicity studies on rats and mice. [89]

**Clinical Trials**

*Psidium guajava* has been the subject of therapeutic research for several conditions, including dysmenorrhea, infantile rotaviral enteritis, infectious gastroenteritis, and cardiovascular effects. Although no significant differences were seen in the frequency and consistency of liquid stools when compared to the control group, the Phytodrug based on *P. guajava* folia provided a beneficial and likely spasmolytic effect that was clearly observed in the group receiving treatment. When compared to baseline, the intensity of menstrual pain decreased throughout each treatment cycle in the clinical trial on the effectiveness of a chemically standardised extract from *Psidium guajava*, although the change was not statistically significant.[90-94] The length of stomach pain decreased in a double-blind clinical research that was also conducted to examine the effects of a phytodrug (QG-5) made from guava leaf, which is ascribed to the antispasmodic properties of the quercetin found in the leaf extract [95-96].

**CONCLUSIONS**

The well-known guava tree, *Psidium guajava*, is cultivated in tropical regions for its fruit. Diarrhea, dysentery, gastroenteritis, hypertension, diabetes, caries, pain alleviation, cough, oral ulcers, improved locomotor coordination, and liver damage inflammation are all conditions where it is reported to be useful. The intuit fruit, which is high in vitamins (A and C), iron, phosphate, calcium, and minerals, has a lot of phytochemicals in its skin. Guava's phenolic chemicals aid in the treatment of malignant cells and delay premature skin ageing. Numerous fungistatic, bacteriostatic, and significant oxidants are present in the leaves. Its ethyl acetate extract has quercetin, which can prevent thymus formation and germ infection. Guava has anti-mutagenic, anti-inflammatory, antiplaque, antiviral, and anti-inflammatory properties. However, The many pharmacological effects of guava extracts and extracted phytochemicals, have only been studied in vitro with laboratory animals, therefore the conclusions drawn may not always be applicable to human situations. It is still abundantly obvious that guava is a plant with enormous broad use now and with amazing potential for the future, even though there are gaps in the studies completed so far that need to be filled in order to realize the full therapeutic potential of guava. The low toxicity of guava extracts and their derived phytochemicals, as well as their use as nutraceutical (fruit) and medicinal (leaves, bark, seeds, and roots) agents, are supported by studies that demonstrate the efficacy of both traditional formulations (infusions, decoctions, tinctures) and their derived phytochemicals (phenolics, flavonoids, carotenoids, triterpenes, and other components of essential oils, among others), *Psidium guajava* will only become more widely recognized as an essential component of our biodiversity that must be protected and used sustainably for future generations through additional study, clinical trials, and commercial development.

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**Table 1: Common name of *Psidium guajava* in different regions**

Sl No	Region	Common Name
1.	Arabic	Guwāfah
2.	Bengali	Piara
3.	Brazil	Araca
4.	Cambodia	Trapaeksruk
5.	Chinese	Fan shiliu
6.	English	Apple guava
7.	French	Gouyave
8.	Germany	Guavenbaum
9.	India	Amarood; Jamba
10.	Portuguese	Goiaba
11.	Spanish	Guayaba
12.	Thailand	Farang
13.	Philippines	Bayabas

**Table 2: Ethnomedicinal use of *Psidium guajava***

Plant part	Ethnomedicinal Use	Compound	Reference
Leaves	Antioxidant, anti-inflammatory, anti-cancer, hepatoprotection, anti-hyperglycaemic, analgesic activity, anti-spasmodic, antimicrobial	Isoflavonoids, gallic acid, phenolic compounds, rutin, epicatechin, naringenin, kaempferol, caechin	[21-27]
Pulp	Antioxidant, Anti-neoplastic, anti-hyperglycemic	carotecoids (lycopene, $\beta$ -carotene, $\beta$ -cryptoxanthin), Ascorbic acid	[28-31]
Seed	Antimicrobial activity	Glycosids, phenolic compounds, Carotenoids,	[32-33]
Skin	increased food absorption	Phenolic compounds	[34-35]
Bark	stomach-ache and anti-diarrhoeal activity, Strong antibacterial activity,	Phenolic compounds	[21,36]

**Table 3: *Psidium guajava*'s ethnomedical applications/Uses worldwide [37]**

Country	Usage
India	for anorexia, childbirth, convulsions, epilepsy, nephritis, cerebral ailments, chorea
Malaya	for dermatosis, epilepsy, menstrual disorders, diarrhea, hysteria
Mexico	for deafness, diarrhea, itch, scabies, stomachache, wounds, swelling, ulcer, worms
Peru	for conjunctivitis, cough, diarrhea, digestive problems, gastritis, lung problems, PMS, shock, vaginal discharge, vertigo, vomiting, worms, dysentery, edema, gout, hemorrhages, gastroenteritis,
Philippines	for sores, wounds and as an astringent
Trinidad	bacterial infections, blood cleansing, diarrhea, dysentery





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Amazonia	for diarrhea, dysentery, menstrual disorders, stomach ache, vertigo
Brazil	for anorexia, cholera, diarrhea, digestive problems, laryngitis, mouth (swelling), skin problems, sore throat, ulcers, vaginal discharge, dysentery, gastric insufficiency, inflamed mucous membranes
Cuba	for cold, dysentery, dyspepsia
Ghana	coughs, diarrhea, dysentery, toothache
Haiti	for dysentery, diarrhea, epilepsy, itch, piles, scabies, wounds and as an antiseptic and astringent, skin sores, sore throat, stomachache
Elsewhere	for anorexia, aches, bacterial infections, boils, bowel disorders, bronchitis, catarrh, cholera, chorea, rheumatism, scabies, sore throat, spasms, sprains, stomach problems, swelling, tonic, toothache, ulcers, worms, wounds and as an antiseptic and astringent, colds, colic, convulsions, coughs, diarrhea, dysentery, dyspepsia, edema, epilepsy, fever, gingivitis, hemorrhoids, itch, jaundice, menstrual problems, nausea, nephritis, respiratory problems,

**Table 4: Nutritional value of *Psidium guajava***

SI No	Name	Content
1.	Moisture	2.8-5.5g
2.	Crude fiber	0.9-1.0g
3.	Protein	0.1-0.5
4.	Fat	0.43-0.7mg
5.	Ash	9.5-10mg
6.	Carbohydrate	9.1-17mg
7.	Calcium	17.8-30mg
8.	Phosphorous	0.30-0.70mg
9.	Iron	200-400 I. U.
10.	Carotene	0.046mg
11.	Thiamine	0.03-0.04mg
12.	Riboflavin	0.6-1.068mg
13.	Niacin	40 I.U.
14.	Vitamin	B3 35 I. U.
15.	Vitamin	G4 36-50mg
16.	Calories	77-86g



**Fig 1: *Psidium guajava* L. Leaves and Fruit**

**Fig 2: *Psidium guajava* L. Flower**





## Effectiveness of Deep Cervical Flexor Muscle Training using Pressure Biofeedback on forward Head Posture and Pectoralis Minor Length in College Going Female Students - Experimental Study

Manshree Hirapara<sup>1\*</sup> and Nilesh Parmar<sup>2</sup>

<sup>1</sup>MPT Scholar, Department of Community Rehabilitation, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujrat, India

<sup>2</sup>MPT in Community based Rehabilitation, Department of Community Rehub, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujrat, India

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### \*Address for Correspondence

#### ManshreeHirapara

MPT Scholar,  
Department of Community Rehabilitation,  
Parul Institute of Physiotherapy,  
Parul University, Vadodara, Gujrat, India.  
E. Mail : manshreehirapara99@gmail.com



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### ABSTRACT

Posture is define as “a position or attitude of the body; the relative arrangement of body parts for a specific activity; or a characteristic manner of bearing one’s body. Forward head posture (FHP) is characterized by increased flexion of the lower cervical spine and upper thoracic region and increased extension of upper cervical vertebrae which also lead to changes in the lumbar spine. FHP is a measured of the poor posture of the neck, so this study conducted to find effect of deep cervical flexor muscle training using pressure biofeedback on forward head posture and pectoralis minor length in college going female students with 20-28 year of age. Study design: an experimental study. Methodology: Total 20 college going female students were recruited as per selection criteria, taken from Parul University Forward head posture measured by craniovertebral angle and shorting of pectoralis minor muscle measured by pectoralis minor length test. Pre assessments were taken and intervention was giving for 2 weeks and after that it was re-assessed. Result: Wilcoxon signed rank test was used to evaluate the data. For Craniovertebral angle posttest mean  $\pm$  SD value was  $47.53 \pm 3.18$  with p value 0.01 and for pectoralis minor length test post test mean  $\pm$  SD value was  $5.04 \pm 2.02$  with p value 0.001. Conclusion: Hence, deep cervical flexor muscle training with using of pressure biofeedback was effective in reducing forward head posture and improves pectoralis minor length in college going female students.

**Keywords:** Pressure biofeedback, Forward head posture, Craniovertebral angle, Pectoralis minor length test





## INTRODUCTION

Posture is define as “a position or attitude of the body; the relative arrangement of body parts for a specific activity; or a characteristic manner of bearing one’s body [1,2]. When the head changes its position from normal and moves forward from the cervical spine the condition is termed as forward head posture(FHP).It moves the center of gravity forward from spine. So the abnormal spine puts abnormal stress on the cervical musculature causing muscle imbalance [3]. A FHP is also known as “hunched upper back”. So, it is defined as anterior standing of the neck over head in which lower part of cervical spine goes into hyper flexion and the upper part of cervical spine goes into hyperextension associated with forwarding shoulder and rounded upper back [4].

A sedentary lifestyle can cause the FHP [5,6]. FHP is frequently seen in general population due to the involuntary maintenance of the head in a forward head position for long time with repetitive usage of new technology as smartphones, computers , videogames, TVs [7,8]. .According to Janda’s theory, this abnormal alignment causes upper cross syndrome (UCS) [9,10]. which is associated with lordosis of the lower cervical vertebrae, in addition to kyphosis of the upper thoracic vertebrae. FHP was described as UCS which is caused by poor sitting posture for long periods and improper posture can weakness of the deep neck flexors and scapular retractors muscles [7]. A study showed prevalence of FHP to be 85.5% and a significant association was seen between FHP and gender. The prevalence in children and teenagers was 53.5%. The prevalence of FHP among university students was found to be 63.96%. [3]. A prevalence of 63% of FHP among 12-16- year- old school going students [1]. Forward head posture was found to have an incidence of 66% in healthy adult between the ages of 20-50 years [11,12]. In this study using pressure biofeedback unit (PBU) method use for deep cervical flexion (DCF) strengthening. The purpose of this study were to investigate the effect of DCF training on maintenance of FHP, muscular endurance and cervical mobility. This study also aimed to find an effective method of DCF training with a PBU [13].

The most common way to objectively assess the FHP is measuring the CV angle. This angle is considered to be a valid and reliable evaluation tool Yib et al(2008) reported an average value of 55.02+2.86 degree for this angle. If this angle was less than 50 degree, the subjects would be included in this study [14]. Sahrman has described “A number of clinical syndromes that are associated with a shortening of pectoralis minor and these include thoracic outlet syndrome, scapular abduction syndrome, scapular winging syndrome, scapular depression syndrome, scapular downward rotation syndrome and forward head posture. Pectoralis minor is attach on the coracoids process a shortening of pectoralis minor will lead to the anterior tilting of the scapula .When the pectoralis minor muscle is of normal length the distance between the treatment table and posterior aspect of the acromion process (patient supine, arms by side, elbows flexed). The distance should not exceed 2.54 cm (2.6 cm / 1 inch). A distance greater than this would suggest a muscle imbalance had occurred and the muscle had shortened” [15].

## MATERIALS AND METHODOLOGY

- SOURCE OF DATA: Parul University, Vadodara
- STUDY POPULATION: College going Girls
- SAMPLE SIZE: 15
- STUDY DESIGN: An Experimental study
- DURATION: 2 week
- OUTCOME MEASURE: Craniovertebral anglePectoralis minor muscle length

### Inclusion Criteria

- Age between 20 to 28 years
- The Craniovertebral angle will less than 50 degree
- Subjects those who were willing to participation



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- Subjects who had history of cervical surgery, spinal cord compression, spinal tumour, spinal instability
- History of cervical fracture, inflammatory disease of spine, spinal infection
- Subject having neuromuscular conditions, previous shoulder surgery, scoliosis

**Material**

- Pen
- Pencil
- Consent and Assessment form
- Pressure biofeedback unit
- Protractor
- Plastic right angle
- Phone camera

**Procedure**

A total 15 samples were collected from Parul University age ranging between 20-28 years who were fulfilling the inclusion and exclusion criteria. The ethical clearance was given by the institutional ethical committee. Subject's been given a brief introduction and also explained the purpose and procedure of the study. The subject once understands and was willing to participate in the study, a consent form was handed over to each subject in which she filled the basic details and signed the form. Before intervention pre data was taken. i.e. Craniovertebral angle for Forward Head Posture and Pectoralis minor muscle length test for Pectoralis muscle shortening. Pressure biofeedback guided deep cervical flexor training was given for 20 minute. Post intervention outcome measures were re-evaluated after 2 weeks and pre and post were compared.

**Informed Consent Process**

A written and informed consent about enrolment in the study and maintaining adequate privacy and confidentiality will be taken from all subjects included in the study.

**Pressure biofeedback guided deep cervical flexor muscle training**

Subject was in crook lying position. Place the pressure biofeedback unit (folded into thirds) under the upper cervical spine and inflate to 20 mmHg. Instruct the subject to perform Craniocervical flexion and practiced head nodding action. Increase pressure on the cuff to 22 mm Hg and hold the pressure steady for 10 seconds and the release. Repeat the same for 10 times. And continue the same procedure increasing the pressure of 2 mmHg for next 2 iteration. Exercise duration did not exceed 20 minute per day.

Asked to perform head nodding Repetition: 10 rep. with 10 sec hold

Total sets: 3 sets (2 min rest between sets)

Frequency: 3 days/ week for 2 weeks

**Assessment of Outcome Measures**

**Craniovertebral Angle** The most common way to objectively assess the FHP is measuring the CV angle. This angle is considered to be a valid and reliable (ICC= 0.88&0.98) evaluation tool. A picture of the lateral view of each subject was taken and asked to stand barefoot on the floor with her arms resting at the sides, and looking straight ahead. The tragus of the ear was clearly marked and the plastic pointer was taped to the skin overlying the spinous process of seventh cervical vertebra (C<sub>7</sub>). This angle is measured in the sagittal plane formed by intersection of an imagery horizontal line draw through the spinous process of the C<sub>7</sub> and a line draw from the tragus of the ear to the C<sub>7</sub>. The photos were captured by a digital camera (iphone 13 pro) from the dominant side of the upper extremities. The camera was positioned on a tripod 50 cm away from the subject. The CV angle was calculated by image. If this angle was less than 50°, the subject was included in the study.





### **Pectoralis Minor Length Test**

Subjects were asked to lie supine on a standard treatment table with their natural relaxed posture. The subjects placed their arms by their sides and the elbows were flexed and rested against the lateral wall of the abdomen. The therapist measured the linear distance in centimeter using a rigid standard plastic transparent right angle, the base of the protractor was placed on the treatment table and the vertical side was placed adjacent to the lateral aspect of the acromion. Each measurement for each side was measured 3 times in succession, and on each occasion the right angle was replaced as previously described. If the distance more than 2.6 cm, the subject would be included in the study.

### **Statistical Analysis**

#### **Statistical Software**

- For the analysis of the data IBM SPSS version 20 was used.
- Graphs and tables were also generated by Microsoft Excel and Microsoft Word 2019.

### **Statistical Method**

Descriptive analysis was done which include Age, Craniovertebral angle for Forward Head Posture and Pectoralis minor muscle length test for Pectoralis muscle shorting.

## **RESULT**

Graph no. 2 shows pre and post intervention mean difference of CV angle. Paired t- test was used for analysis of data, pre test mean  $\pm$  SD value was  $45\pm 3.07$ , and post test mean  $\pm$  SD value was  $47.53\pm 3.18$ . Here, was a notable difference post intervention in CV angle and Z value was -3.50, used Wilcoxon Ranked Test and p value was found to be 0.01 with  $p < 0.05$  is considered to be significant. Graph no. 3 shows pre and post intervention mean difference of Pectoralis minor length test. Paired t- test was used for analysis of data, pre test mean  $\pm$  SD value was  $5.77\pm 2.13$ , post test mean  $\pm$  SD value was  $5.04\pm 2.02$ . Here, was a notable difference post intervention in Pectoralis minor length test and Z value was -3.19, used Wilcoxon Ranked Test and p value was found to be 0.01 with  $p < 0.05$  is considered to be significant.

## **DISCUSSION**

The present study was conducted to evaluate effectiveness of deep cervical flexor muscle training using pressure biofeedback on forward head posture and pectoralis minor length in college going female students in Parul University. Data was collected by assessing forward head posture by CV angle and shorting of pectoralis muscle by pectoralis minor length test. Intervention was given for 2 weeks and results were obtained. Pre intervention mean score for CV angle was 45 and post intervention mean score was 47.53. Pre intervention mean score for pectoralis minor length test was 5.77 and post intervention mean score was 5.04. Following 2 weeks of intervention, a significant improvement in CV angle and Pectoralis minor length.

Six weeks of Craniocervical flexor training by Falla et al showed increase endurance of DCF and hence improved ability to maintain an upright cervical posture during the task. Deep cervical flexor (longuscolli and longuscapitis) has a major postural function in supporting the cervical lordosis especially in functional mid-ranges of cervical spine. Decrease muscle performance of these muscles may affect neck posture. The results of this study suggest that DCF training with a PBU improves muscular endurance by facilitating DCF contraction, and that stretching exercises induce increases mobility of shortened muscles in subjects with FHP. PBU training is beneficial because strengthening the weak muscles are required to achieve these optimal length and strength of those muscles thereby improving muscular performance. The possible explanation for the finding in our study could be that the subject was receiving feedback for her muscle performance by seeing the calibrated dial so she can precisely control the recruitment pattern and correct the CV angle and shoulder position for pectoralis muscle shorting. In DCF muscles, there is an increase number of high density of muscle spindles leading to improved kinesthetic sense following Craniocervical flexor training.







## CONCLUSION

The present study concluded that DCF training with using of PBU was effective in reducing forward head posture and improves pectoralis minor length in college going female students.

### Limitation

- Study was conducted on small sample.
- Age group was limited.
- Only female subjects were selected.
- Long term follow-up was not there to check the consistency and long term effect of the treatment.

### Recommendation

- Study can be done for more duration to rule out the long term effect of treatment.
- Multi center trials can also be done to check carry over effect.
- Both genders can be included in the study.

## ACKNOWLEDGMENT

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Self

### Ethical Approval

Ethical approval was obtain from The Institutional review board from Parul Institute of Physiotherapy, Waghodia, Vadodara.

### Conflict of Interest

None

### Consent for Publication

All individuals participating in this research signed a informed consent from prior to their inclusion in the study.

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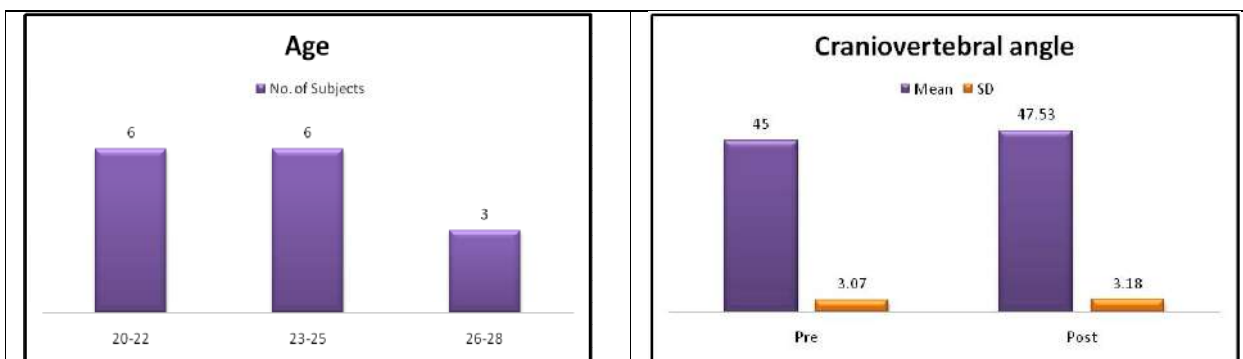
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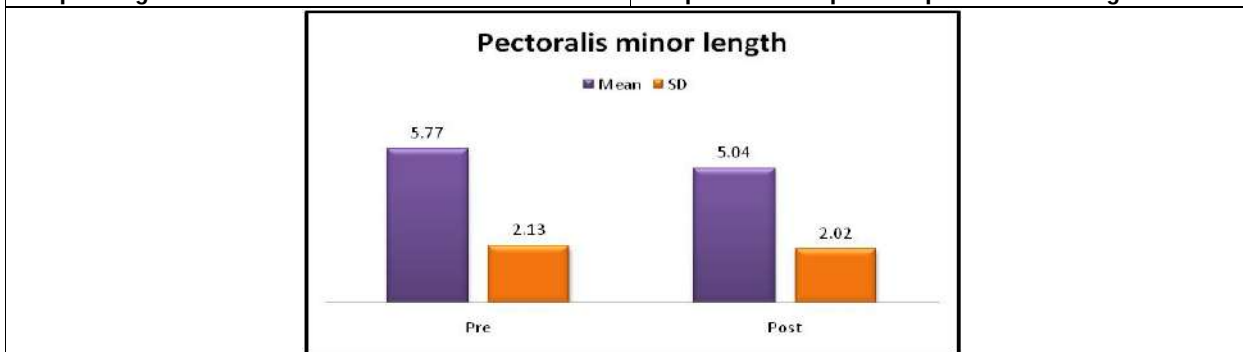
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Graph 1: Age distribution

Graph 2: Pre and post comparison of CV angle



Graph 3: Pre and post comparison of pectoralis minor length





## Impact of Dietary and Life Style Education Programme on Body Composition Status in Obese Persons

Pramila.B<sup>1</sup>, Anitha. C<sup>2\*</sup> and Rajeshwari.J<sup>3</sup>

<sup>1</sup>Student, DOSR in FSN, Karnataka State Open University, Mysuru-570006, Karnataka, India

<sup>2</sup>Assistant Professor, DOSR in FSN, Karnataka State Open University, Mysuru- 570006, Karnataka, India.

<sup>3</sup>Associate Professor, Department of Home Science, Maharani's Science College for Women, Mysuru-05, Karnataka, India.

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### \*Address for Correspondence

#### Anitha. C

Assistant Professor,  
DOSR in FSN,  
Karnataka State Open University,  
Mysuru- 570006, Karnataka, India.  
E.Mail: anithaksou@gmail.com



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### ABSTRACT

Obesity is a complex multifactorial chronic disease developing from interactive influences of numerous factors-social, psychological, metabolic, cellular, and genetic. Therefore, the present clinical study using a probable sampling design was undertaken to identify possible causative factors and to understand the impact of dietary intervention on their nutritional status. A total of 100 men and women b/w 20 to 49 years were drawn from the dietetic clinic. Over all fat deposition was found to be high in all the subjects; however 40% women have had high fat deposition. Study reveals that 70% subjects had sedentary life style. 50% women observed to skip breakfast than men respectively at 35% giving reasons as losing weight, busy schedule etc. There was a significant reduction of fat and adipose tissue around hip through dietary treatment. BMI was reduced from 35 to 28 in the different age groups, after the dietary treatment of 3 months. Hence forth to conclude, the data proves beyond doubt that there is no alternative to dietary intervention with life style changes as a major approach in weight management. The study reinforces the fact that healthier food choices are an essential instrument in balancing energy and nutrients intake in preventing obesity.

**Key words:** Obesity, Body mass, Fat mass, Weight management, Nutritional status





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## INTRODUCTION

The unprecedented changes in 21<sup>st</sup> century in this world have changed the nature of lifestyle and food habits of the people. This environment is not encouraging the people to maintain good food habits and to do regular physical activities. People are becoming more nutrition and diet conscious. Print and electronic media are giving nutrition messages to the public. Supermarkets are flooded with varied types of foods like natural, processed, and ready to eat. To get the scientifically proved information on this Nutrition and Dietetics, common man is turning towards nutrition scientists and dietitians [1,2]. Obesity is currently one of the largest health problems globally due to its high prevalence and association with several co-morbidities. By 2025, it has been projected that approximately three billion people will be overweight worldwide; of these, 700 million will be obese. The assessment of obesity does not depend solely on the measurement of an individual's total body mass but also on body composition and fat distribution [4]. Obesity is a state in which there is a generalized accumulation of excess adipose tissue in the body leading to more than 20 per cent of the desirable weight. Obesity is due to positive energy balance; the intake of calories is more than the expenditure of energy. Obesity is a complex multifactorial chronic disease developing from interactive influences of numerous factors-social, behavioral, psychological, metabolic, cellular, and molecular (genetic) [3]. The increase in weight of the body consists of two phases: overweight and obesity [1]. Overweight is a condition where the body weight is 10-20 per cent greater than the mean standard weight [3]. If the body is unable to correct the overweight, it leads to excess body or obesity [1]. Excess body weight is a hindrance leading to breathlessness or moderate exertion and predisposes a person to diseases like atherosclerosis, high blood pressure, stroke, diabetes, gallbladder, disease, and osteoarthritis or weight bearing joints and varicose veins [4].

Genetic inheritance probably influences 50-70 per cent chance of becoming fat more than any other factors. Studies conducted at Nutrition Foundation of India have shown more females are obese than males. Hormonal predisposition put women at higher risk of obesity when compared to men [3]. Studies have documented that the prevalence of obesity in Indian woman is more in the age between 40-49 years (23.7%), residing in cities (23.5%), having high qualification (23.8%), and households in the highest wealth quintile (30.5%). Highest percentage of obese women is found in Punjab (29.9%), although this number seems small in the international perspective [18]. This suggests the Asian Indian body composition with regards to obesity and provides a gender-specific prevalence of the co-morbidities. Recent data show that women (15-61%) have higher prevalence of overweight and obesity as compared with men (12-54%) in India and that obesity is increasing in the youth. Importantly, prevalence of abdominal obesity has been consistently higher in women than in men. There are a number of factors that predisposed Indian women to obesity; sedentary behavior, imbalanced diets, sequential and additive postpartum weight gain and further decrease in physical activity during this period and cultural issues [19]. Obesity, overweight and central obesity and sedentary behavior coexist with under nutrition and have become a public health problem in India. Sedentary behavior was significantly associated with obesity compared to non-obese subjects in both sexes, which may be due to greater economic development in metro cities [20].

Body composition evaluation is rarely performed in overweight/obese subjects whereas BMI has been considered as valuable tool in epidemiological surveys [9]. A multidimensional evaluation was performed using bio impedance analysis (BIA). Based on physical fitness, the body composition is used to describe the percentages of fat, bone, water and muscle in human bodies. As muscular tissue takes less space in our body than fat tissue, our body composition determines leanness [6]. Therefore, the present clinical study using a probable sampling design was undertaken to identify possible causative factors and to understand the impact of dietary intervention on their nutritional status with the following objectives





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## OBJECTIVES

1. To understand the body composition of the selected obese/overweight individuals.
2. To understand the lifestyle of the obese with respect of physical activity.
3. To understand dietary practices of selected overweight individuals.
4. Correlate the analysis of body composition with respect to weight loss got through the dietary modification and change in the life style.

## METHODOLOGY

A total of 100 men and women (50 each) having body mass index greater than 25, between age group of 20 to 49 years were drawn from the dietetic clinic for the study. The tools for collecting information and measuring different indicators were used to study following variables: Background information and personal data including demographic data, socio-economic status, dietary pattern, food behavior, approaches to weight loss and treatment, nutritional awareness, body composition using bio-electrical impedance analyzer, dietary intake and physical activity. The weight management information involved recording the responses towards weight management. Their responses towards food and nutrition awareness on supporting normal health and on therapeutic aspects were also recorded. Anthropometric assessment and body composition was done before and after the intervention. Body composition was determined by the intervention using segmental bio-electrical impedance analyzer. The machine was set with personalized data such as age, height, gender, ideal fat based on gender as per the instructional manual of the bias in order to obtain a precise data on fat and fat free mass. The body composition data recorded included-weight, body mass index, basal metabolic rate, percentage of fat, amount of fat present in the body, fat free mass, total body water and impedance. The study focused on the fat mass in terms of percentage and kg in the body composition.

The subjects were interviewed with the help of a questionnaire for assessing the individual subject's 24 hours food intake by recall method for two random days within a month. The subjects were given a physical activity record in which they had to enter the details of activities performed over a 24-hour period along the time spent on each activity. From the data obtained on the activities of two days, the energy cost of activities will be recorded. Modified diet charts with balanced diet and Physical activity – walking, yoga or any other activities was prescribed to the subjects for three months. The impact of dietary treatment on weight loss and its effects on the body composition particularly body fat were recorded before and after the study period. The collected information from the general survey on the subjects was consolidated and computed using descriptive analysis.

## RESULTS AND DISCUSSION

**Most of the subjects belong to a higher socio-economic status with better findings varied by socio-economic status indicator.**

Figure 1 indicates that 35% and 33% of men and women belonged to 20-29 year, in the age range of 30-39, 45% of the subjects were of men and 40% of the subjects were of women, while, 20% of men and 27% of women were in the age range of 40-49 respectively.

Based on the demographic data obtained in table-2, marital status shows that 74-75% of total men women were married; where as 13% of men and 12% of women were not married. According to the data obtained 33% of men were in nuclear type of family and only 10% in women were from nuclear type of family when compared to joint family as 64%. However 16% of both men and women came from an extended family. Very small family sizes of 4 members were observed in 50% of the subjects. Most of the subjects were well-educated as degree. Only 5% of them had education upto 10th STD. The table-2 also shows the occupational status of the subjects. 13% of the women

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subjects were homemakers and 4-10% of the subjects. 20% men and 8% women were employed in government sector, while 20-33% of women and men were working in private sectors respectively. Perusal of the figure revealed that 50% of men were tobacco chewing on regular basis and 60% of them consumed alcohol occasionally. 20% and 40% of men smoked regularly and occasionally respectively. Women revealed that consumption of soft drinks on regularly (40%) and some (20%) occasionally. None of the women have chewed pan in their lifetime.

Physical activity plays an important role in weight management. Jogging, walking, floor exercise, weights, and yoga are some of the exercises done by the subjects. Fig. 2 shows the frequency of the type of exercises done by the subjects. Majority of subjects took up brisk walking (76%) than slow walking (60%), followed by yoga (64%). The observation shows that the subjects were giving more importance to the physical activity to maintain their weight and health. Some of them were home makers did revealed that they do not get time for any physical exercise. The study shows subjects are health oriented.

Table-6 shows that 40% of men and 74% of women were vegetarian; remaining 60% and 22% consumed fleshy food. The diet pattern is mainly of cereals, pulses, root and tubers, milk and milk products, greens, and other vegetables being food items of daily menu. Most of them followed three meals per day. In skipping of meals, was observed more in men than in women. This might be due to some reasons like they have misconception that skipping of breakfast helps in losing weight. Another common reason might be a busy lifestyle. Some of them opined that, avoiding tea and snacks helps them to lose their weight. Table shows that frequency of eating out is more (40%) in men when compared to women (4%) daily. However, 40% women revealed that eating out once in a week is necessary. This gives them break at least for few hours from their monotonous lifestyle.

Table – 7 shows the frequency of food in subjects. Cereals like ragi, rice, jowar, wheat are eaten daily. In pulses, tur dal is consumed daily while other pulses are consumed weekly, monthly or occasionally based on their availability. Less quantity of nuts and oil seeds are used daily. It was surprising to see that consumption of snacks was high (60%) among the study group. The study depicts that subjects were in favor of consuming non-nutritious food. These types of foods are consumed by some subjects to maintain the trend but some subjects crave for these junk foods.

**DIETARY INTERVENTION AND LIFESTYLE MODICATION**

Modified diet charts with balanced diet and Physical activity – walking, yoga or any other activities was prescribed to the subjects for three months. The impact of dietary treatment on weight loss and its effects on the body composition particularly body fat were recorded before and after the study period.

**Anthropometric Assessments**

Anthropometric assessment and body composition was done before and after the intervention. The body composition data recorded included-weight, body mass index, percentage of fat, amount of fat present in the body. The study focused on the fat mass in terms of percentage and kg in the body composition. Table-5 and the figure– 4 indicates that in the age range 20-29 yr showed high weight loss than other two groups, however; there was no much difference in weight loss among 30-39 and 40-49 years age. This can be attributed to the higher BMR in younger age. There is a similar weight reduction in all the age ranges (20-29, 30-39 & 40-49) after the dietary treatment of 3 months. Though these subjects were well educated and leading a comfortable life, their unawareness of nutritional needs and busy lifestyle plays a major role. This leads to the development of obesity in the obesity which also includes less physical activity and sedentary

**BODY MASS INDEX**

Distribution of subjects by their BMI is evidenced in the subjects in the age range 20-29 men moved to 32 from 35. BMI indicate that younger age group has responded well. similar pattern was noted in the age range 30-39 yr moving from BMI 29 to 26, whereas age range 40-49 yr has not shown shift of BMI from 29 to 28 only.

Women subjects by age range 20-29 yr were in obesity++ moved to obesity+ where as age range showing BMI 29 to normal BMI 25.similar pattern of reduction was observed in all age groups indicating the positive effects of life style



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and dietary modification on weight management. In the age range of 20-29, hip measurement of 115cms reduced to 112 cms after the assessment. There was a reduction from 104 to 95cms after the intervention among 30-39 years, and from 102 to 98 cms in the age group of 40-49 years respectively. Perusal of the table indicates a shift in the hip circumference from 114 cms to 107 cms in among the subjects in the age range of 20-29 yrs, 104 to 97 cms among 30-39 and 113 to 102cms in the age range of 40-49yrs subjects respectively. This shows accumulation of fat and adipose tissue around hip reduced to the intervention of physical exercise and dietary modification..

Form the table and the figure we can conclude that similar trend to reduction in the waist circumference was evident after the intervention program. The anthropometric indices of the subjects were estimated in both men and women. In the age range of 20-29, the average range was 104cm which was reduced to 92cm after the assessment. In the age range of 30-39, waist was found to be in an average of 93cm and reduced to 85cm. In the age range of 40-49, the average range is 103cm and it was reduced to 92cm. This shows the accumulation of adipose tissue and visceral fat in the middle leading to central obesity.

**WAIST/HIP RATIO**

WHR of 0.98 (high) indicates the presence of abdominal obesity of the subject. After the dietary assessment, in the age range of 20-29, it was in an average range of 0.9. Age range 20-29 and 30-39 depicts that younger in age, better the response. Age range 40-49 showed very little improvement in their WHR after the treatment.

Women subjects of age range 30-39 and 40-49 showed better WHR compared to 20-29 age range. Age range 20-29 and 30-39 moved closer to normal WHR whereas age 40-49 showed central obesity even after dietary treatment. Women subjects responded by their improved WHR to diet.

**FAT%****Initial and final fat % of the men subjects in response to diet treatment**

The body composition analysis was used to obtain the data of fat% and fat (kg). This was measured by Bio-electrical Impedance Analyzer. The fat% was 29 in the age ranges of 30-39 and 40-49 where as it was 35 in the age range of 20-29. This was found in an initial visit of the subjects. After the dietary assessment, there was a less reduction of fat in these subjects. There was a fat loss of about 3% both in the age ranges of 20-29 and 30-39 while there was only 1% of fat reduction in the age range of 40-49. Among the three age ranges, younger age range of 20-29 responded better to the treatment by losing a mean of 34 of fat mass.

**Initial and final body fat% of women subjects in response to diet treatment**

The fat% was 33 in the age range of 40-49. It was further increased to 34 in the age range of 20-29. The fat% was about 29 in the age range of 30-39. These were found in the initial visit of the subjects. After the dietary assessment, there was a reduction of 5% of fat in 40-49 range while it was 4% in case of 30-39 range. There was a reduction of 3% in the range of 20-29%. Age range 40-49 showed high fat loss.

In the age range of 20-29 yr, men showed 33% of fat where as women group showed more fat (40%).The similar trend was noted in age range of 30-39 yr, women showed 35% of fat.

In the age range of 20-29, 21% of the fat was shown in men and 30% of the fat was found to be in women. In the age range of 30-39, 21% of the fat was of men and 25% of the fats were of women. Finally, in the age range of 40-49, 22% of the fat was men and 35% of the fat was of women. Age range 40-49 of both gender showed higher fat percent against BMI 28. Though age range of 20-29 and 30-39 of both gender showed higher BMI, showed lesser percentage of fat mass can be attributed that advanced age accumulates more fat in the body as BMI increases.

**FAT (kg)**

Initially, it was found that the increased fat was about 39kg in the age range of 40-49 years. This was later decreased to 17 kg after the dietary treatment. This showed the great reduction of 22 kg in 3 months of dietary assessment. In





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the age range of 30-39 years, initially, the fat (kg) was found to 26 kg which was decreased to 17 kg after the dietary assessment. This shows about 9 kg reduction in this age range. In the age range of 20-29 years, there is a very less (2 kg) reduction. Mean of fat (kg) showed an increase in the age of 40-49 years of about 28 kg. This further increased to 32 kg in the age of 20-29 years. This was shown after the dietary treatment of 3 months. This is based on the response to the treatment and also their food behavior.

When the subjects were initially presented to the assessment, the fat found was about 40 kg in the age range of 20-29. There was a fat (kg) reduction of about 4 kg after the dietary assessment for a period of 3 months. Initially, fat (kg) was found to be 39 kg in the age range of 40-49. This was reduced to 25 kg. This was a good response to the study decreasing about 14 kgs. Further in the age range of 30-39, initially it showed 35 kg. Later it was reduced to 30 kgs which shows a solid reduction of about 15 kg during this assessment.

In the age range of 20-29, 33 kg of fat was in men and 40 kg of fat in women. In the age range of 30-39, 26 kg of fat was in men and 35 kg of fat in women. Finally, in the age range of 40-49, 39 kg was in men and 39 kg was in women. Irrespective of the age women subjects showed lesser BMI and higher fat mass in kg.

Male subjects with BMI 30 to 32 range were shown higher fat in terms of kg compared to BMI 26 to 28 where as women subjects with BMI 30-31 were shown high fat (35.7 kg) mass than women subjects with BMI 32.6 though women subjects with age range 40-49 shown higher BMI appeared less fat mass(25). This may be regarded that advanced age contribute fat mass to increased BMI in women subjects. The fat deposition was found to be not similar in men and women. Based on the study, it was seen that fat deposition was found to be high in all the Subjects.

## SUMMARY AND CONCLUSION

Obesity has become one of the new health challenges of the present century. This condition is increasing in an alarming rate and is becoming a highly pressing health and nutrition problem in India. At the same time by confronting obesity problem, there are tremendous opportunities to prevent the unnecessary co-morbidities and disability with dietary intervention coupled with increased physical activity and life style changes. The present study was undertaken with a view to identify possible causative factors by assessing the nutritional status and life style of selected obese persons. On evaluating the present status of weight management, the efficacy of using dietary intervention with lifestyle changes was also determined. A total of 50 men and 50 women based on their BMI in the group ranging from 20 to 49 years were drawn from the clients visiting a diet clinic and served as subjects for the study. Results revealed that the dietary pattern, meal time, and menu were found to be similar. The extent of the regularity of meals revealed the habit of skipping meals particularly breakfast more so in the younger age group and were found to favor eating in between meals either at home or outside home. Frequency of food use indicated 30% of the subjects consuming bakery items (mostly biscuits) daily. The food behavior characteristics of the subjects were found to be influenced by trends, availability of time and also tradition to a greater extent. The subjects' awareness regarding the importance of nutrient, nutrition to health particularly in terms of body weight maintenance either by gender or by age group was significantly low. The age range of 20-29 showed better weight loss when compared to other age ranges. Compared to men, women responded well in all the age ranges.

The somatic status of the subjects revealed that all body size measurements except for height showed better response. Advanced age contribute fat mass to increased BMI in women subjects. The fat deposition was found to be not similar in men and women. Age range 40-49 of both gender showed higher fat percent against BMI 28. Though age range of 20-29 and 30-39 of both gender showed higher BMI, showed lesser percentage of fat mass can be attributed that advanced age accumulates more fat in the body as BMI increases. Indices like BMI, WHR, body fat%, fat mass (kg) indicate the obese status for these subjects. Body composition as measured by BIA in terms of fat% and fat mass (kg) showed better response in case of women when compared to men.







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Food intake of both gender group indicated a differing pattern while men were found to consume significantly higher amounts of cereals, other vegetables, fats and oils, and women were found to consume significantly higher amounts of roots and tubers, mild, sugar, fruits, fleshy foods, nuts and oilseeds. Dietary intervention used as an approach to regulate along with its style changes in terms of increased physical activity and behavior was found to be highly effective. Over a period of three months, weight loss was highly significant as indicated by decreased in BMI. BIA analysis was clearly indicative of the fact that dietary interventions approach resulted in significant weight loss due to reduction in the fat mass. Thus, the findings in the study are indicative of the fact that the factors contributing to the development of obesity in these subjects are mainly high socio-economic status, food behavior changes in dietary pattern towards increased consumption of energy dense diets and their physical environment being sedentary in nature, their lack of awareness of their own nutritional needs besides low nutrition and health awareness was also found to be a contributing factor. The study findings prove beyond doubt that there is no alternative to dietary intervention with life style changes as a major approach on weight management or persons with the obesity problems. The study reinforces the fact that healthier food choices or eating is essential in balancing energy and nutrients intake with regular physical activity for all Indians in prevention of obesity.

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**Table-1 Demographic and Socioeconomic features of subjects**

Features	Men	Women
<b>Marital Status</b>		
Not Married	13(26%)	12(24%)
Married	37(74%)	38(76%)
<b>Type of Family</b>		
Extended	8(16%)	8(16%)
Nuclear	33(66%)	10(20%)
Joint	9(18%)	32(64%)
<b>Family Size</b>		
Up to 4 Members	25(50%)	25(50%)
5-6 Members	15(30%)	13(26%)
Above 6 Members	10(20%)	12(24%)
<b>Education</b>		
10 <sup>th</sup> Standard	5(10%)	5(10%)
PUC	15(30%)	18(36%)
Degree	30(60%)	27(54%)
<b>Occupational Status</b>		
Homemakers	--	13(26%)
student	2(4%)	5(10%)
Government	10(20%)	4(8%)
Private	23(46%)	20(40%)
Business	15(30%)	8(16%)

**Table 2. Meal pattern of the subjects (%)**

Characteristics	Men	Women
Vegetarian	20(40%)	37(74%)
Fleshy Food	30(60%)	11(22%)
<b>Meal Pattern</b>		
Two meals	10(20%)	13(26%)
Three meals	38(76%)	29(58%)
Four meals	3(6%)	6(12%)
<b>Skipping of meals</b>		
Yes	3(6%)	6(12%)
Breakfast	18(36%)	16(32%)
Lunch	15(30%)	---
Tea & Snacks	8(16%)	13(26%)
Supper	3(6%)	6(12%)
Never	18(36%)	16(32%)





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Outdoor eating frequency		
Never	13(26%)	6(12%)
Daily	20(40%)	2(4%)
Weekly twice	5(10%)	3(6%)
Weekly once	8(16%)	20(40%)
Monthly twice	3(6%)	6(12%)
Monthly once	3(6%)	11(22%)

**Table 3. Frequency of Food No. %**

Food Items	Daily	Weekly	Monthly	Occasionally
Cereals	100	---	---	---
Pulses	78	16	4	2
Nuts & Oil seeds	22	4	70	4
Coconut	60	16	12	12
Roots & Tubers	50	20	14	16
Greens	40	24	22	14
Other Vegetables	70	12	16	2
Fruits	56	20	12	12
Milk & Products	50	20	14	16
Egg	30	26	22	22
Fleshy Food	38	30	20	12
Sugar & Jaggary	50	20	14	16
Ghee and butter	20	30	40	20
Oil	78	16	4	4
Sweets	30	22	26	22
Bakery items	60	20	16	4
Biscuits	24	40	22	14
Chats	78	18	4	2
Chocolate/Toffee	40	22	14	24
Ice Cream	20	54	24	2
Samosa	16	50	16	18
Cutlet	24	40	14	22
Gobi Manchurian	20	40	30	10
Mushroom Manchurian	10	50	22	18
Pizza	24	33	14	40
Berger	30	26	26	26
Pav Bhaji	38	30	20	12
Vada Pav	40	24	22	14
Tea/coffee	60	16	12	12
Fruit juice bottle/can	24	14	40	22
Fresh fruit juice	26	22	30	22





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**Table 4. Weight of the subjects before and after the dietary and life style modification**

Age (yr)	Men		Women	
	Before (kg)	After (kg)	Before (kg)	After (kg)
20-29	104	93	83	75
30-39	83	74	67	59
40-49	78	73	77	68

**Table 5. BMI of the subjects by their age group before and after the intervention**

Age (yr)	Men		Women	
	Before	After	Before	After
20-29	35	32	34	31
30-39	29	26	29	25
40-49	29	28	33	28

**Table 6 . Hip measurement of the subjects before and after dietary and lifestyle modification**

Age (yr)	Men		Women	
	Before (cms)	After (cms)	Before (cms)	After (cms)
20-29	115	112	114	107
30-39	104	95	104	97
40-49	102	98	113	102

**Table 7. Classification of mean Waist in men before and after dietary treatment**

Age (yr)	Men		Women	
	Before (cms)	After (cms)	Before (cms)	After (cms)
20-29	110	101	104	92
30-39	102	90	93	85
40-49	101	96	103	92

**Table 8. Classification of men subjects by WHR by their age group**

Age (yr)	Men		Women	
	Before (cms)	After (cms)	Before (cms)	After (cms)
20-29	0.95	0.9	0.9	0.86
30-39	0.97	0.94	0.94	0.87
40-49	0.99	0.98	0.98	0.9

**Table 9. FAT% in men and women before and after intervention**

Age (yr)	Men		Women	
	Before (cms)	After (cms)	Before (cms)	After (cms)
20-29	35	32	34	31
30-39	29	26	29	25
40-49	29	28	33	28





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**Table 10. Comparison of BMI with fat percent of both men and women before dietary treatment**

AGE	MEN		WOMEN	
	BMI	FAT %	BMI	FAT %
20-29 YR	35	33	34	40
30-39 YR	29	26	28	35
40-49 YR	33	39	33	39

**Table 11. comparison of BMI with fat percent of men and women after dietary treatment.**

AGE	MEN		WOMEN	
	BMI	FAT %	BMI	FAT %
20-29 YR	32	21	31	30
30-39 YR	26	21	30	25
40-49 YR	28	22	28	35

**Table 12. Mean fat (kg) of the subjects before and after dietary treatment**

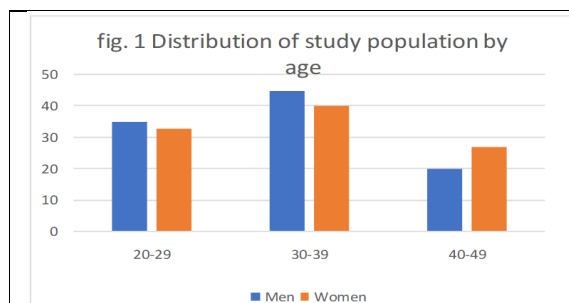
Age (yr)	Men		Women	
	Before (kg)	After (kg)	Before (kg)	After (kg)
20-29	33	31	40	36
30-39	26	17	35	20
40-49	39	17	39	25

**Table 13. Correlation BMI with of mean fat mass before dietary treatment**

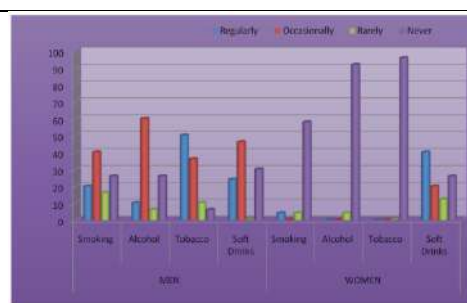
Age (yr)	Men		Women	
	BMI	FAT (kg)	BMI	FAT (kg)
20-29	35	33	33	40
30-39	29	26	28	35
40-49	33	39	32	39

**Table 14. Classification of mean Fat mass after dietary treatment**

	Male		FEMALE	
	BMI	FAT ( kg)	BMI	FAT (kg)
20-29yr	32	31	31	36
30-39yr	26	17	25	20
40-49yr	27.5	17	33	25



**Fig. 1 Distribution of study population by age**



**Fig. 2 Personal Habit of Subjects**





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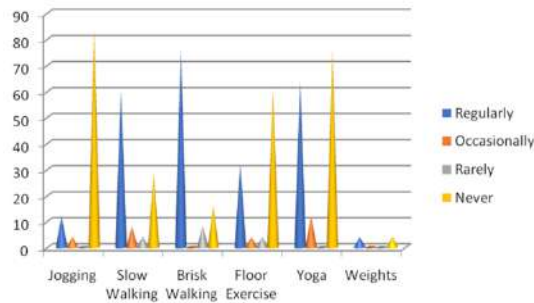
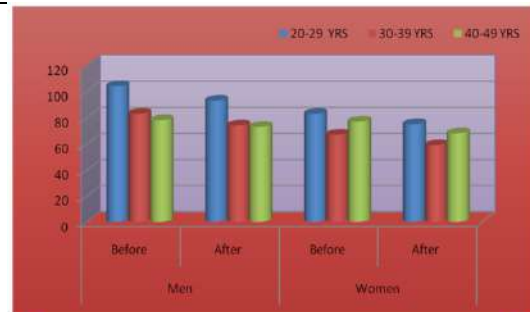
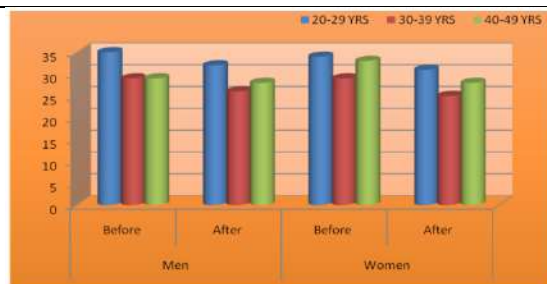


Fig-3 Frequency of type of the exercise by subjects (%)



\* Friedman's Q Test as a Chi Square = 8.2, P= 0.04 at  $\alpha=0.05$

Fig. 4. Correlation of Weight before and after the dietary and life style modification



\* Friedman's Q Test as a Chi Square = 8.1, P= 0.04 at  $\alpha=0.05$

Fig.5 Comparison of BMI before and after education programme

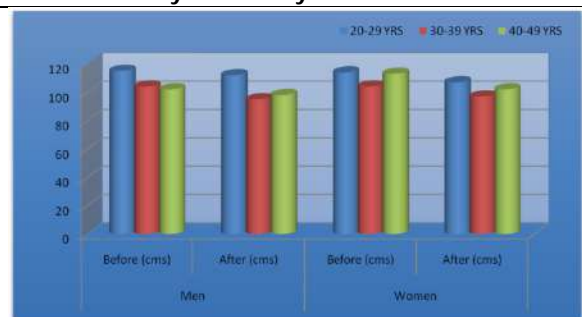


Fig- 6. Hip measurements of the subjects before and after the education programme

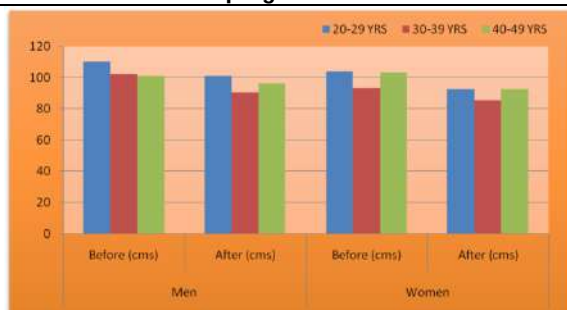
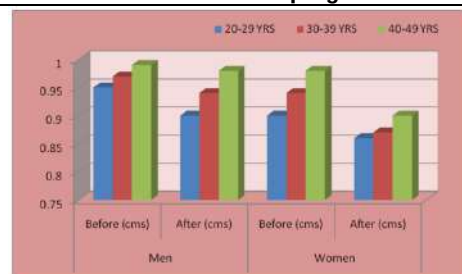


Fig. 7. Classification of mean Waist in men before and after dietary treatment



\* Friedman's Q Test as a Chi Square = 9.0, P= 0.02 at  $\alpha=0.05$

Fig. 8. Classification of men subjects by WHR by their age group

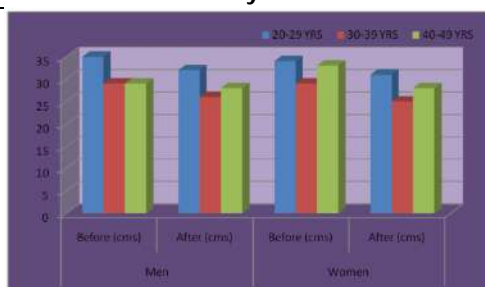


Fig. 9. FAT% in men and women before and after intervention

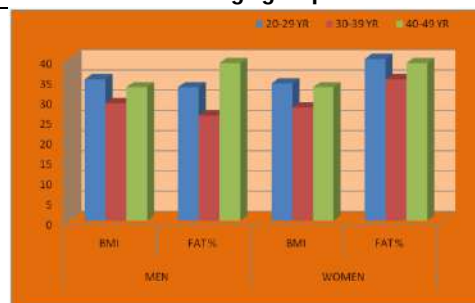
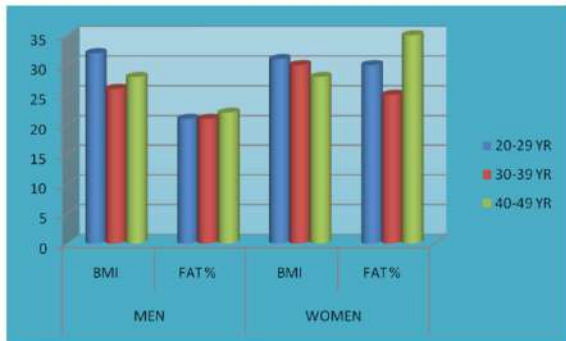


Fig-10. Comparison of BMI with fat percent of both men and women before dietary treatment





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\* Kruskal-Wallis 'H' Test as a Chi Square = 3.9; P= 0.04 at  $\alpha= 0.05$

Fig. 11. comparison of BMI with fat percent of men and women after dietary treatment

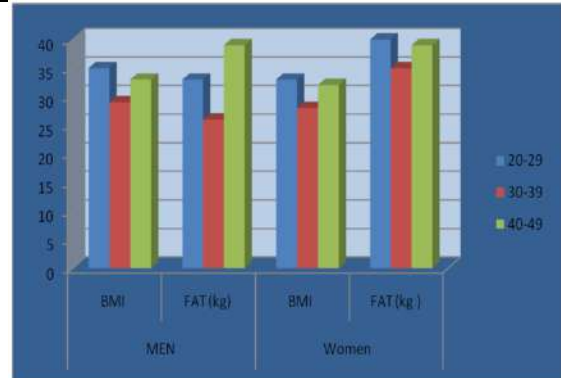
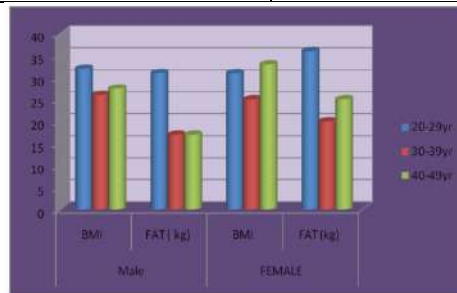


Fig. 13. Correlation BMI with of mean fat mass before dietary treatment



\* Mann-Whitney's 'U' Test = 0.000; P= 0.05 at  $\alpha= 0.05$

Fig.14. Classification of mean Fat mass after dietary treatment





## Intuitionistic Fuzzy Perfectly Generalized – Continuous Functions in Topological Spaces.

J.Christy Jenifer<sup>1\*</sup> and V.Kokilavani<sup>2</sup>

<sup>1</sup>Research Scholar, Department of Mathematics, Kongunadu Arts and Science College (Autonomous), Coimbatore, Tamil Nadu, India.

<sup>2</sup>Assistant Professor and Head, Department of Mathematics, Kongunadu Arts and Science College (Autonomous), Coimbatore, Tamil Nadu, India.

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### \*Address for Correspondence

**J.Christy Jenifer**

Research Scholar,

Department of Mathematics,

Kongunadu Arts and Science College (Autonomous),

Coimbatore, Tamil Nadu, India.

E.Mail: christijeni94@gmail.com



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### ABSTRACT

This paper is devoted to the study of intuitionistic fuzzy topological spaces. Here, Intuitionistic fuzzy perfectly generalized  ${}^{\#}\alpha$ -continuous functions and Intuitionistic fuzzy almost generalized  ${}^{\#}\alpha$ -continuous functions are introduced and study some of its properties are deliberated.

**Keywords:** IFS, IFT, IFpG  ${}^{\#}\alpha$ CF, IFaG  ${}^{\#}\alpha$ CF.

**MATHEMATICS SUBJECT CLASSIFICATION:** 54A40.

### INTRODUCTION

Zadeh[6] initiated the concept of fuzzy sets. The idea of generalized intuitionistic fuzzy sets using the view of fuzzy sets was initiated by Atanasov[1]. Coker[2] established intuitionistic fuzzy topological spaces using the concept of intuitionistic fuzzy topological spaces. Late Kokilavani.V established the view of IFG  ${}^{\#}\alpha$ -closed sets and IFG  ${}^{\#}\alpha$ -continuous functions. Also, explored the principle of intuitionistic fuzzy completely generalized  ${}^{\#}\alpha$ -continuous. In continuation of above we establish intuitionistic fuzzy perfectly generalized  ${}^{\#}\alpha$ -continuous function and intuitionsitic fuzzy almost generalalized  ${}^{\#}\alpha$ -continuous and explore its properties.







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**PRELIMINARIES**

**Definition 2.1.** [2] An intuitionistic fuzzy topology (IFT in short) on  $X$  is a family  $\tau$  of IFSs in  $X$  satisfying the following axioms.

- (1)  $0_-, 1_- \in \tau$
- (2)  $G_1 \cap G_2 \in \tau$ , for any  $G_1, G_2 \in \tau$
- (3)  $\cup G_i \in \tau$  for any family  $\{G_i | i \in J\} \subseteq \tau$

In this case the pair  $(X, \tau)$  is called an intuitionistic fuzzy topological space.

**Definition 2.2.** [3] A mapping  $h : (E, \tau) \rightarrow (F, \sigma)$  is said to be an perfectly continuous if  $h^{-1}(V)$  is clopen in  $X$  for every open set  $V \subset Y$ .

**Definition 2.3.** An IFS  $C$  in  $(E, \tau)$  is proposed to be an IFG<sup>#</sup> $\alpha$ -CS if  $\alpha cl(A) \subseteq U$ , whenever  $C \subseteq U$  and  $U$  is an IFGOS in  $(E, \tau)$ . The family of all IFG<sup>#</sup> $\alpha$ CS of an IFTS  $(E, \tau)$  is denoted by IFG<sup>#</sup> $\alpha$ C(E).

**Definition 2.4.** A mapping  $h : (E, \tau) \rightarrow (F, \sigma)$  is said to be an IFG<sup>#</sup> $\alpha$ -continuous if  $h^{-1}(V)$  is an IFG<sup>#</sup> $\alpha$ -CS in  $(E, \tau)$  for every IFCS  $V$  of  $(F, \sigma)$ .

**Intuitionistic Fuzzy Perfectly Generalized <sup>#</sup> $\alpha$ -continuous function**

**Definition 3.1.** A mapping  $h : (E, \tau) \rightarrow (F, \sigma)$  is said to be an intuitionistic fuzzy perfectly generalized <sup>#</sup> $\alpha$ -continuous if  $h^{-1}(C)$  is clopen in  $E$  for every IFG<sup>#</sup> $\alpha$ CS  $C$  of  $F$ .

**Definition 3.2.** A mapping  $h : (E, \tau) \rightarrow (F, \sigma)$  is said to be an intuitionistic almost generalized <sup>#</sup> $\alpha$ -continuous if  $h^{-1}(C)$  is an IFG<sup>#</sup> $\alpha$ CS in  $E$  for every IFRCS  $C$  of  $F$ .

**Theorem 3.3.** Every IFpG<sup>#</sup> $\alpha$ -continuous is IF continuous, reverse implication is not possible.

**Proof:** Consider  $h : (E, \tau) \rightarrow (F, \sigma)$  be IFpG<sup>#</sup> $\alpha$ -continuous. Consider  $C$  be IFCS in  $F$ . We have IFCS an IFG<sup>#</sup> $\alpha$ CS in  $F$  and so  $h$  is IFpG<sup>#</sup> $\alpha$ -continuous,  $h^{-1}(C)$  is IF-clopen in  $E$ . We know that  $h^{-1}(C)$  is an IFCS in  $E$ , thus  $h^{-1}(C)$  is an IFCS in  $E$ . Therefore  $h$  is an IF continuous.

**Example 3.4.** Consider  $E = \{p, q\}$ ,  $F = \{r, s\}$ . Here  $J_1 = \langle e, (0.4_p, 0.3_q), (0.4_p, 0.5_q) \rangle$ ,  $J_2 = \langle f, (0.4_r, 0.3_s), (0.4_r, 0.5_s) \rangle$  and  $\tau = \{0_-, J_1, 1_-\}$  and  $\sigma = \{0_-, J_2, 1_-\}$  are IFTs on  $E$  and  $F$  separately. We describe  $h : (E, \tau) \rightarrow (F, \sigma)$  by  $h(p) = r$  and  $h(q) = s$ . Thus IFS  $C = \langle f, (0.4_r, 0.5_s), (0.4_r, 0.3_s) \rangle$  is an IF continuous in  $E$ . Then  $h^{-1}(C)$  is an IFCS in  $E$ . Therefore  $h$  is an IF-continuous mapping, but not an IFpG<sup>#</sup> $\alpha$ -continuous mapping. Since for an IFG<sup>#</sup> $\alpha$ CS,  $C = \langle f, (0.4_r, 0.5_s), (0.4_r, 0.3_s) \rangle$  in  $F$  and  $h^{-1}(C)$  is not an IF-clopen in  $E$ , as  $cl(h^{-1}(C)) = J_1^c = h^{-1}(C)$  and  $int(h^{-1}(C)) = J_1 \neq h^{-1}(C)$ .

**Theorem 3.5.** Every IFpG<sup>#</sup> $\alpha$ -continuous is IF <sub>$\alpha$</sub> -continuous, reverse implication is not possible.

**Proof:** Consider  $h : (E, \tau) \rightarrow (F, \sigma)$  be IFpG<sup>#</sup> $\alpha$ -continuous. Consider  $C$  be IFCS in  $F$ . We have IFCS an IFG<sup>#</sup> $\alpha$ CS in  $F$  and so  $h$  is IFpG<sup>#</sup> $\alpha$ -continuous,  $h^{-1}(C)$  is IF-clopen in  $E$ . We know that  $h^{-1}(C)$  is an IFCS in  $E$ , thus IFCS is an IF <sub>$\alpha$</sub> CS,  $h^{-1}(C)$  is an IF <sub>$\alpha$</sub> CS in  $E$ . Therefore  $h$  is an IF <sub>$\alpha$</sub>  continuous.

**Example 3.6.** Consider  $E = \{p, q\}$ ,  $F = \{r, s\}$ . Here  $J_1 = \langle e, (0.3_p, 0.2_q), (0.4_p, 0.3_q) \rangle$ ,  $J_2 = \langle f, (0.7_r, 0.7_s), (0.1_r, 0.1_s) \rangle$  and  $\tau = \{0_-, J_1, 1_-\}$  and  $\sigma = \{0_-, J_2, 1_-\}$  are IFTs on  $E$  and  $F$  separately. We describe  $h : (E, \tau) \rightarrow (F, \sigma)$  by  $h(p) = r$  and  $h(q) = s$ . Thus IFS  $C = \langle f, (0_r, 0.1_s), (0.8_r, 0.7_s) \rangle$  is an IFCS in  $F$ . Here the mapping  $h$  is an IF <sub>$\alpha$</sub> -continuous mapping, but not an IFpG<sup>#</sup> $\alpha$ -continuous mapping. Since for an IFG<sup>#</sup> $\alpha$ CS,  $C = \langle f, (0_r, 0.1_s), (0.8_r, 0.7_s) \rangle$  in  $F$  and  $h^{-1}(C)$  is not an IF-clopen in  $E$ , as  $cl(h^{-1}(C)) = J_1^c \neq h^{-1}(C)$  and  $int(h^{-1}(C)) = J_1 \neq h^{-1}(C)$ .

**Theorem 3.7.** Every IFpG<sup>#</sup> $\alpha$ -continuous is IFS-continuous, reverse implication is not possible.





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**Proof:** Consider  $h: (E, \tau) \rightarrow (F, \sigma)$  be  $IFpG^\# \alpha$ - continuous. Consider  $C$  be IFCS in  $F$ . We have IFCS an  $IFG^\# \alpha CS$  in  $F$  and so  $h$  is  $IFpG^\# \alpha$ - continuous,  $h^{-1}(C)$  is IF-clopen in  $E$ . We know that  $h^{-1}(C)$  is an IFCS in  $E$ , thus IFCS is an IFSCS,  $h^{-1}(C)$  is an IFSCS in  $E$ . Therefore  $h$  is an IFS continuous.

**Example 3.8.** Consider  $E = \{p, q\}$ ,  $F = \{r, s\}$ . Here  $J_1 = \langle e, (0.7p, 0.9q), (0.3p, 0.1a) \rangle$ ,  $J_2 = \langle f, (0.7r, 0.9s), (0.3r, 0.1s) \rangle$  and  $\tau = \{0, J_1, 1\}$  and  $\sigma = \{0, J_2, 1\}$  are IFTs on  $E$  and  $F$  separately. We describe  $h: (E, \tau) \rightarrow (F, \sigma)$  by  $h(p) = r$  and  $h(q) = s$ . Thus IFS  $C = \langle f, (0r, 0.1s), (0.8r, 0.9s) \rangle$  is an IFCS in  $F$ . Here the mapping  $h$  is an IFS-continuous mapping, but not an  $IFpG^\# \alpha$ - continuous mapping. Since for an  $IFG^\# \alpha CS$ ,  $C = \langle f, (0r, 0.1s), (0.8r, 0.9s) \rangle$  in  $F$  and  $h^{-1}(C)$  is not an IF-clopen in  $E$ , as  $cl(h^{-1}(C)) = J_1^c \neq h^{-1}(C)$  and  $int(h^{-1}(C)) = 0 \neq h^{-1}(C)$ .

**Theorem 3.9.** Every  $IFpG^\# \alpha$ - continuous is IFb- continuous, reverse implication is not possible.

**Proof:** Consider  $h: (E, \tau) \rightarrow (F, \sigma)$  be  $IFpG^\# \alpha$ - continuous. Consider  $C$  be IFCS in  $F$ . We have IFCS an  $IFG^\# \alpha CS$  in  $F$  and so  $h$  is  $IFpG^\# \alpha$ - continuous,  $h^{-1}(C)$  is IF-clopen in  $E$ . We know that  $h^{-1}(C)$  is an IFCS in  $E$ , thus IFCS is an IFbCS,  $h^{-1}(C)$  is an IFSCS in  $E$ . Therefore  $h$  is an IFb continuous.

**Example 3.10.** Consider  $E = \{p, q\}$ ,  $F = \{r, s\}$ . Here  $J_1 = \langle e, (0.6p, 0.3q), (0.4p, 0.3q) \rangle$ ,  $J_2 = \langle f, (0.3r, 0.7s), (0.4r, 0.3s) \rangle$  and  $\tau = \{0, J_1, 1\}$  and  $\sigma = \{0, J_2, 1\}$  are IFTs on  $E$  and  $F$  separately. We describe  $h: (E, \tau) \rightarrow (F, \sigma)$  by  $h(p) = r$  and  $h(q) = s$ . Thus IFS  $C = \langle f, (0.3r, 0.3s), (0.6r, 0.7s) \rangle$  is an IFCS in  $F$ . Here the mapping  $h$  is an IFS-continuous mapping, but not an  $IFpG^\# \alpha$ - continuous mapping. Since for an  $IFG^\# \alpha CS$ ,  $C = \langle f, (0.3r, 0.3s), (0.6r, 0.7s) \rangle$  in  $F$  and  $h^{-1}(C)$  is not an IF-clopen in  $E$ , as  $cl(h^{-1}(C)) = J_1^c \neq h^{-1}(C)$  and  $int(h^{-1}(C)) = 0 \neq h^{-1}(C)$ .

**Theorem 3.11.** Every  $IFpG^\# \alpha$ - continuous is  $IFG^\# \alpha$ - continuous, reverse implication is not possible.

**Proof:** Consider  $h: (E, \tau) \rightarrow (F, \sigma)$  be  $IFpG^\# \alpha$ - continuous. Consider  $C$  be IFCS in  $F$ . We have IFCS an  $IFG^\# \alpha CS$  in  $F$  and so  $h$  is  $IFpG^\# \alpha$ - continuous,  $h^{-1}(C)$  is IF-clopen in  $E$ . We know that  $h^{-1}(C)$  is an IFCS in  $E$ , thus IFCS is an  $IFG^\# \alpha CS$ ,  $h^{-1}(C)$  is an  $IFG^\# \alpha CS$  in  $E$ . Therefore  $h$  is an  $IFG^\# \alpha$ -continuous.

**Example 3.12.** Consider  $E = \{p, q\}$ ,  $F = \{r, s\}$ . Here  $J_1 = \langle e, (0.6p, 0.3q), (0.4p, 0.5q) \rangle$ ,  $J_2 = \langle f, (0.7r, 0.8s), (0.3r, 0.2s) \rangle$  and  $\tau = \{0, J_1, 1\}$  and  $\sigma = \{0, J_2, 1\}$  are IFTs on  $E$  and  $F$  separately. We describe  $h: (E, \tau) \rightarrow (F, \sigma)$  by  $h(p) = r$  and  $h(q) = s$ . Then  $J_2^c = \langle f, (0.3r, 0.2s), (0.7r, 0.8s) \rangle$  is an IFCS in  $F$ . Here the mapping  $h$  is an  $IFG^\# \alpha$ -continuous mapping, but not an  $IFpG^\# \alpha$ - continuous. Since for an  $IFG^\# \alpha CS$ ,  $C = \langle f, (0.3r, 0.4s), (0.7r, 0.6s) \rangle$  in  $F$  and  $h^{-1}(C)$  is not an IF-clopen in  $E$ , as  $cl(h^{-1}(C)) = J_1^c \neq h^{-1}(C)$  and  $int(h^{-1}(C)) = 0 \neq h^{-1}(C)$ .

**Theorem 3.13.** Every  $IFpG^\# \alpha$ - continuous is  $IFaG^\# \alpha$ - continuous, reverse implication is not possible.

**Proof:** Consider  $h: (E, \tau) \rightarrow (F, \sigma)$  be  $IFpG^\# \alpha$ - continuous. Consider  $C$  be IFRCS in  $F$ . We have IFRCS an  $IFG^\# \alpha CS$  in  $F$  and so  $h$  is  $IFpG^\# \alpha$ - continuous,  $h^{-1}(C)$  is IF-clopen in  $E$ . We know that  $h^{-1}(C)$  is an IFCS in  $E$ , thus IFCS is an  $IFG^\# \alpha CS$ ,  $h^{-1}(C)$  is an  $IFG^\# \alpha CS$  in  $E$ . Therefore  $h$  is an  $IFaG^\# \alpha$ -continuous.

**Example 3.14.** Consider  $E = \{p, q\}$ ,  $F = \{r, s\}$ . Here  $J_1 = \langle e, (0.5p, 0.6q), (0.5p, 0.4q) \rangle$ ,  $J_2 = \langle f, (0.2r, 0.1s), (0.8r, 0.9s) \rangle$  and  $\tau = \{0, J_1, 1\}$  and  $\sigma = \{0, J_2, 1\}$  are IFTs on  $E$  and  $F$  separately. We describe  $h: (E, \tau) \rightarrow (F, \sigma)$  by  $h(p) = r$  and  $h(q) = s$ . Then  $J_2^c = \langle f, (0.8r, 0.9s), (0.2r, 0.1s) \rangle$  is an IFRCS in  $F$ . Here the mapping  $h$  is an  $IFaG^\# \alpha$ -continuous mapping, but not an  $IFpG^\# \alpha$ - continuous. Since for an  $IFG^\# \alpha CS$ ,  $C = \langle f, (0.4r, 0.2s), (0.1r, 0s) \rangle$  in  $F$  and  $h^{-1}(C)$  is not an IF-clopen in  $E$ , as  $cl(h^{-1}(C)) = 1 \neq h^{-1}(C)$  and  $int(h^{-1}(C)) = 0 \neq h^{-1}(C)$ .

**Theorem 3.15.** A mapping  $h: (E, \tau) \rightarrow (F, \sigma)$   $IFpG^\# \alpha$ - continuous if and only if inverse image of each  $IFG^\# \alpha OS$  in  $F$  is an intuitionistic fuzzy clopen in  $E$ .

**Proof: Necessity:** Consider a mapping  $h: (E, \tau) \rightarrow (F, \sigma)$  be  $IFpG^\# \alpha$ - continuous. Consider  $C$  be  $IFG^\# \alpha OS$  in  $F$ . Then  $C^c$  is an  $IFG^\# \alpha CS$  in  $F$ . Since  $h$  is an  $IFpG^\# \alpha$ -continuous mapping,  $h^{-1}(C^c)$  is IF clopen in  $E$ . As  $h^{-1}(C^c) = (h^{-1}(C))^c$ , we have  $h^{-1}(C)$  is IF clopen in  $E$ .





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**Sufficiency:** Consider  $C$  be an IFG $^{\#}\alpha$ CS in  $F$ . Then  $C^c$  is an IFG $^{\#}\alpha$ OS in  $F$ . By hypothesis,  $h^{-1}(C^c)$  is IF clopen in  $E$ , which implies  $h^{-1}(C)$  is IF clopen in  $E$ , as  $h^{-1}(C^c) = (h^{-1}(C))^c$ . Therefore  $h$  is an IFpG $^{\#}\alpha$ - continuous mapping.

**Theorem 3.16.** Consider  $h: (E, \tau) \rightarrow (F, \sigma)$  be IF continuous and  $e: (F, \sigma) \rightarrow (G, \delta)$  is IFpG $^{\#}\alpha$ - continuous, then  $e \circ h: (E, \tau), (G, \delta)$  is IFpG $^{\#}\alpha$ -continuous.

**Proof:** Consider  $C$  be IFG $^{\#}\alpha$ CS in  $G$ . Since  $e$  is an IFpG $^{\#}\alpha$ - continuous,  $e^{-1}(C)$  is an IF clopen in  $F$ . Since  $h$  is an IF continuous,  $h^{-1}(e^{-1}(C))$  is an IFCS in  $E$ , as well as IFOS in  $E$ . Hence  $e \circ h$  is an IFpG $^{\#}\alpha$ -continuous.

**Theorem 3.17.** The composition of two IFpG $^{\#}\alpha$ -continuous is IFpG $^{\#}\alpha$ - continuous in general.

**Proof:** Consider  $h: E \rightarrow F$  and  $e: F \rightarrow G$  be any two IFpG $^{\#}\alpha$ -continuous. Let  $C$  be an IFG $^{\#}\alpha$ CS in  $G$ . By hypothesis,  $e^{-1}(C)$  is IF clopen in  $F$  and hence an IFCS in  $F$ . Since every IFCS is an IFG $^{\#}\alpha$ CS,  $e^{-1}(C)$  is an IFG $^{\#}\alpha$ CS in  $F$ . Further, since  $h$  is an IFpG $^{\#}\alpha$ -continuous mapping,  $h^{-1}(e^{-1}(C)) = (e \circ h)^{-1}(C)$  is IF clopen in  $E$ . Hence  $e \circ h$  is an IFpG $^{\#}\alpha$ -continuous.

**Theorem 3.18.** Consider  $h: (E, \tau) \rightarrow (F, \sigma)$  be IFpG $^{\#}\alpha$ - continuous and  $e: (F, \sigma) \rightarrow (G, \delta)$  is an IFG $^{\#}\alpha$ - irresolute, then  $e \circ h: (E, \tau) \rightarrow (G, \delta)$  is an IFpG $^{\#}\alpha$ - continuous.

**Proof:** Consider  $C$  be IFG $^{\#}\alpha$ CS in  $G$ . By hypothesis,  $e^{-1}(C)$  is an IFG $^{\#}\alpha$ CS in  $F$ . Since  $h$  is an IFpG $^{\#}\alpha$ -continuous,  $h^{-1}(e^{-1}(C)) = (e \circ h)^{-1}(C)$  is IF clopen in  $E$ . Hence  $e \circ h$  is an IFpG $^{\#}\alpha$ -continuous.

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## Ramifications of Class Struggle in Kamala Markandaya's *A Handful of Rice*

Shilpisudha Goswami\*

Assistant Professor, English Programme, Assam down town University, Guwahati, Assam, India.

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### \*Address for Correspondence

**Shilpisudha Goswami**

Assistant Professor,

English Programme,

Assam down town University,

Guwahati, Assam, India.

Email: sudha.shilpi5@gmail.com



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### ABSTRACT

From a historical perspective, colonialism and the freedom struggle have created a phenomenal assimilation of the East and the West. The class struggle of colonial India and the assimilation have left a thin line between the classes from a superficial perspective. But the pre-independent India witnessed the plight of the oppressors through the zamindari system, construction of dam or a pleasure bungalow. This paper discusses the class struggle as depicted in *A Handful of Rice* in light of Karl Marx's theory of class struggle. Marx opines that the change in class systems as, in, if the production is on the masses, then capitalism will be replaced by socialism which can eradicate the class system from the world

**Keywords:** : class-struggle, Bourgeoisie, Proletariat, upper-class

### INTRODUCTION

Since the inception of life, people have been tussling for sustenance. It took eons to reach the coeval stage. From anape to a human being—it was a strenuous but adventurous expedition. The struggle for basic needs always persists; first people had to hunt and accumulate the gifts of nature as their vocation; unity sustained amongst the illiterate, uneducated mass; subsequently they try to earn living through the work of herdsman and perambulated many places in quest of food, here, they get the wind of cultivation and culinary skills. Discovery of lightening fire begins from the spark produced by two striking stones. This led to emotional values and establishment of families commences here. Assisting hands is the under prop to many at this stage as reciprocation is the source to have a better dwelling, it is the emergence of barter system. Eventually, comprehension of life makes humankind coveted for wisdom, bravery makes mankind wise and through the ages commercialism glides unknowingly to bring a metamorphosis to the world. Education, career, livelihood become the sole aim where everyone chases to have an elegant life.



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Literature mirrors the society; it furnishes us diachronic study of the evolution of human beings and its artery towards commercialism. We can see people of all stages, classes, caste and creed in literature. One can move around the world if he/she has the right choice of books. This paper aims to discuss about the class struggle in the society as penned by Kamala Markandaya in her *A Handful of Rice*. The study is basically textual and analytical. This paper is the product of a close reading of the of the text that have been chosen. First of all, when we talk about class struggle, the picture of India strikes our mind. Here, I have mentioned India because, it is the country that bears different kinds of people. Walking on the road, you will see various vendors, huge buildings followed by roof thatched hut and footpath covered in tarpaulin to live in. However, these pictures have made their place in the papers too in words with some measures of transition. Since Mulk Raj Anand, Raja Rao, Anita Desai, Mahashweta Devi, Mamani Raisam Goswami and many other writers have represented the society with a hope of reformation. The class struggle, I am talking about is based on the economic condition; this economic condition is again based on the work and work based on the social environment.

Kamala Markandaya, an Indian expatriate has seen the sufferings of people. She has studied lives, degradation, hunger, changes microscopically and analyzed through her mind eyes; economy being the root cause of inequality and people's urge to imitate the English as they are shown as the best; and migration to urban areas have been beautifully penned by her. She claims through her writings that man is the painting of society, a person is crafted by the society itself. In all the novels, she does not keep us only to the character, she makes us move around the character, his/her surrounding, events say how social atmosphere changes a person's behaviour, how he/she has to move out from his/her ideology to cope up with the society. In relation to this we can refer to Markandaya's character Rukmani, the daughter of village headman learns to live in poverty, Lalitha who is inclined towards the west through Mrs. Mendoza's education and at last is absorbed in the city. We see Val is Possession, a person with a talent becomes the slave of the system but he finds his way back towards the end. Thus, Markandaya's novels discuss the societal problems to bring forth them into limelight. Though she is a diaspora, she has always been dreaming of India, she imagines her homeland as a land of peace, as a land of equality and fraternity. Her works present us many characters, each being a stereotype of the society, specially focused on middle class and poor people. If one wants to visualize a better picture of India and Indians, colonized India, Indians in abroad, then Markandaya's novels would be amongst the best pictures collectively.

This paper aims to discuss how Kamala Markandaya has represented the working class in her novel *A Handful of Rice*. It also focuses on the study of the class struggle through the lens of Marx's theory. Since mankind has been split into antagonistic classes, history talks about the struggle between these classes, i.e., of the oppressed against the oppressor, the working people versus the exploiters. The history of slave-owning, feudal and capitalist societies is replete with outburst of fighting between slave and slave-owners, serfs and feudal lords, proletariat and bourgeoisie. For never could the oppressed people reconcile themselves to a situation where they – the creators of all the material values – were doomed to poverty, hunger, inequality and brutal exploitation, while a handful of overloads appropriated the fruits of their labour and grew rich on the exploitation of millions. History has recorded a multitude of heroic deeds performed by the people in the fight for their liberation. The slaves' insurrections in Ancient Rome and the Kingdom of Bosphorus, the peasant uprisings in Medieval Germany and France, the peasant wars in China and Russia and the proletariat's revolutionary battles – the Paris commune and the first Russian revolution of 1905-1907 ---- were examples of this struggle. But each time, the ruling classes were able to retain power, preserving their economic might and political supremacy.

Subsequently, for the first time in history came the hour of defeat for exploiter rule ---- the socialist revolution of October 1917 triumphed in Russia. For the first time, the people had become the masters of their country and their future. The workers' struggle against exploitation against social and natural operation had been long and hard but it was crowned with their complete victory. The counter-revolutionary forces were defeated and the exploiter classes liquidated. But class-struggle has been going on in different forms, when we talk about class struggle, first the philosopher Karl Heinrich Marx strikes our mind. The concept of class struggle became prominent after "The Communist Manifesto" and "Das Capital". Marx, a German philosopher, sociologist, journalist and economist



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studied and analyzed history with a different ideology. He realized that the development of mankind is dependent on production. Marx perceived that in the beginning it was God and slave's relation where we see God with his slaves Adam and Eve, then it transformed to landowner and tenant's relation which further moved to Bourgeoisie and Proletariat's relation. Bourgeoisie is the management class, the ruling class and Proletariat is the working class. Marx observed that economy controls the people, money is needed for sustenance, but once it becomes a convention, one is unable to unhive himself, eventually one goes deeper into it and hence pretermits the working class. The proletariat works for their subsistence, and their hard work accounted for the expanding wealth of the Bourgeoisies. The wealth of Bourgeoisie is the resultant of the exploitation the proletariat succumbs to. To show the base of the class struggle between the Bourgeoisie and Proletariat, Marx has contemplated the concept of base and superstructure. According to him, everything that we need for our livelihood is based on the economy, production of goods and machinery whereas the things we human beings produce such as needs, profession, literature, law, politics are the superstructure. On the whole, we can say, base is the economic structure of the society in the beginning of the development, it is the production, demand and distribution of goods.

In the essay Base and Superstructure Marta Harnecker says,

"Marx and Engels used the terms Infrastructure or Base for the economic structure of society, and superstructure for the juridico-political institutions, the state, the law etc and the forms of social consciousness which correspond to a determinant infrastructure." (Harnecker, 33)

"By means of the notions of infrastructure and superstructure, Marx and Engels expressed the relationship which exists between the economic level of society and the juridico-political and ideological levels." (Harnecker, 33). The relation between base and superstructure indicate that one influences the other. It is said that base has a dominant and determining role. On the other hand, in some cases, the superstructure exerts its influence upon the base. Bae is the economy that rules every other fields in the society.

Marx says, "In the social production of their existence, men inevitably enter into definite relations, which are independent of their will, namely, relations of production, appropriate to a given stage in the development of material forces of production. The totality of these relation of production constitutes the economic structure of society, the real foundation, on which arises a legal and political superstructure and to which correspond definite forms of social consciousness." (Harnecker, 34)

Engels writes, " political, juridical, philosophical, religious, literary, artistic etc development is based on economic development. But all these react upon one another and also upon the economic basis. It is not that the economic situation is cause, solely active, while everything else is only passive effect. There is rather interaction on the basis of economic necessity, which ultimately always asserts itself". (Harnecker, 35)

According to Marx the change in class systems as in if the production is on the masses then capitalism will be replaced by socialism which can eradicate the class system from the world. Marx also opines that Proletariat will not tote the oppression and common mass will overthrow the Bourgeoisie for their rights and socialism would enter where the common mass will be the owner of goods.

**CLASS STRUGGLE AS SILHOUETTED IN A HANDFUL OF RICE:**

*A Handful of Rice*, as the title suggests portrays the life of Ravi and the myriad challenges, he confronts to live a content life. The class hierarchy and the orient list attitude are computed through the protagonist Ravi and the flat characters like Memsahibs; Ravi inspite of all the hurdles pleads to lead a virtuous life. One always strives hard to attain thriving standards of living. Deteriorated life conditions are never welcomed, in fact, it becomes an obstacle in upliftment. Man is the product of environment. Since birth one learns what one sees around, happiness becomes a desired object. Ravi, the village boy comes to the city in search of work, happiness and better livelihood. He is introduced to us when he is chased by the police in boots. An unequipped Indian Ravi, is barefoot and the police,



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another Indian, a slave of the British trying to imitate their lifestyle is wearing boots but his feet in the boots are not comfortable. Big boots were after him, very hard and purposeful; but the feet inside were Indian, unused to running in boots (HR, 5). With an end eavour to picturise the inequality and constant struggle, Markandaya depicts Ravi as a boy who has self-esteem. But sometimes hunger takes that away too. Saving himself from police he ran to a house in search of something. There he is beaten by the house owners as he tries to steal things. Finding no way out Ravi asks for food, bed and shelter for the night.

He had left his family, a long time ago --- three years was it? --- as his brothers had done, as all young men he knew had done or wanted to do, joining the exodus to the cities because their villages had nothing to offer them. The cities had nothing either, although they did not discover until they arrived: but it held out before them like an incandescent carrot the hope that one day, some day, there would be something. (HR, 25-26). But gradually he realises: The city was full of graduates --- the colleges turned them out in their thousands each year --- looking for employment, so what chance had he, with his meagre elementary-school learning? (HR, 26-27). He stays with the family of a tailor who fed him once, there, he marries his love, promises to keep her happy; he with his father in law tries to run the house smoothly. He is tired of trying to making the ends meet. The city life too has no space for people like him. He dreams for a happy life but he does not know that he is not allowed to do so. The thought of immediate future haunts him. He says What I wanted to buy was something quite different, something that would stop me thinking about tomorrow because the more I think of it the sicker I get ---- sick, sick of it! (HR, 9). When he has no way out, again, in search of work, he goes to Damodar, a rich man. Though Damodaris ready to offer him job, Ravi's conscience does not allow him to accept the proposal. Hence,each time he seeks Damodar's help, he comes back empty-handed.

Damodar grinned broadly and slapped him on the back. 'Ai, you have got a soft conscience! But you're a decent one, I'll say that for you: a decent one.' (HR, 14). Damodar's wallet is fat with ten-rupee notes, he must have two or three hundred rupees with him. Ravi tries not to be jealous, but as Marx says, economy is the root cause of everything, Ravi could not help but becomes envious though he knows it is wrong to be resentful of friends, he starts thinking when he could earn that much and live a happy life. He imagines of a happy life for himself too, which torments him a lot. Reality and imagination become a contradiction which results in his dilapidated relationship.

Nalini said to Ravi,

'You are getting high and mighty, putting yourself on a level with high-class folk. How can we ever be like them? Why can't you be content with what we have?'

'Because I want more,' he cried, his temper rising. 'I want a bed for one thing! I'm fed up sleeping on the floor. They all have beds, the people we slave for, do you know that? Days-beds, night-beds, double-beds, divans---' (HR 75)

Accompanying his father-in-law, Ravi goes to deliver dress to the memsahibs. There Ravi's eyes become fixed to their lifestyle. He too wants to have such a lifestyle, it seems to him the best of everything in the world. The feeling of not having enough becomes more and more.

Ravi would peep into others room, catching glimpses of silk hangings and tall windows, gleaming floors and fine furniture, and feel an awe of so much wealth. What did it feel like, he frequently wondered, running his fingertips over satinwood surfaces, sinking an inquiring toe into inch-thick carpets, to live like this, without worry, without wanting, every need and craving satisfied? He tried very hard, but his imagination never quite stretched cover it. (HR, 83)

Ravi toils, tries to earn more but every time he fails to achieve what he craves for. The limited things he has could not please him anymore. When Ravi and Nalini with their son Raju sat on the beach as they could not afford going anywhere else, Ravi again thinks of doing something better. Ravi would have preferred a coffee bar, one of those modern places with neon street-lights behind the coffee machines and stools to sit on where one could rub shoulders with people from quite other classes than one's own in a way one could not easily do elsewhere, and certainly not in a village. Ravi liked that. It gave him the sensation of living in high society... (HR, 132)

Here the protagonist tries to analyse the difference between city life and village life: village life teaches one to be happy with limited materialistic things whereas city life does not. Once one gets exposure to the luxuries and



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aristocracies of life, one realizes how they have become the prey of exploitation and so one cannot enjoy a comfortable life. The desire to earn more and to have a better living than the fellow residents constantly prevails in the town atmosphere which leads to one's mental disturbances, anxiety disorders and depression. In his village children lingered, but old men died easily. They had not the stamina to fight, and long before the end they had lost the will to live. What he overlooked was that Apu had become a townsman, and townsman had not the same acceptance: they had had to contest every inch of ground in the ferocious race that town living was, and even confronted by death the habit clung. (HR, 146) .

Ravi loses his father-in-law, and endeavours to take his job as a commitment to the family; but he could not acquire the skill of tailoring and thus he fails. Ravi timidly tries and delivers the costume to the memsahib. As the delivery of the gown is delayed the memsahib shouts at Ravi. The reason being his father-in-law's death does not soften her. The upper class cannot understand the pain of the oppressed. They are always exploited. These people, she thought, with their innumerable uncles and aunts and cousins who seemed to be forever dying – really, they were quite impossible, impossible people inhabiting an impossible country. (HR, 184). Ravi's son Raju is crying out of pain, looking at the deteriorating health of son the helpless father tries to do give some homemade remedy. When Nalini asked Ravi for a doctor for their ailed son, Ravi yelled 'A doctor', he cried, 'What are we, memsahibs or something to send for a doctor for every ache and pain? Will you pay his bills? Five rupees before he even steps out of his house!' Raju dies. When there is scarcity everywhere Ravi thinks of approaching Damodar again. This time he tries to walk in his shoes but turns away disappointed and thwarted.

But they were dirty hands, hands that grew rich by squeezing people's throats. People like him. People like his wife who stood two hours each day in a line outside the grain shops, a line that lengthened daily as the shortage grew. When the lines were really long, the money would come rolling in, not peanuts, Damodar wasn't interested in peanuts: real money. All he had to do was to get in on Damodar's side, before the government pegs come down while the money was still totting up. Get rich and get out. (HR, 217)

Ravi is portrayed as the hero of the oppressed. Through this character Markandaya has depicted the troubled mindset of people. They are in constant fear of doing something. People like Damoder tempts them for money, some walks on that covetous but ill-fated path whereas people like Ravi are left impoverished and agonized in the middle of the road. Ravi's self-esteem and conscience could not retain in his hazardous life where power is in the hands of people like Damoder. Ravi, contradicting with society and mind all his life, failed everytime; beats his loving wife, misbehaves his family relations, moreover rapes his mother in law in insanity.

**CONCLUSION**

*A Handful of Rice* silhouettes the picture of Ravi as a young enthusiastic boy, who comes to the town in an endeavour to assist himself and his family economically; but the town and his aspirations make him insane, he has to strive for each meal, but he cannot meet the ends towards the end. He loses his son; he rapes his mother in law; can we blame him as the villain for all these? He cannot be blamed as he is the product of his catastrophically dwindling environment and the reflection of his surroundings. Had the memsahibs tried to understand his pains, had his friend Damoder offered him an honest way of livelihood, had the police not been bribed, Ravi would have been a better person. But the town teaches him that luxury, pleasure and happiness are not for the poor, they are vehemently meant to work for the Bourgeoisie as always. Till the time class-system exists, oppression will prevail. Karl Marx, the philosopher has been propounding about the aforementioned hindrance; when economy is in the hands of persecutors, enslavement subsists. Marx' principle of equal and unbiased society can be fulfilled with pertinent education, analyzation, thinking, conscience and coming out together for their own rights.







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## Analysis and Forecasting of Water Deficiency: A Case Study for Chennai City

Jyoti Gautam<sup>1\*</sup>, Nitima Malsa<sup>2</sup>, Amlan Chakrabarti<sup>3</sup>, Megha Jain<sup>2</sup> and Aritra Dutta<sup>4</sup>

<sup>1</sup>Associate Professor, NSUT, East Campus, Delhi, India

<sup>2</sup>Assistant Professor, JSS Academy of Technical Education, Noida, Uttar Pradesh, India

<sup>3</sup>Professor and Director, A.K. Choudhury School of I.T, Kolkata, West Bengal, India

<sup>4</sup>Assistant Professor, Guru Nanak Institute of Technology, Kolkata, West Bengal, India

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### \*Address for Correspondence

#### Jyoti Gautam

Associate Professor,  
NSUT, East Campus,  
Delhi, India

E. Mail: jyotijssaten@gmail.com



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### ABSTRACT

The water supply of Chennai is mostly reliant on four reservoirs. The future supply of water from reservoirs is not promising. As a result, there is a pressing need to keep track of reservoir water levels. Fruitful planning to counter the water deficit in the city necessitates water supply versus demand forecasts. This motivated us to develop the proposed forecasting models, to the best of our knowledge this is a first-of-its-kind forecasting model development for the Chennai city reservoirs. Data was acquired from verified sites such as the Chennai Metropolitan Water Supply and Sewerage Board, and the study effort was separated into numerous modules. Polynomial Regression, SARIMA, and Auto ARIMA techniques were used to forecast values for each of the responsible components, such as water reservoir levels, rainfall, population, water available per person per day, and lastly, water shortage, for the years 2020-23. Parameters such as RMSE and AIC were determined to evaluate the performance of the proposed models. The generated models can be used in any other place with water scarcity.

**Keywords:** Chennai, Linear Regression, SARIMA, Auto ARIMA, Supply versus Demand, Water Deficiency

## INTRODUCTION

Rapid development and growing population have impacted water resources to a great extent. The Chennai city is used as a case study. Despite the seemingly abundant sources of water, Chennai suffers from water shortage since it is dependent on rainfall. Rainfall forecasting is an important subject in Chennai because of the scarcity of water [1].

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“33 % of Chennai’s wetlands have been lost in the last decade. During the same period, Chennai lost 24 % of agricultural land, crucial for improving the groundwater table” [2]. Chennai is entirely dependent on groundwater resources which are replenished by rainwater and the city’s average rainfall is 140 cm (yearly). The major sources of water for the city are four freshwater reservoirs - Red Hills, Chembarambakkam, Cholavaram and Poondi which have a combined capacity of 11,057 Mcft. There are other seemingly abundant sources of water, but the majority of the water supply in Chennai is still dependent upon these four reservoirs [18]. Even though the amount of rainfall should be sufficient to meet the needs of the people, its uneven distribution causes problems. There is irregularity in the rainfall patterns and rain generally occurs in the latter half of the year. The climate of the Chennai city is controlled by the northeast and southwest monsoons. Precipitation data of 115 years (1901-2015) was taken along with rainfall analysis giving emphasis on drought data to quantify the trends. By analyzing the trends annually and seasonally, and a non-significant increasing trend in annual rainfall and a significant decreasing trend in winter [15] has been observed. Andhra Pradesh (AP), Tamil Nadu (TN), Odisha and southern West Bengal experience higher accumulated rainfall during the pre-monsoon season among eastern coastal states. Karnataka and Kerala suffer maximum rainfall from Cyclonic Disturbances among western coastal states. Gujarat received ~70% and both AP and TN received up to 20–30% of rainfall by Cyclonic Disturbances during the pre-monsoon months [16]. The southwest monsoon season receives 35% of annual rainfall. The variability of monsoon and annual rainfall is 26% and 25% respectively given by [5]. Rainfall provides a way of managing reservoirs and fulfilling the supply of water to each city. Various machine learning methods have been applied under different scenarios and different time horizons for forecasting rainfall [16].

This prediction helps agricultural, industrial and personal utilization of water efficiently. The daily demand of a person in Chennai can be broken down into three sectors - water requirement for households, industrial water requirement, and service sector requirement. The annual water requirement for these three sectors comes out to be 21.14TMcft [18]. The type of water supply in Chennai depends on the area of the respondent. North Chennai depends on hand pumps, South Chennai depends on water tanks, and Central Chennai depends on hand pumps and water tanks, apart from this, pipelines are being used for Chennai respondents [20]. The state of Tamil Nadu (Chennai being the capital) has total water resource of 46.52km<sup>3</sup> /1,643TMC which includes 23.05km<sup>3</sup>/814TMC groundwater potential. The per capita annual water availability of this state is 590m<sup>3</sup> and the deficit befalls 1,110m<sup>3</sup> (65.29%) now. If the water resource of this state is not improved, there can be drop of 416m<sup>3</sup> per capita water resource in 2050 with a deficiency of 1,284m<sup>3</sup> (75.53%), which would allow to facilitate only one meal in a day to the people of this state [11]. With each passing year the demand for water is rising and the supply is declining due to various environmental problems like ground water pollution, surface water pollution, industrial effluent discharge etc. [9]. Ground water quality deterioration can be controlled by recharging groundwater through rainwater harvesting and controlling seawater intrusion. Due to the increasing population and demand, proper structure of rainwater harvesting has to be implemented in every house holds for recharging the groundwater [14]. These traditional methods alone cannot work efficiently; so there is a need to understand the complete scenario. The Chennai city is dependent for its Water Supply through the four reservoirs mainly, and the reservoirs are dependent on Rainfall for maintaining their adequate water levels. At the same time, there is a need to assess the demand versus supply situation for the coming years, i.e., to find water deficiency for the coming years. According to requirements, many techniques like regression can be applied to data and also the error between the actual and predicted values and the accuracy can be calculated as done by [10]. Choosing the right algorithm is highly important and modeling should be done as per the requirements. So for prediction of rainfall, water storage in reservoirs, water availability per person and water supply versus demand, SARIMA supports modeling through seasonal components of the series. Polynomial regression model can be used for prediction of population [13]. Thus, the main aim of this research work is to predict water deficiency [6] in Chennai by analyzing and forecasting rainfall patterns, reservoir levels, population, and water available per person and finally, supply and demand patterns using machine learning techniques. The deficiency of water supply in Chennai depends upon the demands and supplies of water. Initially, the data is retrieved from CMWSSB (Chennai Metropolitan Water Supply and Sewerage Board) only from 2004 to 2019. The data has been analysed for inherent patterns like seasonality, and





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based on that, appropriate models have been applied for forecasting. The basic assumption made in this paper is that for finding deficiency of water, supply from only four reservoirs Chembarambakkam, Cholavaram, Poondi and Red Hills is considered.

To obtain the same, five modules are used:

- a. Rainfall forecasting
- b. Water reservoir levels forecasting
- c. Chennai’s Population forecasting
- d. Water available per person forecasting
- e. Supply versus demand forecasting

Various modelling techniques have been applied like Polynomial Regression Model for forecasting population; auto\_ARIMA function has been used in SARIMA model [19][21] for forecasting rainfall patterns, water level of the reservoirs and supply and demand patterns. The auto ARIMA function is used to obtain the parameters as it discovers the optimal order for an ARIMA model. Finally, deficiency has been calculated.

**SARIMA Model**

SARIMA models are an adaptation of autoregressive integrated moving average (ARIMA) models to specifically fit seasonal time series [1]. Seasonal nature of the series is considered for model preparation. The parameters of SARIMA are:

- p: auto regression (AR) term that indicates the number of lag observations included in the model, also known as lag order
- d: degree of differencing (indicates the number of times the data had past values subtracted)
- q: the size of the moving average window, also known as an order of moving average
- P, D and Q are similar to p, d and q. P, D and Q refer to the autoregressive, differencing, and moving average terms for the seasonal part of the model.
- s is the seasonal factor. The number of time steps for a single seasonal period.
- The general form of multiplicative seasonal model SARIMA (p,d,q) (P, D,Q)s,
- $\phi_p(B^s)\varphi_p(B)(1 - B)^d(1 - B^s)^D Z_t = \theta_q(B)\vartheta_Q(B^s)e_t$  (1)
- Where,  $e_t$  is a white noise process with mean zero,  $\phi_p, \varphi_p, \theta_q, \text{ and } \vartheta_Q$  are polynomials of order P, p, q and Q respectively.
- *Seasonal autoregressive operator of order P is*
- $(B^s) = 1 - \phi_1 B^s - \phi_2 B^{2s} - \dots - \phi_p B^{ps}$  (2)
- *Regular autoregressive operator of order p is*
- $\varphi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \dots - \phi_p B^p$  (3)
- *Regular moving average operator of order q is*
- $\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q$  (4)
- *Seasonal moving average operator of order Q is*
- $(B^s) = 1 - \vartheta_1 B^s - \vartheta_2 B^{2s} - \dots - \vartheta_Q B^{Qs}$  (5)
- And B is backshift operator (i.e. Z(t)B=Z(t-1)).
- By analyzing the datasets, the value of s was chosen as 12, because it suggests a yearly seasonal cycle of monthly data. Hence the above equation (1) can be written as:

$$\phi_p(B^{12})\varphi_p(B)(1 - B)^d(1 - B^{12})^D Z_t = \theta_q(B)\vartheta_Q(B^{12})e_t \quad (6)$$

**Auto\_ARIMA Function**

The auto\_ARIMA function is used to obtain the parameters as it discovers the optimal order for an ARIMA model. Auto-ARIMA functions by performing differencing tests to decide the order of differencing, d, and then fitting models within ranges of defined start\_p, max\_p, start\_q, max\_q ranges. An auto-ARIMA tries to find the optimal P and Q hyper-parameters once the Canova-Hansen Test [23] has been conducted to determine the optimal order of seasonal differencing, D.



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Akaike's Information Criterion (AIC) helps to select the best ARIMA model. The AIC creates a ranking for the models and ranks them from best to worst. A model that neither under-fits nor over-fits will be chosen as the "best" model. The formula is defined as:

$$AICc(p,q)=\ln(\sigma^2(p,q))(2*(p+q))/T \quad (7)$$

Where:

- T is the number of non-missing values in the time series.
- p is the order of the AR component model.
- q is the order of the MA component model.
- $\sigma$  is the standard deviation of the residuals.
- The lower AICc values, the better is the model.

Water Deficiency forecasting has been done for the 2004-2023 years for the city of Chennai using Time-Series Analysis. Forecasting of rainfall levels, water storage level of reservoirs, population of Chennai, water available per person per day, water supply versus demand has been done using various machine learning techniques in order to forecast deficiency. Here, auto\_ARIMA function has been used in SARIMA model for forecasting the various patterns. Auto ARIMA takes into account the AIC and BIC values generated to determine the best combination of parameters. For comparing the models, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values are used. The lower these values, the better the model. The generated models can be applied to any other Water Deficient city to assess Demand Supply situation and to help the Policy Makers to take appropriate measures well in time.

## MATERIALS AND METHODS

The major goal of this article is to identify the water supply shortage in Chennai, which is determined by water demand and supply. Furthermore, demand and supply are influenced by a variety of factors, including population, rainfall, reservoir levels, and so on. Five modules are utilized to determine the water supply shortfall, as mentioned. The following steps have been taken in each module as part of data collection, pre-processing, analysis and forecasting:

- a. Collecting data from different sources.
- b. Performing pre-processing steps on data.
- c. Performing analysis of the data.
- d. Applying machine learning predictive models for forecasting.

### Data Collection

The employed datasets for the first two modules include information on rainfall levels in millimeters and water availability in million cubic feet for the four major reservoirs: Poondi, Cholavaram, Redhills, and Chembarambakkam. The information is gathered from a variety of sources [8]. The World Population Review provided the year-by-year population figures for Chennai 2019 [4]. The water supply data in cusecs was obtained from the Chennai Metropolitan Water Supply and Sewerage Board CMWSSB 2019 [3], which is available on the government website of Chennai.

### Data Pre-processing

To begin, datasets are checked to verify if they include all of the required values and if any are missing. The average and total of all daily rainfall levels, as well as reservoir storage and supply levels, were estimated next. Pandas libraries are used to sort daily data into monthly data. For this group by() and to\_datetime() methods are applied on pandas objects. For finding water availability per person, unit of total storage is converted from Mcft to litres whereas a unit of supply is converted from cusec to million liters per day (MLD) to get a better idea.





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**Data Analysis** Data is analyzed using graphs, pie charts, box plots, histograms, and inbuilt python functions like `df.describe()` and `df.info()` to get insight into the data, i.e. details about the rows and columns, and to determine the various categories of data included in the data frame.

### Forecasting

Rainfall levels, reservoir water storage levels, and reservoir water supply are all time series data with seasonality. The SARIMA (Seasonal Autoregressive Integrated Moving Average) model is used to anticipate their future values for the years 2020 to 2023, while the polynomial regression model is utilized to forecast the population of Chennai.

### Polynomial Regression Model

Polynomial Regression is a regression algorithm that models the relationship between a dependent(y) and independent variable(x) as nth degree polynomial.

The Polynomial Regression equation is given below:

$$y = b_0 + b_1x + b_2x^2 + b_3x^3 + \dots + b_nx^n \quad (8)$$

Since, the data-points are arranged in a non-linear fashion, so Polynomial regression model can be used for forecasting the population.

$r^2$ (coefficient of determination) is a goodness of fit measure for regression model performance that gives the variation in Y (dependent variable) explained by the independent variable i.e. X. The ideal value for r-square is 1. The closer the value of r-square to 1, the better is the model fitted.

Measuring the Responsible Factors for Determining Deficiency of Water Supply

### Rainfall Level

The sum of the rainfall levels in four reservoirs is referred to as the 'Total' [Figure 1]. Then, using the re-sampling function of the pandas library in Python, we turned the daily data into monthly data. The newly obtained dataset now has two columns: a Month column and a Total column, which contains values equal to the total rainfall received by all reservoirs in that month. With the help of `auto_ARIMA` function, SARIMA order having least AIC obtained is (1, 0, 4) (0, 1, 12)<sup>12</sup>. Training and testing datasets are divided in ratio 80:20. The RMSE (i.e. root mean squared error) value obtained is 222.79. We applied this model to obtain the values for years 2020 to 2023. From Figure 1, the predictive power of SARIMA (1, 0, 4) (0,1,12)<sup>12</sup> is very appreciable as it fits well to the test data. The forecasted values (graph) tend to be very close to the actual points from 2017 to 2023. Therefore, the model predicts well.

### Water Storage Level of Reservoirs

To begin, [Figure 2], the sum of the water storage values from four reservoirs is taken and call it 'Total.' Then, using the re-sampling function, we changed the daily data to month-by-month data and averaged it. The obtained dataset now comprises two columns: a Month column and a Total column, both of which contain values corresponding to the average value of total water storage for that month. This means that the total amount of water obtained from all reservoirs will remain constant throughout the month. With the help of `auto_ARIMA` function, SARIMA order having least AIC obtained is (3,1,2)(3,0,2)<sup>12</sup>. The ratio 75:25 has been used for dividing Training and testing datasets. The RMSE value obtained is 456.16. This model is applied to obtain the values for years 2020 to 2023. From figure 2, the predictive power of SARIMA (3,1,2)(3,0,2)<sup>12</sup> is very appreciable as it fits well to the test data. The forecasted values tend to be very close to the actual points as seen from graph. Therefore, the model predicts well.

### Population of Chennai

Polynomial regression model has been used for predicting the Population of Chennai. The datasets have been taken from World Population Review and the graphs have been plotted.





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### Water Availability per Person

To achieve this objective, dataset of predicted water storage of reservoirs and predicted population of Chennai are used. First of all the water levels in reservoirs are converted from Mcft into litres, where: 1 Mcft= 28316846.592litres

The total water level of four reservoirs (monthly on a daily basis) was then divided by the population of Chennai for successive years to get the litres of water available per person per day for that year. Excessive water usage and waste were not taken into account in this estimate since they were unknown and difficult to compute due to a lack of dataset

### Supply versus Demand

This objective has two parts: Supply and Demand [Figure 3]. We have taken the supply dataset from(CWSSB2019). First of all, the aggregate values of supply of 4 reservoirs is taken and named it as 'Total'. Then converted the daily basis data to month-wise data by using re-sampling function and took average of that. Now, obtained dataset has 2 columns i.e. Date column and Total column which contains values equivalent to average value of total supply in that particular month. It means supply will remain same for entire month. With the help of auto\_ARIMA function, SARIMA order having least AIC obtained is (4, 1, 0)(4,0,1)12. The ratio 75:25 has been used for dividing Training and testing datasets. The RMSE value obtained is 355.28. This model is applied to obtain the values for years 2020 to 2023.From figure 3, the predictive power of SARIMA (4, 1, 0)(4,0,1)12 is very appreciable as it fits well to the test data. The forecasted graph (in red) tends to be very close to the actual points. Therefore, the model predicts well.

For demand, the Chennai chapter of the India Meteorological Society's newsletter [18] and Chennai's estimated population are utilized. According to this publication, the average daily water demand per person is around 135 litres, with agricultural and industrial water demands accounting for roughly 35% of total home demand. As a result, the demand for Million litres per day (MLD) for the coming years is determined using the formula 9, 10:

$$\text{Per\_Capita\_Demand} = \text{predicted\_population} * 0.000135, \quad (9)$$

$$\text{Predicted\_Demand} = \text{Per\_Capita\_Demand} + \text{Per\_Capita\_Demand} * 0.35 \quad (10)$$

## RESULTS

Deficiency of water is the lack of sufficient water, or not having access to safe water supplies. In this paper, the deficiency has been calculated as:

$$\text{Predicted Deficiency} = \text{Predicted\_Demand} - \text{Predicted\_Supply} \quad (11)$$

Demand and supply depends on various factors like rainfall, water reservoir levels, population and water required per person. Modules related to these factors are used in a sequential order to come up with precise prediction of deficiency. The results produced in these modules are as follows:

### Rainfall Level

Figure 4 shows that Chennai receives the majority of its water during the monsoon season, which runs from October to December. 2018 appears to be a year with very little rainfall. A few more years appear to be comparable; 2012-2014 and 2016 appear to have low rainfall levels, however, 2015 appears to have gotten the most rainfall. Rainfall has been scarce in recent years, but it is expected to increase in the following years, particularly in 2021 and 2022.





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### Water reservoir level

Water level has a seasonality that can be seen in the Figure 5. As compared to the rainfall seen above, it is clear that rainfall has been the same from year to year, however, the water reservoir level keep decreasing. Periodic cycle is disturbed in the current phase. Significant downfall in total water level has been observed since 2016 and evidence of water shortage can be noticed between a period of 2017- 2018(year transition) and also, the total water availability is very low in 2019. In upcoming years i.e. 2021-2023, monsoon will not contribute to any significant increase in reservoir levels. Rainfall will increase but still the level of water storage will decrease continuously. It implies that this will remain a tragic water management issue in coming years.

### Chennai Population

Since 1950, the Population of Chennai has increased exponentially. Though according to recent data, the rate of growth had gone down overall population has increased, hence population has increased quite fast between the years 2000 to 2019. The Polynomial Regression model of machine learning has been used for predicting the population of Chennai [4]. From Figure 6, it can be seen that the growth of the population with time is exponentially more than what is given in the dataset. The population growth has somewhat become constant in recent years but the population is still increasing exponentially and it will lead to an increase in water demand in upcoming years.

### Water Availability per person

The water level in the reservoirs continues to fall, while the population of Chennai grows at an exponential rate. As a result, the amount of water accessible per person per day in reservoirs has steadily dropped since 2010, and by significant amounts. Water was abundant from 2005 to 2010, however there was evidence of a water crisis during the 2017-2018 year transition, and water availability was extremely low in 2019. From Figure 7, it can be observed that water availability per person per day will follow a decreasing trend in coming years and scenario will get worse and the reason behind this is decreasing trend of water storage level of reservoirs.

### Supply versus Demand

Demand rises in tandem with population growth, yet water levels fall year after year, resulting in a water supply that falls short of satisfying the city of Chennai's water consumption demands. Figure 8(a) shows that water supply was greater than demand in 2005 and 2015, owing to extremely high reservoir water levels in both years. With the exception of 2005 and 2015, demand has always been higher than supply for the majority of the years. In coming years there will be huge difference between demand and supply which can be seen easily in the figure 8(a). Demand will remain higher than supply in coming years because population will increase exponentially whereas reservoirs' level will follow decreasing trend.

### Deficiency of Water

From figure 8(b), it appears that in a period of 2005-2006 and 2015-2016, the value of deficiency was negative. It means supply was more than demand in those years. Similar scenario was in 2010 and 2012. However, except these few years, the value of deficiency remains positive. It means required amount of water was not available to the people as per their demand for most of the years. As shown in figure 8(b), the value of deficiency will remain positive in coming years i.e. 2020 to 2023 which means there will be a water scarcity in future.

### Future Scope

The forecasting of rainfall and water reservoir levels is very important in terms of water resource management, domestic water usage etc. Rainfall pattern and level of reservoirs does not remain linear therefore various machine learning techniques have been used to produce forecasting results. The paper is devised in such a way that any water scarce region can use it effectively. The research work can be used for other populated cities like Delhi, Mumbai also. Prediction can be done for other coming years also.







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## CONCLUSIONS

This research work helps to forecast water deficiency in the Chennai city starting from 2004 to 2023 by forecasting values of the responsible factors. As per forecasting results, the city has received low rainfall in recent years but may receive more rainfall in upcoming years especially in 2021 and 2022. According to water reservoir level forecasting, in upcoming years i.e. 2021-2023, monsoon will not contribute to any significant increase in reservoir levels. Rainfall might increase but still the level of water storage will decrease continuously. There is an exponential rise in population of the city and remain so in the coming years. Water availability per person per day will follow a decreasing trend in coming years and scenario will get worse in coming years. Demand will remain higher than supply in coming years because population will increase exponentially whereas reservoirs' level will follow decreasing trend. The value of deficiency will remain positive in coming years i.e. 2020 to 2023 which mean there will be a water scarcity in future. Dried up reservoirs, decreased ground water levels, overdependence on the rainfall and continuous growth of population are pushing Chennai towards an alarming situation that needs to be taken care of. The values for the 2022 and 2023 can provide significant stats on the water deficiency to the Water Policy Makers for making future planning and decisions. Since the rainfall is dominant only in three months (October to December), so for the rest of the months, there should be other reliant sources of water and not only the stored ones. With the population increasing and the water supply decreasing, the water available per person is declining at an alarming rate. The research work provides significant statistical measures to the Water Policy makers, so that appropriate measures can be taken well in time.

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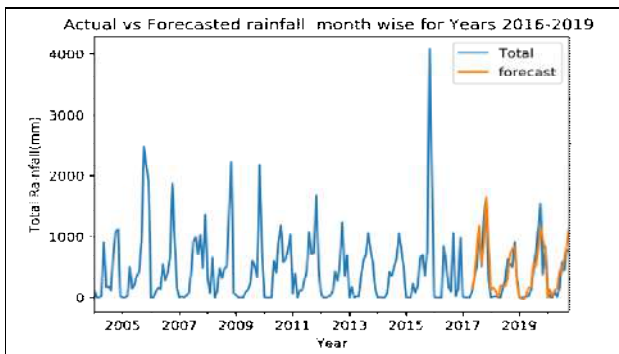
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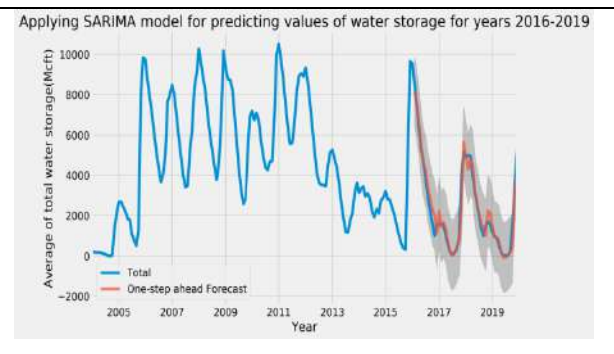


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**Figure 1. Actual versus Forecast Rainfall**

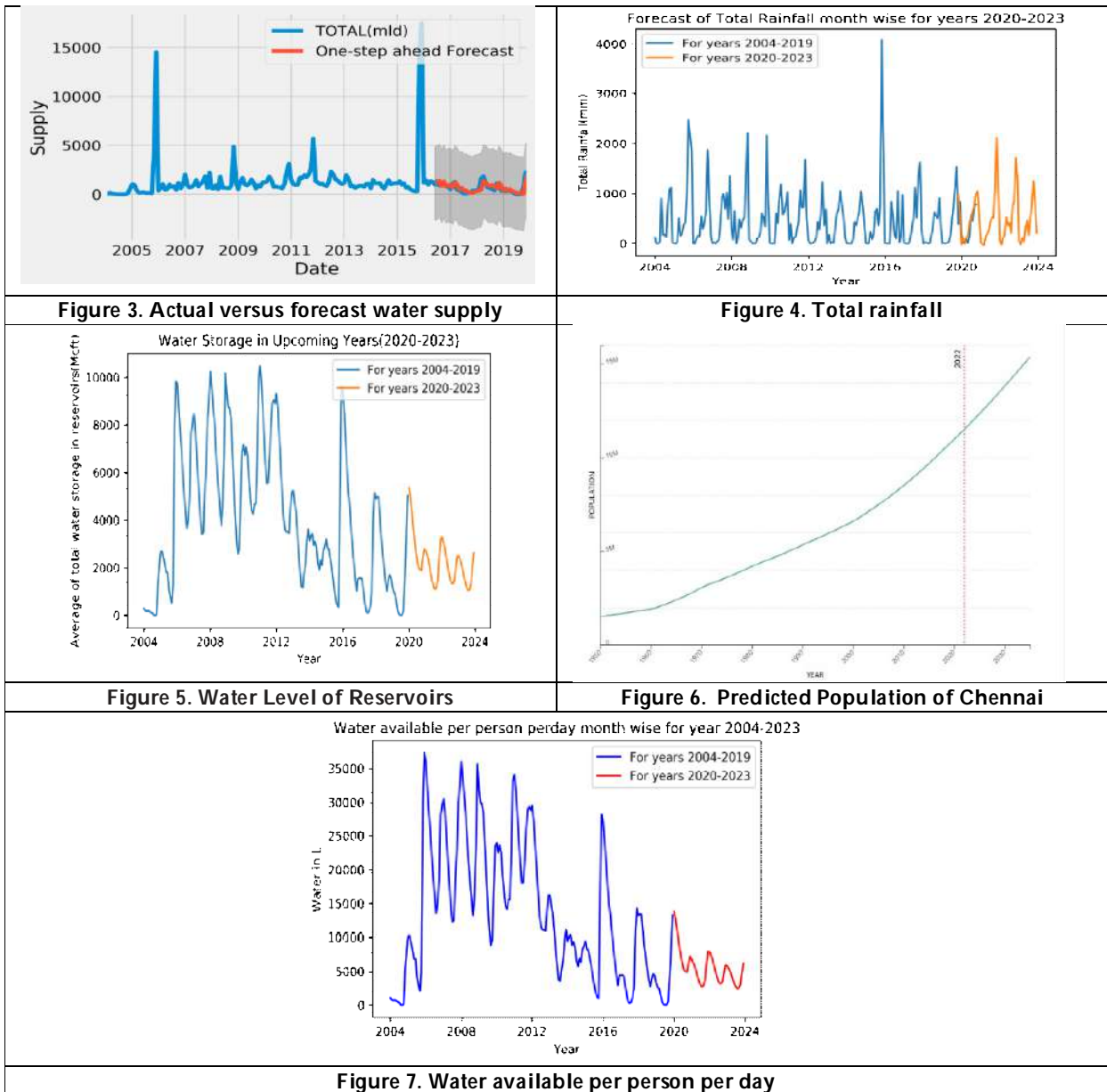


**Figure 2. Actual versus Forecast average water storage of reservoirs**





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## Selection of Medical Waste Disposal Method using MCDM Problems in Neutrosophic Vague Refined Set

A. Angel Marina<sup>1\*</sup> and A. Francina Shalini<sup>2</sup>

<sup>1</sup>Ph.D Research Scholar, Department of Maths, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Maths, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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### \*Address for Correspondence

#### A. Angel Marina

Ph.D Research Scholar,  
Department of Maths,  
Nirmala College for Women,  
Coimbatore, Tamil Nadu, India.  
E. Mail: angelmarinamat2020@gmail.com



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### ABSTRACT

Safety Measures for human health and environmental consideration plays a prime role in this modernized world. Medical Waste Disposal Method is considered as a main concern in hospital management. This paper initiates Weighted Average Operator (WAO) and Weighted Geometric Operator (WGO) of Neutrosophic Vague Refined (NVR) sets which tends to aggregate the neutrosophic vague refined information. New score function is established in order to find out the perspective comparison for neutrosophic vague refined numbers. Eventually, to show its viability and soundness of proposed decision method a numerical example is given depending on the above operators and developed score function which results in selecting the best medical waste disposal method.

**Keywords:** NVR number, NVR weighted average operator, NVR weighted geometric operator, score functions, multi-criteria decision making.

### INTRODUCTION

Classic Fuzzy theory describes only membership function in  $[0,1]$  was made known by Zadeh [1]. By adding the extensions of fuzzy set Atanassov [3] generalized fuzzy idea by introducing a idea in brief namely intuitionistic fuzzy set (IFS). Gau and Buehrer [2] presented the vide idea of another set termed as vague set. F. Smarandache gave an introduction of neutrosophic sets [10] and researchers have initiated different findings regarding neutrosophic set and combining with hybrid structures. By combining two sets namely neutrosophic vague set [4] and neutrosophic refined set[5], A. A. Marina and A. F. Shalini[6] framed the term namely neutrosophic vague refined set and some





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related extensions[11,12]. Usually, the topic considered as most dominant and major research is aggregation operators. Many researchers put effort in working this area and thereby introduced different operators. In practical point of view, multiple attribute decision making (MADM) problems has its major role in IFS and great development have achieved the academic research [7]. Multiple Criteria Fuzzy Decision Making Problems (MCFDMP) on Vague sets was discussed by S.M. Chen *et.al.*, [8]. Ye *et.al.*, [9] proposed single valued neutrosophic hybrid weighted arithmetic operator (SVNHWAO) and single valued neutrosophic geometric aggregation operator (SVNHGAO), single valued neutrosophic hybrid ordered weighted arithmetic Operator (SVNHOWAO) and single valued neutrosophic geometric operator (SVNGO) under single valued neutrosophic(SVN) number information and handle these operators to solve MADM problems. The remaining part of the paper is structured as follows: Sec 2, shortly gives basic approaching concepts of neutrosophic vague refined set. Sec 3, establishes some operators on NVRWA and NVRWG operators using desired set. Sec 4, develops a neutrosophic vague refined MCDM approach which tends in selecting the most preferable one(s). Sec 5, presents a numeric example for better understanding to signify the developed approach. By the by, section 6 provides conclusions with references.

**Preliminaries**

**Definition 2.1[6]**

Let  $\mathbb{U}$  be a non-empty universal set of discourse. A neutrosophic vague refined set (shortly NVRS)  $A$  on  $\mathbb{U}$  is defined as the form

$$A = \{ \langle x, (\hat{\epsilon}_A^1(m), \hat{\epsilon}_A^2(m), \dots, \hat{\epsilon}_A^g(m)), (\hat{\alpha}_A^1(m), \hat{\alpha}_A^2(m), \dots, \hat{\alpha}_A^g(m)), (\hat{\beta}_A^1(m), \hat{\beta}_A^2(m), \dots, \hat{\beta}_A^g(m)) \rangle, m \in \mathbb{U} \}$$

The membership, indeterminacy, non-membership functions of NVR set is defined respectively as,  $\hat{\epsilon}_A^t = [\hat{\epsilon}_A^{t-}, \hat{\epsilon}_A^{t+}]$ ,  $\hat{\alpha}_A^t = [\hat{\alpha}_A^{t-}, \hat{\alpha}_A^{t+}]$ ,  $\hat{\beta}_A^t = [\hat{\beta}_A^{t-}, \hat{\beta}_A^{t+}]$  and  $\hat{\epsilon}_A^{t+} = 1 - \hat{\beta}_A^{t-}$ ,  $\hat{\alpha}_A^{t+} = 1 - \hat{\epsilon}_A^{t-}$  where  $\hat{\epsilon}_A^1(m), \hat{\epsilon}_A^2(m), \dots, \hat{\epsilon}_A^g(m): \mathbb{U} \rightarrow P[0,1]$ ,  $\hat{\alpha}_A^1(m), \hat{\alpha}_A^2(m), \dots, \hat{\alpha}_A^g(m): \mathbb{U} \rightarrow P[0,1]$ ,  $\hat{\beta}_A^1(m), \hat{\beta}_A^2(m), \dots, \hat{\beta}_A^g(m): \mathbb{U} \rightarrow P[0,1]$  such that  $0^- \leq \hat{\epsilon}_A^{t-}(m) + \hat{\alpha}_A^{t-}(m) + \hat{\beta}_A^{t-}(m) \leq 2^+$  and  $0^- \leq \hat{\epsilon}_A^{t+}(m) + \hat{\alpha}_A^{t+}(m) + \hat{\beta}_A^{t+}(m) \leq 2^+$  for  $t=1,2,\dots,g$  for any element  $m \in \mathbb{U}$  and  $P[0,1]$  is denoted as the power set of  $[0,1]$ . Here,  $(\hat{\epsilon}_A^1(m), \hat{\epsilon}_A^2(m), \dots, \hat{\epsilon}_A^g(m)), (\hat{\alpha}_A^1(m), \hat{\alpha}_A^2(m), \dots, \hat{\alpha}_A^g(m)), (\hat{\beta}_A^1(m), \hat{\beta}_A^2(m), \dots, \hat{\beta}_A^g(m))$  is represented as a sequence of membership, sequence of indeterminate and sequence of non-membership of the element respectively. Also,  $g$  is called the dimension of neutrosophic vague refined set  $A$ .

**Remark 2.2[6]**

The arrangement of sequence of membership is in decreasing order. But the sequence of indeterminate and non-membership may not be in increased order or in decreased order.

**Example 2.3[6]**

Let  $\mathbb{U} = \{s, t\}$  be any non-empty set. Then

$$A = \left\{ s, \left[ \begin{array}{l} ([0.1, 0.6], [0.5, 0.8], [0.1, 0.8]), \\ ([0.3, 0.5], [0.8, 0.9], [0.6, 0.8]), \\ ([0.4, 0.9], [0.2, 0.5], [0.2, 0.9]) \end{array} \right], t, \left[ \begin{array}{l} ([0.5, 0.8], [0.3, 0.9], [0.2, 0.5]), \\ ([0.7, 0.8], [0.3, 0.4], [0.2, 0.3]), \\ ([0.2, 0.5], [0.1, 0.7], [0.5, 0.8]) \end{array} \right] \right\}$$

is neutrosophic vague refined subset in  $\mathbb{U}$ .

**Basic Operations for Neutrosophic Vague Refined Set and Its Properties**

**Definition 3.1**

Suppose  $h_1 = \{ \langle (\hat{\epsilon}_{h_1}^1(m), \hat{\epsilon}_{h_1}^2(m), \dots, \hat{\epsilon}_{h_1}^g(m)), (\hat{\alpha}_{h_1}^1(m), \hat{\alpha}_{h_1}^2(m), \dots, \hat{\alpha}_{h_1}^g(m)), (\hat{\beta}_{h_1}^1(m), \hat{\beta}_{h_1}^2(m), \dots, \hat{\beta}_{h_1}^g(m)) \rangle, m \in \mathbb{U} \}$

$h_2 = \{ \langle (\hat{\epsilon}_{h_2}^1(m), \hat{\epsilon}_{h_2}^2(m), \dots, \hat{\epsilon}_{h_2}^g(m)), (\hat{\alpha}_{h_2}^1(m), \hat{\alpha}_{h_2}^2(m), \dots, \hat{\alpha}_{h_2}^g(m)), (\hat{\beta}_{h_2}^1(m), \hat{\beta}_{h_2}^2(m), \dots, \hat{\beta}_{h_2}^g(m)) \rangle, m \in \mathbb{U} \}$

be two NVR number. Therefore, the operations for NVRs are defined as follows:

**Multiplication by Scalar**

$$\lambda h_1 = \langle [1 - (1 - \hat{\epsilon}_1^{i+})^\lambda, 1 - (1 - \hat{\epsilon}_1^{i-})^\lambda], [(\hat{\alpha}_1^{i+})^\lambda, (\hat{\alpha}_1^{i-})^\lambda], [(\hat{\beta}_1^{i+})^\lambda, (\hat{\beta}_1^{i-})^\lambda] \rangle$$





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**Power**

$$h_1^\lambda = \langle [(\hat{\epsilon}_d^{i+})^\lambda, (\hat{\epsilon}_d^{i-})^\lambda], [1 - (1 - \hat{\epsilon}_d^{i+})^\lambda, 1 - (1 - \hat{\epsilon}_d^{i-})^\lambda], [1 - (1 - \hat{\epsilon}_1^{i+})^\lambda, 1 - (1 - \hat{\epsilon}_1^{i-})^\lambda] \rangle$$

**Addition**

$$h_1 + h_2 = \langle [\hat{\epsilon}_d^{i+} + \hat{\epsilon}_2^{i+} - \hat{\epsilon}_d^{i+} \cdot \hat{\epsilon}_2^{i+}, \hat{\epsilon}_d^{i-} + \hat{\epsilon}_2^{i-} - \hat{\epsilon}_d^{i-} \cdot \hat{\epsilon}_2^{i-}], [\hat{\alpha}_d^{i+} \hat{\alpha}_2^{i+}, \hat{\alpha}_d^{i-} \hat{\alpha}_2^{i-}], [\hat{\beta}_1^{i+} \hat{\beta}_2^{i+}, \hat{\beta}_1^{i-} \hat{\beta}_2^{i-}] \rangle$$

**Multiplication**

$$h_1 \cdot h_2 = \langle [\hat{\tau}_1^{i+} \hat{\tau}_2^{i+}, \hat{\tau}_1^{i-} \hat{\tau}_2^{i-}], [\hat{\alpha}_d^{i+} + \hat{\alpha}_2^{i+} - \hat{\alpha}_d^{i+} \cdot \hat{\alpha}_2^{i+}, \hat{\alpha}_d^{i-} + \hat{\alpha}_2^{i-} - \hat{\alpha}_d^{i-} \cdot \hat{\alpha}_2^{i-}], [\hat{\beta}_1^{i+} + \hat{\beta}_2^{i+} - \hat{\beta}_1^{i+} \cdot \hat{\beta}_2^{i+}, \hat{\beta}_1^{i-} + \hat{\beta}_2^{i-} - \hat{\beta}_1^{i-} \cdot \hat{\beta}_2^{i-}] \rangle$$

where  $\lambda > 0$ .

**Definition 3.2: (Proposed Score Function)**

Suppose  $h_1 = \langle (\hat{\epsilon}_{h_1}^1(m), \hat{\epsilon}_{h_1}^2(m), \dots, \hat{\epsilon}_{h_1}^n(m)), (\hat{\alpha}_{h_1}^1(m), \hat{\alpha}_{h_1}^2(m), \dots, \hat{\alpha}_{h_1}^n(m)), (\hat{\beta}_{h_1}^1(m), \hat{\beta}_{h_1}^2(m), \dots, \hat{\beta}_{h_1}^n(m)) \rangle, m \in \mathbb{U}$

$h_2 = \langle (\hat{\epsilon}_{h_2}^1(m), \hat{\epsilon}_{h_2}^2(m), \dots, \hat{\epsilon}_{h_2}^n(m)), (\hat{\alpha}_{h_2}^1(m), \hat{\alpha}_{h_2}^2(m), \dots, \hat{\alpha}_{h_2}^n(m)), (\hat{\beta}_{h_2}^1(m), \hat{\beta}_{h_2}^2(m), \dots, \hat{\beta}_{h_2}^n(m)) \rangle, m \in \mathbb{U}$

be two NVR number. Then, the score function  $Scr(Q)$  of a NVR number are defined as follows:

$$Scr(Q) = \sum_{i=1}^N \left[ \frac{4 + \hat{\epsilon}_i^{i-} + \hat{\epsilon}_i^{i+} - \hat{\alpha}_i^{i-} - \hat{\alpha}_i^{i+} - \hat{\beta}_i^{i-} - \hat{\beta}_i^{i+}}{6N} \right]$$

**Definition 3.3: (Neutrosophic Vague Refined Weighted Average Operator)**

Suppose

$k_j = \langle (\hat{\epsilon}_{k_j}^1(x), \hat{\epsilon}_{k_j}^2(x), \dots, \hat{\epsilon}_{k_j}^n(x)), (\hat{\alpha}_{k_j}^1(x), \hat{\alpha}_{k_j}^2(x), \dots, \hat{\alpha}_{k_j}^n(x)), (\hat{\beta}_{k_j}^1(x), \hat{\beta}_{k_j}^2(x), \dots, \hat{\beta}_{k_j}^n(x)) \rangle, m \in \mathbb{U}$  for  $j = 1, 2, \dots, p$  and  $i = 1, 2, \dots, n$  be a family of NVR numbers. A mapping  $A_\delta: O_n \rightarrow O$  is called neutrosophic vague refined weighted average operator (NVRWAO) if it satisfies

$$A_\delta(k_1, k_2, \dots, k_p) = \sum_{j=1}^p \delta_j k_j$$

$$= \langle [1 - \prod_{j=1}^p \prod_{i=1}^n (1 - \hat{\epsilon}_j^{i+})^{\delta_j}, 1 - \prod_{j=1}^p \prod_{i=1}^n (1 - \hat{\epsilon}_j^{i-})^{\delta_j}], [ \prod_{j=1}^p \prod_{i=1}^n (\hat{\alpha}_j^{i+})^{\delta_j}, \prod_{j=1}^p \prod_{i=1}^n (\hat{\alpha}_j^{i-})^{\delta_j} ], [ \prod_{j=1}^p \prod_{i=1}^n (\hat{\beta}_j^{i+})^{\delta_j}, \prod_{j=1}^p \prod_{i=1}^n (\hat{\beta}_j^{i-})^{\delta_j} ] \rangle$$

where  $\delta_j$  is the weight of  $k_j$  ( $j = 1, 2, \dots, p$ ),  $\delta_j \in [0, 1]$  and  $\sum_{j=1}^p \delta_j = 1$ .

**Theorem 3.4**

Suppose  $k_j = \langle (\hat{\epsilon}_{k_j}^1(x), \hat{\epsilon}_{k_j}^2(x), \dots, \hat{\epsilon}_{k_j}^n(x)), (\hat{\alpha}_{k_j}^1(x), \hat{\alpha}_{k_j}^2(x), \dots, \hat{\alpha}_{k_j}^n(x)), (\hat{\beta}_{k_j}^1(x), \hat{\beta}_{k_j}^2(x), \dots, \hat{\beta}_{k_j}^n(x)) \rangle, m \in \mathbb{U}$  for  $j = 1, 2, \dots, p$  and  $i = 1, 2, \dots, n$  be a family of NVR numbers. Then NVRWAO satisfies the following properties,

**Idempotency:** If  $k_j = k$  for all  $j=1, 2, \dots, p$  then  $A_\delta(k_1, k_2, \dots, k_p) = k$

**Boundedness:**  $\min_{j=1, 2, \dots, p} \{k_j\} \leq A_\delta(k_1, k_2, \dots, k_p) \leq \max_{j=1, 2, \dots, p} \{k_j\}$

**Monotonicity:** If  $k_j \leq k_j^*$  for all  $j = 1, 2, \dots, p$  then,  $A_\delta(k_1, k_2, \dots, k_p) \leq A_\delta(k_1^*, k_2^*, \dots, k_p^*)$

**Definition 3.5: (Neutrosophic Vague Refined Weighted Geometric Operator)**

Let  $k_j = \langle (\hat{\epsilon}_{k_j}^1(x), \hat{\epsilon}_{k_j}^2(x), \dots, \hat{\epsilon}_{k_j}^n(x)), (\hat{\alpha}_{k_j}^1(x), \hat{\alpha}_{k_j}^2(x), \dots, \hat{\alpha}_{k_j}^n(x)), (\hat{\beta}_{k_j}^1(x), \hat{\beta}_{k_j}^2(x), \dots, \hat{\beta}_{k_j}^n(x)) \rangle, m \in \mathbb{U}$  for  $j = 1, 2, \dots, p$  and  $i = 1, 2, \dots, n$  be a family of NVR numbers. A mapping  $G_\delta: O_n \rightarrow O$  is called neutrosophic vague refined weighted geometric operator (NVRWGO) if it satisfies

$$G_\delta(k_1, k_2, \dots, k_p) = \prod_{j=1}^p k_j^{\delta_j}$$

$$= \langle [ \prod_{j=1}^p \prod_{i=1}^n (\hat{\epsilon}_j^{i+})^{\delta_j}, \prod_{j=1}^p \prod_{i=1}^n (\hat{\epsilon}_j^{i-})^{\delta_j} ], [ 1 - \prod_{j=1}^p \prod_{i=1}^n (1 - \hat{\alpha}_j^{i+})^{\delta_j}, 1 - \prod_{j=1}^p \prod_{i=1}^n (1 - \hat{\alpha}_j^{i-})^{\delta_j} ], [ 1 - \prod_{j=1}^p \prod_{i=1}^n (1 - \hat{\beta}_j^{i+})^{\delta_j}, 1 - \prod_{j=1}^p \prod_{i=1}^n (1 - \hat{\beta}_j^{i-})^{\delta_j} ] \rangle$$

where  $\delta_j$  is the weight of  $k_j$  ( $j = 1, 2, \dots, p$ ),  $\delta_j \in [0, 1]$  and  $\sum_{j=1}^p \delta_j = 1$ .





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**Theorem 3.6**

Let  $k_j = \{ \langle (\hat{\epsilon}_{k_1}^1(x), \hat{\epsilon}_{k_2}^2(x), \dots, \hat{\epsilon}_{k_p}^n(x)), (\hat{\alpha}_{k_1}^1(x), \hat{\alpha}_{k_2}^2(x), \dots, \hat{\alpha}_{k_p}^n(x)), (\hat{\beta}_{k_1}^1(x), \hat{\beta}_{k_2}^2(x), \dots, \hat{\beta}_{k_p}^n(x)) \rangle, m \in \mathbb{W} \}$  for  $j = 1, 2, \dots, p$  and  $i = 1, 2, \dots, n$  be a family of neutrosophic vague refined numbers. Then NVRWG satisfies the following properties,

**Idempotency:** If  $k_j = k$  for all  $j=1,2,\dots,p$  then  $G_\delta(k_1, k_2, \dots, k_p) = k$

**Boundedness:**  $\min_{j=1,2,\dots,p} \{k_j\} \leq G_\delta(k_1, k_2, \dots, k_p) \leq \max_{j=1,2,\dots,p} \{k_j\}$

**Monotonicity:** If  $k_j \leq k_j^*$  for all  $j = 1, 2, \dots, p$  then,  $G_\delta(k_1, k_2, \dots, k_p) \leq G_\delta(k_1^*, k_2^*, \dots, k_p^*)$ .

**Multi Criteria Decision Making Method Based On NVRWA Operator & NVRWG Operator**

In this segment, an approach have generated in reference to  $A_\delta$  (or  $G_\delta$ ) operator and the above mentioned ranking method is discussed to handle MCDM problems using NVR information.

Let us take  $U = \{U_1, U_2, \dots, U_p\}$  and  $V = \{V_1, V_2, \dots, V_n\}$  be the set of alternatives and criterions or attributes respectively.

Let  $\delta = (\delta_1, \delta_2, \dots, \delta_p)^T$  be the weight vector of attributes, such that  $\sum_{j=1}^p \delta_j, \delta_j \geq 0$  ( $j = 1, 2, \dots, p$ ) where  $\delta_j$  specified as the weight of attribute  $V_j$ . The decision maker evaluate the alternative on criterions and the evaluation values are described by the form of NVR numbers.

Suppose that  $(k_{ij})_{p \times n} = \langle (\hat{\epsilon}_{k_{ij}}^1, \hat{\alpha}_{k_{ij}}^n, \hat{\beta}_{k_{ij}}^n) \rangle_{p \times n}$  is the decision matrix presented by the decision maker;  $k_{ij}$  is a NVR number for the alternative  $U_i$  associated with the criterions  $V_j$ . Conditions followed as  $(\hat{\epsilon}_{k_{ij}}^1, \hat{\alpha}_{k_{ij}}^n, \hat{\beta}_{k_{ij}}^n), (\hat{\alpha}_{k_{ij}}^1, \hat{\alpha}_{k_{ij}}^2, \dots, \hat{\alpha}_{k_{ij}}^n), (\hat{\beta}_{k_{ij}}^1, \hat{\beta}_{k_{ij}}^2, \dots, \hat{\beta}_{k_{ij}}^n) \in [0, 1]$  such that  $0 \leq \hat{\epsilon}_{k_{ij}}^n + \hat{\alpha}_{k_{ij}}^n + \hat{\beta}_{k_{ij}}^n \leq 2$  for  $i = 1, 2, \dots, n$  and  $j = 1, 2, \dots, p$ .

Now, an algorithm can be proposed as follows.

**Algorithm**

**Step 1.**

Compose the decision matrix presented by the decision maker as;

$$(k_{ij})_{p \times n} = \langle (\hat{\epsilon}_{k_{ij}}^n, \hat{\alpha}_{k_{ij}}^n, \hat{\beta}_{k_{ij}}^n) \rangle_{p \times n}$$

**Step 2.**

Determine  $k_i = A_\delta(k_{i1}, k_{i2}, \dots, k_{in})$  (or  $G_\delta(k_{i1}, k_{i2}, \dots, k_{in})$ ) for each  $i = 1, 2, \dots, n$ .

**Step 3.**

Evaluate the score values of  $Scr(k_i)$  ( $i = 1, 2, \dots, n$ ) for the collection of overall NVR number of  $k_i$  ( $i = 1, 2, \dots, n$ ).

**Step 4.**

Ranking all the software systems of  $V_i$  ( $i = 1, 2, \dots, n$ ) in accord to the score values.

Now, illustrative example can be given as follows:

**Illustrative Example**

This example portrays the procedure of proposed decision to a MCDM problem in the wide area of Medical Management. Nowadays, various type of diseases spread unpredictably and there should be a necessary process to prevent against it. Commonly, waste is a risk factor which affects the biodiversity. Therefore, Medical disposal waste destroys the environment and the resulting infections spread dangerous disease to another organisms. Due to the effect of contagious medical discharge from the hospital environment, various kind of germs may produce in numbers and cause huge loss for the life of human being. These infections are dangerous to humans but to the plants





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and animals. There should be the best method to overcome those infectious diseases which is induced by infectious germs.

The main intention of the proposed decision structure is mainly to find out the best procedure to dispose the medical waste.

Let us consider evaluation criterion as:

$U_1$  = Technical,

$U_2$  = Economic,

$U_3$  = Social,

$U_4$  = Environmental.

and the disposal methods as:

$V_1$  = Autoclaving,

$V_2$  = Incineration,

$V_3$  = Microwaving,

$V_4$  = Land Disposal.

Using the neutrosophic vague refined values, four possible alternatives are evaluated  $U_j$  ( $j = 1, 2, 3, 4$ ) which come under above four attributes. Also, the weight vector of the attributes  $V_i$  ( $i = 1, 2, 3, 4$ ) is  $\omega = (0.1, 0.2, 0.3, 0.4)^T$ .

**Step 1.** Compose the decision matrix presented by the expert as:

**Step 2.** Determine  $k_i = A_{\delta}(k_{i1}, k_{i2}, k_{i3}, k_{i4})$  for each  $i = 1, 2, 3, 4$  as:

$$k_1 = \begin{bmatrix} ([0.2961, 0.4230], [0.2981, 0.6111], [0.3108, 0.3958]), \\ ([0.3923, 0.4677], [0.2670, 0.5030], [0.3322, 0.3798]), \\ ([0.5770, 0.7039], [0.6111, 0.7019], [0.6042, 0.6892]) \end{bmatrix}$$

$$k_2 = \begin{bmatrix} ([0.2366, 0.3423], [0.2763, 0.3758], [0.2176, 0.3293]), \\ ([0.3542, 0.5123], [0.3000, 0.4472], [0.2421, 0.4178]), \\ ([0.6928, 0.7634], [0.6242, 0.7237], [0.6707, 0.7825]) \end{bmatrix}$$

$$k_3 = \begin{bmatrix} ([0.3213, 0.5102], [0.2808, 0.3966], [0.3881, 0.4537]), \\ ([0.1479, 0.4444], [0.2627, 0.4444], [0.3327, 0.5761]), \\ ([0.4898, 0.6788], [0.6035, 0.7354], [0.5463, 0.6285]) \end{bmatrix}$$

$$k_4 = \begin{bmatrix} ([0.3080, 0.4158], [0.1559, 0.4067], [0.2878, 0.4643]), \\ ([0.1335, 0.1943], [0.2518, 0.3315], [0.3799, 0.4874]), \\ ([0.5843, 0.6920], [0.5933, 0.8441], [0.5357, 0.7122]) \end{bmatrix}$$

**Step 3.** Evaluate the score values of  $Scr(k_i)$  ( $i = 1, 2, \dots, n$ ) for the collection of overall NVR number of ( $i = 1, 2, \dots, n$ ).

$S(k_1) = 0.0642$

$S(k_2) = 0.0830$

$S(k_3) = 0.0524$

$S(k_4) = 0.0487$

**Step 4.** Ranking all the software systems of  $V_i$  ( $i = 1, 2, \dots, n$ ) in accord to the score values as:

$V_2 > V_1 > V_3 > V_4$

The following graph shows the differences in the score values of each attribute for  $i = 1, 2, 3, 4$ .

Thus  $2$  is the most desirable alternative. On various methods, **Incineration method** is considered as the most feasible method in safely disposal of medical waste.







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**CONCLUSION**

A Speedy development in the universe and the upgraded explosion towards the medical care have a spectacular increase in number of medical waste all over the worldwide. Inappropriately disposed and handled medical waste creates high risk in remarkable threat of infection including exposed danger to the hygiene of an individual by spreading bacteria and virus. Therefore, a right treatment and proper disposal of medical waste has turn into a trouble for many authorities. This paper aggregates NVR information using  $A_\delta$  and  $G_\delta$  operators. Also, score function for neutrosophic vague refined set has been introduced. Moreover, depending on  $A_\delta$  and  $G_\delta$  operators and the score functions, a MCDM approach have developed and takes the form of NVR numbers. Finally, to demonstrate the above application and to show the usage of the developed method, a numerical example of this method was given. As a result, appropriate disposal method is considered as incineration. This resulting method has its advantage in notable reduction of wastage volumes.

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**Table 1.: Decision Matrix**

	$U_1$	$U_2$	$U_3$	$U_4$
$V_1$	$([0.1,0.3],[0.3,0.4],$ $[0.7,0.9]),$ $([0.3,0.3],[0.2,0.5],$ $[0.7,0.7]),$ $([0.4,0.5],[0.5,0.5],$ $[0.5,0.6])$	$([0.2,0.4],[0.3,0.4],$ $[0.6,0.8]),$ $([0.1,0.2],[0.3,0.5],$ $[0.8,0.9]),$ $([0.3,0.5],[0.4,0.5], [0.5,0.7])$	$([0.4,0.5],[0.5,0.5],$ $[0.5,0.6]),$ $([0.5,0.5],[0.4,0.4],$ $[0.5,0.5]),$ $([0.3,0.4],[0.2,0.2],$ $[0.6,0.7])$	$([0.3,0.4],[0.4,0.5],$ $[0.6,0.7]),$ $([0.2,0.4],[0.2,0.6],$ $[0.6,0.8]),$ $([0.3,0.3],[0.4,0.5],$ $[0.7,0.7])$
$V_2$	$([0.4,0.4],[0.5,0.6],$ $[0.6,0.6]),$ $([0.3,0.3],[0.3,0.4],$	$([0.2,0.2],[0.3,0.5],$ $[0.8,0.8]),$ $([0.5,0.5],[0.3,0.5],$	$([0.1,0.2],[0.3,0.4],$ $[0.8,0.9]),$ $([0.3,0.5],[0.3,0.5],$	$([0.3,0.4],[0.5,0.6],$ $[0.6,0.7]),$ $([0.1,0.2],[0.3,0.4],$





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	[0.7,0.7]), ([0.2,0.4],[0.3,0.6], [0.6,0.8])	[0.5,0.5]), ([0.4,0.5],[0.3,0.4], [0.5,0.6])	[0.5,0.7]), ([0.1,0.2],[0.1,0.3], [0.8,0.9])	[0.8,0.9]), ([0.2,0.3],[0.4,0.5], [0.7,0.8])
$V_3$	([0.3,0.6],[0.2,0.4], [0.4,0.7]), ([0.2,0.2],[0.1,0.3], [0.8,0.8]), ([0.3,0.3],[0.3,0.4], [0.7,0.7])	([0.4,0.4],[0.5,0.6], [0.6,0.6]), ([0.3,0.5],[0.5,0.5], [0.5,0.7]), ([0.2,0.5],[0.1,0.6], [0.5,0.8])	([0.3,0.4],[0.1,0.2], [0.6,0.7]), ([0.1,0.2],[0.1,0.4], [0.8,0.9]), ([0.3,0.4],[0.6,0.6], [0.6,0.7])	([0.3,0.6],[0.1,0.3], [0.4,0.7]), ([0.4,0.5],[0.5,0.5], [0.5,0.6]), ([0.5,0.5],[0.4,0.6], [0.5,0.5])
$V_4$	([0.3,0.3],[0.2,0.3], [0.7,0.7]), ([0.4,0.5],[0.5,0.5], [0.5,0.6]), ([0.2,0.4],[0.2,0.3], [0.6,0.8])	([0.1,0.3],[0.3,0.4], [0.7,0.9]), ([0.2,0.4],[0.4,0.4], [0.6,0.8]), ([0.1,0.1],[0.2,0.3], [0.9,0.9])	([0.3,0.4],[0.1,0.1], [0.6,0.7]), ([0.1,0.5],[0.2,0.5], [0.5,0.9]), ([0.4,0.6],[0.5,0.6], [0.4,0.6])	([0.4,0.5],[0.1,0.2], [0.5,0.6]), ([0.1,0.3],[0.2,0.2], [0.7,0.9]), ([0.3,0.5],[0.5,0.6], [0.5,0.7])





## Formulation and Standardization of Immune Booster Drink for the Stabilization and Strengthening of Immune System

Naveena S<sup>1</sup> and Hema T. H<sup>2\*</sup>

<sup>1</sup>Post Graduate Student, Department of Clinical Nutrition, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University) Porur, Chennai, Tamil Nadu -600116, India.

<sup>2</sup>Lecturer, Department of Clinical Nutrition, Faculty of Allied Health Sciences, Sri Ramachandra Institute of Higher Education and Research, Porur, Chennai, Tamil Nadu -600116, India.

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### \*Address for Correspondence

**Hema T.H**

Lecturer, Department of Clinical Nutrition,  
Faculty of Allied Health Sciences,  
Sri Ramachandra Institute of Higher Education and Research,  
Porur, Chennai, Tamil Nadu -600116, India.  
E. Mail: hema@sriramachandra.edu.in



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### ABSTRACT

Improved immunity leads to a healthy and a disease-free life. In today's world, Nutrition plays a major role in providing immunity to an individual. This paper focuses on essential nutrients for improving the immunity, the action of specific nutrients in creating an immune response. Based on the immune booster nutrients identified, an Immune Booster drink is being formulated and standardized followed by sensory and nutrient analysis. The selection criteria of the ingredients and formulation of the recipe from the selected ingredients are also discussed further. The Nutrient value of the immune booster drink before preparation is calculated using the IFCT generated values which is compared with the nutrient analysis of the same after preparation by an ISO Accredited Laboratory. A mathematical model is formulated based on the interrelationship of immunity, obesity and activeness of an individual. The aim of this study is to formulate and standardize an Immune Booster Drink for the Stabilization and Strengthening of Immune system. To formulate and standardize an Immune Booster Drink, to evaluate the sensory characteristics of developed product, to analyze the nutrient composition of the formulated immune booster drink. The study concluded that the taste attribute received the lowest mean score which was  $8.8 \pm 0.16$  whereas the other five attributes like appearance, colour, texture, flavour and overall acceptability received the highest mean score comparatively which was  $8.9 \pm 0.09$ .

**Keywords:** IFCT, ISO Accredited laboratory, Nutrient Analysis, Immunity, Nutrition





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## INTRODUCTION

Lindsay B. Nicholson [2016]. states that all organisms in this world are linked to each other in one way or another. Each organism starting from the microorganism till human beings has an immune system which helps in protecting themselves from any kind of disease or infections. [14]. David D. Chaplin [2010]. refers to a point that immunity plays a major role in helping the host to get rid of pathogens or foreign substances from entering into the body and thereby prevents occurrence of any kind of fatal conditions or any kind of disorders. The immune system acquires various mechanisms for the production of immune response and the probability of incidence of a disease or disorder is more when there is a disturbance in the working of immune system thereby leading to reduction in the immune response. [4]. Kirthana Ganeshan *et. al.*, [2014]. describes that for a proper life sustenance of an individual the immune system systematically senses each time a pathogen enters the body thereby secreting some substances in order to prevent the entry of pathogen. Some of the substances secreted by the individual in response to the entry of the pathogen includes Chemokines, Cytokines and some of the Inflammatory mediators by the Innate immune cells. These innate immune cells in addition to secretion of substances also extends in activating the adaptive immune system. Proper nutrition plays an important role in activating the immune response in two different ways. Firstly, Production of ATP is essential for maintenance of various cellular functions in the individual. Proper nutrition helps in producing substrates for the ATP production thereby leading to better immune response. Secondly, Proper nutrition will help in synthesis and activation of macromolecules such as Energy, Protein, Carbohydrate, RNA and DNA thereby leading to activation of immune cells resulting in modulation of the immune response. [13].

## LITERATURE REVIEW

Philip C. Calder *et.al.*, [2020].concluded from a study that nutrients are essential in improving the immunity, preventing the entry of pathogen and also in maintaining the immunity thereby preventing further infections and inflammations of organs. Some of the vitamins like Vitamin A, Vitamin C, Vitamin D, Vitamin E and trace elements like zinc is essential for maintenance of proper immune response. When these vitamins are being deficient, it will lead to compensation of immunity and production of reduced immune response. Vitamin C helps in reducing the incidence and severity of upper respiratory tract infections especially cough, cold and flu. Vitamin D administration helps in reducing respiratory infections. Administering Vitamin E helps in improving T cell mediated immune function thereby increasing the production of antibodies and improving the immunity. Deficiency of zinc leads to impairment of activation of lymphocytes thereby disturbing the cellular immunity. [23]. Adrian F. Gombart *et.al.*, [2020]. concludes from a study that multiple micronutrients like Vitamin A, Vitamin D, Vitamin E, Vitamin B6, Vitamin B12, iron, selenium and zinc are essential for the regulation of the immunomodulatory response. Vitamin A is useful in production of intestinal immune response, also helps in reducing the effects of ROS. Vitamin D especially calcitriol will help in modulating different kinds of antimicrobial proteins thereby producing intestinal microbiota for a healthier composition and also helps in protecting the lungs against any kind of infections. Vitamin C helps in promoting the synthesis of collagen and also helps in protecting cell membranes from various damages which is caused by free radicals, thereby also maintaining the integrity of epithelial barriers. Vitamin E helps in protecting all the cell membranes from various damage caused by free radicals thereby supporting and maintain the integrity of the cell membranes [2].

Muhammad Sajid Arshad *et.al.*, [2020]. conducted a mini review which specifies the importance of plant-based foods for improving the immunity especially for fighting against Covid – 19. Importance and benefits of plant-based foods was discussed which helped in concluding that plant-based foods will help in creation of more of beneficial bacteria in the intestine. The plant-based foods are rich in minerals like zinc, magnesium and also certain micronutrients. Along with a proper lifestyle, when the specific plant-based foods rich in the above nutrients mentioned are being consumed, then proper level of immunity is being provided to fight against Covid 19. [19]. Dharmendra Kumar Maurya *et. al.*, [2020]. conducted a study expressing on a point that the authors evaluate on the importance of certain





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phytochemicals and pharmacological agents by using certain approaches or methods like molecular dynamics and molecular docking methods especially in some Indian herbs which is helpful in preparing various ayurvedic supplements especially in the form of kadha which helps majorly in treating respiratory disorders like cold, cough and flu. This study will help in concluding with a list of phytochemicals that will help in preventing the entry of COVID -19 which will help in preventing further inflammations. [5].

**MATERIALS AND METHODS**




**Acquisition of Ingredients**

Initially, the nutrients that are essential for boosting the immunity is being identified. Then the ingredients that are rich in the specific nutrients that are identified as immune boosters are listed. Out of all the ingredients, the ingredients which has the highest level of immune booster nutrients is selected. Then all the ingredients are utilized in formulating a new recipe which is easy to prepare, not much time consuming and made in such a way that the ingredients utilized are cost effective and affordable. Some of the ingredients which are selected for the formulation of the recipe includes Ginger, Mint leaves, Tulsi Leaves, Cumin Seeds, Cinnamon Powder, Pepper Powder, Turmeric Powder, Honey, Lemon Juice, Cucumber and Amla.

**Criteria for the Selection of the Recipe**

- Nutrient content of the recipe
- Availability of the ingredients
- Accessibility of the ingredients
- Ease in the preparation of the recipe




**Why These Ingredients Are Being Chosen**




NAME OF THE INGREDIENT UTILISED	IMMUNE BOOSTING NUTRIENT PRESENT	PROPERTIES OF THE INGREDIENT	PICTURES OF THE INGREDIENT
Ginger	Vitamin C	<ul style="list-style-type: none"> <li>• Supports <b>healthy human system</b>, helps relieve tension and headaches.</li> <li>• <b>Gingerol</b>, a component present in ginger has an <b>anti-obesity effect</b>, helping food to digest faster and stimulate the body to speed digested food through the colon(7).</li> </ul>	
Tulsi	Vitamin C, Zinc	<ul style="list-style-type: none"> <li>• Increases the <b>T helper cells and Natural Killer cells</b> boosting the Immunity.</li> <li>• Tulsi leaves help to <b>accelerate</b> body's <b>metabolism</b>.</li> <li>• The faster your metabolism, the easier it is to burn calories.</li> <li>• Tulsi also helps boost digestion naturally and eliminates toxins from your body(8).</li> </ul>	
Mint	Vitamin C, D, E and A	<ul style="list-style-type: none"> <li>• Mint leaves <b>improves</b> the body's immune system, protects the cells from any damage.</li> <li>• Mint <b>stimulates digestive enzymes</b>, which help facilitate <b>better absorption of nutrients from food</b>.</li> <li>• When the body is able to assimilate nutrients properly, your metabolism improves. A faster metabolism aids weight loss(9).</li> </ul>	





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NAME OF THE INGREDIENT UTILISED	IMMUNE BOOSTING NUTRIENT PRESENT	PROPERTIES OF THE INGREDIENT	PICTURES OF THE INGREDIENT
Cinnamon	Vitamins B, K, antioxidants choline, beta-carotene, alpha-carotene, beta-cryptoxanthin, lycopene, lutein.	<ul style="list-style-type: none"> <li>The antioxidants in cinnamon have anti-inflammatory effects, which may help lower the risk of disease, also aids in weight loss(10).</li> </ul>	
Cumin Seeds	Vitamin A, E, C, K	<ul style="list-style-type: none"> <li>Cumin has the potential for helping you lose weight because of a <b>unique active ingredient — thymoquinone, a naturally occurring chemical that has antioxidant and anti-inflammatory properties.</b></li> <li>Thymoquinone can <b>target free radicals in your body</b>, assisting your body in cleansing itself of toxins. <b>cumin seeds are beneficial for fat reduction and weight loss(11).</b></li> </ul>	
Cucumber	Vitamin A, B, C, K	<ul style="list-style-type: none"> <li>The <b>water content and Vitamin C</b> present in cucumber can arrest the spread of damaged cells in the body.</li> <li>The <b>antioxidants</b> in cucumber will <b>fight inflammation</b> by boosting the immune effects of the body(12).</li> </ul>	

NAME OF THE INGREDIENT UTILISED	IMMUNE BOOSTING NUTRIENTS PRESENT	PROPERTIES OF THE INGREDIENT	PICTURES OF THE INGREDIENT
Black Pepper	Vitamin C, E, A, K	<ul style="list-style-type: none"> <li>The spice is loaded with <b>antibacterial and anti-inflammatory properties</b> that help keep infections away and thus works wonder in boosting our immunity.</li> <li>Pepper helps in <b>reducing fatty acids, triglycerides, phospholipids and cholesterol</b> level in the plasma and lipid profile(13).</li> </ul>	
Turmeric Powder	Vitamin C	<ul style="list-style-type: none"> <li>Traditionally known for its an <b>anti-inflammatory effects, curcumin</b> is a potent immunomodulatory agent that can modulate the <b>activation of T cells, B cells, macrophages, neutrophils, natural killer cells, and dendritic cells.</b></li> <li>It also helps in <b>emulsifying fat</b> and its metabolism(14).</li> </ul>	
Amla	Vitamin C	<ul style="list-style-type: none"> <li>It is the richest source of vitamin c, which boosts the <b>production of white blood cells</b> in the body that help in fighting several infections.</li> <li>Amla helps in <b>increasing the metabolism rate.</b></li> <li>The faster the metabolism, the faster you'll lose weight.</li> <li>With the <b>presence of fibre</b> in the amla, <b>bowel movement becomes easier</b> and it helps in <b>eliminating constipation</b>, helps in digestion and improves gut health(15).</li> </ul>	





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NAME OF THE INGREDIENT UTILISED	IMMUNE BOOSTING NUTRIENTS PRESENT	PROPERTIES OF THE INGREDIENT	PICTURES OF THE INGREDIENT
Lemons	Vitamin C	<ul style="list-style-type: none"> <li>Lemons are an excellent source of vitamin C and flavonoids, which are antioxidants.</li> <li>Antioxidants help remove free radicals that can damage cells from the body.</li> <li>Lemons also have diuretic properties, which help in detoxifying the body, thereby helping burning fat(16).</li> </ul>	
Honey	Ascorbic acid, pantothenic acid, niacin and riboflavin; along with minerals such as calcium, copper, iron, magnesium, manganese, potassium and zinc.	<ul style="list-style-type: none"> <li>The phytonutrients in honey are responsible for its antioxidant properties, as well as its antibacterial and antifungal power.</li> <li>Honey acts as a fuel to make the liver produce glucose.</li> <li>This glucose keeps the brain sugar levels high and forces it to release fat burning hormones(17).</li> </ul>	

Standardization of the Immune Booster Drink

RECIPE NAME	INGREDIENTS	STANDARDIZED QUANTITY
Immune Booster Drink	Ginger	10 grams
	Mint Leaves	5 grams
	Tulsi Leaves	5 grams
	Cumin seeds	5 grams
	Cinnamon Powder	1 gram
	Pepper Powder	2 grams
	Turmeric Powder	1 gram
	Cucumber	100 grams
	Amla	15 grams
	Honey	15 ml
	Lemon Juice	10 ml

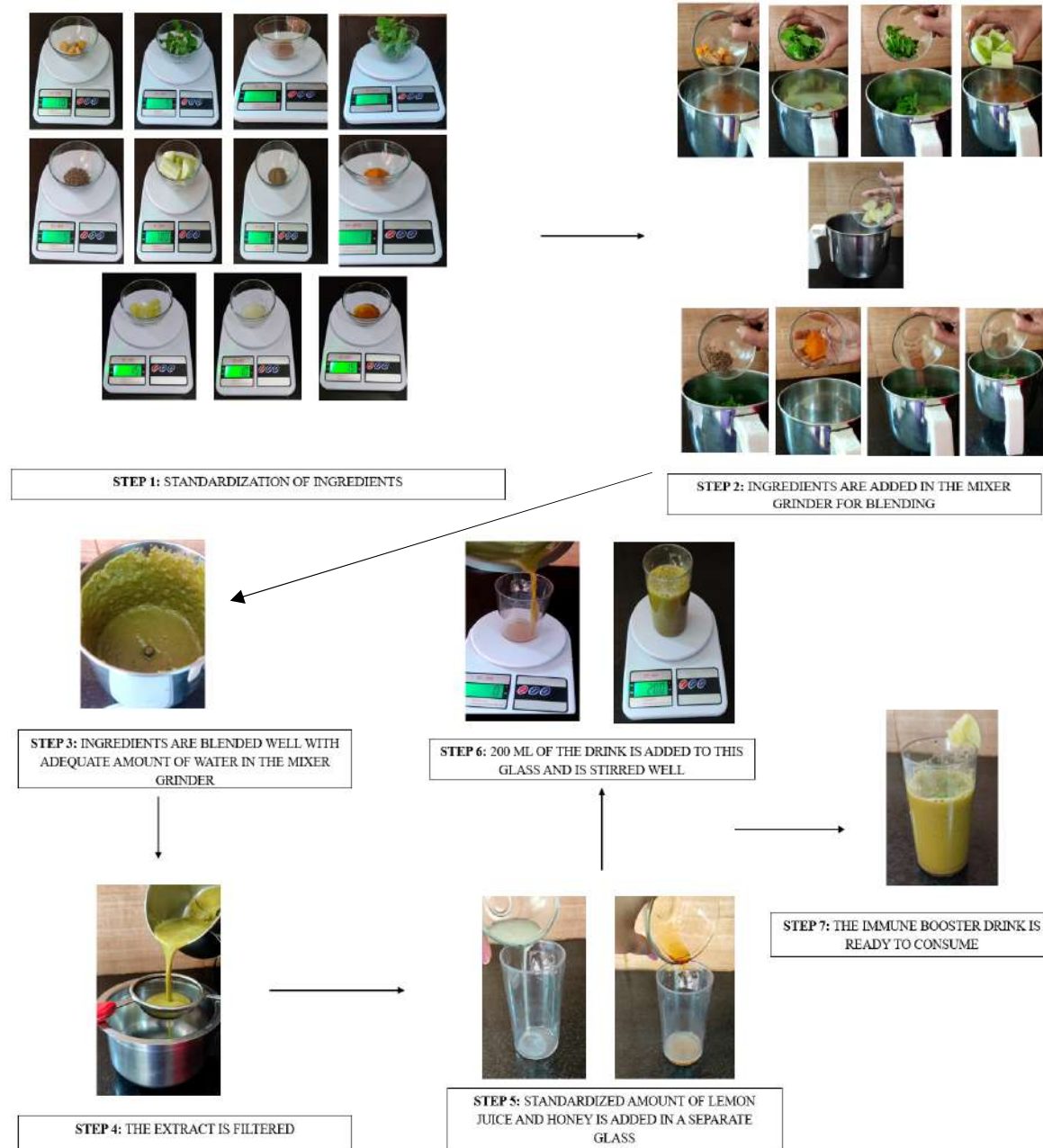




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### Formulation of the Recipe

The schematic flowchart representation of the recipe being formulated is shown as follows



### Sensory Analysis

The recipe was evaluated to assess the overall palatability. The sensory analysis was done by nutritionists who were 30 in number and consumers who were 50 in number. The sensory evaluation was done with the help of a 9-point hedonic scale where the score 9 implies that the evaluator extremely likes the product and the score 1 implies that the evaluator extremely dislikes the product. The recipes were calculated on the basis of six criteria like taste, appearance, texture, colour, flavour and overall acceptability.





**Naveena and Hema****Nutrient Analysis**

Nutrients like Energy, Protein, CHO, Fat, Vitamin C, Vitamin E, Vitamin A, Vitamin D and Zinc were evaluated for the formulated recipe. Before the formulation, the nutrients were analysed with the help of the IFCT calculated Values [2017]. The formulated product was given to an ISO accredited Laboratory to be nutritionally analysed, where nutritional analysis of Protein was carried out by Kjeldahl method, Carbohydrate and Fat by the gravimetric method, Vitamin C and Vitamin A by the UV Spectroscopic method, Vitamin D and Vitamin E by the High-Performance Liquid Chromatography [HPLC]. Method and Zinc by Atomic Absorption Spectroscopy [AAS]. method.

**Cost Analysis**

Cost of the formulated product per 200 ml was calculated based on the cost of individual ingredients used in the formulation of the recipe. The total cost included the overhead cost like the electricity cost, labour cost etc.

**Statistical Analysis**

The statistical analysis was regulated by accumulating all the details obtained from the organoleptic evaluation and nutrient analysis which is expressed with the aid of parameters like mean and standard deviation.

**Performance Analysis**

The performance analysis is conducted where the details of the already existing proposal is compared with the proposed formulated product. In this paper, the mean values are being compared with the existing proposal to the mean values of the proposed formulated product.

**Mathematical Model**

This paper deals with the formulation of a mathematical model which will provide with the information in regard to the interrelationship between immunity, obesity and activeness of an individual in relation to the consumption of the immune booster drink.

**RESULTS AND DISCUSSION****The Formulated Recipe and its Standardized ingredients**

The above table 1 depicts the ingredients used in formulating the recipe and the standardized amount of ingredients in preparing the formulated immune booster drink.

**Mean Sensory Scores of Immune Booster Drink [N = 80].**

Ten Judges were made to evaluate the formulated product – Immune Booster Drink where 30 of them were Nutritionists who are trained in the field of nutrition and the rest 50 of them were Consumers who are not trained in the field of nutrition. From the Table 2, it is well understood that Appearance, Colour, Texture, Flavour and Overall Acceptability received the highest mean scores [8.9 ± 0.09], when compared to Taste which received the least mean scores comparatively [8.8 ± 0.16].

**Diagrammatic Representation of Organoleptic Evaluation of the Formulated Recipe**

Diagrammatic representation in the form of bar chart is depicted in the Fig-1. From the above diagramme, it is well understood that taste has the least amount of mean value scores [8.8]. when compared to appearance, colour, texture, flavour and overall acceptability which has the highest level of mean scores [8.9].

**Nutritional value of the immune booster drink – before preparation [IFCT calculated values].**

The Table 3 Depicts the ingredients used in the formulated recipe, the standardized quantities of ingredients that are used in the formulated recipe and the nutritional values of all the standardized ingredients which are calculated with the aid of IFCT values.





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#### **Nutritional value of the immune booster drink – after preparation [nutritional analysis values].**

The Table 4 Depicts the values obtained for each nutrient after the formulated product is being nutritionally analyzed.

#### **Comparison of the Nutritional Value**

The Table 6 Depicts the difference between the IFCT Calculated values and Nutrient analysis values. From the table, it is observed that there was a loss of 4.88 Kcals of Energy, gain of 23.9 grams of protein, loss of 23.22 grams of Carbohydrate, loss of 0.71 grams of fat, loss of 68.77 mg of Vitamin C, gain of 4.01 mg of Vitamin E, loss of 0.67 mcg of Vitamin D, gain of 8.74mcg of Vitamin A and gain of 8.91 grams of Zinc. The reasons for the loss of nutrients might be due to oxidation, loss of nutrients during the process of filtering, or loss of heat liable nutrients due to the heat generated during the process of blending in the mixer grinder.

#### **Performance Analysis**

##### **Performance Analysis with respect to Mean**

##### **Foot Note**

The Existing Product was taken from the article in the name of “Development and evaluation of polyherbal formulation as energy booster”, Journal of Pharmacognosy and Phytochemistry, vol. 7, no. 3, 2018. The Table 5 Depicts the comparison between the mean values of an existing immune booster powder with the mean value of the proposed formulated product. From the above table, it is well understood that the mean value of the formulated product that is proposed is higher than the mean value of the existing immune booster powder. The diagrammatic representation is depicted in the form of bar chart for comparison between the mean values of the existing immune booster powder and the formulated product that is proposed as Fig-2.

#### **COST ANALYSIS-Total Cost – Rs. 20.00 [Inclusive of overhead costs].**

#### **Mathematical Model**

Let the state of human before consuming Immune drink = i [Individual].

Let the consumption of Immune drink = x

Let the state of energy in human = y

Let the state of obesity = z

Let the state of human after consuming Immune drink = hp [healthy person].

$$x + i = i + y \quad \text{_____} \quad [1].$$

$$x + i = i - z \quad \text{_____} \quad [2].$$

Combining Equation [1]. & [2].

$$x + i = i + y - z \quad \text{_____} \quad [3].$$

$$x + i = hp \quad \text{_____} \quad [4]$$

## **CONCLUSION**

The study concludes that the immune booster drink being formulated has highly acceptable characteristics including sensory characteristics and has adequate amount of nutrients which can also be availed at an affordable cost. The immune booster drink is being formulated with the standardized level of ingredients. The immune booster drink as a result is made from ingredients that consists of immune booster nutrients that are analysed both sensorily and nutritionally. The immune booster drink is mainly formulated with the objective of increasing the immunity and overall health of an individual. The immune booster drink has good amount of nutrients including all the macronutrients like Energy, Protein, CHO, Fat and Micronutrients like Vitamin C, E, D, A and minerals like Zinc. A mathematical model is also being proposed explaining the benefits of consuming the formulated immune booster drink in increasing the energy and activity levels of an individual and helping in the weight loss of an individual





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thereby explaining the positive interrelationship of activity, immunity, and obesity on consuming the formulated immune booster drink.

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**Table 1 : The Formulated Recipe And Its Standardized ingredients**

RECIPE NAME	INGREDIENTS	STANDARDIZED QUANTITY
Immune Booster Drink	Ginger	10 grams
	Mint Leaves	5 grams
	Tulsi Leaves	5 grams
	Cumin seeds	5 grams
	Cinnamon Powder	1 gram
	Pepper Powder	2 grams
	Turmeric Powder	1 gram
	Cucumber	100 grams
	Amla	15 grams
	Honey	15 ml
Lemon Juice	10 ml	

**Table 2 : Sensory Evaluation**

S.NO.	CRITERIA	MEAN ± SD
1.	Taste	8.8 ± 0.16
2.	Appearance	8.9 ± 0.09
3.	Colour	8.9 ± 0.09
4.	Texture	8.9 ± 0.09
5.	Flavour	8.9 ± 0.09
6.	Overall acceptability	8.9 ± 0.09





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**Table 3 : Nutritional Value Of The Immune Booster Drink – Beforepreparation [Ifct Calculated Values].**

RECIPE NAME	INGREDIENTS	QUANTITY	ENERGY [Kcals].	PROTEIN [grams].	CHO [grams].	FAT [grams].	VITAMIN C [mg].	VITAMIN E [mg].	VITAMIN D [mcg].	VITAMIN A [mcg].	ZINC [mg].
Immune Booster Drink	Ginger	10 grams	5.5	0.22	0.9	0.09	0.54	0.03	0.41	1.48	0.04
	Mint Leaves	5 grams	1.85	0.23	0.12	-	0.86	-	0.17	38.35	-
	Tulsi Leaves	5 grams	1.15	0.16	0.13	0.03	0.9	-	-	-	0.81
	Cumin Seeds	5 grams	15.22	0.7	1.13	0.83	-	0.07	0.61	0.74	0.21
	Cinnamon Powder	1 gram	2.47	0.04	0.81	0.01	0.04	0.02	-	1.77	0.02
	Pepper Powder	2 grams	4.35	0.2	0.72	0.05	-	0.03	0.51	2.56	0.02
	Turmeric Powder	1 gram	2.81	0.08	0.49	0.05	-	0.03	0.19	0.09	0.03
	Cucumber	100 grams	19.6	0.71	3.48	0.16	6.11	0.02	1.26	0.89	0.17
	Amla	15 grams	54.6	0.16	13.41	0.04	90	-	-	1.35	-
	Honey	15 ml	47.85	0.05	11.93	-	-	-	-	-	-
Lemon Juice	10 ml	3.66	0.04	0.7	0.08	4.82	0.01	0.02	0.04	0.01	
TOTAL			<b>159.06</b>	<b>2.59</b>	<b>33.82</b>	<b>1.34</b>	<b>103.27</b>	<b>0.21</b>	<b>3.17</b>	<b>47.24</b>	<b>1.31</b>

**Table 4. Nutritional value of the immune booster drink – after preparation [nutritional analysis values].**

RECIPE NAME	QUANTITY	NUTRIENTS	NUTRIENT ANALYSIS VALUE
Immune Booster Drink	200 ml	Energy [Kcals].	154.18
		Protein [grams].	26.49
		CHO [grams].	10.60
		Fat [grams].	0.63
		Vitamin C [mg].	34.5
		Vitamin E [mg].	4.22
		Vitamin D [mcg].	2.5
		Vitamin A [mcg].	55.98
		Zinc [mg].	10.22

**Table 5 Comparison Of The Nutritional Value**

RECIPE NAME	QUANTITY	NUTRIENTS	IFCT CALCULATED VALUES	NUTRIENT ANALYSIS VALUE	DIFFERENCE
Immune Booster Drink	200 ml	Energy [Kcals].	159.06	154.18	-4.88
		Protein [grams].	2.59	26.49	+23.9
		CHO [grams].	33.82	10.60	-23.22
		Fat [grams].	1.34	0.63	-0.71
		Vitamin C [mg].	103.27	34.5	-68.77
		Vitamin E [mg].	0.21	4.22	+4.01
		Vitamin D [mcg].	3.17	2.5	-0.67
		Vitamin A [mcg].	47.24	55.98	+8.74
		Zinc [mg].	1.31	10.22	+8.91

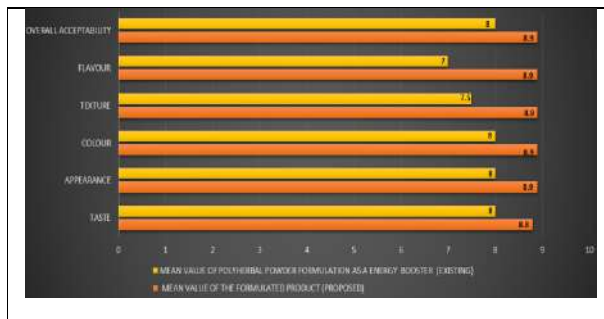




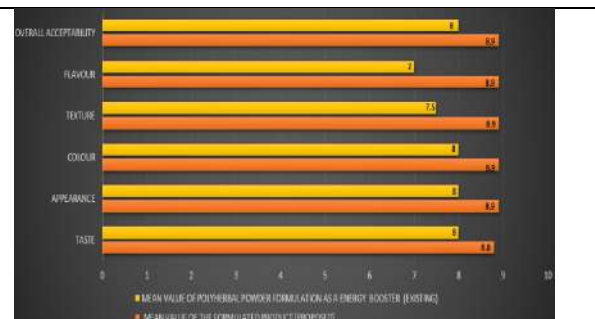
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**Table 6 : Performance Analysis with respect to Mean**

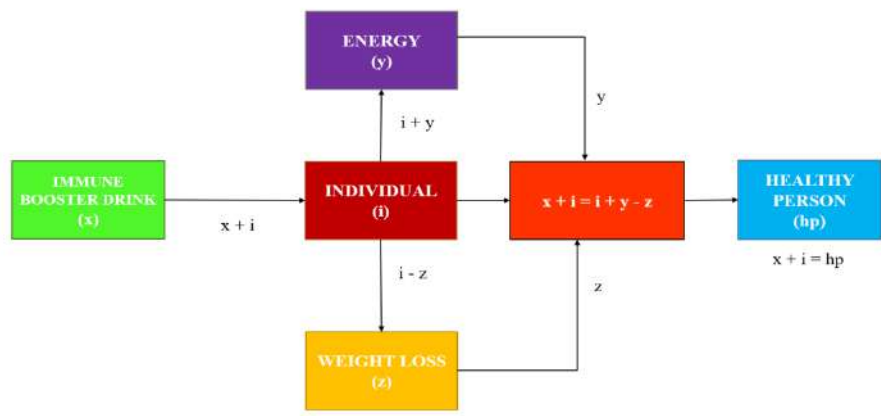
ATTRIBUTES	MEAN VALUE	
	MEAN VALUE OF POLYHERBAL POWDER FORMULATION [Existing].	MEAN VALUE OF FORMULATED PRODUCT [Proposed].
Taste	8 ± 0	8.8 ± 0.16
Appearance	8 ± 0	8.9 ± 0.09
Colour	8 ± 0	8.9 ± 0.09
Texture	7.5 ± 0	8.9 ± 0.09
Flavour	7 ± 0	8.9 ± 0.09
Overall Acceptability	8 ± 0	8.9 ± 0.09



**Fig.1. Diagrammatic Representation of Organoleptic Evaluation**



**Fig.2. Diagrammatic representation is depicted in the form of bar chart for comparison between the mean values of the existing immune booster powder and the formulated product that is proposed.**



**Fig.3. Mathematical Model**





## Determination of Total Phenolic, Flavonoids, and *In vitro* Evaluation of the Antifungal Activity of Ethanolic Extracts of *Cerana indica* Propolis

Ishfaq Mohiuddin<sup>1</sup> and T. Ramesh Kumar<sup>2\*</sup>

<sup>1</sup>Research Scholar, Department of Zoology, Faculty of Sciences, Annamalai University, Annamalai nagar 608 002, Tamil Nadu, India.

<sup>2</sup>Professor, Department of Zoology, Faculty of Sciences, Annamalai University, Annamalai Nagar 608 002, Tamil Nadu, India.

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### \*Address for Correspondence

**T. Ramesh Kumar**

Professor,

Department of Zoology,

Annamalai University, Annamalai Nagar,

Cuddalore, Tamil Nadu, India.

Email: krameshau@gmail.com



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### ABSTRACT

Propolis contains polyphenolic components such as phenols and flavonoids, which have a wide range of biological actions such as antioxidant, antibacterial, and many more. In this study, the ethanolic extract of Kashmiri propolis (EEKP) from *Cerana indica* honeybees was examined for its total phenolic content (TPC), total flavonoid content (TFC), and antifungal activity. TPC and TFC contents were determined using Folin-Ciocalteu colorimetric and aluminum chloride methods, respectively. The TPC was  $302.8 \pm 1.05$  mg GAE/g and the TFC was  $182.25 \pm 0.95$  mg RE/g. The FT-IR spectra of EEKP show functional characteristic peaks for alcohols, carboxylic acids, aromatic chemicals, alkanes, alkenes, amines, phenols, sulfones, and sulfonyl chlorides, indicating the presence of several different compounds. EEKP's antifungal efficacy was assessed against many fungus strains. The highest zone of inhibition was shown by *Candida albicans* (17.67 mm) followed by *Candida parapsilosis* (16.67 mm), *Candida glabrata* (16.33 mm), and *Cryptococcus neoformans* (15.67 mm) at 400 µg/mL. The antioxidant and antifungal action of EEKP may be produced by the presence of phenols and flavonoids, which can also be employed to treat microbial infections and control human pathogenesis brought on by oxidative stress.

**Keywords:** *Cerana indica*, FT-IR, Antifungal, Phenols, Flavonoids.

### INTRODUCTION

Honeybees collect propolis (*Cerana indica*), a viscous material that is coupled with salivary and enzymatic secretions,



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from the buds, leaves, bark, and exudates of numerous trees and plants [1,2]. It is often referred to as “Bee-glue”, which is a natural resinous (wax-like) substance [3] that honey bees use to cement gaps and cracks in their colonies [4,5]. Bees also employ propolis to guard against microbial diseases in their comb, honey storage, and larvae [6,7]. To provide a smooth, germ-free surface, it is also used to clean the parts of the hive where the comb is linked to an object [8,9]. Furthermore, honey bees utilize it to prevent the decomposition of invader carcasses in hives [10,11] and to keep the interior hive temperature [12,13] at about 35 °C [14,15]. Its primary goal is to enhance hive health by avoiding infections and serving as a thermal insulator [12]. Propolis has been utilized both internally and externally in traditional medicine. It is a great choice for food technology applications [16,17]. The diverse geographical and botanical origins of propolis have an impact on its complex and diverse chemical composition [17]. Generally, it is composed of 50% resin and vegetable balsam, 30% wax, 10% essential and aromatic oils, 5% pollen, and 5% other substances, such as organic compounds and minerals [18]. Propolis contains significant amounts of flavonoids and phenolic compounds as its primary organic constituents [1]. The percentage of various materials contained in propolis is determined by the period of the collection as well as its geographical origin [19-21]. The color of propolis changes according to location and plant source [22-24]. At low temperatures, it is hard, while at high temperatures, it is soft [25,26].

The biological activity of propolis samples varies according to their diverse geographic origin [4]. Propolis is used in many different ways and has a substantial impact on human health. Nowadays, it is used as an anesthetic, antibacterial, anti-inflammatory, antiviral, antioxidant, antitumor/anticancer, antifungal, antiseptic, and antimutagenic agent nowadays [6, 27–30]. Due to its high phenolic content, particularly its flavonoid potency, Propolis is thought to be responsible for its antibacterial properties [31], since simple phenols, phenolic acids, and polyphenols are all potent antimicrobial agents. The use of natural antifungal agents in food items may provide an alternative to artificial preservatives [32]. Furthermore, natural substances such as flavonoids and phenolic acids can be used in food products to increase nutritional content, minimize food fungal contamination, and extend the shelf life of many foods, including meat [33-35], milk, and other dairy products such as yogurt, cheeses, and creamy cheeses [36]. The free polyphenolic elements from the film matrix are responsible for the films' antioxidant effects when propolis extract is present. By absorbing free radicals and chelating metal ions, the released polyphenolic components have strong antioxidant activity [37]. The current study aimed to determine the total phenolic and total flavonoid content and to evaluate the antifungal efficacy of EEKP. This study is significant since no previous research on *C. indica* propolis from the Kashmir region has been documented.

## MATERIAL AND METHODS

### Chemicals

Ethanol, Potato Dextrose agar (PDA), dimethyl sulfoxide (DMSO), FC-Reagent, Aluminum chloride, sodium acetate, and antifungal discs (Amphotericin B) were procured from Himedia (Mumbai, India), and Sigma-Aldrich (St. Louis, MO, United States). Gallic acid and Rutin were used as standards.

### Sample Collection and Extraction

Propolis samples of *C. indicabees* were collected directly from hives placed at Chunt-Waliwar village of District Ganderbal, Jammu and Kashmir (N 34° 17' 00" 74° 45' 15" E). Propolis was obtained by scrapping the surfaces of the sides, frames, openings, and coatings of the bee hives. The 40 grams of chopped propolis was extracted with 100 mL of ethanol at room temperature with constant agitation for 36 hrs. The extract was filtered by using Whatman filter paper No.1. Prior to further examination, the obtained extract was stored at -20°C.

### Determination of TPC

The total phenolic content of EEKP was evaluated according to the methodology described by [38] with gallic acid as the standard. All the extracts used in the test were taken at a concentration of 1mg/mL. 800 µL of FC reagent (10% w/v) were combined with 200 µL of each sample extract. 2 mL of sodium carbonate solution (8%) was added to the





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mixture following a 5 min incubation period at room temperature and the absorbance was measured at 765nm against the blank on Spectra UV-VIS Double Beam PC Scanning spectrophotometer (UVD-2950, Labomed, Inc.). The amount of phenolic content overall was expressed as micrograms of gallic acid equivalent (GAE) per gram of sample.

**Determination of TFC**

The flavonoid content of EEKP was evaluated by the aluminum chloride colorimetric method [39] using rutin as a standard. 500  $\mu$ L of the extract was mixed with 1.5mL ethanol (95%), 100  $\mu$ L aluminum chloride (10%), 100  $\mu$ L of 1M sodium acetate, and 2.8 mL distilled water. After being incubated for 30 minutes in the dark at room temperature, the absorbance was measured at 415nm against the blank on Spectra UV-VIS Double Beam PC Scanning spectrophotometer (UVD-2950, Labomed, Inc.). The total flavonoid content in ethanolic extract was expressed as micrograms of Rutin equivalent (RE) per gram of sample.

**Fourier Transform Infrared Analysis**

Using the Perkin Elmer Spectrum 2 MIR Spectrometer (L1600235), Fourier transforms infrared (FT-IR) spectra were recorded between 4,000 and 500  $\text{cm}^{-1}$ . The FTIR spectra were recorded to identify possible functional groups. The ATR plate was gently cleaned with 70% ethanol twice, followed by soft tissue drying until filling with the next sample and leaving the ATR plate to dry [40].

**Determination of antifungal activity**

The antifungal activity of propolis extracts was investigated by a well diffusion technique using PDA [41,42]. A drop of fungal spore suspension was placed in the center of Petri plates containing PDA and dispersed evenly using a sterile glass spreader. Wells were bored with a sterile cork-borer (6 mm) and filled with 100  $\mu$ L of extracts at different concentrations (100, 200, and 400  $\mu\text{g mL}^{-1}$ ) and an equivalent volume of negative control i.e., dimethyl sulfoxide (DMSO). Plates were refrigerated for 10 min before being shifted to an incubator held at 28  $^{\circ}\text{C}$  and were incubated for 48 - 72 hours, and then the plates were observed for a zone of inhibition. The inhibition zones on the plates were ascertained, and the findings were compared to the positive control containing Amphotericin B (20  $\mu\text{g mL}^{-1}$ ). All assays were carried out in triplicate, and mean values were calculated.

**Fungal Strains**

The antifungal activity of ethanolic extract of propolis was tested against *Candida albicans* (MTCC-227), *Candida glabrata*(MTCC-3019), *Cryptococcus neoformans* (MTCC-327), and *Candida parapsilosis* (MTCC-2513). All the microbial strains were procured from the Institute of Microbial Technology (IMTECH), Chandigarh, India.

**Statistical analysis**

All the activities conducted were carried out in triplicate and statistical analysis was performed by Duncan test.

**RESULTS AND DISCUSSION****Total Phenolic and Flavonoid Content**

Propolis extracts are known to be rich in polyphenols, and therefore, the concentrations of total phenolics and flavonoids of EEKP of *C. indica* bee propolis samples were analyzed and determined in the present study. Table 1 and Fig 1 show the total phenolic and flavonoid contents present in the EEKP. The concentration of phenolic moieties was expressed in mg GAE/g and was found to contain  $302.8 \pm 1.05$  mg GAE/g. It should be mentioned that the Folin-Ciocalteu reagent was reported in the literature as not specific to only phenols and could react with other reducing compounds that could be oxidized by the Folin reagent [43]. The flavonoid content was expressed in mg RE/g, and the results revealed that the amount of flavonoids in EEKP was  $182.25 \pm 0.95$  mg RE/g. Flavonoids can form complexes with aluminum chloride, producing a yellow solution.



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In the total phenolics content test, electrons are transported in the basic medium from the phenolic moieties and the reducing group to molybdenum, where they create blue-colored coordination complexes between the metal and the phenolic moieties found in the extract [44]. Flavonoids have been shown to improve membrane permeability and inhibit membrane-bound enzymes such as ATPase and phospholipase A2 [45]. Wali *et al.*, 2016 [46] showed the highest TPC values of  $260 \pm 20$  mg GAE/g dry extract for KPEt and the highest TFC values of  $105 \pm 5$  mg QE/g dry extract for KPEt in Kashmir area propolis. The findings also support the effect of geographic area and collection season on the quality and characteristics of propolis [47]. Ahnet *et al.*, 2007 [48], Moreira *et al.*, 2008 [12], Laskar *et al.*, 2010 [49], and Lagouriet *et al.*, 2013 [50] found phenol levels ranging from 42.9 to 329.0 mg per g of propolis and flavonoids ranging from 8 to 188 mg per g of propolis in China, India, Macedonia, Iran, and Portugal.

**FT-IR Analysis**

FTIR spectroscopy was used to determine functional groups correlating to chemical bonds of compounds found in propolis, which invariably correlate to chemical components potent in *C. indicapropolis*. The FTIR spectrum showed the existence of functional groups in *C. indica* EEKP, with peak locations at  $3430.79\text{ cm}^{-1}$ , (alcohols, carboxylic acids, and amines),  $3005.44\text{ cm}^{-1}$  (alcohols, alkenes, and carboxylic acids),  $2921.46\text{ cm}^{-1}$  (alcohols, amine salts, and alkanes),  $1659.40\text{ cm}^{-1}$  (alkenes, aromatic compounds, and imines),  $1436.23\text{ cm}^{-1}$  (aromatic compounds, alkanes, and Carboxylic acid),  $1311.04\text{ cm}^{-1}$  (alcohols, phenols, amines, sulfones, and Sulfonyl chlorides),  $1017.88\text{ cm}^{-1}$  (Tertiary alcohols and amines),  $955.67\text{ cm}^{-1}$  (alkenes), and  $697.51\text{ cm}^{-1}$  (alkenes) (Table 2 and Figure 2). According to Ahmed *et al.*, 2020 [51] the FT-IR results of the propolis indicated the O–H and C = O at ( $\sim 1168\text{ cm}^{-1}$ ) and C–O and C–C at ( $\sim 1000\text{ cm}^{-1}$ ), and the frequency ( $2848\text{ cm}^{-1} - 2915\text{ cm}^{-1}$ ) revealed the presence of O–H stretch and C–H bond for alcohol. Mustafa *et al.*, 2020 [52] published the FTIR spectra between  $3,550$  and  $3,540\text{ cm}^{-1}$  confirming the presence of an OH group and an asymmetric  $\text{CH}_2$  methyl group at  $2,900\text{ cm}^{-1}$ .

**Antifungal activity**

Regarding propolis' antifungal properties, it can be seen that EEKP had a considerable impact on several strains (Table 3). The sizes of the inhibitory zones range from 11.67 to 17.67 mm, depending on the strain and the dose of propolis extract. The most effective strain was *C. albicans* with an inhibition zone of 17.67 mm at  $400\text{ }\mu\text{g/mL}$ . The high concentration of flavonoids and phenolics identified in the EEKP may be the cause of the substance's strong antifungal action, which may have an antagonistic effect on microbes [53]. Other causes could include the fact that most naturally occurring secondary metabolites have good solubility in organic solvents, which is why EEKP exhibits strong antifungal activity [54]. Our findings support earlier research on propolis samples from diverse geographical locations, including India, Pakistan, Brazil, China, and Egypt [55-58], which shows that propolis has antifungal activity. According to reports, around 25% of modern medicines used to treat disorders are derived from nature [59]. These results serve as a basis for additional research, in which the researchers will examine the best uses for each type of ethanolic propolis extract, such as improving food production safety.

**CONCLUSION**

The findings of the current work revealed that EEKP contains several bioactive substances with excellent antioxidant, antifungal, and functional potential. Propolis extracts have substantial functional potential and a wide range of antibacterial properties, which suggest their application in the treatment of several infectious disorders. These findings might potentially be utilized as a baseline for future standardization and as a consideration in evaluating the application strategy for propolis samples used in apitherapeutic procedures. This research would also act as a reference for the development of various other scientific and industrial projects. Further research is required to increase the production of antioxidants and flavonoids in non-alcoholic propolis extracts so that it can be extensively employed in both the food industry and medicinal industries.

**CONFLICT OF INTEREST**

The authors declare that they have no conflict of interest.





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**Table 1.** Total phenolic and total flavonoid content of EEKP

Propolis Extract	Total phenolic content (mg GAE/g)	Total flavonoid content (mg RE/g)
EEKP	302.8 ± 1.05	182.25 ± 0.95

EEKP= Ethanolic extract of kashmiri propolis;

No significant difference detected for both TPC and TFC since  $p > 0.05$ .

**Table 2.** FT-IR peaks and their assigned functional groups of EEKP of *C.indica*.

S. NO	Wave number (cm <sup>-1</sup> )	Compound Class	Functional Group
1	3430.79	Alcohol	O-H stretching
		Carboxylic acid	O-H stretching
		Amine	N-H stretching



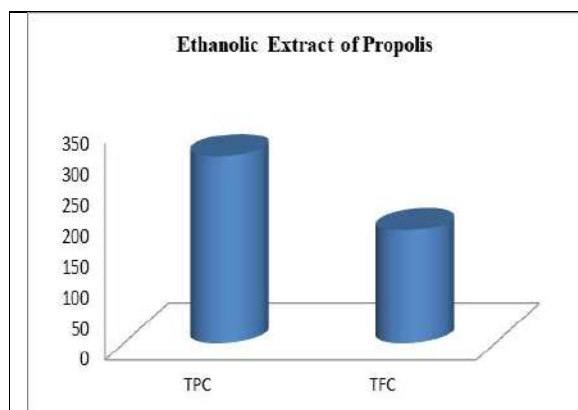


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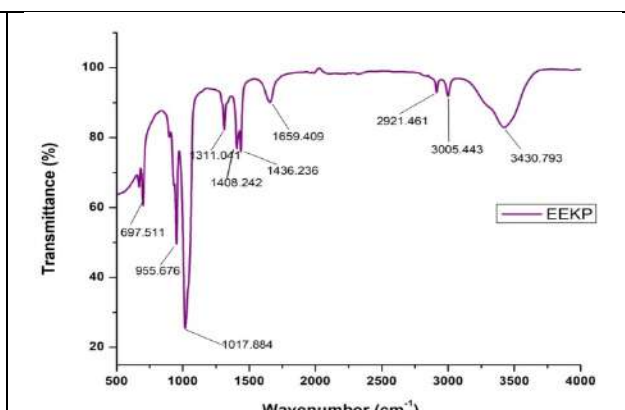
2	3005.44	Alcohol	O-H stretching
		Alkene	C-H stretching
		Carboxylic acid	O-H stretching
3	2921.46	Alcohol	O-H stretching
		Amine salt	N-H stretching
		Alkane	C-H stretching
4	1659.40	Alkene	C=C stretching
		Aromatic compound	C-H bending
		Imine/oxime	C=N stretching
5	1436.23	Aromatic compound	C=C stretching
		Alkane	C-H bending
		Carboxylic acid	O-H bending
6	1311.04	Alcohol	O-H bending
		Phenol	O-H bending
		Amine	C-N stretching
		Sulfones, Sulfonyl chlorides, Sulfates, Sulfonamides	S=O stretching
7	1017.88	Tertiary alcohol	C-O stretching
		Amine	C-N stretching
8	955.67	Alkene	C=C bending
9	697.51	Alkene	C=C bending

**Table 3. Antifungal activity of ethanolic extract of *C. indicapropolis***

Fungal Strains	Zone of Inhibition Diameter (mm)			
	100 µg/mL	200 µg/mL	400 µg/mL	Amphotericin B (20 µg/mL)
<i>C. albicans</i>	12.33 ± 0.88	15.67 ± 0.33	17.67 ± 0.33	19.67 ± 0.33
<i>C. neoformans</i>	11.67 ± 0.33	13.67 ± 0.33	15.67 ± 0.88	19.67 ± 0.88
<i>C. glabrata</i>	12.00 ± 0.58	14.33 ± 0.33	16.33 ± 0.33	18.33 ± 0.88
<i>C. parapsilosis</i>	11.67 ± 0.88	13.67 ± 0.67	16.67 ± 0.67	19.33 ± 0.67



**Figure 1. TPC and TFC of ethanolic extract of *C. indica propolis***



**Figure 2. Fourier transform infrared spectrometer (FTIR) spectrum from EEKPoP of *C. indica***





## Seasonal, Spatial and Statistical Analysis of Heavy Metals in Water and Soil from Riverine Wetlands of Tamiraparani in Thoothukudi District, Tamilnadu

A.S.Santhalakshmi<sup>1\*</sup>, T.Sakthika<sup>2</sup> and P.Kombiah<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Zoology, Sri KGS Arts College, Srivaikuntam, Thoothukudi, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Zoology, A.P.C.Mahalaxmi College for Women, Thoothukudi, Tamil Nadu, India.

<sup>3</sup>Assistant Professor, Department of Zoology, Pasumpon Muthuramalinga Thevar College, Melaneelithanallur, Tirunelveli, Tamil Nadu, India.

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### \*Address for Correspondence

#### A.S.Santhalakshmi

Assistant Professor,  
Department of Zoology,  
Sri KGS Arts College,  
Srivaikuntam, Thoothukudi,  
Tamil Nadu, India.



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### ABSTRACT

In the present investigation the seasonal and spatial variations of heavy metals in Tamiraparani Riverine wetlands. Likewise, heavy metals such as Chromium (Cr), Zinc (Zn), Iron (Fe), Cadmium (Cd), Copper (Cu) and Lead (Pb), were analysed in surface water and soil in Tamiraparani riverine wetlands. The sample analysis was done by Atomic Absorption Spectrophotometer. An exponential increasing trend from water to soil was evident throughout the river stretch. Theme and concentration for all the heavy metals in water and soil was within the limits of BIS and WHO standards. The heavy metals in water and soil samples showed the order of Cr > Zn > Fe > Cd > Cu and Pb. It has been observed that the quality of water is not safe for various aquatic and even unfit for human drinking and irrigation purposes, therefore, necessary conservation and management measures should be taken to improve the deteriorating water quality of this wetland. This study will provide valuable information for appropriately determining how land should be used in future reclamation areas, as well as for the sustainable management of estuarine areas around the world.

**Keywords:** Tamiraparani, Riverine wetlands, water, soil, Heavy metals and Atomic Absorption Spectrophotometer



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## INTRODUCTION

Wetlands are recognized as one of the most important natural environments for humans. At the same time, heavy metal pollution has an important impact on wetlands (Xuedong Wang *et al* 2019; leetD *et al* 2019). Heavy metals are more easily accumulated in wetlands due to changes in natural environment and influence of human activities (Mitsch and Gosselink, 2000; Mays and Edwards, 2001). In wetlands, heavy metals exist mainly in water and soil. Their distribution can bring in changes among the different compartments of each system. The accumulation of heavy metals in wetland has deleterious effect on human health, as the wetlands are the important sources of food and water for human beings. Wetlands, the biological filters of the Earth, play an important role in biochemical transformation of various pollutants. Wetland plants, in this direction, help in accumulating various contaminants from aquatic bodies (Navdeep Singh *et al* 2017). The gradual accumulation of these metals in the food chain will lead to severe problems to the ecosystem. Countries such as Bangladesh and Italy have experienced recent problems of groundwater contamination with arsenic (As) (Alam *et al.*, 2003). Majority of wetlands have been exploited for their natural cleansing capacity for assimilating various pollutants including heavy metals and pesticides (Joyce, 2012). Aquatic plants uptake most of these pollutants through root and shoot structures because of their fast growth and high biomass [Bonanno and LoGiudice, 2013; Matache *et al.*, 2013]. High levels of Cd, Cu, Pb and Fe can act as ecological toxins in aquatic and terrestrial ecosystems (Balsberg-Pahlsson, 1989; Guillizzoni, 1991). Numerous studies on heavy metals in the aquatic systems have been carried out in India including wetlands (Prusty, 2007; Rai and Thripathi, 2007; Rai, 2008a, 2008b). The heavy metal pollution of fresh water is the single most important environmental threat to the future (Rachna, 2011). Heavy metal contamination in river is one of the major quality issues in many fast developing cities, as the maintenance of water quality and sanitation infrastructure did not increase along with population and urbanization growth especially for the developing countries (Reza, 2010). Wetlands are facing serious threat from industrial, domestic. Elevated concentrations of pollutants in these systems have resulted in bioaccumulation of toxic metals and a serious environmental problem, which threatens aquatic organisms and human health (Sasmaz *et al.*, 2008). and urban pollution (Kashem and Singh, 1999; Choi *et al.*, 2006). Impact of mining on aquatic ecosystems became an issue of increasing concern. Mining by its nature consumes, diverts, and seriously pollutes water resources (Kapusta *et al* 2015). Heavy metal accumulations in the water, sediment and aquatic plants have been studied in different parts of the world. Present study is aimed at to determine the spatial distribution, seasonal variation, distribution of heavy metals in soil and surface water of the Tamiraparani Riverine wetlands and to assess the pollution load in water and soil using multivariate statistical analysis. To analyse heavy metals concentrations in surface water and soil samples in 25 sites of wetlands. To analyse the variation among the different sites during difference season and to identify the most pollution site.

## MATERIALS AND METHODS

Water and soil samples were collected from 25 sites in the Tamiraparani Riverine wetlands along the lower reaches. Water and soil samples were collected in clean rinsed polyethylene bottles. Soil samples were collected with Eckman grab sampler at each point. Soil samples were wrapped with polythene bags, kept on ice and subsequently, transported to the laboratory. Samples were digested before the samples were subjected for analysis to the determination of trace metals using AAS with specific flame and wavelength Atomic Absorption Spectrometer (Elico) Table 1 & 2.

## RESULTS AND DISCUSSION

### Iron

Iron is an essential element with no any significant health effect, but develops yellowish colour and a peculiar taste when present in high concentration in water bodies (Aamir and Tahir, 2006). Long term consumption of drinking water with high concentration of iron may lead to liver diseases. Iron is one of the most abundant metals on earth's





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crust. It is found in natural freshwaters at levels ranging from 0.5 to 50 mg/l and is an essential element in human nutrition (WHO, 2008). In the present study water showed maximum iron content during north-east monsoon period and the minimum was in south-west monsoon season whereas in soil, the values showed the maximum during post-monsoon season and minimum during south-west monsoon season. The iron content in water and soil showed a noticeable variation between the seasons (Table 3 -14; Fig 1-6).

**Cu**

High concentration of Cu was observed during the north-east monsoon season in the river water and in soil. This study shows that Cu in water and soil were higher than the permissible limits of FAO for agriculture purpose irrigation (Table 3 -14; Fig 1-6). Its excessive amounts usually influence water as well as soil (Perveen *et al.*, 2006). Occurrence of higher concentration of Cu in the water can also be attributed to the resulting of natural weathering of soil and discharges from industries and sewage-treatment plants (Hutchinson, 1988, Wu *et al.*, 2001).

**Zinc**

Water and soil during the study period showed higher values during post-monsoon period and minimum values during north-east monsoon period (Table 3 -14; Fig 1-6). In higher animals, zinc salts were capable of inducing mutagenic effects (Sures, 2003). As similar to Cu, there is a general trend observed that for zinc, decreasing its concentration based on monsoon variations.

**Cadmium**

In water maximum values of cadmium were observed during north-east monsoon season and lowest values were observed during post-monsoon season. In soil, considerable seasonal variations of cadmium were observed in all the seasons (Table 3 -14; Fig 1-6). The higher levels of Cd in soil during north-east monsoon season in the study sites might be due to concentration effects as reported by Lokeshwari and Chandrappa (2006). It is one of the most dangerous pollutants due to its high potential toxic effects, and is extremely toxic, and the primary use of water high in Cd could cause adverse health effect to consumers such as renal disease and cancer (Fatoki *et al.*, 2002).

**Lead**

During study period lead content was maximum observed during post-monsoon season and minimum observed in the other two seasons. Soil also exhibited similar seasonal trends with highest concentrations of lead during post-monsoon season (Shetye *et al.*, 2009). Lead poisoning is linked with permanent brain damage, behavioral disorders and impaired hearing (Table 3 -14; Fig 1-6). Alkyl lead poisoning is acute, causing irritability, headache, convulsion, delirium and coma (Nielsen, 2011). Natural sources of lead into the surface environment arise from the weathering of geological materials and emissions from the atmosphere from windblown dust, biogenic material and forest fires.

**Chromium**

During study period chromium value was high in post-monsoon season, due to anthropogenic activities, because it not originated from lithogenic sources. After a long period of more than fourteen years, the gradual increase of Cd concentration is found within the study area, which indicate the study area is polluted (Table 3 -14; Fig 1-6). These metals are the major pollutants into the river; several of these elements are highly hazardous to the aquatic life and human's beings. Basically, these elements are not biodegraded and live for a long time in the environment (James, 2010).

**Principal Component Analysis for Water**

Axes of PC1, PC2, PC3, PC4, account for 35.30 % Fe, 21.58 % Cu, 16.70 % Zn, 11.16 % Cd, of the total variance, during south-west monsoon period. PC1 had high loading of Fe, Zn and Cr. North-east monsoon period, PC1, PC2, PC3, PC4 account for 45.07 % Fe, 19.43 % Cu, 16.79 % Zn and 8.59 % of the total variance, respectively. PC1 had high loading of Fe and Cr during north-east monsoon period. During post-monsoon period, PC1, PC2, PC3, PC4 were 44.88 %, 20.87 %, 12.29 % and 9.749 % of the total variance, respectively (Table 3 -14; Fig 1-6).



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### Principal Component Analysis for Soil

The results of PCA of metal contents of the soil samples during south-west monsoon period showed that PC1 represented 35.303% of the total variance and are the most important component. This distribution was control by Fe, Cu, Zn, Cd, Pd, and Cr in the first principal component which could be due to non-point source such as agricultural activities. PC2 explained 21.58% of the variance of total results. In the study area, it was noticed that the soil samples collected from river contained high amount of Fe. PC3 and PC4 explained 16.70 % and 11.16 % of the total variance, respectively. PC3 showed the high loading of the Zn, while PC4 showed the high loading of the Cu (Table 3 -14; Fig 1-6).

Continuous reclamation activities, especially for agriculture and aquaculture, which poses even greater risks to public health and environmental degradation, has yet to gain policymakers' attention (Xiaolu Yan *et al* 2018). The results presented will provide valuable information for appropriately determining how land should be used in future reclamation areas, as well as for the sustainable management of estuarine areas around the world.

### CONCLUSION

This study provides the first comprehensive analysis of heavy metals status in surface water and soil of in Tamiraparani Riverine wetlands. From this investigation, it was showed that the heavy metal levels were much higher in soil samples, which indicated that this riverine wetlands was heavily polluted by human activities and discharging of effluents from textile, electroplating industries. We conclude that the Tamiraparani Riverine wetlands soil quality was deteriorating and potentially hazardous to public health. This needs proper maintenance by the authorities by continuous monitoring of the riverine wetlands by controlling the discharge of waste and effluents in these study area in Tamiraparani Riverine wetlands, the abundances of such metals caused by the river contribution of soil from areas with unplanned agricultural development and from the industrial, activity carried out on the riverine wetlands. It is concluded that in and around study area, the concentration of heavy metals is higher due to anthropogenic and industrial effluent in Tamiraparani Riverine wetlands. Furthermore, concentrations may rely on other sources such as loads in storm water run-off, remobilized metals that were bound on river sediments and even loadings from atmospheric deposition. If this situation deteriorate further may lead to abiologically deadriver having severe impact on aquatic life and city dwellers.

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4. High levels of Cd, Cu, Pb and Fe can act as ecological toxins in aquatic and terrestrial ecosystems (Balsberg-Pahlsson,1989; Guilizzoni, 1991
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**Table.1. Seasonal variation of heavy metals in water**

Heavy metals	Units	South-west monsoon	North-east monsoon	Post-monsoon
Iron	mg/l	3.98	2.54	558
Copper	mg/l	0.98	2.96 6	2.01
Zinc	mg/l	0.18	0.47	1.88
Cadmium	mg/l	0.3 5	1.54	0.26
Lead	mg/l	0.03	0.07	0.21
Chromium	mg/l	3.58	3.1 8	3.90





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**Table.2 Seasonal variation of heavy metals in soil**

Heavy metals	Units	South-west monsoon	North-east monsoon	Post-monsoon
Iron	mg/l	3.19	2.18	6.32
Copper	mg/l	2.23	4.83	6.11
Zinc	mg/l	18.59	6.33	21.55
Cadmium	mg/l	3.33	5.88	6.38
Lead	mg/l	1.23	1.56	2.22
Chromium	mg/l	101.02	60.23	105.90

**Table.3. PCA loadings of heavy metals in water during south-west Monsoon period**

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Fe	0.5853	0.6023	-0.1125	0.1321	-0.508	0.08086
Cu	0.5457	-0.3123	0.5137	0.5723	0.03933	-0.1079
Zn	0.2659	0.7085	0.512	-0.1759	0.341	0.1336
Cd	0.5822	0.09107	-0.6629	0.2578	0.3589	0.1342
Pb	0.6369	-0.5639	0.141	-0.3036	-0.08289	0.3968
Cr	0.8139	-0.07906	-0.06696	-0.3681	0.03562	-0.4359

**Table.4. PCA of heavy metals in water during south-west monsoon period**

PC	Eigen value	% variance
1.	2.11816	35.303
2.	1.29482	21.58
3.	1.00254	16.709
4.	0.670111	11.169
5.	0.512876	8.5479
6.	0.401489	6.6915

**Table.5. PCA loading of heavy metals in water during north-east monsoon period**

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Fe	-0.5632	0.6771	0.3407	0.07234	0.1836	0.2633
Cu	0.5956	-0.616	0.3676	0.2145	0.08379	0.2787
Zn	0.4887	0.159	-0.8106	0.1229	0.1937	0.162
Cd	0.7092	0.4571	0.113	0.4277	-0.2984	-0.05824
Pb	0.8208	0.1985	0.2862	-0.05921	0.3852	-0.2305
Cr	0.7834	0.2342	0.06883	-0.5129	-0.186	0.1705

**Table.6. PCA of heavy metals in water during north-east monsoon period**

PC	Eigen value	% variance
1.	2.70104	45.017
2.	1.16633	19.439
3.	1.00765	16.794
4.	0.515865	8.5978
5.	0.350252	5.8375
6.	0.258854	4.3142





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**Table .7. PCA loading of heavy metals in water during post-monsoon period**

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Fe	0.7782	-0.04469	0.2436	0.3912	-0.3876	-0.1726
Cu	0.2181	0.8021	0.5285	-0.07037	0.0934	0.1264
Zn	0.8356	0.122	-0.1036	-0.3569	0.2218	-0.3156
Cd	0.7956	-0.2493	-0.04723	-0.3903	-0.2761	0.2721
Pb	0.5019	0.5519	-0.5961	0.2705	0.03698	0.1164
Cr	0.676	-0.4745	0.1753	0.2721	0.4394	0.1413

**Table.8. PCA of heavy metals in water during post-monsoon period**

PC	Eigen value	% variance
1.	2.69332	44.889
2.	1.25219	20.87
3.	0.737787	12.296
4.	0.584942	9.749
5.	0.478864	7.9811
6.	0.252897	4.2149

**Table.9. PCA loading of heavy metals in soil during south-west monsoon period**

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Fe	0.5853	0.6023	-0.1125	0.1321	-0.508	0.08086
Cu	0.5457	-0.3123	0.5137	0.5723	0.03933	-0.1079
Zn	0.2659	0.7085	0.512	-0.1759	0.341	0.1336
Cd	0.5822	0.09107	-0.6629	0.2578	0.3589	0.1342
Pb	0.6369	-0.5639	0.141	-0.3036	-0.08289	0.3968
Cr	0.8139	-0.07906	-0.06696	-0.3681	0.03562	-0.4359

**Table.10. PCA of heavy metals in soil during south west-monsoon period**

PC	Eigen value	% variance
1.	2.11816	35.303
2.	1.29482	21.58
3.	1.00254	16.709
4.	0.670111	11.169
5.	0.512876	8.5479
6.	0.401489	6.6915

**Table.11. PCA loadings of heavy metals in soil during north-east monsoon period**

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Fe	-0.5632	0.6771	0.3407	0.07234	0.1836	0.2633
Cu	0.5956	-0.616	0.3676	0.2145	0.08379	0.2787
Zn	0.4887	0.159	-0.8106	0.1229	0.1937	0.162





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Cd	0.7092	0.4571	0.113	0.4277	-0.2984	-0.05824
Pb	0.8208	0.1985	0.2862	-0.05921	0.3852	-0.2305
Cr	0.7834	0.2342	0.06883	-0.5129	-0.186	0.1705

**Table.12. PCA of heavy metals in soil during north-east monsoon period**

PC	Eigen value	% variance
1.	2.70104	45.017
2.	1.16633	19.439
3.	1.00765	16.794
4.	0.515865	8.5978
5.	0.350252	5.8375
6.	0.258854	4.3142

**Table.13. PCA loadings of heavy metals in soil during post-monsoon period**

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
Fe	0.7782	-0.04469	0.2436	0.3912	-0.3876	-0.1726
Cu	0.2181	0.8021	0.5285	-0.07037	0.0934	0.1264
Zn	0.8356	0.122	-0.1036	-0.3569	0.2218	-0.3156
Cd	0.7956	-0.2493	-0.04723	-0.3903	-0.2761	0.2721
Pb	0.5019	0.5519	-0.5961	0.2705	0.03698	0.1164
Cr	0.676	-0.4745	0.1753	0.2721	0.4394	0.1413

**Table.14. PCA of heavy metals in soil during post-monsoon period**

PC	Eigen value	% variance
1.	2.69332	44.889
2.	1.25219	20.87
3.	0.737787	12.296
4.	0.584942	9.749
5.	0.478864	7.9811
6.	0.252897	4.2149





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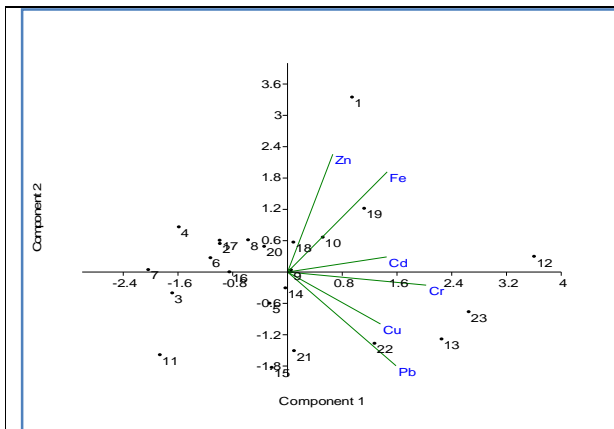


Figure.1. PCA of heavy metals in water during south-west monsoon period

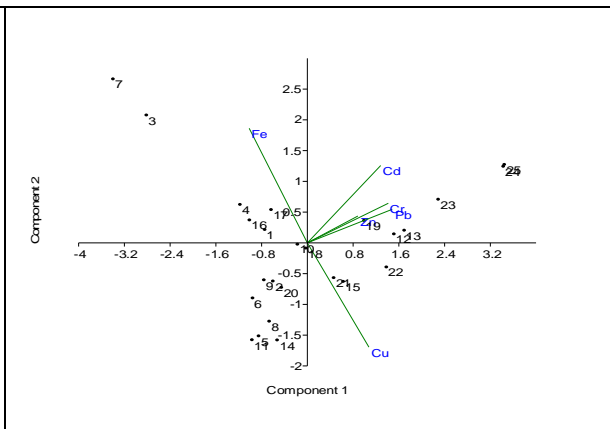


Figure.2. PCA of heavy metals in water during north-east monsoon period

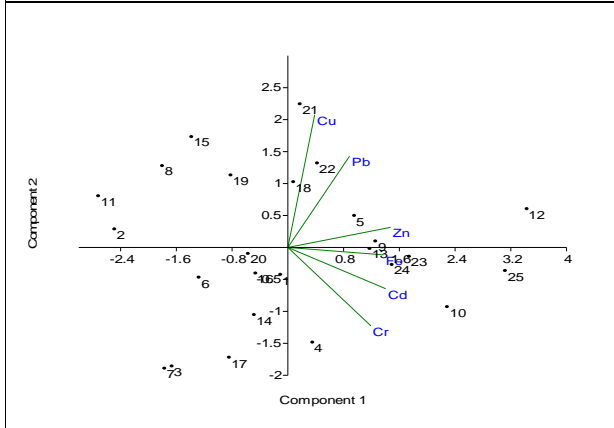


Figure.3. PCA of heavy metals in water during post-monsoon period

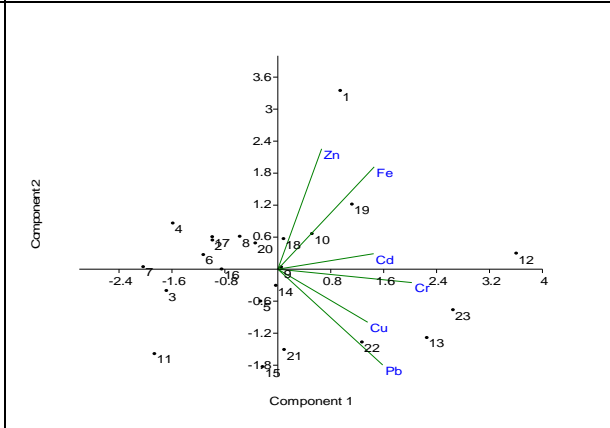


Figure.4. PCA of heavy metals in soil during south-west monsoon period

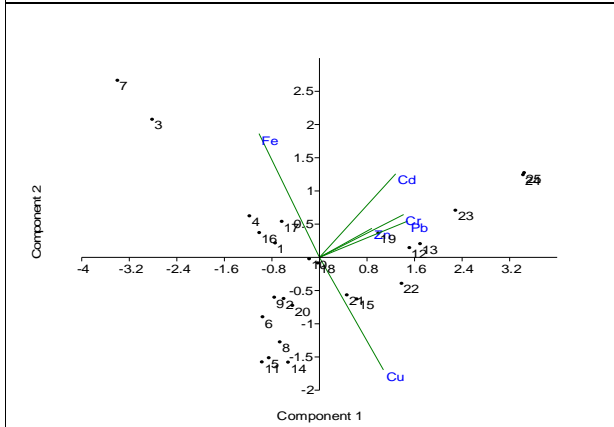


Figure.5. PCA of heavy metals in soil during north-east monsoon period

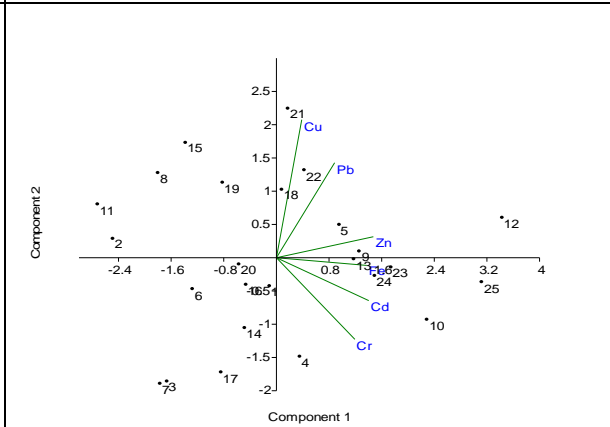


Figure.6. PCA of heavy metals in soil during post-monsoon period





## A Systematic Review on Organisational Citizenship Behaviour and Organisational Commitment in Academicians: Antecedent and Implications

Ekta Jain<sup>1</sup>, Charu Dhankar<sup>2\*</sup> and Gargi Sharma<sup>2</sup>

<sup>1</sup>Ph.D Scholar, Department of Psychology, Manipal University Jaipur, Rajasthan, India

<sup>2</sup>Assistant Professor, Department of Psychology, Manipal University Jaipur, Rajasthan, India

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### \*Address for Correspondence

#### Charu Dhankar

Assistant Professor,  
Department of Psychology,  
Manipal University Jaipur,  
Rajasthan, India  
E.Mail :charu.dhankar@jaipur.manipal.edu



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### ABSTRACT

Employees' behaviours that assist the organisation are referred to as organisational citizenship behaviour. These actions are not part of the employees' job descriptions. Employees have traditionally been urged to put in extra hours and labour for an organisation as a symbol of loyalty. The concept of being a good employee compels people to participate in tasks that are not part of their job description, which leads to unhealthy work habits. Organizational Commitment is another essential component connected with Organizational Citizenship Behaviour (OCB). Employees' organisational commitment is the link they have with their employers. It refers to employees' psychological and emotional attachment to their employers. Organizational Citizenship and Organizational Commitment Employees' mental health can suffer as a result of their behaviour. The current study is an attempt to conduct a systematic literature review using PRISMA to understand the model's use in this context. The study examines 31 academic articles on the subject. A detailed review of the current literatures is undertaken in order to determine the factors. The researcher was able to uncover a few common factors after conducting a thorough literature review.

**Keywords:** Organizational Citizenship Behaviour, Organizational Commitment, academicians

### INTRODUCTION

Organisational Citizenship Behaviour is activities that are indulged by employees of an organization that benefits the organization. These activities are not involved in the job description of the employees. Employees have always been

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encouraged to dedicate extra hours and work for an organization as a sign of being a good employee. The idea of being a good employee forces the employees to take activities that are not in their job description and this leads to unhealthy work patterns. Employees tend to take up a lot of work overload to impress their employers and this leads to fatigue among the employees (Ibrahim & Aslinda, 2013; Jehanzeb & Mohanty, 2019). The organizational culture tends to play an important role in the adoption of Organisational Citizenship Behaviour by the employees. The forced efforts by the employees to take up OCB activities have the tendency to lead to a number of negative effects on the mental health of the employees. Another important factor that is associated with Organizational Citizenship Behaviour (OCB) is Organizational Commitment (The & Sun, 2012; Sajjad et al., 2011). Organizational Commitment is the bond shared by the employees with their employers. It is the psychological and emotional attachment of employees to their employers. Organizational Commitment and Organizational Citizenship Behaviour have the tendency to negatively impact the mental health of an employee. It is important to identify the negative impacts that it has on the employees for the proper functioning of an organization and to reduce the employee turnover rate. This paper attempts to identify the relationship between the various factors that impact the Organizational Citizenship Behaviour of the employees and also the mediating and moderating factors. An extensive systematic literature review is conducted for this purpose to help in identifying the factors.

### Background

In any workplace interaction among the employees is essential they may behave in a positive way or in a negative attitude as the success of an organization i.e universities or schools depends on the academicians commitment to the organization goals and values. As we know that teachers play a very vital role in an organization as they are the role model for the students and they work hard for their own progress and for the progress of the institution so nowadays every institute has started taking care of the teacher's physical, mental, economic and social factors, because so many findings from the research have resulted in the welfare of the psychological behaviour of the teacher's. Academicians sometimes display certain behaviours that go beyond job calling. Behaviour that does not reward but are important for effective functioning of the organization is called Organizational Citizenship Behaviour. So the teachers OCB consists of activities related to helping behaviours towards supervisors, students, colleague like preparing some special lessons for students or suggesting changes and improvements necessary for the organization. According to (Organ, 1988) OCB is defined as "work-related behaviours that are discretionary, not related to the formal organisational reward system, and, in aggregate, promote the effective functioning of the organisation".

According to previous researches Academicians who have a high level of commitment towards the institution put more efforts in the classroom as compared to the teachers who do not have a good commitment towards the institutions so Organizational commitment refers to the emotional connection of the work, identification and participation of an individual in the organization. Some of the researches have shown that there is a great impact of organizational commitment on the whole organization. A study of (Crosswell, 2004) stated that for an organization to be successful it is important to have a high dedication and commitment of the teachers towards the organization. In the present study Organizational commitment is defined as the relative ability to identify and to engage with an organization. The following section holds an extensive literature review of the study to identify the factors impacting OCB and the mediating and moderating factors influencing OCB and Organizational Commitment.

### Sources

As discussed previously, the study employs a systematic review, and the two databases, Scopus and Web of Science, are scoured for publications to include in the review. These two databases feature a diverse range of publications produced by researchers from around the world on a variety of topics. As a result, these two databases are suitable for accumulating research articles. Keywords used in database searches include terms such as "Organizational Commitment", "Organizational Citizenship Behaviour" and so on. The next part describes the detailed procedure for finalising the final articles. The search string involved in the process includes- Search String Set 1 — ("Organizational





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Commitment”) AND (“Organizational Citizenship Behaviour”) Once the search results using the above keywords are generated, the process followed for their selection is discussed in the following section.

### Data Extraction and Synthesis

One of the most important criteria for completing a systematic literature review is the use of a rigorous method for selecting articles for final evaluation. The relevancy of the title is utilised to evaluate the articles in the first step. Following the establishment of the relationship between the title and the subject, the abstract is carefully examined to see if the piece meets the standards. Following an analysis of the abstracts, the final articles for this study are chosen. Following comprehensive research, the most significant subjects derived from the final evaluation papers are listed. The PRISMA developed below includes a flow chart describing the complete procedure.

### Quality Parameters Used for selection

Dyba&Dingsoyr, (2008) developed a questionnaire checklist to ensure the quality of systematic review papers. These questions are evaluated using three major factors: credibility, rigour, and relevancy. The nominated products are assigned a score of 1 or 0 depending on their compliance with the three quality standards. Content with a score of 4 or higher is considered to be of good quality and may be included in the evaluation. The appendix offers a table with the respective scores to assist you understand the technique.

### Threats to validity of research and mitigations

It is necessary to assess the construct and external validity components before conducting a review. The quality assurance parameters checklist developed by Dyba&Dingsoyr, (2008) is used to address any inequities or dangers arising from validity concerns in the articles. Second, the PRISMA method of acquiring articles is the most effective tool for limiting authenticity threats.

## RESULTS

The results from the data extraction process conducted is as follows –

SI. No.	Author/s	Findings	Factors identified
1.	Bakshiet al., (2011)	The researchers identified that “organizational commitment” has an association with OCB. The researchers identified three components of “organizational commitment” and all three factors were observed to have an association with OCB.	OCB, organizational commitment
2.	Erkutlu, (2011)	The researchers in this study identified a mediating relationship of “organizational culture” with organizational justice and OCB. Organizational justice was observed to have a strong association with organizations having higher respect for the employees.	OCB, organizational culture, organizational justice
3.	Chun, et al., (2011)	The researchers in this study identified that “collective organizational commitment” has a significant relationship with interpersonal OCB.” The researchers identified that collective organizational commitment and interpersonal OCB positively impact organizational performance.	organizational performance, organizational commitment, and interpersonal OCB
4.	Bolino, et al., (2013)	The researchers in this study identified a few negative aspects that are related to OCB. The researchers in this study observed that activities of the employees that positively influence OCB might negatively impact the	Job stress, work overload, work-life conflict





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		satisfaction level of the employees. It may lead to job stress, work overload, and work-life conflict.	
5.	Fox et al., (2012)	The researchers in this study identified that there exists a positive relationship between "Counterproductive Work Behaviour" and "Organizational Citizenship Behaviour". The researchers further, observed that there also exists a positive association between stressors and "Organizational Citizenship Behaviour".	Counterproductive Work Behaviour, Organizational Citizenship Behaviour, job stress, work process problems, social loafing
6.	Xeri&Brunetto, (2013)	The researchers in this study identified the existence of an association between organizational commitment and innovative behaviour. The researchers further observed a significant relationship between OCB and "innovative behaviour."	Innovative behaviour, organizational commitment, and interpersonal OCB
7.	Purnama, (2013)	The results of the study indicated that organizational commitment and OCB influence organizational performance. Organizational culture and organizational commitment were observed to have a strong association with OCB.	OCB, organizational culture, organizational commitment
8.	Kim, (2014)	The results of the study indicated that organizational commitment has a significant mediating role between Organisational culture and OCB. Organizational culture was observed to partially mediate the relationship between transformational leadership and OCB.	OCB, transformational leadership, organizational culture, organizational commitment
9.	Pavalache-Ilie, (2014)	The researchers in this study identified that there exists an association between "self-efficacy and OCB". The researchers further identified that factors such as work satisfaction, and the personality of the employees are influenced by "self-efficacy".	OCB, work satisfaction, employee personality, self-efficacy.
10.	Rahman et al., (2014)	The researchers in this study identified that there exists an association of OCB with self-efficacy. The researchers further stated that there also exists an association between self-efficacy and job satisfaction.	OCB, job satisfaction and self-efficacy.
11.	"Tziner&Sharoni, (2014)"	The researchers in this study identified a significant relationship between the variables - job stress and work-family conflict with organisational citizenship behaviour. The researchers in this study further identified a strong association between job stress and OCB.	OCB, organisational justice, job stress, and work-family conflict
12.	Bolino, et al., (2015)	The researchers in this study identified that the activities which have an association to OCB have the potential that leads to a number of negative emotions among the employees. The results indicated that the employees might develop stress and burnout due to OCB activities.	Citizenship fatigue, stress, role overload, burnout, organisational citizenship behaviour
13.	Saxena&Saxena, (2015)	The researchers in this study identified a relationship between organizational commitment and job involvement. The researchers further observed a significant relationship between OCB and job involvement.	job involvement, organizational commitment, and interpersonal OCB
14.	Zayas-Ortiz et al.,	The results of the study indicated that organizational	OCB, organizational



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	(2015)	commitment has a significant relationship with OCB. The researchers identified indicators - civic virtue, altruism, and courtesy as important influencing factors between organizational commitment and OCB.	commitment
15.	Hawriki, (2016)	The researchers in this study identified that organizational commitment does not have a significant impact on the OCB. Organizational culture, however, was observed to have a significant impact on OCB.	OCB, organizational culture, organizational commitment
16.	Pooja, et al.,(2016)	The researchers in this study identified the relationship between two job stressors –overload of work and conflict at interpersonal level with OCB. The results of the study indicated that job stressors have an association with OCB. The researchers further, observed that the increase in social interaction decreases the level of job stress among the employees.	OCB, work overload and interpersonal conflict
17.	Pradhan, <i>et al.</i> , (2016)	The researchers in this study identified that organizational commitment has a significant relationship with OCB. The researchers identified that work-life balance has a significant impact on OCB and it acts as mediating role between OCB and organizational commitment.	OCB, organizational commitment, work-life balance
18.	Thompson, <i>et al.</i> , (2016)	The study's findings suggested that employees high on honesty-humility demonstrated a very high engagement in OCB. The researchers further observed that employees low on honesty-humility engaged in revenge due to co-worker incivility. Workplace incivility was observed to have an indirect impact on OCB.	Honesty-humility, OCB, work incivility
19.	Kao, (2017)	The researchers in this study observed that self-efficacy has the tendency to impact OCB.	OCB, self-efficacy.
20.	Marchiondo, <i>et al.</i> , (2018)	According to the study's findings, some targets generated challenge assessments of uncivil encounters, particularly when they attributed low malicious intention to offenders, challenge appraisal was associated with increases in job satisfaction and thriving. The researchers hypothesized that regular intervention to reduce workplace incivility could have a positive impact on OCB.	OCB, work incivility, job satisfaction
21.	Choong, <i>et al.</i> , (2019)	The researchers in this study identified that there exists an association between self-efficacy and OCB. The researchers further stated that there exists a significant association between trust and OCB.	OCB, trust and self-efficacy
22.	Liu, <i>et al.</i> , (2019)	The results of the study indicated an indirect influence of workplace incivility on OCB. A significant association was identified between the two factors. The two factors were observed to have a significant influence on burnout. The researchers in this study observed an association between workplace incivility and burnout.	Burnout, OCB, work incivility
23.	Nawaz &Abid, (2019)	The researchers in this study observed that work incivility has the potential to impact OCB. The	Self-efficacy, OCB, work incivility, hope, and



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		researchers stated that workplace incivility should be reduced in order to increase the OCB.	resilience.
24.	Chughtai,& Shah, (2020)	The researchers in this study identified that work incivility has an indirect relationship with OCB. The researchers observed that moderation in work ethics has the potential to reduce the negative effect of work incivility on OCB.	OCB, workplace incivility, work ethics, dark triad
25.	Erum, <i>et al.</i> , (2020)	The researchers in this study identified that self-efficacy plays a mediating role between work incivility and OCB.	OCB, work incivility, self-efficacy.
26.	Paramasivam, (2020)	The researchers identified that OCB has an association with self-efficacy. The researchers further, identified that family-supportive organizational perceptions played a mediating role between self-efficacy and OCB.	OCB, family-supportive organizational perceptions, self-efficacy.
27.	Woo &Ko, (2020)	The study's findings suggested that workplace incivility had an indirect effect on OCB. The two variables were shown to have a substantial relationship. The two variables were found to have a significant impact on burnout. The researchers in this study discovered a link between workplace incivility and burnout. The researchers stated that these factors impacted the quality of life of an employee.	Burnout, OCB, work incivility, quality of life
28.	Ullah, <i>et al.</i> , (2021)	The researchers in this study observed that self-efficacy leads to OCB among the employees. The researchers further identified an association between work incivility and OCB. These two factors were observed to have an influencing role on OCB among the employees.	Self-efficacy, OCB, work incivility.
29.	Wang, <i>et al.</i> , (2021)	The researchers in this study identified that co-worker incivility experience has a strong positive relationship with guilt among employees. The factor of guilt is further, observed to have a strong association with OCB. An indirect relationship was observed between work incivility and OCB.	Work incivility, state guilt, attribution orientation, OCB
30.	Annalakshmi, <i>et al.</i> , (2022)	The researchers in this study observed that workplace incivility and workplace stress have the tendency to predict OCB. However, the researchers stated that the impact was not significant in nature. The researchers further identified that self-efficacy has a significant role in predicting OCB.	Self-efficacy, OCB, work incivility, workplace stress
31.	Shahzad, <i>et al.</i> , (2022)	According to the study's findings, interpersonal deviance was observed to play a mediating role between incivility in the workplace and OCB. Organizational support was observed to play a moderating role between the two factors.	OCB, work incivility, interpersonal deviance



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## DISCUSSION

Researchers have identified a few negative aspects that are related to OCB. The researchers in this study observed that activities of the employees that positively influence OCB might negatively impact the satisfaction level of the employees. It may lead to job stress, work overload, and work-life conflict (Bolino *et al.*, 2013; Fox *et al.*, 2012; Tziner&Sharoni, (2014). Researchers have observed that activities of the employees that positively influence OCB might negatively impact the satisfaction level of the employees. It may lead to job stress, work overload, and work-life conflict. Studies have been identified that indicates that Organisational Citizenship Behaviour have the potential that leads to a number of negative emotions among the employees. The results indicated that the employees might develop stress and burnout due to OCB activities (Bolino *et al.*, 2015; Annalakshmi *et al.*, 2022). Literature studies have identified a significant impact of job stress on Organizational Citizenship Behaviour. It has also been identified in a research study that workplace incivility and workplace stress have the tendency to predict OCB. However, the researchers stated that the impact was not significant in nature. The researchers further identified that self-efficacy has a significant role in predicting OCB. These have been observed in a number of studies. A number of studies were identified where researchers observed the influencing role played by work incivility and self-efficacy on OCB (Ullah *et al.*, 2021; Annalakshmi *et al.*, 2022). A few researchers have observed that workplace incivility and OCB are associated with each other through burnout (Liu *et al.*, 2019; Woo & Ko, 2020; Shahzad *et al.*, 2022). Contrary to most findings researchers Marchiondo *et al.*, (2018), observed that some targets generated challenge assessments of uncivil encounters, particularly when they attributed low malicious intention to offenders, challenge appraisal was associated with increases in job satisfaction and thriving. The researchers hypothesized that regular intervention to reduce workplace incivility could have a positive impact on OCB. Some researchers have also observed the existence of a positive impact of work incivility on OCB. Nawaz & Abid, (2019), conducted research on the working environment of private hospitals. The researchers in this study observed that there exists a significant association between work incivility and OCB. The researchers stated that workplace incivility should be reduced in order to increase the OCB. The researchers further stated that the OCB of nurses will be at an optimal level if there exists an environment of self-efficacy, hope, and resilience. Self-efficacy was observed to have a positive relationship with OCB. A number of factors were observed to have influenced this relationship such as trust, employee personality, family-supportive organizational perceptions, and job satisfaction (Rahman *et al.*, 2014; Choong *et al.*, 2019; Paramasivam, 2020; Lumley *et al.*, 2011; Van Dyk & Coetzee, 2012; Visagie & Steyn, 2011)

The organizational culture tends to play an important role in the adoption of Organisational Citizenship Behaviour by the employees. This was observed in a number of studies where organizational culture was observed to influence both organizational commitment and Organizational Citizenship Behaviour (Shaheen *et al.*, 2016; Newman *et al.*, 2014). Researchers in a study indicated the existence of a strong mediating relationship of organizational culture with organizational justice and OCB. Organizational justice was observed to have a strong association with organizations having higher respect for the employees (Erkutlu, 2011; Jung & Yoon, 2015). Organizational culture and organizational commitment were observed to have a strong association with OCB (Purnama, 2013; Hawriki, 2016; Khan & Rashid, 2012). Some researchers observed a mediating role between OCB and organizational commitment (Kim, 2014; Bakshiet *et al.*, 2011; Zayas-Ortiz *et al.*, 2015). Researchers have also identified that collective organizational commitment and interpersonal OCB positively impact organizational performance (Chun *et al.*, 2011). The factors identified through the literature study have been discussed below:

### Work Incivility

Work incivility is defined as a "behaviour of the employees that are intended to harm the target" (Andersson and Pearson, 1999). Workplace incivility leads to a number of negative health consequences of the employees. It negatively impacts the OCB of the employees.





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### Job Stress

Job stress is “a dynamic process in which subjective cognitive appraisals of job-related stressors produces negative health and/or behavioural strain outcomes” (Preston, 2017). Job stress is observed to have a significant impact on OCB.

### Self-Efficacy

Self-efficacy is defined as, “the perception of individuals about their capacities to deliver the estimated and accepted performance” (Bandura, 1994).

### Organizational Culture

Organizations are observed to have a unique set of characteristics which is evident through the culture it adopts. It is defined by Richard Perrin as, “the sum of values and rituals that serve as a glue to integrate the organization’s members”.

### Organizational Citizenship Behaviour

Organizational Citizenship Behaviour is impacted by a number of factors. It is defined as “activities involved by the employees that are beyond the job description of the employees but are beneficial to the organisation” (Campbell Pickford, 2016).

### Organizational Commitment

Organizational Commitment can be defined as “the identification of the individual and his/her involvement towards an organisation” Porter *et al.*, (1974).

Based on the research studies identified the following conceptual model is propose

Through various models and research papers, the literature study was able to discover the association between OCB and Organisational Commitment. Similarly, Organisational Culture has a significant impact on both OCB and Organisational Commitment. It was observed that Organisational Citizenship Behaviour plays a mediating role between Organisational Commitment and three factors – Job stress, Work Incivility, and Social Efficacy. These three factors are not directly associated with Organisational Commitment but are indirectly associated with Organisational Citizenship Behaviour playing a mediating role. Organisational Culture is observed to play a moderating role with having an impact on both Organisational Commitment and OCB. The relationship between these factors has been displayed in figure 1. The consolidated model will give scope for a future empirical study that will identify the degree to which the components have an impact on each other.

## CONCLUSION

A thorough review of the existing literature was carried out in the current investigation. This research seeks to identify the relationship between the many elements that influence employees' organizational citizenship behaviour, as well as the mediating and moderating factors. To assist in identifying the factors, an exhaustive systematic literature review is done. It was observed that employees have traditionally been urged to put in extra hours and labour for an organisation as a symbol of loyalty. The concept of being a good employee compels people to participate in tasks that are not part of their job description, which leads to unhealthy work habits. Employees tend to take on a lot of work overload in order to please their employers, which lead to employee weariness. Employees' adoption of Organizational Citizenship Behaviour is heavily influenced by organisational culture. Employees' forced efforts to participate in OCB activities have the potential to have a range of detrimental repercussions on their mental health. A thorough review of the current literature is carried out in order to determine the factors. The researcher was able to uncover a few common factors after conducting a thorough literature review. The researchers discovered the relationship between Organizational Citizenship Behaviour and Organizational Commitment after completing a thorough systematic literature study. Similar to this, organizational culture has a major impact on both





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organizational commitment and organizational citizenship behaviour. Organizational Citizenship Behaviour was discovered to perform a mediating effect between Organizational Commitment and three factors: Job Stress, Work Incivility, and Social Efficacy. These three parameters are not directly related to organizational commitment, but they are indirectly related to organizational citizenship behaviour, which plays a mediating role. Organizational Culture has been found to exert a moderating function in both organizational commitment and organizational citizenship behaviour. The study puts forward the identified factors through a literature review. An empirical study to analyse the relationship of the factors is required to be conducted.

### **Implications of the Study**

In the past years, progress has been observed in the understanding of the occurrence of workplace incivility in organizations. Workplace incivility is a growing concern that requires to be addressed and it is necessary to identify the areas in which it negatively impacts the workers. The present study highlights certain implication which could be adopted by organization to enhance the organization culture.

### **Research Implication**

The human resource of an organization is one of the most crucial and volatile in nature and it is one of the most complicated components of an organization, it is therefore, necessary to conduct continuous research in this area to constantly improve the functioning of an organization. The present study forwards a framework that helps in determining the crucial factor that impacts the behaviour and commitment of the employees. It will help various other academicians and researchers to gain insight and further carry on research in this area since there is wider scope for research in this topic. The framework can be further tested and validated among various organizations to identify the areas that require attention. The framework presented in this study can be utilized as a guide for conducting future studies on organizational citizenship behaviour and organizational commitment.

### **Limitations of the Study**

The research study conducted is theoretical in nature. The research findings are based on the findings of the existing research studies. The researcher has forwarded a conceptual framework which requires to be empirically tested. The research study could be extended by conducting an empirical study and testing the validity of the conceptual model.

### **Conflict of Interest**

The authors declare that there is no conflict of interest

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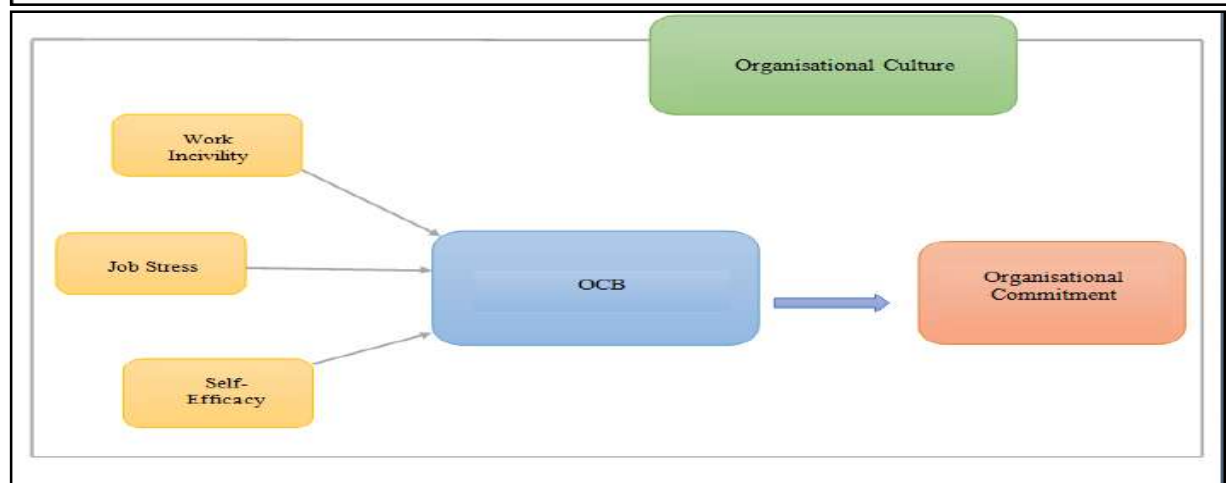
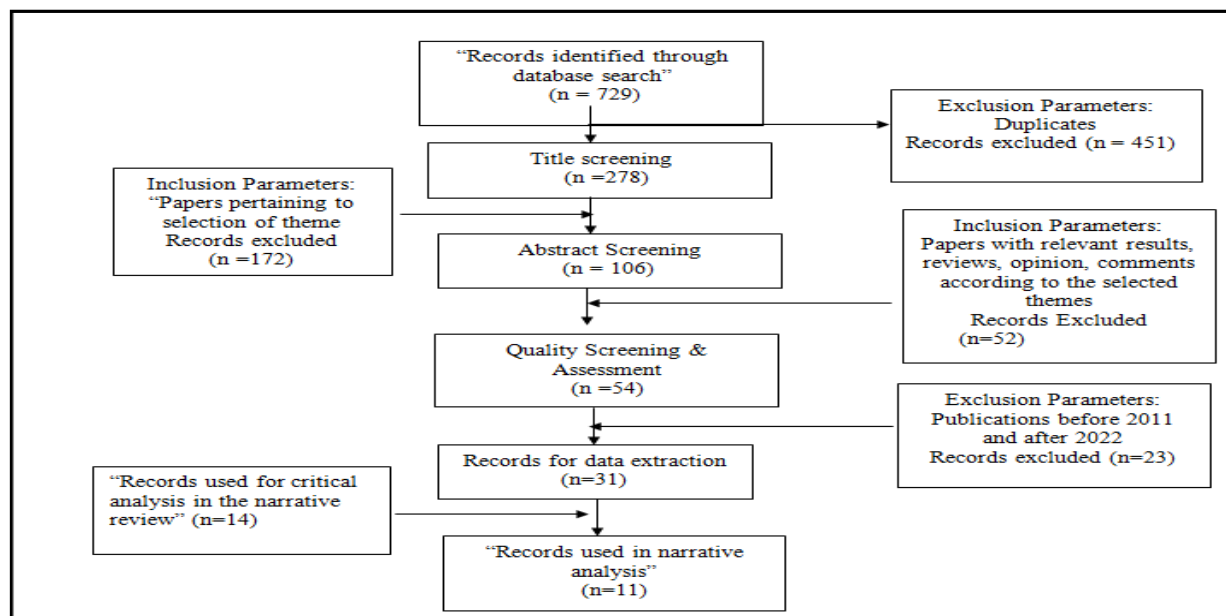


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**Table 2 – Details on the Articles used**

Database Name	Source	Number of Articles Retrieved
SCOPUS	Journal Articles	31





## Production of Biocompost from Solid Waste Spent Mushroom Substrate and Coir Pith

M.Fernandus Durai\*

Assistant Professor, Department of Biochemistry, Sacred Heart College, Tirupattur, Tamil Nadu, India

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### \*Address for Correspondence

**M.Fernandus Durai**

Assistant Professor,  
Department of Biochemistry,  
Sacred Heart College,  
Tirupattur, Tamil Nadu, India  
E. Mail: fernandusdurai@shcpt.edu



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### ABSTRACT

The projected rise in global population of 2.4 billion people by 2050 will put more strain on agricultural systems that produce food, fuel, and fiber, making it more difficult for them to ensure food security and environmental sustainability. *Pleurotus ostreatus*, the oyster mushroom, oyster fungus, mushroom is a common edible mushroom. During the manufacture of mushrooms (*Pleurotus ostreatus*), spent mushroom compost (SMC) is the substrate that is left behind; for every kg of mushrooms, 5 kg of SMC is produced. Straw, cow manure, and amirdha karaisal make around 60 to 70 % of mushroom compost. Spent mushroom substrate is a waste material after the production of mushroom. These waste products are processed to create organic manure, a product with additional value that can be used to restore soil nutrients. Replenishing the soil with these minerals is crucial. Compost made from distillery effluent has been discovered to have favorable physio-chemical properties and nutritional value that promote healthy plant growth. The item has found widespread use as a soil conditioner and ameliorating agent to replace soil nutrients for sustainable agriculture. Compost was analyzed by using FTIR to determine the nitrogen, potassium and phosphorus, in this study we are compared nitrogen, potassium, phosphorus level between soil and compost.

**Keywords:** *Pleurotus ostreatus*, Spent mushroom compost, FTIR, NPK.

### INTRODUCTION

Many methods of composting have been used for thousands of years. Early civilizations used "compost" to refer to a mixture of plant and animal wastes that had been deposited into pits or plies and allowed to decay for a while. Bio compost is a boon to the eco system as it prevents soil erosion, wetland and landfill cover system. Monitoring of the

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compost is one of such methods in bio composting. This system includes the shredding of plant matter, with enough amount of water for the perfect moisture and then regularly adding the mixture for an enhanced aeration. A mixture of ingredients, that fertilize the soil is called compost. It is prepared using a decomposed plant, food waste and recycling organic materials. Bio-composting is generally the biodegradation of organic matter through micro-organisms with the help of macro- organisms under a controlled aerobic condition (L.C.Schisler *et al.*, 1980).Composting of organic waste through bio stimulation strategy improves microbial density, with the upgradation of the microorganic activity in a contaminated zone with the alteration of the moisture and nutrient supply. Biodegradability and bioavailability are some important factors that determine the success of this process(Chilton *et al.*, 1983b).

The Indore technique listed some of the fundamental moisture, temperature, and aeration requirements necessary to generate a compost product, as well as some of the first criteria for generating top quality compost, including the size of the pile. (Howard,2013; Diaz and de Bertoldi *et al.*, 2007).Using living microorganisms to eliminate or degrade environmental toxins is known as bioremediation. Bioremediation is the process of removing or neutralizing unwelcome chemicals from air, soil, or water by using living organisms like bacteria, fungi, or plants. Production is crucial to address the food deficit (Imtiaj and Rahman, 2008,Tibuhwa *et al.*, 2013), particularly for developing nations like Ethiopia. (Rowel 2000).

The most widely commercially grown edible mushroom species globally is *Pleurotus ostreatus*, also known as oyster mushrooms. Proteins, vitamins, minerals, and bioactive substances like glucans, ergosterol, lectins, and antioxidants are all present in *pleurotus* mushrooms. Growing mushrooms is an environmentally responsible activity since it makes use of leftover materials from farming, poultry, breweries, and other sources to create fruit bodies with exceptional and distinctive health benefits. The creation of spent mushroom substrate following crop harvest is a source for worry since, if improperly managed, it can lead to a number of environmental issues, such as ground water contamination and annoyance. One whole crop of mushrooms has been harvested when compost is deemed "spent" or when further crop expansion is no longer profitable.The term "used mushroom substrate" has been adopted because of the variety of uses for spent mushroom substrate that have lately come to light in managing agriculture, the environment, and the recycling of energy(Boa, 2004). Before weathering, SMS contains 1.9-0.4-2.4% (N-P-K), while after 8–16 months of weathering, it contains 1.9–0.6–1.0 (N-P-K). SMS is exempt from being labelled as a hazardous substance because it contains significantly fewer heavy metals than sewerage sludge. (Hayes *et al.*, 1978).

SMC may be broken down into humus material, which has a strong ability for water retention and ventilation. Hence, it can increase soil aeration and stop soil from hardening. Apart from compensating for any soil deficiencies, SMC is also abundant in organic matter and a variety of mineral nutrients that increase soil fertility and output per unit area.(Stametes *et al.*,1993).It is estimated that 12 million tons of mushrooms are produced worldwide each year. According to the China Business Research Institute, surveyed the edible mushroom production at a global level reached an annual yield of 38.42 million tonnes in 2019. For every kilogram of mushrooms, around 5 kg of SMW are created. Typically, "spent" (used) mushroom substrates are abandoned or thrown away after each manufacturing cycle. SMW treatment and disposal are still one of the key environmental issues in the nations that produce mushrooms.

The coconut plant is a member of the arecaceae family of the genus species of *cocos*. The ratio of N to K in the leaves and the key values of foliar N, P, K, Ca, and Mg were fixed at 1.8 to 2, 0.12, 0.8 to 1.0, 0.5, and 0.3 percent of dry matter, respectively, in a study on coconut yield. Every day, the coir industry in Tamil Nadu produces close to 4.5 lakh tonnes of organic waste (coir pith), which needs to be properly disposed of. Lignin (30%) and cellulose (26%), two components of coir pith, are slow to disintegrate but can be done so by using the fungus *Pleurotus*. With 38% cellulose, 25% hemicellulose, and 12% lignin, rice straw is a lignocellulosic biomass.Paddy straw has a high C:N ratio and is high in organic carbon (51.76%), nitrogen (0.65%), phosphorus (0.20%), and potassium (0.30%).



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Moreover, it contains a lot of lignin and silica, which makes it hard to break down. This study created and tested discarded mushroom compost as a viable raw material for biofertilizer for crops.

**MATERIALS AND METHODS****Materials**

Spent mushroom waste (Oyster), animal waste: Cow dung, Cow Urine, Coir pith, Amirdhakaraisal, SHC Campus Humus Soil: Grass clippings, Twigs and sticks were used for the production of Biocompost in organic method.

**Production of Biocompost**

Compost to begin with Twigs sticks in bottom spread first layer, Twigs should cut to small size and spread. Create a larger that about 5cms thick. Twigs being at bottom facilitates aeration of heat air circulation is crucial because microorganisms facilitate composting, need a constant supply of oxygen to survive. Carbon-di-oxide produced by their activity also needs to remove on top of twigs. Then spent mushroom waste, Coir waste, Dried leaves Humus, Cow dung, these four materials placed in layer one by one and finally Amirtha Karaisal sprinkled over the bed, its called one bed, the above bed placed repeatedly four times in the same manner. Every single layer must be containing the above material 15cm size. First one week every 48hrs the material mixed well ups and down. From second week onwards every weekly once it was mixed thoroughly and ups and down and sprinkle Amirtha karaisal. Because Amirdhakaraisal facilitates microorganism's growth thereby accelerating the composting process. The temperature was checked thoroughly. Amirdhakaraisal should be sprinkled on to maintain level as a final step of heap preparation. A polythene sheet should spread over the heap. Sheet helps to retain heat and moisture inside the heap as decomposes this speeds up the composting process.

**Fourier- Transform Infrared Spectroscopy**

200 mg of KBr (FT-IR grade) was combined with 2 mg of the material to create a pellet. After preparation, the pellet was immediately tested using the transmission mode in the mid-infrared region (wave number range 4000-400 cm<sup>-1</sup>) in ambient lighting. 32 scans were recorded, averaged, and adjusted against background ambient air at a resolution of 4 cm<sup>-1</sup>. A Bruker Equinox 55 was used for all experiments. The sample preparation described above guarantees very strong spectral repeatability.

**Kjeldahl Method for Determination of Nitrogen**

One of the five main elements included in organic substances like protein is nitrogen. The protein content of a range of materials, including food for humans and animals, fertilizer, waste water, and fossil fuels, can be determined using the Kjeldahl method of nitrogen analysis, which is the international standard according to the AOAC (1970) method [11].

**Estimation of Phosphorus And Potassium by Atomic Absorption Spectrometric**

By directly aspirating the filtered or digested and filtered sample into an air-acetylene flame, atomic absorption spectrometry can be used to detect the amounts of potassium and phosphorus in the sample. (Fishman and Downs, *et al.*, 1966). Samples of effluent must first be digested in nitric acid, then they must be solubilized in hydrochloric acid. Atomic absorption spectrometer featuring automatic zero and concentration controls, as well as an electronic digital readout.

**RESULTS AND DISCUSSION****Production of Compost**

These are typically the items that are used to make compost.. 1)wasted mushroom substrate, clippings, leaves, paddy straw, and humus plant material are examples of plant-based materials. 2)compost made from animal and human waste that is based on manure. All of the aforementioned sources have large levels of organic matter and



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quantifiable concentrations of macro- and micronutrients. (Stewart, *et al.*, 1998) a good soil conditioner and bio-fertilizer that can be utilized in crop cultivation to lessen the need for inorganic fertilizer, resulting in a sustainable agricultural system, is the leftover mushroom substrate compost left over after harvesting. The environment for root development was improved by spent mushroom substrate by improving soil density, decreasing clod and surface crust formation, and raising infiltration level. (Stewart *et al.*, 1998) Companies that produce potting mixtures sold in supermarkets use spent mushroom substrate as one of their ingredients. The ideal temperature range is between 54 and 60 °C. Our compost contains 38 to 40°C 3 months decomposting duration. For microbial activity, water serves as a solvent and a necessary component. During the composting process, a moisture level of 40 to 60% is desirable. When using compost as a soil amendment or fertilizer as opposed to surface mulch, it's necessary to take into account its nutrient level, pH, and soluble salt concentration. Compost is evaluated using the senses of color, smell, and temperature. Eventually, stable, mature composts have an earthy aroma and are dark in color.

**Fourier- Transform Infrared Spectroscopy Analysis**

(Table – 1) The FTIR analysis of soil results showed (figure - 6) the peaks at 3437.49 cm<sup>-1</sup> to 3695.78 cm<sup>-1</sup> alcohol groups (OH stretching). The peak of 2932.61 cm<sup>-1</sup> C-H stretching alkane (C-H stretching), A peak of 1640.62 shows the presence of alkene and conjugated alkene (C=C extending), the top at 1383.72 cm<sup>-1</sup> alkene group (C-H stretching), The peak at 1032.52 corresponds to sulfoxide (S=O Stretching), the height of 753.63 cm<sup>-1</sup> denotes the alkene (C=O bonding) They also claimed the presence of functional groups like Alcohol, alkane, alkene, conjugated alkene, sulfoxide (Muruganantham S *et al.*, 2009). (Figure – 7) The FTIR analysis of compost results showed (Table - 2) the top at 3427.38 cm<sup>-1</sup> revealed the existence of alcohol group (OH-stretching), maximum at 2927.4 cm<sup>-1</sup> correlates to alkane (C-H stretching), a peak at 2847.57 cm<sup>-1</sup> shows the alkane (C-H stretching), a peak of 1641.04 cm<sup>-1</sup> shows being present imine/ oxime (C-N stretching), the peak of 1411.87 cm<sup>-1</sup> indicate the alcohol (OH bonding). A peak of 1096.82 cm<sup>-1</sup> revealed secondary alcohol (C-O stretching), a peak of 793.68 cm<sup>-1</sup> indicate alkene (C=C bonding) FTIR analysis by compost sample was found the presence of Alcohol, secondary alcohol, alkane, alkene, imine/oxime (Packialakshmi N *et al.*, 2014).

**Determination of Nitrogen by Kjeldahl Method**

Nitrogen was estimated by Kjeldahl method in both soil and compost sample, in soil sample (Table - 3) shows 0.1048% of Nitrogen (N) and in compost shows 0.1141% of Nitrogen (N). The compost shows nitrogen content comparatively high percentage than soil nitrogen more than normal soil. Whether the protein based on this data the compost assures to promote the plant growth in respective ways. because nitrogen (N) is essential to the cycle of life in plants. It is the primary mineral nutrient required by plants for the synthesis of chlorophyll and other components of plant cells. Nitrogen (N) is one of the most important elements in plants after carbon, hydrogen, and oxygen due to its crucial involvement in the creation of chlorophyll, which is needed for the photosynthetic process. (Hoffland *et al.*, 2000) Moreover, nitrogen is a component of several enzyme proteins that catalyse and control activities involved in plant growth. Furthermore, nitrogen helps produce chemical compounds that defend against parasites and plant diseases. Plant N condition affects crop output. Due to the economic and environmental effects of nitrogen fertilizer, it has thus been a focus of significant investigation. Lastly, N fertilization has a significant impact on crop output and biomass.

**Determination of Phosphorus by Atomic Absorption Spectrometric method**

The AAS shows the phosphorus content average in soil 0.035% and in compost 0.24%. literally the compost shows 14.6% more (Table - 4) phosphorus than in the soil. A necessary but scarce element, soil phosphorus (P) is often leached from the soil during the drainage process. Runoff or soil loss are two ways that soluble soil phosphorus can be transported through agricultural areas. It is one of the nutrients that is most crucial to both the transfer of energy for living things and the sustainability of crops. Despite the fact that soil phosphorus (P) is a crucial nutrient for continued crop development, it is nevertheless necessary to execute a realistic simulation of this pollutant because of its elevated concentrations. In other words, it influences the health of soil microorganisms as well as the growth of terrestrial systems and crops. Surprisingly, this element, with a high geographical and temporal variability, may typically be found in substantial concentrations in the drained water from agricultural regions.





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Some soil types, it is preferable to apply surplus P fertilizer over the demands of the crop in an effort to increase crop production. Phosphorus (P) is a crucial component for influencing the growth and productivity of plants. P availability in soil is rarely sufficient for plants to grow and develop at their best due to soil fixation of P. For better seedling vigor and seed germination, seed P concentration is crucial. The only P accessible to plants at the time of germination is in the seed, which supports the growth of the young seedlings. Despite having little significance for adult plants, this P pool is crucial for the nourishment and quicker establishment of young seedlings. During seed germination, the roots of the plant absorb P through the growth medium. wheat seeds with higher soil P uptake when compared to seeds with lower soil P uptake. This was primarily caused by the higher root system development in seeds with large P reserves. (Zhu and Smith *et al.*, 2001). Seed phytate P is hydrolyzed during the early stages of seedling development, and non-phytate P is then remobilized to assist the growth of maize seedlings (Nadeemet *et al.*, 2011, 2012). Although some genotypes were discovered to be sensitive, some research reported that reduced seed P concentration did not affect seedling vigor, plant biomass, or yield when compared to high seed P plants. (Rose *et al.* 2012; Pariasca-Tanaka *et al.* 2015). Thus, larger P concentrations in seeds may be useless because an ideal seed P concentration is sufficient for seed germination.

#### Determination of potassium by Atomic Absorption Spectrometric method

The AAS shows the potassium content average in soil 0.03565% and in compost 0.409935. literally the compost shows 8.69% more (Table - 5) potassium than in the soil. A necessary but scarce ingredient, soil potassium (K), is typically leached from the soil during the drainage process. Runoff or soil loss can transport soluble soil potassium through agricultural areas. It is one of the nutrients that is most crucial to both the transfer of energy for living things and the sustainability of crops. K is required by plants to control the stomata's opening and shutting. the pores in leaves that exchange oxygen (O<sub>2</sub>), water vapor, and carbon dioxide (CO<sub>2</sub>) with the atmosphere. For photosynthesis, water and nutrient delivery, and plant cooling, the stomata must work properly. The guard cells that surround the stomata enlarge and gather water when K enters them, which causes the pores to open and permit gases to flow freely in and out. When water supply is short, K is pumped out of the guard cells. The pores seal firmly to stop water loss and lessen the plant's stress from drought. (Thomas and Thomas, *et al.*, 2009).

## CONCLUSION

Composting materials often fall into one of three types. These categories are: 1) plant-based products, including grass clippings, leaves, wheat straw, woody plant material, and leftover food from the food processing industry.; 2) biosolids made from municipal solid wastes, such as sewage sludge from homes and businesses; and 3) compost made from animal and human waste that is based on manure. All three sources have significant levels of macro- and micronutrients as well as substantial levels of organic matter (Stewart, *et al.*, 1998) A sustainable farming system can be achieved by using the leftover substrate compost that is left over after harvesting as a good soil conditioner and bio-fertilizer to lower the amount of inorganic fertilizer needed for crop production. The environment for root development was improved by spent substrate by improving soil density, decreasing clod and surface crust formation, and raising infiltration level. (Stewart, *et al.*, 1998) Companies that produce potting mixtures sold in supermarkets use spent mushroom substrate as one of their ingredients.

Since microbial activities are temperature sensitive, temperature regulates the population of microorganisms during the composting process. The ideal temperature range is between 54 and 60 °C. Our compost contains 38 to 40°C 3 months decomposing duration. For microbial activity, water serves as a solvent and a necessary component. During the composting process, a moisture level of 40 to 60% is desirable. The production of odors and anaerobic breakdown are caused by excessive moisture. When using compost as a soil amendment or fertilizer as opposed to surface mulch, it's necessary to take into account its nutrient level, pH, and soluble salt concentration. Compost must be well-decomposed, stabilized, and mature in addition to having precise physical and chemical characteristics in order to be useful for agricultural and horticultural uses. Compost is evaluated using the senses of color, smell, and temperature. The appearance and aroma of stable, mature compost are dark and earthy.







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**Table: 1 FTIR Absorbance of soil**

Abs cm-1	Appearance	Group	Compound	Comments
3695.78, 3620.14, 3437.49	Medium, sharp, strong bond	O-H stretching	Alcohol	Free intermolecular bonded
2932.61	Medium	C-H stretching	Alkane	-
1640.62	Medium	C=C stretching	Alkene, conjugated alkene	Vinylidene
1383.72	Medium	C=C stretching	Alkene	Gem dimethyl
1032.52	Strong	S=O stretching	Sulfoxide	-
753.63	Strong	C=C bonding	Alkene	Disubstituted(cis)





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**Table 2: FTIR Spectra of Compost**

Abs cm-1	Appearance	Group	Compound	Comment
3427.38	strong, broad O-H stretching	O-H stretching	alcohol intermolecular bonded Alcohol	bonded intermolecular bonded
2927.42	Medium	C-H stretching	Alkane	-
2847.57	Medium	C-H stretching	Alkane	-
1641.04	Medium	C=N Stretching	Imine/oxime	-
1411.87	Medium	O-H bonding	Alcohol	-
1096.82	Strong	C-O Stretching	Secondary alcohol	-
793.68	Medium	C=C bonding	Alkene	-

**Table 3: Determination of Nitrogen by Kjeldahl**

Content	Nitrogen %	Nitrogen 1	Average	Protein %
Soil	0.1048%	0.1050%	0.1049%	0.6555%
Compost	0.1141%	0.1145%	0.1143%	0.7134%

**Table 4: Determination of Phosphorus by Atomic Absorption Spectrometric**

Content	Phosphorus	Phosphorus 1	Average
Soil	0.034%	0.036%	0.035%
Compost	0.23%	0.25%	0.24%

**Table 5: Determination of potassium by Atomic Absorption Spectrometric**

Content	Potassium	Potassium 1	Average
Soil	0.03560%	0.03570	0.03565%
Compost	0.40998%	0.40989	0.409935%



**Figure 1: Preparation process of Compost with Layer 1**



**Figure 2: Preparation process of Compost with Layer 2**





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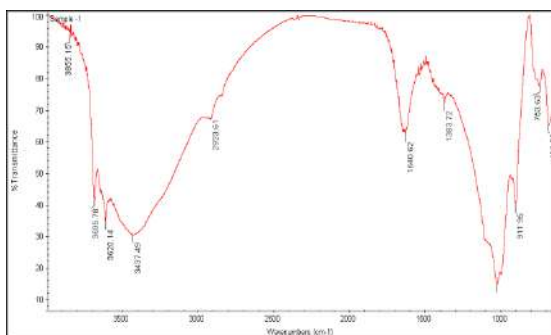
**Figure 3: Preparation process of Compost with Layer 3**



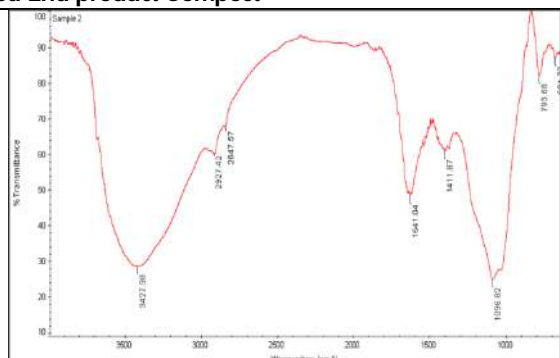
**Figure 4: Preparation process of Compost with Layer 4**



**Figure 5: The final value added End product Compost**



**Figure 6: Infrared spectra analysis of soil.**



**Figure 7: Infrared spectra analysis of a compost.**





## Contra Harmonic Index of Silicate Networks

S.Ragavi<sup>1\*</sup> and R.Sridevi<sup>2</sup>

<sup>1</sup>Part Time Research Scholar, Sri S. Ramasamy Naidu Memorial College, (Affiliated to Madurai Kamaraj University), and Assistant Professor, PG and Research Department of Mathematics, Mannar Thirumalai Naicker College, Madurai, Tamil Nadu, India

<sup>2</sup>Assistant Professor of Mathematics, Sri S. Ramasamy Naidu Memorial College, Sattur, Madurai, (Affiliated to Madurai Kamaraj University), Tamil Nadu, India

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### \*Address for Correspondence

#### S.Ragavi

Part Time Research Scholar,  
Sri S. Ramasamy Naidu Memorial College,  
(Affiliated to Madurai Kamaraj University),  
and Assistant Professor,  
PG and Research Department of Mathematics,  
Mannar Thirumalai Naicker College,  
Madurai, Tamil Nadu, India  
E. Mail: stragavi22@gmail.com



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### ABSTRACT

Topological index is a quantitative parameter which describes the topology of structural framework. The advantage of topological indices may be used in QSPR and QSAR. We found new topological index namely Contra Harmonic Index  $CH(G)$  which is defined as the sum of the terms  $\frac{d(u)^2+d(v)^2}{d(u)+d(v)}$  over all edges  $uv$  of  $G$ , where  $d(u)$  and  $d(v)$  denotes the degree of vertices  $u$  and  $v$  in  $G$  respectively. In this paper, we find the Contra Harmonic Index of Some Silicate networks.

**Keywords:** Contra Harmonic Index, Molecular graph, Silicate networks

## INTRODUCTION

Let  $G$  be a simple connected graph with  $n$  vertices and  $m$  edges. If an ordinary graph's vertices and edges represent atoms and bonds, respectively, then the graph is a molecular graph. A simple graph is one without numerous edges or loops that is undirected and un weighted. A graph is referred to as being linked if a path connects every pair of its vertices. Therefore, a molecular graph is always a straightforward linked graph. It has been widely used to simulate chemical structures using graph theory. An essential area of mathematical chemistry is chemical graph theory, which applies graph theory to the mathematical description of chemical events. The growth of mathematical chemistry and





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the chemical sciences is significantly influenced by chemical graph theory. An important area of mathematical chemistry is computing topological indices[9]. The topological index has developed into a very helpful tool for predicting a compound's physicochemical and pharmacological qualities. The topological index of molecular structure is determined by the number of vertices and edges. Numerous graph-theoretical indices have emerged as a result of applications of graph theory. Many scholars utilise these indexes in their study. The chemist Harold Wiener used a topological index for the first time in 1947. Many reseachers have been working on calculating topological indices recently [3], [4], [5], [11], [12], [13], [14], [15].

#### Silicate Network

The silicates are the largest, the most interesting and the most complicated class of minerals by far. The basic chemical unit of silicates is the  $(SiO_4)$  Tetrahedron. A silicate sheet is a ring of tetrahedrons which are linked by shared oxygen nodes to other rings in a two dimensional plane that produces a sheet like structure. The Silicate Network of level 3 is shown in the figure 1

#### Theorem 1

For Silicate Network  $SL_n$ ,  $CH(SL_n) = 198n^2 - 24n$ .

#### Proof

The number of vertices in silicate network  $|V(SL_n)| = 15n^2 + 3n$  and the number of edges  $|E(SL_n)| = 36n^2$ .

The edge set of  $SL_n$  has the following partitions,

$$E_{(3,3)} = \{e = uv \in E(SL_n) | d_{SL_n}(u) = 3, d_{SL_n}(v) = 3\},$$

$$E_{(3,6)} = \{e = uv \in E(SL_n) | d_{SL_n}(u) = 3, d_{SL_n}(v) = 6\},$$

$$E_{(6,6)} = \{e = uv \in E(SL_n) | d_{SL_n}(u) = 6, d_{SL_n}(v) = 6\}$$

$$\text{Then } |E_{(3,3)}| = 6n, |E_{(3,6)}| = 18n^2 + 6n, |E_{(6,6)}| = 18n^2 - 12n$$

$$\begin{aligned} CH(SL_n) &= \sum_{uv \in E} \frac{d(u)^2 + d(v)^2}{d(u) + d(v)} \\ &= \sum_{uv \in E_{(2,2)}} \frac{3^2 + 3^2}{3 + 3} + \sum_{uv \in E_{(2,3)}} \frac{3^2 + 6^2}{3 + 6} + \sum_{uv \in E_{(3,3)}} \frac{6^2 + 6^2}{6 + 6} \\ &= 6n \left( \frac{18}{6} \right) + (18n^2 + 6n) \left( \frac{45}{9} \right) + (18n^2 - 12n) \left( \frac{72}{12} \right) \\ &= 18n + (18n^2 + 6n)5 + (18n^2 - 12n)6 \\ &= 198n^2 - 24n \end{aligned}$$

#### Triangular Silicate Network

An n- dimensional triangular network is denoted by  $TSL_n$ . The triangular silicate network of level 3 I shown in the fig.2

#### Theorem 2

For Triangular Silicate Network  $TSL_n$ ,  $CH(TSL_n) = \frac{4617n^2 - 6123n + 3297}{95}$ .

#### Proof

The number of vertices in triangular silicate network  $|V(TSL_n)| = \frac{3n^2 + 3n + 2}{2}$  and the number of edges  $|E(TSL_n)| = \frac{9n^2 + 3n}{2}$ .

The edge set of  $TSL_n$  has the following partitions,

$$E_{(3,3)} = \{e = uv \in E(TSL_n) | d_{TSL_n}(u) = 3, d_{TSL_n}(v) = 3\},$$

$$E_{(3,7)} = \{e = uv \in E(TSL_n) | d_{TSL_n}(u) = 3, d_{TSL_n}(v) = 7\},$$

$$E_{(7,7)} = \{e = uv \in E(TSL_n) | d_{TSL_n}(u) = 7, d_{TSL_n}(v) = 7\}$$

$$E_{(3,12)} = \{e = uv \in E(TSL_n) | d_{TSL_n}(u) = 3, d_{TSL_n}(v) = 12\},$$





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$E_{(7,12)} = \{e = uv \in E(TSL_n) | d_{TSL_n}(u) = 7, d_{TSL_n}(v) = 12\}$   
 $E_{(12,12)} = \{e = uv \in E(TSL_n) | d_{TSL_n}(u) = 12, d_{TSL_n}(v) = 12\}$ ,  
 Then  $|E_{(3,3)}| = 3, |E_{(3,7)}| = 9n - 3, |E_{(7,7)}| = 3n - 3, |E_{(3,12)}| = 3n^2 - 9n + 6, |E_{(7,12)}| = 6n - 12$  and  $|E_{(12,12)}| = 3 \left( \frac{n^2 - 5n + 6}{2} \right)$

$$\begin{aligned}
 CH(TSL_n) &= \sum_{uv \in E} \frac{d(u)^2 + d(v)^2}{d(u) + d(v)} \\
 &= \sum_{uv \in E_{(3,3)}} \frac{3^2 + 3^2}{3 + 3} + \sum_{uv \in E_{(3,7)}} \frac{3^2 + 7^2}{3 + 7} + \sum_{uv \in E_{(7,7)}} \frac{7^2 + 7^2}{7 + 7} + \sum_{uv \in E_{(3,12)}} \frac{3^2 + 12^2}{3 + 12} + \sum_{uv \in E_{(7,12)}} \frac{7^2 + 12^2}{7 + 12} \\
 &\quad + \sum_{uv \in E_{(12,12)}} \frac{12^2 + 12^2}{12 + 12} \\
 &= 3 \left( \frac{18}{6} \right) + (9n - 3) \left( \frac{58}{10} \right) + (3n - 3) \left( \frac{98}{14} \right) + (3n^2 - 9n + 6) \left( \frac{153}{15} \right) \\
 &\quad + (6n - 12) \left( \frac{193}{19} \right) + \left( \frac{3n^2 - 15n + 18}{2} \right) \left( \frac{288}{24} \right) \\
 &= 9 + (9n - 3) \left( \frac{29}{5} \right) + (3n - 3)(7) + (n^2 - 3n + 2) \left( \frac{153}{5} \right) \\
 &\quad + (6n - 12) \left( \frac{193}{19} \right) + \left( \frac{3n^2 - 15n + 18}{2} \right) (12) \\
 &= \frac{4617n^2 - 6123n + 3297}{95}
 \end{aligned}$$

**Chain Silicate Networks**

A chain silicate network of dimension n symbolizes as  $(CS_n)$  is obtained by arranging n tetrahedral linearly. The number of vertices in  $(CS_n)$  with  $n > 1$  are  $3n+1$  and number of edges are  $6n$ . A chain silicate network of dimension n is shown in Fig. 3. Now we find the partition of edge set of  $(CS_n)$  based on the degrees of end vertices of each edge, and by using this partition we compute certain topological indices which are based on this partition.

**Theorem 3**

For Chain Silicate Network  $CS_n, n \geq 2, CH(CS_n) = 29n - 10$ .

**Proof**

The number of vertices in chain silicate network  $|V(CS_n)| = 3n + 1$  and the number of edges  $|E(CS_n)| = 6n$ .

The edge set of  $CS_n$  has the following partitions,

$E_{(3,3)} = \{e = uv \in E(CS_n) | d_{CS_n}(u) = 3, d_{CS_n}(v) = 3\}$ ,

$E_{(3,6)} = \{e = uv \in E(CS_n) | d_{CS_n}(u) = 3, d_{CS_n}(v) = 6\}$ ,

$E_{(6,6)} = \{e = uv \in E(CS_n) | d_{CS_n}(u) = 6, d_{CS_n}(v) = 6\}$

Then  $|E_{(3,3)}| = n + 4, |E_{(3,6)}| = 4n - 2, |E_{(6,6)}| = n - 2$

$$\begin{aligned}
 CH(CS_n) &= \sum_{uv \in E} \frac{d(u)^2 + d(v)^2}{d(u) + d(v)} \\
 &= \sum_{uv \in E_{(2,2)}} \frac{3^2 + 3^2}{3 + 3} + \sum_{uv \in E_{(2,3)}} \frac{3^2 + 6^2}{3 + 6} + \sum_{uv \in E_{(3,3)}} \frac{6^2 + 6^2}{6 + 6} \\
 &= 3(n + 4) + 5(4n - 2) + 6(n - 2) \\
 &= 29n - 10
 \end{aligned}$$

**Note**

For  $n=1, CH(CS_1) = 18$ .

**Double Chain Silicate Network**

**Theorem 4**

For Double Chain Silicate Network  $Dc_n, n \geq 2, CH(DC_n) = 126n + 50$ .





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**Proof**

The number of vertices in chain silicate network  $|V(DC_n)| = 11n + 7$  and the number of edges  $|E(DC_n)| = 12(2n + 1)$ .

The edge set of  $DC_n$  has the following partitions,

$$E_{(3,3)} = \{e = uv \in E(DC_n) | d_{DC_n}(u) = 3, d_{DC_n}(v) = 3\},$$

$$E_{(3,6)} = \{e = uv \in E(DC_n) | d_{DC_n}(u) = 3, d_{DC_n}(v) = 6\},$$

$$E_{(6,6)} = \{e = uv \in E(DC_n) | d_{DC_n}(u) = 6, d_{DC_n}(v) = 6\}$$

$$\text{Then } |E_{(3,3)}| = 2n + 4, |E_{(3,6)}| = 14n + 10, |E_{(6,6)}| = 8n - 2$$

$$\begin{aligned} CH(DC_n) &= \sum_{uv \in E} \frac{d(u)^2 + d(v)^2}{d(u) + d(v)} \\ &= \sum_{i=1}^{2n+4} \frac{3^2 + 3^2}{3+3} + \sum_{i=1}^{14n+10} \frac{3^2 + 6^2}{3+6} + \sum_{i=1}^{8n-2} \frac{6^2 + 6^2}{6+6} \\ &= 3(2n + 4) + 5(14n + 10) + 6(8n - 2) \\ &= 126n + 50 \end{aligned}$$

**Rhombus Silicate Network****Theorem 5**

For Rhombus Silicate Network  $RHSL_n, n \geq 2, CH(RHSL_n) = 66n^2 - 16n - 2$ .

**Proof:**

The number of vertices in rhombus silicate network  $|V(RHSL_n)| = 5n^2 + 2n$  and the number of edges  $|E(RHSL_n)| = 12n^2$ .

$$\begin{aligned} CH(RHSL_n) &= \sum_{uv \in E} \frac{d(u)^2 + d(v)^2}{d(u) + d(v)} \\ &= \sum_{i=1}^{4n+2} \frac{3^2 + 3^2}{3+3} + \sum_{i=1}^{6n^2+4n-4} \frac{3^2 + 6^2}{3+6} + \sum_{i=1}^{6n^2-8n+2} \frac{6^2 + 6^2}{6+6} \\ &= 3(4n + 2) + 5(6n^2 + 4n - 4) + 6(6n^2 - 8n + 2) \\ &= 66n^2 - 16n - 2. \end{aligned}$$

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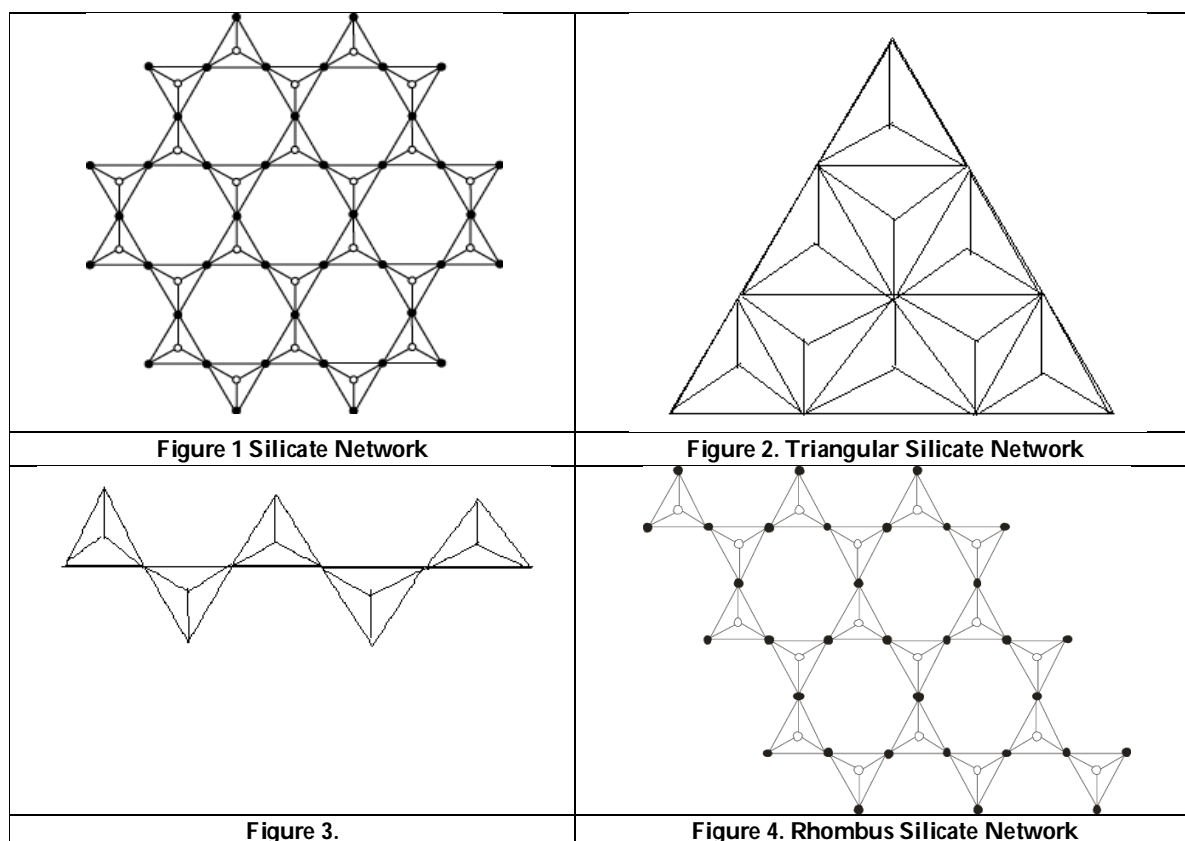
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## The Impacts of Space Weather on Technological Systems: a Review

D.K.Tripathi<sup>1\*</sup>, S.Nandi<sup>2</sup>, P.Roy<sup>3</sup> and R.Karmakar<sup>3</sup>

<sup>1</sup>Assistant Professor (Physics), Department of Basic Science and Humanities, Narula Institute of Technology, Kolkata, W.B., PIN - 700109, India.

<sup>2</sup>Associate Professor (Chemistry) and Head, Department of Basic Science and Humanities, Narula Institute of Technology, Kolkata, W.B., PIN - 700109, India.

<sup>3</sup>Student, Department of Information Technology, Narula Institute of Technology, Kolkata, W.B., PIN - 700109, India.

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### \*Address for Correspondence

**D.K.Tripathi**

Assistant Professor (Physics),  
Department of Basic Science and Humanities,  
Narula Institute of Technology,  
Kolkata, W.B., PIN - 700109, India.  
Email: dhananjay.tripathi@nit.ac.in



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### ABSTRACT

The space weather affects the technological systems in the space as well as on the earth surface. Damage to the spacecraft electronics, GPS signal scintillation, high frequency radio wave disturbance, radiation effects on avionics etc. are some of the impacts of space weather on modern day technology. This paper critically reviews the effects of space weather on modern technological systems

**Keywords:** GPS signal scintillation, Geomagnetically induced current, Space Environment, Telluric currents, Radio Communication

### INTRODUCTION

The environment of the space changes violently due to coronal mass ejections and solar flares. The rapidly changing conditions of geo-space environment and also on the Sun and interplanetary medium is called as space weather. The space weather is controlled by geomagnetic activities. Damage to spacecraft electronics, GPS signal scintillation, high frequency radio wave disturbance, radiation effects on avionics, geomagnetic ally induced currents in power system, telluric currents in pipelines, magnetic interference in exploration surveys and effects in submarine cables are due to the solar storms [1-2]. These storms are sometimes so energetic that they can produce very strong shock waves which can deform the earth's magnetosphere [3-4]. The energetic particles spew out by Sun can Cause misoperation of the satellite by damaging its circuit. Theses energetic particles can affect the health of the astronauts and the pilot of an aeroplane. The communication and navigation systems are affected due to these storms. The magnetic disturbances induce electric currents in power lines results in outages of power system. The pipeline corrosion is also seen due to

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change in the space condition. Cosmic rays (galactic cosmic rays, extragalactic cosmic rays and solar cosmic rays) penetrate deep inside Earth's atmosphere where airplanes travel every day. The crew members and passengers can absorb significant amount of cosmic rays during flight. The pilots of the aircrafts during a year generally absorb radiation equal to a worker in a nuclear power plant. Studies have shown that the passengers of a flight flying at mid-latitude about 11Km can absorb nearly 30times more ionizing radiation than people at sea level during low solar activity. During high solar activity or if the flight is flying over the poles then this dose may be higher.

## ANALYSIS AND RESULT

### Effect on Power Systems

Sudden changes of the geomagnetic field due to the space weather induces an electric field in the surface of the earth. This electric field induces electric currents called geomagnetically induced current (GIC) in the power grid and also in other grounded conductors [5]. GIC can result instabilities in power transmission network and burn out of transformer. With the geomagnetic variations the electric field changes with time [6-12]. These current magnetizes the core of the transformer in one polarity and can cause the core to magnetically saturate on one half-cycle of the AC voltage results in peaks in the magnetizing current drawn from the grid system. Due to this half-cycle saturation, the magnetic flux can escape from the core which can cause rapid heating in the transformer and the production of gases in the insulating oil, which leads to alarms being triggered, shut-down of the transformer, and, in the most severe incidents, serious thermal damage to the transformer. Even if no immediate damage is caused, the performance of the transformer can degrade. The problem occurs simultaneously on many power systems due to Geomagnetically induced current(GIC) unlike other types of power system problems due to lightning strikes or equipment failures, which are more localized. The localized power failures can be prevented with modern interconnections of power systems but prevention of power failures due to GIC is tedious.

### Effect on Satellites

The environment in which the satellites are operating is filled with charged particles. These charged particles affect satellites in many ways [10-12]. They can damage the circuitry of the satellites results in loss of control or satellite failure. They can penetrate the electronics of the satellite or can charge the spacecraft. Surface and internal charging can occur. Both involve complex interactions between the space environment. The discharge creates problem. Data upsets, false commands and even component damage can be caused due to coupling of discharge into sensitive electronics. The low energy electrons (<100keV) interacts with only surface materials and can cause surface charging [1]. Potential differences of several kilovolts may arise between various Different surfaces, results to an electrostatic discharge under some conditions. The grounding of surfaces and the conductive coatings are the techniques used to suppress the surface charging, but recently it is seen in new form creating major power losses in solar arrays.

In internal charging, the high-energy electrons (>100 keV) can penetrate into the spacecraft equipment and deposit charge inside insulating materials (especially plastics) and ungrounded metals. This problem is still unsolved. Persistently high fluxes of magnetic storms for a day or two days can build up enough charges for internal charging. Microelectronic devices of the satellite can be damaged due to ionizing dose provided by the electrons. At last the whole equipment may fail. Energetic protons and ions present as a background flux of galactic cosmic rays and can be greatly enhanced for several days at a time by solar energetic particles (SEPs) increases the total ionizing dose which causes following two effects:

**Displacement damage:** The crystalline structure of materials used in microelectronic devices may be disrupted due to total ionizing dose which reduces the performance of the transistors and affects the optoelectronic devices.

**Single event effects:** If the individual particles are accumulated in the sensitive regions of microelectronics, then single event effects arise. This type of depositions occurs either by direct ionization or by nuclear interactions. Due to these effects, some of the devices got burnout like metal oxide semiconductors.





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The high upset rate due to SEPs results in operational outages and failures. The effect of particle fluxes and total ionizing doses is reduced using Physical shielding at component, equipment and spacecraft level. Circuits are designed in a manner so that some degree of degradation and unwanted behavior can be accounted in microelectronic components and the components are carefully selected, screened and tested.

### **Telluric Currents in pipelines**

For transporting gas, oil and water on surface, underground and under the sea, pipelines are used. To withstand the pressure, these pipelines are built using steel. The damage may come in the form of physical cracking and corrosion. The steel of the pipeline is covered with an isolated coating and connected to cathodic protection rectifiers to prevent corrosion [6-8]. The variations in the Earth's magnetic field induce electric currents in long conducting pipelines and surrounding soil. In pipeline industry, these currents are called as telluric current. These currents can create voltage fluctuations in pipeline-cathodic protection rectifier system which make it tedious to maintain pipe-to-soil potential in the safe region. During magnetic storms, these variations can become high enough to keep a pipeline in the unprotected region for some time resulting in reduction of the lifetime of the pipeline.

### **Effect on radio communication systems**

The effect of solar radio bursts on the performance of the mobile phone networks is reported continuously. The impact of SRBs depends on its intensity and whether the antenna is pointed at the Sun [9-13]. Now a day, base stations and mobiles are designed in keeping in mind the signal outages without loss of connection, only temporary loss of services. Solar events of longer duration can affect the mobile network. Mobile handsets are protected from solar noise by surrounding buildings and trees. Particular mobiles may be affected rather than the whole system in spite of high external noise from the solar radio bursts. The base stations are more likely to be affected due to external noise as they have lower noise figure than mobiles. Due to their antennae, the base stations can be affected only when the Sun is closed to the horizon. The horizontal beam width is limited, so the sectors facing the sun will be affected only. The SRB must occur near to sunrise or sunset and the mobiles served by the sector in the direction of the Sun will be only affected. The mobiles which produces a weak signal at the base station will be most affected. So, we can conclude that extreme solar radio bursts are likely to have significant impact on the mobile phone network and to only base stations facing the Sun at the time of the event.

### **Effects on GPS signal**

The fluctuation in the Amplitude of radio signals propagating in ionosphere near the equatorial region due to space weather event is called as scintillation. This scintillation can intense or degrades the signal quality or can reduce the information content or can cause failure of the signal reception [14-15]. In the dynamic atmosphere of ionosphere due to space weather, during nighttime, the development of high depletions in the ionospheric plasma density, called as Equatorial Plasma Bubbles (EPBs), can interfere in the satellite links in different ways. Two main issues regarding GNSS signals over low latitudes - the ionospheric scintillation and the fading events, both taking place at the nighttime due to the existence of the EPBs and being capable of degrade and can cause temporary outages in GNSS-based systems. Ionospheric scintillation refers to fluctuations in the received signal amplitude and/or phase and is caused by the abrupt variations in the ionospheric index of refraction associated with the EPBs. The EPB structures causing the ionospheric scintillation and the fading events are believed to be generated over the equatorial region due to the Rayleigh-Taylor instability. A large number of growing technologies dependent on satellite navigation like driverless cars, road tolling, and railways control systems can be affected by space weather events. These technologies may face positional errors due to unexpected changes in ionospheric delay and the loss or fading of signals caused by ionospheric scintillation. So, the space weather impact should be mitigated at the level of development or designing of these highly technological system [16].

### **Effects on Aviation**

The high-altitude pilots, crew, frequent flyers and commercial space travelers always faces the hazards of galactic cosmic ray (GCR) and solar energetic particles (SEPs) during their traveling at and above commercial aviation



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altitudes, i.e., above 8 km [17]. Galactic cosmic rays are coming from outside the solar system. GCRs mostly have protons but they also contain heavy ions like iron. SEPs originate from solar flares. These cosmic rays (both GCR and Solar cosmic rays (SCRs)) enter the earth's atmosphere at various magnetic latitudes and can influence the atmospheric molecules. At about 100 km from the surface of the earth (just below the top of the atmosphere), the particles in GCRs and SCRs interact with neutral molecules (dominantly  $N_2$  and  $O_2$ ) to produce secondary and tertiary particles and photons, such as  $n$ ,  $p$ ,  $e$ ,  $\alpha$ ,  $\pi$ ,  $\mu$ , and  $\gamma$  rays. The fluxes of the primary particles (particles of GCRs and SEPs) decrease with decreasing height whereas the secondary radiation component from lower energy cascading particles and photons produced by the impacts increases. The processes of decrease in primaries and increase in secondaries at lower altitudes result in maximum ionization rate which occurs between 20 and 25 km. Below this altitude, from the Earth's surface, the dose rate used to decrease with particle or photon absorption in an increasingly thick atmosphere. These secondary particles having varying energies with neutrons and protons may radiate in all directions but they are generally directed downward. These secondary and tertiary particles may collide with an aircraft hull and interior components, people, or fuel to cause a further alteration of the radiation spectrum. This complex radiation field consists of many streams of particles, including neutrons, which can cause an increased cancer risk.

#### Effects on Submarine internet cables

Submarine internet cables are stretched on the sea floor for connecting different continents, uses repeaters which boost the optical signals by repeating the incoming waves. These cables are equipped with repeaters at each 100 km-150 km. To provide power to many repeaters, a landing station is there on both sides of the sea or ocean. These landing stations have the lasers and redundant high-voltage powering feed equipment (PFE) for providing powers to the repeaters. It is recently reported that geomagnetically induced currents of high magnitude due to solar storms could surge through these cables and can burn out the repeaters as these cables are designed to operate at a constant 1 A current [18]. Installation of submarine internet cables take nearly two to three years and destruction of some of them would be severe impact of space weather. The lifetime of the repeaters in submarine internet cables is 25 years [18]. These cables are highly resilient and generally not damaged until and unless there is human interaction. Basically, the damages in the submarine internet cables are localized and the cause of these damages are fishing vessels, ship anchors or submarine landslides or tsunamis. The repairing of a single point on the cable takes days to weeks. The extent of damage in the cable due to strong solar storm has never been tested. So, it is not possible to predict the extent of damage in the submarine cables and the time required to repair that. It is also reported that a rare solar super storm may cripple the infrastructure of world's internet and can cause an outage which could last for months [19-21].

## CONCLUSION

The space weather is very dynamic and variable situations in space which is affected by varying radiations from the Sun. The variation in the radiation of the Sun is caused by the varying conditions of plasma, magnetic field, highly energetic charged particles, etc. leads to the change in the conditions of the atmosphere of the earth, ionosphere, magnetosphere and interplanetary space. These changes affect every modern communication system, transport system, energy system, control systems, etc. So, during the design and development of these systems the space weather influence should be mitigated.

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## Psychological Predictors of Academic Well-Being

Abhilasha Agarwal<sup>1</sup>, Bhavana Arya<sup>2\*</sup> and Sandhya Verma<sup>3</sup>

<sup>1</sup>Research Scholar, Department of Psychology, Manipal University Jaipur, Jaipur, Rajasthan, India

<sup>2</sup>Associate Professor, Department of Psychology, Manipal University Jaipur, Jaipur, Rajasthan, India,

<sup>3</sup>Scientist 'E' DIPR, DRDO, Delhi

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### \*Address for Correspondence

#### Bhavana Arya

Associate Professor,

Department of Psychology,

Manipal University Jaipur,

Jaipur, Rajasthan, India.

E. Mail: bhavana.jaipur@gmail.com



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### ABSTRACT

Academic wellbeing can be defined as wellbeing of students in the context of academic which involves both positive and negative aspects of wellbeing. Present study aims to investigate the role of academic engagement, academic perseverance, and learning strategies in academic well-being. Purposive sampling was used to collect data from 350 university students pursuing post-graduation. The students filled out four questionnaires: The Approaches and Study Skills Inventory for Students (ASSIST), The Utrecht Work Engagement Scale for Students (UWES), College Students Subjective Wellbeing Questionnaire (CSSWQ), and Academic Perseverance Scale (Grit-8). Results confirmed a significant positive impact of academic engagement, academic perseverance and learning strategies on academic wellbeing.

**Keywords:** Academic wellbeing, Learning Strategies, Academic Perseverance, Academic Engagement.

## INTRODUCTION

Since the dawn of positive psychology in the 1990s, the holistic concept of well-being has replaced the traditional concept of illness. Well-being is a dynamic condition that includes the capacity to fulfil one's personal and social goals (Borgonovi and Pál, 2016). The same extension led to the concept of academic well-being of students since academics is a big part of the lives of students (Korhonen, 2014). In recent times, the academic well-being of students taking into account the centrality of school (Govorova *et al.*, 2020; Eccles & Roeser, 2009) has been linked to positive student results (Robinson and Snipes, 2009; Korhonen *et al.*, 2014; Shek and Chai, 2020). Similarly, Parker *et al.*, (2005) have demonstrated that emotional abilities are connected with greater academic accomplishment in first-year undergraduates. In another study by Turashvili and Japaridze (2012) on Georgian students, well-being and academic performance were positively associated, pointing to the importance of academic well-being in modern content. On

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the other hand, studies have mentioned depression as one of the top ten challenges to achieving academic success, and withdrawal due to depression has also been associated with worse grades (Meilman *et al.*, 1992).

The concept of academic well-being is diverse, incorporating various positive and negative indicators like subjective well-being, self-esteem, school value, school burnout, schoolwork engagement, and stress (Pollard & Lee, 2003). In a study, academic well-being was measured by subjective well-being and school burnout, which were central indicators of well-being at school (Merhi, Paniagua & Decals, 2018). School-related burnout is characterized as a combination of exhaustion from schoolwork, cynicism about the purpose of education, and a sense of inadequacy as a student (Salmela-Aro *et al.*, 2009). Exhaustion in school is characterized as feelings of tension, particularly persistent exhaustion brought on by excessive workload and high academic standards. Cynicism shows up as an aloof attitude toward education in general, a lack of enthusiasm for one's schooling, and a failure to see its purpose. Inadequacy, on the other hand, describes lowered perceptions of one's abilities, successes, and accomplishments as a learner (Salmela-Aro *et al.*, 2009). Burnout can be brought on by differences between students' internal resources, school workload, and academic performance expectations (Kiuru *et al.*, 2008). Subjective Well-Being is a person's fundamental level of subjective well-being and pertains to how people assess their life (Diener, 1984). Seligman (2011) states that subjective well-being is a multifaceted concept of happy feelings, engagement, fulfilling relationships, purpose, and accomplishments. Subjective Well-being is often considered a predictor of academic well-being (Bücker *et al.*, 2018; Steinmayr *et al.*, 2018). Hence, it can be considered a measure of academic well-being.

**Academic Engagement**

According to Fredericks *et al.*, (2004), engagement is a complex construct with cognitive, behavioral, and emotional characteristics that measures a student's overall involvement in the classroom. Academic engagement refers to a happy, content, study-related mental state marked by vigor, dedication, and absorption (Schaufeli *et al.*, 2002). Among these three aspects, vigor refers to strong levels of mental resilience when studying, a willingness to put effort into one's schooling, and a positive attitude. Dedication is defined by a sense of relevance, passion, pride, identity, and inspiration toward education, as well as a perception of academics as worthwhile. Absorption is defined by behavioral successes and flow-like experiences, such as being so thoroughly absorbed and enthusiastically engrossed in one's studies that time flies rapidly (Schaufeli *et al.*, 2002). Schaufeli and his colleagues (2002) initially conceptualized engagement as work-related involvement, but it was eventually transformed into school engagement. Researchers argued that a student's duties and activities could be regarded as 'work' since the student, like an employee, is involved in coercive, regulated tasks and activities directed toward a certain goal (Ouwneel *et al.*, 2013; Salmela-Aro & Upadhyaya, 2012).

Academic engagement is a crucial resource strengthened by regular encounters with positive well-being. This view is postulated by the broaden-and-build theory (Fredrickson, 1998, 2001), which states that positive emotions are fundamentally adaptive because they let people think about things from other perspectives, which helps them create long-lasting social, psychological, and physical resources. People who feel and express happy emotions have greater personal resources and are more likely to do well and exhibit optimal functioning, leading to increased school engagement (Fredrikson 2013). A significant body of research verifies this proposition. In a longitudinal study on Filipino high school students, measures of subjective well-being (life satisfaction & lack of negative affect) significantly predicted academic engagements over some time. This relationship is not only one-way but rather bidirectional. According to a review, high levels of school involvement are inversely correlated with students' well-being, including depressive symptoms and exhaustion, and positively correlated with academic performance (Upadhyaya and Salmela-Aro, 2013). Students highly engaged at school also tend to be happier and more satisfied with their lives, among other aspects of well-being. This is because students' engagement positively impacts their adjustment to the academic context and their overall success (Upadhyaya & Salmela-Aro, 2013).

The relationship between burnout and academic engagement can be studied from a job demands-resources (JD-R) model view, which lent itself to a job-related concept (Salmela-Aro & Upadhyaya, 2014). The job demands-resources (JD-R) model of occupational stress assumes that environmental characteristics can typically be divided into two



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categories: demands, which consider physical and psychological effort, and resources, which are useful in achieving work goals, reducing the demands, and promoting personal growth and development (Llorens, Bakker, Schaufeli, & Salanova, 2006). The variety of study demands and resources that students face in academic environments may subsequently show up in their degree of engagement and burnout at school and in their general well-being. This idea has also lent support from research findings, demonstrating that burnout and weariness reduce students' likelihood of sticking with academic tasks and institutions (Bask & Salmela-Aro, 2013). A study found a moderate negative relationship between two sub-scales of burnout (cynicism and exhaustion) and school engagement and a high positive correlation between professional efficacy and engagement (Liu *et al.*, 2018). Similarly in a study negative correlation was found between academic engagement and burnout in nursing students (Wang *et al.*, 2021).

**Academic Perseverance**

Perseverance is defined as an individual's ability to endure in the face of obstacles (Kwong and Mokand Kwong, 1997). An individual attempts to persist despite difficulties. Academic perseverance is thus the extent to which a student can continue to engage in academic activities in the face of difficulties or obstacles. Researchers have referred to academic perseverance as a variety of non-cognitive skills. According to Farrington *et al.*, (2012), "Academic perseverance refers to student effort and the quality of academic conduct which include intensity, direction, and duration." The concept is closely related to Grit, which is defined as the ability to endure challenges while maintaining a desire for long-term goals (Duckworth *et al.*, 2007). Both academic perseverance and academic grit have been believed to play a role in predicting academic accomplishment (Gutman & Schoon, 2013; Garcia, 2014; Robinson, 2015). Grit is the ability to persevere through adversity and strive relentlessly toward a goal. In other words, those who have more grit are less likely to give up when faced with adversity. In addition, these individuals keep their motivation high in the face of setbacks, challenges, and a lack of resources to reach their goals. Evidence from numerous fields highlights the connections between grit and success in the classroom, relationships, and everyday behaviours. Several studies have found a clear correlation between grit and academic success, including higher GPAs, greater levels of intellectual engagement, and higher self-reported grades.

It can break down grit into two components: G-PE (or "perseverance of effort") and C-I (or "consistency of interest") (G-CI). The term "generalized persistent effort" (G-PE) describes how hard people work to overcome obstacles. Alternatively, G-CI refers to the propensity to maintain a consistent set of preferences over time. In this study, we dissect how these components of grit affect students' sense of competence and motivation to succeed. Students that are engaged and make an effort to study are more likely to embrace beneficial learning goals (i.e., mastery goals and performance-approach objectives). In contrast, students whose motivation and perseverance are weaker are more prone to adopt performance-avoidance plans to avoid education altogether. Thus, it is suggested that the two facets of grit exert a secondary effect on academic achievement. Students' confidence in their ability to learn improves when they believe they have a more significant investment in the subject matter and are more likely to stick with it. It recognizes the symbiotic relationship between the three main parts: Self-Expression, a Determination to Achieve Learning Objectives, and Strategies for Self-Regulated Learning. High-achieving pupils are more efficient with their time, take greater satisfaction from their work, and use more complex thought processes than their less successful counterparts, according to the research.

The triarchic model of grit asserts that grit can positively predict the well-being of students (Datu *et al.*, 2017). More specifically, perseverance of effort, a component of grit, has been linked to increased levels of positive academic functioning and well-being (Datu *et al.*, 2020). Various research has validated these claims. An international study of 7,617 people from six continents found that the perseverance aspect of grit was moderately to highly connected with subjective well-being, perceptions about well-being, and personal strength, independent of cultural variations (Disabato *et al.*, 2019). Similarly, one research explored the association between grit, fulfilment of needs, and subjective well-being in learners (Jin and Kim, 2017). They discovered a negative relationship between grit and depression, which might explain the strong relationship between grit and subjective well-being. Individuals with greater grit levels are often driven by seeking out activities related to personal growth and development in the face





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of negative affect (Mason, 2021). As a result, grit is considered a valued attribute in an academic setting where goal pursuit and engagement are essential qualities for dealing with academic problems (Duckworth & Seligman, 2005).

Similarly, researchers used the JD-R model to explore the impact of grit on students' emotional reactions to academic stress, learning behavior, academic accomplishment, and mental health and to reveal resources that may prevent students from burnout (Teuber, Nussbeck & Wild, 2020). They found that grit is an important component of preventing school burnout. As a result, gritty individuals are less likely to get burnt out and more willing to participate in school-related activities. Their mental health and well-being benefit from successful adjustment. In a study, the students' grit protected against depressive symptoms among adolescents who experienced high levels of exhaustion and cynicism (Tang, Upadhyaya & Salmela-Aro, 2021). In their study, grit did not radically change the influence of tiredness and cynicism on depressive symptoms. On the other hand, grit consistency and grit perseverance safeguarded fatigued and cynical students against depressed symptoms by lowering their symptoms to below-average levels.

**Learning Style**

The styles or approaches to learning are based on the work of Marton and his colleagues, who classified two types of learning styles: deep and surface, which relate to the intentions and motivations of students associated with learning settings in higher education (Marton and Booth, 1997). The deep style refers to active involvement with the subject, which significantly elaborates the learning material while seeking personal comprehension. On the other hand, the surface style suggests using regular memorization to recreate those features of the subject matter that are likely to be examined. Students who are prepared to read widely about the major and associated materials and connect the meaning of current materials and information with prior knowledge to understand the subject choose deep learning techniques thoroughly. However, the motive for using the surface learning strategy is more practical: the main goal of learning is to meet the subject's basic requirements (e.g., a pass in the examination with the least effort). Later, a strategic approach was added to these styles, combining deep and surface learning techniques, depending on the job, to organize their learning to obtain a high or good outcome.

Learning approaches have been linked with academic performance. It was discovered that deep learning was positively connected to GPA, but surface motivation was adversely related to exam scores (Seagrove and Slater, 2003). According to Rodriguez (2009), students who choose deep learning approaches think creatively and critically, attach a personal meaning to the learning task, and develop the ability to be versatile learner; one who recognizes different academic tasks and designs the appropriate learning strategy accordingly (Zhang & Sternberg, 2000, Entwistle, 1977). As a result, the greater the academic ability of pupils, the more they engage in deep learning.

Learning strategies also affect the academic well-being of students. Based on causal agency theory, to obtain greater academic performance and deeper, more meaningful knowledge, the deep learning technique necessitates a high degree of information processing and deeper engagement in the learning process (Tho *et al.*, 2020). Students' personal growth may be enhanced with the use of this information. As a result, students who choose the deep learning strategy will play a causal role in their academic success at the institution, contributing to an improvement in the campus community as a whole. On the other hand, the surface learning technique is described as instrumental and reproductive to meet academic topic minimal criteria with the least amount of information processing work. They do not behave as a causal actor since they are unlikely to engage in self-determined acts. As a result, their general well-being can decline. This was validated by some studies. On a sample of 244 Zanzan medical sciences students, a study was conducted to explore the link between learning approaches, educational well-being, and educational interest (Yosefi Afrashte, Rezaei, and Sadeghi, 2021). They discovered that deep learning strategy, strategic learning approach, and academic well-being were positively connected. On the other hand, the surface learning strategy was negatively correlated with it.

The purpose of this research is to look at the correlation between academic well-being, academic engagement, academic perseverance, and learning methodologies. Our main goal is to investigate the role of academic



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engagement, academic perseverance, and learning strategies in academic well-being. Second, we will look at how these elements differ in different circumstances, such as private institutions and public universities. Finally, we will identify potential interventions that might be employed to improve academic well-being, as well as their efficacy. Although it is widely acknowledged that all of these characteristics play a crucial role in learning, less is known about their impact on academic well-being. This study will seek to fill this knowledge vacuum by offering a thorough examination of the relationship between academic well-being, academic engagement, academic perseverance, and learning strategies. We will also investigate the function of interventions in academic well-being, which can have ramifications for both students and learning settings. Overall, this research will add to the body of knowledge on academic well-being and offer real-world solutions to the issues encountered by educational institutions. The findings of our study can be used to inform legislation, curriculum design, and instructional practices to improve the educational environment.

**MATERIALS AND METHODOLOGY**

In this particular study, the relationship between learning strategies, academic engagement, academic perseverance, and academic well-being was examined. Numerous studies have emerged in the last ten years that show persons with high levels of engagement also have high levels of academic well-being, which leads to good academic performance. The study utilizes a correlational and regression research design.

**Hypothesis**

- H1. There will be a positive correlation between surface learning strategies and academic well-being.
- H2. There will be a positive correlation between deep learning strategies and academic well-being.
- H3. There will be a positive correlation between strategic learning strategies and academic well-being.
- H4. There will be a positive correlation between academic perseverance and academic well-being.
- H5. There will be a positive correlation between academic engagement and academic well-being.
- H6. Learning strategies, academic engagement, and academic perseverance together will significantly predict academic well-being.

**Sample Description**

The sample of the study consists of 350 post-graduation university students from different universities in Jaipur Rajasthan. Purposive sampling was used to collect the sample.

**Tools**

The survey method was used to test the theoretical model. Standardized tools were used to collect data. All tools, in accordance with the objectives of the current research have been briefly described:

**Approaches and Study Skills Inventory for Students (ASSIST)**

ASSIST is a 52 item scale which measures students learning styles in terms of deep, surface and strategic form. It uses five-point Likert scale where 5 = agree, 4 = agree somewhat, 3 = unsure, 2 = disagree somewhat and 1 = disagree. It was developed by Marton & Säljö (1976a, 1976b) and others (Biggs 1987).

**UWES**

The UWES-9S and its three components (zeal, commitment, and attention) had appropriate internal consistency. Multiple-group confirmatory factor analysis backed gender-neutral results. The UWES-9S was a reliable tool for gauging students' study devotion. The self-report scale evaluates energy, devotion, and immersion (AB). On a 7-point frequency scale, each item is rated 0 (never) to 6 (very often) (consistently). UWES-9S1 was translated from Spanish to better its understandability by undergraduate students in Chile, per International Test Commission recommendations (Muiz *et al.*, 2013). Ten participants piloted the nine items to ensure clarity before data collection. No one complained about UWES-9S item content or scoring rubric.



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College Students Subjective Well-being Questionnaire is a self-report happiness instrument (CSSWQ). This survey has three parts: Five items were used to measure weariness, such as "I am emotionally tired from school." Cynicism was graded on a 4-item scale (e.g., "I am more skeptical about how my education will aid me in the future"), and Academic Efficacy had six questions (including "I am an excellent student"). Zero was the least frequent, and seven was the most frequent. Always 1-5. Low Academic Efficient indicates cynicism and emotional and academic weariness. Cacy item scores are flipped. CSSWQ 16 questions. CSSWQ measures academic satisfaction, efficacy, school connectedness, and college gratitude. Each subscale's well-being indicators can be used independently or together to measure college students' subjective well-being.

**The Academic Perseverance Scale**

Given the stakes, researchers need a reliable indicator of how many participants will show academic perseverance over the course of the study. The academic perseverance scale is the assessment tool that will be discussed in this research. Perseverance can be broken down into its parts, which include, but are not limited to, continued involvement in an activity, renewed dedication, and stepped-up efforts in the face of adversity. The internal consistency and test-retest reliability of the MBI-SS were calculated. All three burnout subscales have strong levels of internal consistency, as measured by Cronbach's coefficient. This finding aligns with other international research using other MBI-SS language versions.

**RESULTS AND DISCUSSION**

We recently looked into the correlation between learning strategies, academic engagement, academic perseverance, and academic well-being. Strengthening the learner's participation in their educational activities and encouraging them to perceive academic problems as part of the learning process leads to greater academic achievement. A higher mean value of academic well-being suggests that the ability of a student to perform, think, and invent is better for overall academic attainment. The greatest mean value was for total academic well-being, highlighting the importance of well-being in overall academic attainment. Our research found a link between strategic learning strategies and academic well-being. Students can benefit from deep learning strategies such as information integration, problem-solving, and self-reflection. Learning styles also have an impact on students' academic performance. According to Tho *et al.*, (2020), the deep learning technique necessitates a high level of information processing and deeper participation in the learning process to obtain improved academic accomplishment and deeper, more meaningful knowledge. The application of this knowledge may aid in the personal growth of students. Students who adopt deep learning approaches, according to Rodriguez (2009), think creatively and critically, connect personal meaning to the learning activity, and develop the ability to be versatile learners.

Our findings indicate a relationship between academic perseverance and academic well-being. This suggests that people who can maintain their focus on their academic goals in the face of difficulties or setbacks are more likely to achieve academic success than those who are not as resilient. According to the triarchic model of grit, perseverance can positively predict students' well-being (Datu *et al.*, 2017). Grit, specific perseverance of effort, has been connected to higher levels of positive academic functioning and well-being (Datu *et al.*, 2020).

According to our findings, there is a positive association between academic engagement and academic well-being. If a student has a high degree of academic engagement, their academic well-being is likely to improve. A student who participates actively in academics is more likely to have more self-efficacy, better problem-solving skills, and higher academic performance. According to Upadhyaya and Salmela-Aro (2013)'s review, high levels of academic achievement are adversely connected to students' well-being, including depressive symptoms and weariness, and favorably related to academic success. Students who are actively involved in school are happier and more content with their lives, among other aspects of well-being. People who experience and express happiness are more likely to



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have adequate personal resources, perform well, and display optimal functioning, which increases school engagement (Fredrikson 2013).

**CONCLUSION**

When all three of these components are present in a student's academic life, their academic well-being will likely be improved. Without the development and implementation of effective learning techniques, academic engagement, and academic perseverance, it becomes difficult for a student to achieve academic success. Hence, it can be concluded that learning techniques, academic engagement, and academic perseverance are critical components in predicting academic well-being. With the proper application of these components, students can succeed and reach their academic goals.

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**Table1: Descriptive statistics for Learning Strategies, Academic Engagement, Academic Perseverance, Academic well-being, and Academic Burnout.**

VARIABLES	MEAN	STANDARD DEVIATION
Surface learning strategy	58.60	3.88
Strategic learning strategy	47.17	7.34
Deep learning strategy	51.04	6.33
Academic engagement	41.04	9.41
Academic perseverance	31.44	5.87
Academic well-being	76.57	18.30
Academic burnout	46.84	8.98

The highest and lowest mean values are academic well-being (i.e.,76.57) and academic engagement (i.e.,41.04) respectively. Similarly, the highest and lowest stand deviation can be seen in academic well-being (i.e.,18.30) and surface learning strategy (i.e.,3.88) respectively.

**Table 2: Pearson correlation between Learning Strategies, Academic Engagement, Academic Perseverance, Academic well-being, and Academic Burnout.**

Similarly, the correlation was conducted (using the Pearson method) between different learning strategies, academic engagement, academic well-being academic burnout & academic perseverance at 0.01 and 0.05 levels of significance (2-tailed).

variables	Deep learning strategy	Strategic learning strategy	Surface learning strategy	Academic engagement	Academic perseverance	Academic wellbeing
Deep learning strategy	1	.339**	.151**	.390**	.230**	.460**
Strategic learning strategy		1	.244**	.288**	-.123*	.362**
Surface learning strategy			1	.183**	.285**	.201**
Academic engagement				1	.271**	.602**
Academic perseverance					1	.411**
Academic wellbeing						1

**Table 3: Regression Analysis**

MODEL	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(constant)	-25.422	11.164		-2.277	.023
Surface	-.202	.193	-.043	-1.045	.297
Strategic	.606	.109	.243	5.577	.000
Deep	.460	.125	.159	3.696	.000
Academic Engagement	.765	.083	.393	9.197	.00
Academic	.965	.133	.310	7.232	.000





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<b>Perseverance</b>					
<b>R</b>	.517				
<b>R<sup>2</sup></b>	.719				
<b>Adjusted R<sup>2</sup></b>	.510				

Significance p<.000

The overall regression was statistically significant ( $R^2= .517$ ,  $F (5,34) = 73.557$ ,  $p < .000$ ).







## Assessing Pharmaceutical Care Impact on Gestational Hypertension Study Effect of Various Pharmaceutical Interventions using Parameters to Improve Quality of Health in Hypertensive Pregnant Women

Suhana K<sup>1\*</sup>, Mahesh T.M<sup>2</sup> and Sabitha J<sup>3</sup>

<sup>1</sup>M Pharm II<sup>nd</sup> Year, Department of Pharmacy Practice, Grace College of Pharmacy, Kerala University of Health Science, Kerala, India

<sup>2</sup>Associate Professor, Department of Pharmacy Practice, Grace College of Pharmacy, Kerala, India.

<sup>3</sup>Gynecologist - Obstetrician, Paalana Institute of Medical Science, Palakkad, Kerala, India

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### \*Address for Correspondence

**Suhana K**

M Pharm II<sup>nd</sup> Year,

Department of Pharmacy Practice,

Grace College of Pharmacy,

Kerala University of Health Science, Kerala, India

E.Mail: suhanask121@gmail.com



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### ABSTRACT

Pregnancy-induced hypertension (PIH) is one of the commonest disorders associated with the increased risk of maternal and fetal complications. Clinical pharmacists can provide services by recognizing, and monitoring disease and drug-related problems. The aim of the study was to assess the impact of pharmaceutical care on the management of gestational hypertension during pregnancy. A prospective observational study was carried out for six months at a hospital in Palakkad. The study assesses pregnant women's medication adherence and sleep pattern. Patients were randomly allocated to the study population, and data were entered in a self-design data collection form. All the participants respond to MMAS and PSQ1. The collected cases were entered in MS Excel 2019 and calculated percentage of various parameters by descriptive statistics. The study included a total of 70 participants with age <18. Patients' medication adherence and quality of life improved significantly after pharmacist intervention in the study population at the follow-up time. Among 70 subjects an increase in medication adherence was observed with their value from  $5.37 \pm 1.08$  to  $6.36 \pm 1.05$  during their initial and follow-up visits ( $p < 0.0001$ ) respectively. Out of 70 patients during the study period there is an increase in the number of good sleepers with a mean PSQI score of  $5.20 \pm 1.29$  to  $4.03 \pm 1.09$  during baseline and follow-up visits respectively ( $p < 0.0001$ ). Thus, the above results suggest the importance of clinical pharmacist activities, which positively impacted medication adherence and the quality of life of pregnant women with diabetes.

**Keywords:** Morisky medication adherence scale (MMAS), Hypertension (HTN), *Pittsburgh Sleep Quality Index Scale (PSQI)*, *Body mass index (BMI)*, *Pharmaceutical care*





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## INTRODUCTION

Pregnancy is a process and series of changes that happen in an exceeding woman's organs and tissues as a result of a developing fetus. The whole process from fertilization to birth takes a mean of 266–270 days or about nine months. It's also a dynamic state within which women undergo various adaptive changes (physiological and hormonal) that are essential for the right growth and development of the fetus [1,2]. Women may experience a variety of issues during pregnancy, including gestational diabetes, hypertension, obesity, dyslipidemia, infections, and stillbirth [1,3]. Pregnancy-induced hypertension (PIH), one of these complications, is a major problem and the cause of mother and fetal mortality. [4] PIH is clinically defined as new onset of hypertension (HTN), that is, systolic blood pressure (BP)  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mm Hg or an absolute rise of BP of at least 140/90 mm Hg if the previous BP is not known or a rise in systolic pressure of at least 30 mm Hg or a rise in diastolic pressure of at least 15 mm Hg over the previously known BP, at  $\geq 20$  weeks of gestation in the absence of proteinuria. [4,5].

Up to 10 percent of all pregnancies are affected by hypertensive disorders during pregnancy, which continues to be the leading cause of maternal-fetal morbidity and mortality in both developing and developed countries [1]. Preeclampsia is caused by a number of pathophysiological factors, including placental vascular insufficiency, endothelial dysfunction, arterial stiffness, and systemic inflammation. It is unclear, though, if the same pathophysiological alterations also account for gestational hypertension. Furthermore, little is known about the mechanisms that connect maternal agitation with hypertensive problems during pregnancy. Pregnancy-related hypertensive disorders were strongly associated with a number of other cardiovascular risks factors, such as hypertension, type 2 diabetes, hyperlipidemia, and an elevated body mass index (BMI), according to an oversized cohort study [6].

Chronic hypertension, which complicates 1%–5% of pregnancies and is characterized as a blood pressure greater than 140/90 mm Hg that either precedes pregnancy or develops before 20 weeks of gestation, is the type of hypertension that affects pregnant women. During 20 weeks of pregnancy, pregnancy-induced hypertension sets in and complicates 5%–10% of pregnancies. Gestational hypertension, or pregnancy-induced hypertension alone, can be an early sign of pre-eclampsia or reflect a hereditary susceptibility to chronic hypertension. Pre-eclampsia, also known as pregnancy-induced hypertension, can affect almost every organ system and is accompanied by proteinuria, edema, or both. [7,8].

A complete care plan for women with hypertensive pregnancy disorders should include prenatal education, regular prenatal visits, prompt delivery, adequate intrapartum monitoring and care, and postpartum follow-up. Every stage of these patients' care includes counseling to make sure the woman is aware of the dangers to both her and her fetus so she may make an educated decision. [9] The direct, responsible administration of medication-related care with the aim of achieving particular outcomes that improve a patient's quality of life is known as pharmaceutical care. Proper pharmaceutical care during pregnancy may have a good effect on the quality of life of pregnant women since various pregnancy issues generate an imbalance in sleep, quality of life, and medication adherence. [10,11].

## MATERIALS AND METHODS

- ❖ Hospital based prospective observational study was conducted at Paalana Institute of Medical Sciences, Palakkad. It was done over a period of 7 months. 70 pregnant women having either gestational hypertension or previously diagnosed hypertension were included in the study. The patients without hypertension who are not willing to give consent are excluded from the study.
- ❖ Prior to starting the study, institutional ethical committee approval was acquired **GCP/IEC/112G/2022** dated on **05-07-2022**. Before the study began, all of the participants provided their signed informed permission. conducted interviews with them using a validated, semi-structured questionnaire and a form created by ourselves. For the





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study, we conducted two rounds of interviews with the contributors, lasting roughly 10-15 minutes each. A thorough history will be collected, including the patient's age, gender, occupation, address, and social history. Previous medical and medication histories will also be recorded, as well as test results and medication records.

- ❖ A questionnaire will be used to assess each patient's sleep patterns and medication adherence.
- ❖ The Morisky Medication Adherence Scale (MMAS) was used to investigate medication adherence, and the sleep patterns and their quality are accessed by Pittsburgh Sleep Quality Index (PSQI) Scale.
- ❖ In order to raise awareness among the study population about the significance of adherence and sleep patterns and its quality on their initial visit, we counseled and also distributed patient information leaflets (PIL).
- ❖ Follow-up is conducted within a month to assess the patients' improved clinical status. Data from questionnaires are compared before and after patient counseling to assess the impact of such counseling.

## STUDY TOOL

- ❖ The sleep patterns and their quality are accessed by Pittsburgh Sleep Quality Index (PSQI) Scale. It contains 19 self-rated questions with seven "component" scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction), each of which has a range of 0- 3 points.
- ❖ The sum of scores for their seven component yields are global scores individuals with PSQI < 5 were categorized as good sleepers and those with scores  $\geq 5$  was classified as poor sleepers.
- ❖ The Morisky Medication Adherence Scale (MMAS), which consists of 8 questions, was used to measure medication adherence. The responses on the MMAS scale were recorded as either yes or no. An answer of 'yes' is scored as zero and 'no' is scored as one for the first 7 questions except for the fifth question, where yes is scored as one and no is scored as zero.

## STATISTICAL ANALYSIS

The gathered information was entered into MS-Excel 2019 to calculate the percentage of various factors. When comparing MMAS, PSQI, and BP between the first and second visits, paired student t-tests were used. The relationships between these variables were expressed as Mean  $\pm$  SD.

## RESULTS

The total number of study participants was 70. Among these 70 participants, 68.57% of patients were under the age category >25 years followed by 31.42% under <25 years (table 1). Among the 70 patients, 34 patients (48.57%) women diagnosed with hypertension during the second trimester, 29 patients (41.42%) in the third trimester, and about 7 patients (10%) were spotted in the first trimester. (figure 1). From the study, it is found that primigravidas are more susceptible to hypertension during pregnancy than multigravidas which are 42 patients (60%) and 28 patients (40%) respectively. (figure- 2). Out of 70 patients, most of the patients were having poor sleep 65.71 % (n=46) during the baseline visit, and an increase in sleep was observed during the follow-up visit to 70 % (n=49). (table:2). Out of 70 patients during the study period there is an increase in the number of good sleepers with a mean PSQI score of  $5.20 \pm 1.29$  to  $4.03 \pm 1.09$  during baseline and follow-up visits respectively ( $p < 0.0001$ ). (table:3) On assessing the baseline adherence of the out of 70 patients 42 patients (60%) were having low adherence, 21 patients (30%) had medium adherence and 7 patients (10%) had high adherence respectively. After properly following the intervention the adherence in the baseline got changed in the follow-up to 14 patients (20%) with low adherence, 48 patients (68.57%) with medium adherence, and 8 patients (11.42%) with high adherence. (figure-2). Among 70 subjects an increase in medication adherence was observed with their value from  $5.37 \pm 1.08$  to  $6.36 \pm 1.05$  during their initial and follow-up visits ( $p < 0.0001$ ) respectively. (table-4)



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## DISCUSSION

One of the main causes of maternal and foetal morbidity is hypertension, which complicates 5% to 7% of all pregnancies. [19] In order to effectively manage patients with hypertension, it is necessary to diagnose them early, to treat them with an appropriate drug, and to monitor them after treatment. The demographic information acquired from 70 participants in this prospective observational study revealed that HTN is more prevalent in people over the age of 25. Mehta et al. and Parazzini et al. found that the majority of women experience HTN when they become pregnant beyond the age of 25. [12,13]. According to the current research, HTN develops more during the second trimester of pregnancy than it does during the first and third trimesters. According to a study by Bengal et al. and Mehta et al., HTN was discovered during the second trimester. According to the study, primigravidas are more likely than multigravidas to experience prenatal hypertension. This finding is also supported by Berhr et al. and Duckitt K et al. [15,16]. Using the Pittsburg Sleep Quality Index (PSQI), the sleep quality of pregnant women with hypertension was evaluated. Out of 70 patients, the majority had poor sleep at 65.71% (n=46) at the baseline visit; however, after proper follow-up and intervention, an improvement in sleep was seen at the follow-up visit, reaching 70% (n=49). According to Saadati et. al's study, high-risk pregnant women had poor sleep quality and average quality of life. Therefore, it is essential that healthcare providers provide the appropriate training to enhance mothers' quality of life and sleep [17].

The medication adherence pattern of study subjects was assessed using the Morisky medication adherence scale (MMAS). It is a structured self-report measure of medication-taking behavior, comprises of 8 questionnaires. Based on the score results are categorized into different categories like high adherence, medium adherence, and low adherence. In this study on assessing the baseline adherence of the out of 70 patients 42 patients (60%) were having low adherence, 21 patients (30%) had medium adherence and 7 patients (10%) had high adherence respectively. After properly following the intervention the adherence in the baseline got changed in the follow-up to 14 patients (20%) with low adherence, 48 patients (68.57%) with medium adherence, and 8 patients (11.42%) with high adherence. Among 70 subjects an increase in medication adherence was observed with their value from  $5.37 \pm 1.08$  to  $6.36 \pm 1.05$  during their initial and follow-up visits ( $p < 0.0001$ ) respectively. Amira et.al also follows MMAS to assess the medication adherence pattern of pregnant women having HTN. In that study, she also supports that Significant improvement can be seen in pregnant women due to effective intervention and follow-up. [18]

## CONCLUSION

According to the findings of this study, hypertension in pregnancy is a common pregnancy problem that is related to significant mother and fetal morbidity and mortality. Young primigravidas have pregnancy hypertension more frequently than multigravidas. Understanding the risk factors for hypertension disorders during pregnancy may open up avenues for its prevention. One of the most important elements in preventing pregnancy-related hypertension illnesses and its complications is early detection and treatment through routine antenatal check-ups. The results amply illustrated the effectiveness of educational intervention programs in boosting knowledge and adherence towards PIH by identifying medication adherence and the causes of non-adherence. When the right follow-up and intervention are used, the sleep quality analysis reveals a significant change in sleep from poor sleepers to good sleepers. The above outcome so revealed that clinical pharmacy intervention had a positive impact on HTN patients.

## ACKNOWLEDGMENTS

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## CONFLICTS OF INTEREST

There are no conflicts of interest between the authors.



**ETHICAL STATEMENT**

The study was approved by institutional ethical committee GCP/IEC/112G/2022 dated 05-07-2022.

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**Table 1: Distribution Based on Age**

SL.NO	AGE GROUPS (in years)	NO. OF PATIENTS (n=70)	PERCENTAGE (%)
1	<25	22	31.42
2	>25	48	68.57

**Table 2: Distribution of Sleep Quality Among HTN Patients**

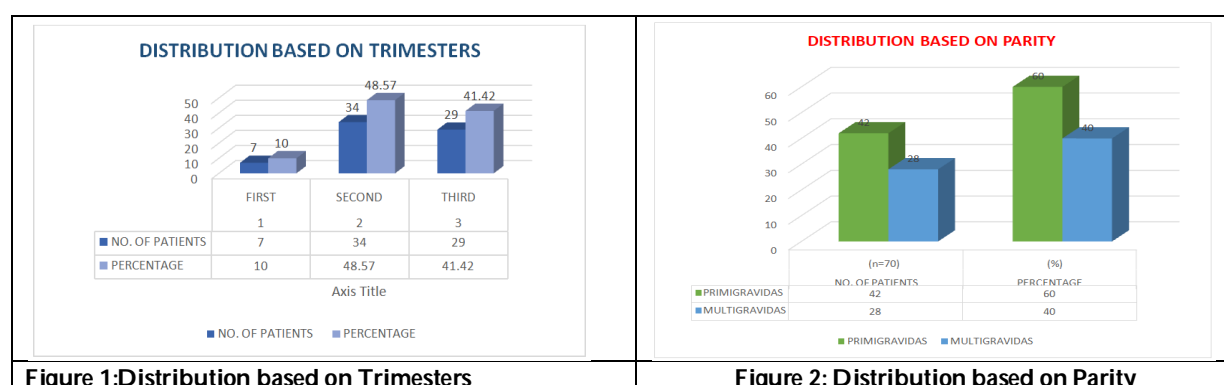
PSQI	BASELINE	PERCENTAGE (%)	FOLLOWUP	PERCENTAGE (%)
	NO.OF PATIENTS (n=70)		NO.OF PATIENTS (n=70)	
GOOD SLEEPERS (<5 scores)	24	34.28	49	70
POOR SLEEPERS (≥5 scores)	46	65.71	21	30

**Table 3: Statistical Analysis of Pittsburgh Sleep Quality Index During Baseline and Follow-Up (PSQI)**

PARAMETERS	PSQI (BASELINE)	PSQI (FOLLOW-UP)	P VALUE
MEAN	5.20	4.03	0.0001
SD	1.29	1.09	
N	70	70	

**Table 4: Statistical Analysis of Morisky's Medication Adherence Scale During Baseline and Follow-Up (MMAS)**

PARAMETERS	MMAS (BASELINE)	MMAS (FOLLOW-UP)	P VALUE
MEAN	5.37	6.36	0.0001
SD	1.08	1.05	
N	70	70	



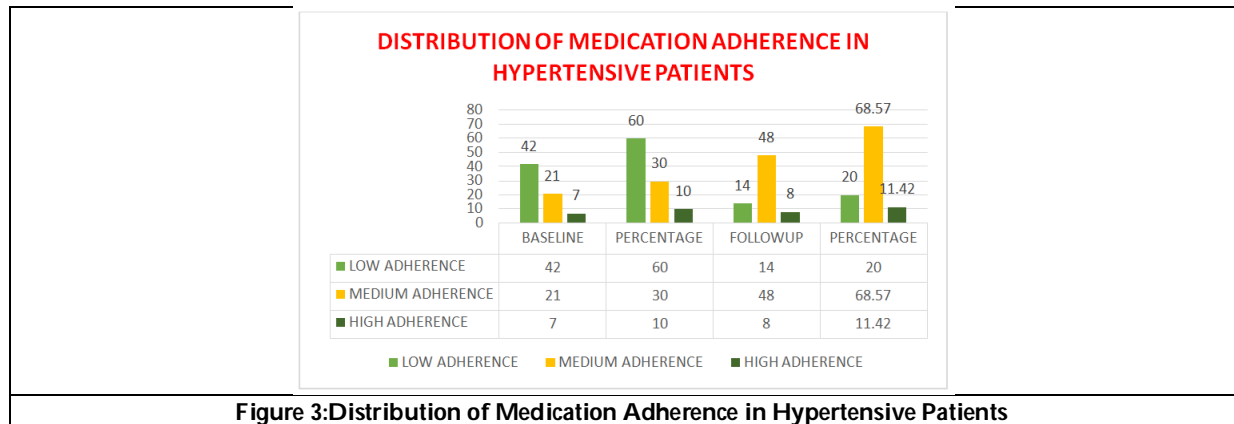
**Figure 1: Distribution based on Trimesters**

**Figure 2: Distribution based on Parity**





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## Ozone Therapy : a Step Ahead in Periodontology

Aayushee Gupta<sup>1</sup>, Aishaan Sharma<sup>1\*</sup>, Amit Bhardwaj<sup>2</sup> and Shalini Kapoor<sup>3</sup>

<sup>1</sup>Post Graduate Student, Department of Periodontology, Faculty of Dental Sciences, SGT University, Gurugram- 122505, Haryana, India.

<sup>2</sup>Professor and Head of Department of Periodontology, Faculty of Dental Sciences, SGT University, Gurugram- 122505, Haryana, India.

<sup>3</sup>Professor, Department of Periodontology, Faculty of Dental Sciences, SGT University, Gurugram- 122505, Haryana, India.

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### \*Address for Correspondence

**Aishaan Sharma**

Post Graduate Student,  
Department of Periodontology,  
Faculty of Dental Sciences,  
SGT University, Gurugram- 122505,  
Haryana, India.

E.Mail: aishaansharma7@gmail.com



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### ABSTRACT

Dental and medical professionals are very concerned about periodontal disorders. Ozone in all of its application forms reduces or treats the bulk of the contributing variables and causes in the etiology of various diseases (gas, water, oil). The use of ozone is well recommended in all stages of gingival and periodontal illnesses due to its favorable biological effects, anti-microbial activity, oxidation of biomolecule precursors and microbial toxins implicated in periodontal diseases, and healing and tissue regeneration properties. This article's main goal is to give a comprehensive overview of the clinical uses of ozone in periodontics. The secondary goal is to list all of the periodontics research that has used ozone in both *in vitro* and *in vivo* settings.

**Keywords:** Ozone, Periodontitis, Antimicrobial. Immunostimulating.

### INTRODUCTION

Periodontitis is known to be a destructive inflammatory condition that affects the tissues that support the teeth. It is brought on by a single microorganism or a cluster of microorganisms, and it causes periodontal pockets, gingival recession, or both as the periodontal ligament and alveolar bone are gradually destroyed [1]. The main cause of the periodontal disease is bacteria. Bacteria must attach to either epithelium surfaces or hard dental surfaces in order to

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avoid eradication. The most prevalent oral diseases, including carious lesions, periodontitis, and peri-implantitis, have been linked to the formation and maintenance of oral biofilms as well as the internal selection of particular microbes [2]. The traditional approaches for periodontal therapy have indeed been mechanical elimination of the plaque and supplementary utilization of antibiotic disinfectants or different antibiotics. One of the contemporary non-drug types of treatment is ozone therapy [3]. The Greek word "ozein," which means odorant, is where the name "ozone" originates. Ozone is an allotropic type of oxygen, that exists naturally in the Earth's atmosphere and is also referred to as triatomic oxygen and trioxigen. At a height of between 50,000 and 100,000 feet, it envelops the planet. Due to its instability, ozone readily releases nascent oxygen molecules to generate oxygen gas [4]. It has long been utilized in human medicine to kill germs, and fungus, inactivate viruses and reduce hemorrhages because of its ability to release nascent oxygen [4]. Thus this review article focuses on the need and current status of ozone therapy in periodontology.

**Historical background**

Schonbein coined the term "ozone" in 1840. He electrically discharged oxygen and observed "the fragrance of electrical stuff." According to Schonbein, odours are caused by a gas that he termed ozone after the Greek word ozein (odorant). Ozone wasn't actually explored in depth by scientists until 1932 when Swiss dentist Dr. E. A. Fisch began using ozonated water as a disinfectant [5]. The first person to use ozone in his practice was Fisch, who used it as gas or ozonated water. Ozone was initially utilized in a medical environment in 1856, only 16 years after its discovery, to sterilize surgical tools and clean operating rooms [6]. Ozone was widely used in mainland Europe by the end of the 19th century to purify drinking water of bacteria and viruses. Prior to 1950, when ozone-resistant materials started to be produced, ozone therapy was difficult and limited due to the absence of ozone-resistant polymers like Nylon, Dacron, and Teflon. At that time, German physicians Hans Wolff and Joachim Hänsler collaborated to create the first ozone generator for use in medicine. They still serve as the inspiration for contemporary machinery [7].

**Ozone therapy: chemistry**

A triatomic molecule called ozone ( $O_3$ ) is made up of three oxygen atoms. It has a molecular weight of 47, 98 g/mol and is a thermodynamically unstable molecule that, depending on the system's temperature and pressure, decomposes quickly to pure oxygen [8]. Ozone is an unstable gas that should be used right away because its half-life at 20 °C is only 40 minutes [9]. Ozone ( $O_3$ ) is created naturally when molecular oxygen ( $O_2$ ) is photo dissociated into activated oxygen atoms, which subsequently interact with other oxygen molecules. Rapid protonation of this transitory radical anion results in the production of hydrogen trioxide ( $HO_3$ ), which in turn disintegrates into the even more potent oxidant, the hydroxyl radical (OH). When employed as an antibacterial agent against bacteria, viruses, fungus, and protozoa, ozone gas has a high oxidation potential and is 1.5 times more effective than chlorine. Additionally, it has the ability to boost the immune system and blood flow. Such characteristics support the present interest in its use in dentistry and medicine [10].

**Ozone generation**

German doctors Joachim Hansler and Hans Wolff created the first ozone generator for medical purpose.

Three alternative methods exist for producing ozone gas [10]

- Ultraviolet system: creates small amounts of ozone that is utilised for air cleansing, saunas, and aesthetic purposes.
- Cold Plasma System: used for the purification of water and air.

High ozone concentrations are produced by the Corona Discharge System. In the medical and dental fields, it is the most often utilised system. It features a controlled rate of ozone production and is simple to handle.

**Biologic effect of ozone therapy**

1. Antimicrobial effect: When it comes to viruses, fungus, and bacteria, ozone is devastating. Ozone's ability to harm cells' cytoplasmic membranes due to the ozonolysis of dual bonds and to modify intracellular contents as a result of secondary oxidants is what gives it its antibacterial properties. Due to their significant antioxidant capacity, human body cells are immune to this effect, which only harms microorganisms [11].



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2. Immuno stimulating effect: Ozone affects the humoral and cellular immune systems. It promotes the growth of immune-competent cells and the production of immunoglobulins. Additionally, it promotes macrophage activity and raises the susceptibility of microbes to phagocytosis. Interleukins, leukotrienes, and prostaglandins, which are helpful in lowering inflammation and wound healing, are produced as a result of ozone exposure. Ozone has an immunostimulating impact at low doses but an immunodepressive effect at high quantities [12].
3. Antihypoxic effect: Ozone enhances oxygen transport in the blood, changing cellular metabolism by activating aerobic processes (such as glycolysis, the Krebs cycle, and -oxidation of fatty acids) and utilising energy sources. By enhancing their oxygenation and lowering overall inflammatory processes, ozone helps the metabolism of inflammatory tissues [13].
4. Biosynthetic effect: It increases the number of ribosomes and mitochondria in the cells and activates systems for protein synthesis. These cellular-level alterations account for the increased functional activity and regenerative capacity of tissues and organs [14].

**Goals of ozone therapy**

1. Pathogen eradication
2. The right oxygen metabolism is restored.
3. Creation of an environmentally friendly environment.
4. A rise in circulation
5. Immune system activation.
6. Humoral antioxidant system simulation

**Various appliances for ozone production for dental purposes [15]**

1. Healozone by kavo is air: The application of the gas is done in a closed circuit, and it is air-based. Manganese ions draw out the excess and neutralise it. Ozone is present in the cap next to the tissue at a quantity of 2100 ppm. For the application of ozone, the cap must be completely airtight. Therefore, the application is only feasible on surfaces that can offer such airtightness.
2. Ozonytron by MYMED Gmb H.: High frequency and voltage are used by oxygen activation generators. Via current strength, the concentration of activated oxygen (ozone) can be changed in five steps. In the interior of the glass probe, which is made up of two glass cameras, is a mixture of noble gases that conducts and emits electromagnetic energy. The probe's tip releases energy as it comes into touch with the body, splitting environmental diatomic oxygen into single atomic oxygen and ozone, and treating the surrounding area. The ozone concentration in the work area ranges from 10 to 100 g/ml (at an intensity of 1 to 5 g/ml, ozone turns into a fungicide, virucide, and bactericide). Since there is no closed circuit present, ozone can be used to treat hard-to-reach areas like root canal or the gingival pocket.
3. Product photo (Prozone) by W&H: The convenience of administration and safety of application (preset tissue-compatible dosages in the indicated areas of endodontitis and periodontitis) are its distinguishing features. Due to its interchangeable plastic attachments, Prozone ensures a hygienic approach when gassing the pockets (Perio tips or Endo tips).

**Route of administering ozone**

1. Gaseous ozone - To prevent inhalation and its negative effects, ozone can be employed in gaseous form via an open system or with a sealing suction system.
2. Ozonated water - Studies have shown that ozonated water is particularly good at warding off germs, fungus, and viruses.
3. Ozonated oil- In addition to its gaseous and aqueous forms, ozonized oils appear to be quite useful. The most popular form of ozone for use in dentistry is ozonated water, despite the fact that gaseous ozone has been demonstrated to have more potent microbicidal qualities than aqueous form due to its harmful consequences if inhaled. Therefore, it is still necessary to create a safe method of injecting gaseous ozone into the periodontal pocket without inhalation.



**Aayushee Gupta et al.,****Ozone therapy in periodontics**

Periodontal disease has a well-established aetiology that involves microorganisms and host defences. Ozonated water (4 mg/l) was found to be effective at killing oral *Candida albicans*, gram-positive and gram-negative oral microbes, and bacteria in plaque biofilm in pure culture. As a result, it may be helpful as a mouthwash to manage oral infectious germs in dental plaque. The effects of ozone therapy on bacterial cell proliferation and ultrastructural alterations were examined by Thanomsut et al. In 2002. (*Escherichia coli*, *Salmonella* sp., *Staphylococcus aureus* and *Bacillus subtilis*). It was found that ozone, at 0.167 mg/min/l, may sterilise water that contains up to 105 cfu/ml of bacteria in less than 30 minutes. It was discovered that the bacterial cell membrane was being destroyed, which led to intercellular leaking and ultimately led to cell lysis. However, at greater concentrations of 106 and 107 cfu/ml, these ozone concentrations have no appreciable impact on the survival of the cells in bacterial cultures [17].

In a 2002 study, Ebensberger et al. Examined the impact of ozonated water irrigation on the growth of cells in the periodontal ligament attached to the root surfaces of 23 recently extracted, fully erupted third molars. The teeth were given a random treatment of 2 minutes of intense ozonated water irrigation or a sterile isotonic saline irrigation as a control group. These teeth's periodontal tissues underwent immunohistochemistry analysis to identify proliferating cell nuclear antigen. The labelling index, which measures the proportion of positive cells to all cells that signal increased metabolism, was found to be greater in the ozone-irrigated teeth (7.8 percent vs. 6.6 percent), although the difference was not statistically significant ( $P = 0.24$ ). They came to the conclusion that the 2-minute irrigation of the avulsed teeth with non-isotonic ozonated water might result in mechanical cleaning as well as root surface decontamination with no adverse effects on periodontal cells still present on the tooth surface [18].

The effectiveness of ozonated water on the survival and permeability of oral microorganisms was examined by Nagayoshi et al. In 2004. In pure culture, gramme negative bacteria like *Porphyromonas endodontalis* and *Porphyromonas gingivalis* are far more susceptible to ozonated water than gramme positive oral streptococci and *Candida albicans*. Furthermore, plaque biofilm bacteria were strongly susceptible to the bactericidal effects of ozonated water. Additionally, ozonated water prevented the in vitro buildup of experimental tooth plaque [19]. Ramzy et al. Irrigated the periodontal pockets of 22 patients with severe periodontitis using ozonized water in 2005. Using a blunt-tipped, sterile plastic syringe, periodontal pockets were irrigated with 150 ml of ozonized water for 5–10 min once per week for a clinical 4 weeks research. Scaling and root planing along with the application of ozone to certain quadrants resulted in a highly significant improvement in terms of pocket depth, plaque index, gingival index, and bacterial count. They also discovered a large decrease in bacterial count in areas with ozonized water treatment [20]. In their study from 2006, Huth et al. Found that under most circumstances, the aqueous form of ozone displayed less cytotoxicity than gaseous ozone or known antimicrobials (chlorhexidine digluconate [CHX]: 2 percent, 0.2 percent; sodium hypochlorite 5.25 percent, 2.25 percent; hydrogen peroxide- $H_2O_2$  3 percent). As a result, aqueous ozone satisfies the best cell biological requirements for oral use in terms of biocompatibility [21].

The effects of ozone gas, photodynamic therapy (PDT), and well-known antiseptic treatments (2 percent chlorhexidine, 0.5 and 5 percent hypochlorate solutions), on an in vitro multispecies oral biofilm were examined by Muller et al. In 2007. The following bacteria were investigated: *Actinomyces naeslundii*, *Veillonella dispar*, *Fusobacterium nucleatum*, *Streptococcus sobrinus*, and *Streptococcus oralis* *Ibicans*. Vacuum ozone delivery device Kavo Healozone produced gasiform ozone. They came to the conclusion that the biofilm's matrix-embedded bacteria populations were well shielded from antimicrobial agents. All bacteria could be efficiently eliminated by a 5 percent hypochlorate solution.

Bacteria in the biofilm could not be reduced by gasiform ozone or PDT [22]. In a research of peri-implantitis, Karapetian et al. Investigated the use of conventional, surgical, and ozone therapy methods and discovered that the ozone-treated group had the most successful bacterial reduction [23]. Brauner has shown that treating gingivitis and periodontitis with daily ozone water rinses combined with professional dental cleaning can improve clinical outcomes. If the professional measures are abandoned, however, plaque indices and a propensity to bleed swiftly reappear. Plaque removal attempts without the use of any mechanical techniques, such as rinsing with ozone water,



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failed [24]. In 2010, 16 patients with widespread chronic periodontitis participated in a randomised, double-blind, crossover split-mouth trial done by Kshitish and Laxman. The 18-day study time was split into two sections, time-intervals from the baseline (0 days) to the seventh day, with a washout period of 4 days and a second interval of time after that a seven-day period of time. Each half of the mouth received subgingival irrigation with either ozone or chlorhexidine completed at varying intervals. They noted a greater percentage of decrease in plaque index (12%) and gingival indices (29%) and bleeding indices (26%) when ozone irrigation was used instead of chlorhexidine. *Porphyromonas gingivalis* (Pg) and *Tannerella forsythensis* did not exhibit any anti-bacterial effects when treated with O<sub>3</sub> and chlorhexidine. Ozone had a noticeable anti-fungal effect throughout the study period, in contrast to CHX, which had no anti-fungal effect from the baseline (37%) through the seventh day (12.5%). Ozone didn't appear to have any antiviral properties. Chlorhexidine was more effective at combating viruses than ozone. Despite the effectiveness of chlorhexidine, they came to the conclusion that ozone irrigation is a very effective way to inactivate bacteria [25].

In 2011, Huth et al. tested the efficiency of ozone with the well-known antimicrobial CHX in the fight against periodontal bacteria. Aqueous ozone (20 g ml [1]) and gaseous ozone (4 g [3]) were more effective than 0.2 percent CHX but did not significantly differ from 2 percent CHX in terms of effectiveness. As a result, large concentrations of gaseous and aqueous ozone warrant additional research as antiseptics in periodontitis treatment [26].

**Contraindications of ozone therapy**

1. Pregnancy
2. Glucose- 6- phosphatase dehydrogenase deficiency (favism)
3. Hyper thyroidism
4. Severe anemia
5. Severe myasthenia
6. Active hemorrhage

**Ozone toxicity**

Ozone should never be inhaled due to the overwhelming body of research demonstrating how vulnerable the bronchial-pulmonary system is to it. Mucosal cells in the respiratory tract lining fluid are especially susceptible to oxidation because the fluid is made up of a very thin, watery layer with very little antioxidant content [28]. Direct intravenous infusion of O<sub>2</sub> and O<sub>3</sub>—a practise forbidden by the European Society of Ozone Therapy since 1983—caused a pulmonary embolism. Epiphora and upper respiratory irritation, rhinitis, cough, headache, sporadic nausea, and vomiting are all recognised adverse effects.

**CONCLUSION**

Contrary to conventional treatments like antibiotics and deodorants, ozone therapy is very affordable, reliable, and conservative. Compared to the current conventional therapeutic techniques, ozone therapy has proven to be more effective. Patients who receive ozone therapy had much shorter treatment times overall and a more thorough bacterial eradication. Completely painless, the procedure promotes patient acceptability and compliance with few side effects. Although more clinical research is required to standardise the indications and treatment methods for ozone therapy, there are still a variety of approaches that are so promising or well-established that it is hoped that ozone therapy will eventually become a standard method for the disinfection of surgical sites in dentistry.

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## Crop Supervision and Recommendation System to Prevent Monkey using Machine Learning

Ashok Kumar<sup>1\*</sup>, Rakesh Kumar Yadav<sup>2</sup> and Abhishek Mishra<sup>3</sup>

<sup>1</sup>Research Scholar, Computer Science and Engineering, IFTM University, Moradabad, Uttar Pradesh, India-244102

<sup>2</sup>Former Assistant Professor, Computer Science and Engineering, IFTM University, Moradabad, Uttar Pradesh, India-244102

<sup>3</sup>Associate Professor, Computer Science and Engineering, IFTM University, Moradabad, Uttar Pradesh, India-244102

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### \*Address for Correspondence

**Ashok Kumar**

Research Scholar,

Computer Science and Engineering,

IFTM University, Moradabad,

Uttar Pradesh, India-244102

E.Mail: waytokiran2020@gmail.com



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### ABSTRACT

Machine learning (ML) is a rising sector for the enhancement of agriculture activity. Machine learning help to reduce the quantity of farmer's manual effort for the protection of crop field. And provide information to the farmer about their crops area protection by giving them real time updates of the crop field as well as able to provide solutions for their agricultural related problems. Crop protection is an essential aspect for farmer from animals attack after drought or storm. In this view we will propose a Crop supervising and recommendation system. It is a Decision support system focused on Protection of crop fields from animal attacks. This system has the limitation and applicable for protection any crops, only the region where monkey destroy the crop within the crop area. Crop supervising and recommendation system work in two phases. First phase is supervising and second recommendation phase. In supervising phase, identify the animals who intend to demolish the crops within threshold distance of the crop area during supervising by agent node and if any suspicious activity found then recommendation phase activated by agent node. In recommendation phase agent node provides information to the farmer for the suspicious activity or possibility of attack in crop field. An environmental friendly action triggered by agent node against the identified animal so those animals run away from the crop field without harm the crops. And particular action does not harm the animal also. Proposed system will be supportive to the farmers for protecting their crops from monkey and save the farmer from financial losses therefore protect farmer's annual income.

**Keywords:** Use Case Diagram, Object Detection, Decision Support System. machine learning.



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## INTRODUCTION

The field of artificial intelligence (AI) and computer programming known as machine learning is focused on the application of data and algorithms to simulate the method in which humans learn, with the goal of continuously improving the accuracy of the simulation. The rapidly developing discipline of data science contains an essential subfield known as machine learning. Data mining initiatives involve the training of algorithms to create classifications or predictions, as well as the discovery of critical insights, through the usage of statistical methodologies. The subsequent decisions made within applications and enterprises are influenced by these insights, which should ideally have an effect on key growth Key metrics. In a similar way, agricultural machine learning is intended to collect particular data and employ particular algorithms in order to ascertain the outcomes that are anticipated. It is able to sort through a tremendous amount of data. The human brain is capable of certain activities that can be imitated by machine learning, such as pattern creation, intelligence, acquiring knowledge, or even decision making. In the field of agriculture, machine learning has the ability to be applied to a variety of areas with outstanding results. This includes the detection of weeds and diseases, the prediction of yield and quality of crops, as well as the collection of data, the provision of insights, and the offering of predictions regarding the production of livestock. The interference that wild animals cause has been a point of frustration for farmers. These animals are responsible for the destruction of the crops while they are free to roam around in the farm areas. This could lead to a decrease in productivity and necessitates a significant increase in the cost of protection for the farmers.

Farmers dislike wild animal interference. These animals eat crops and roam farm fields without farmers. Wireless sensors can be used to transmit landowners and forest authority's animal incursion alerts with images. This provides early warning for invasion type-specific action against specific types of animals [1]. Internet of Things (IoT) devices has connectivity, pervasiveness, and limited computing power. By 2020, 50 billion IoT devices will be online. Detecting threats from compromised IoT devices requires new methods. Machine and deep learning are best for IoT device attack detection [2]. A wireless sensor-based animal infiltration warning system can automatically notify the owner and forest authorities of these hazards. The camera and sensor will catch the animal's movement. Image processing will classify the image. Global System for Mobile communications module will SMS the forest department or owner an alarm signal [3]. Human-animal conflict in forests and farms wastes many resources and endangers human lives. Always monitoring the farm field prevents wild animals from entering. We have a field-monitoring system that uses motion sensors, cameras and a Raspberry Pi to keep an eye on the animals [4]. A Raspberry Pi camera can detect and record forest animals. The system uses pre-trained Tensor- Flow models in Python to identify new species. Remote control is possible if internet is available for you to access the live feed from the camera. Rasp Controller, a Smartphone app, allows system and data access [5].

We use camera-trap networks to monitor and analyses animals. Camera-trap images are crowded, making animal detection difficult and leading to significant false discovery rates. Our DCNN-based detection algorithm achieves 91.4% accuracy on standard camera-traps dataset [6]. Human Wildlife Conflicts (HWC) is harmful interactions between humans and wild animals. HWC's effects include crop devastation, lower agricultural output, animal predation, human injury and death, infrastructure damage, and more. An economical crop security method against animal attacks is needed [7]. Intelligent systems using sensor technology and machine learning to attenuate WVC are fully reviewed. Our review covers significant human-wildlife conflict elements and leading WVC mitigation datasets. Most animal identification systems (except autonomous cars) do not use cutting-edge datasets or machine learning methods [8].The MobileNetv2-SSD detects tigers, jaguars, and elephants at 2-3 frames each second with 80%, 89.47%, and 92.56% accuracy. The system notifies on animal intrusion and reports the rough location, direction of travel, kind, and count of intruders [9]. Machine learning and domain knowledge can help animal ecologists use massive sensor datasets. This strategy requires tight interdisciplinary collaboration to assure novel approach quality. It will also teach a new generation of ecology and conservation data scientists how to apply machine learning to the real-life world [10].



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The Raspberry Pi processes these animal photos next. Deep learning classifies these images. Animals are counted, and the picture is examined for wild animal encroachment to determine the proper response [11]. Wireless sensors can alert landowners and forest officials to animal intrusions. The sensor will detect animal movement and the camera can capture the image using image processing algorithms. After a microcontroller classifies the image, a GSM module alerts the forest department or landowner via SMS [12]. Farmers face a huge number of issues concerning agribusiness. Elephants, monkeys, wild boars etc. cause serious damage to the fields. In this project we use Raspberry pi to protect the farmland from animals. Data regarding intrusions of wild and domestic creatures are sent to cloud [13]. System uses Internet of Things to aid in the detection of wild animal intrusions on agricultural farms. Ultrasonic sensors are adopted at the field's corners, first detecting the intrusion, then capturing the image of the invader. An alert message is sent to the farmer via IoT application [14]. Adaption of temporary solutions like electric fences, trenches, surveillance, guard dogs, etc. are not economic and proven to stay as an unsafe solution for wildlife as well the humans. The proposed system aims in protecting human habitation and livestock at the outskirts of the forest area/ fields by developing an automated system [15].

Object Detection is a field of computer vision and image processing which involves detecting objects of varying class (animal, humans or cars). Some well-researched applications of object detection are in the domain of car detection, face detection, image retrieval and video surveillance [16]. Having accurate, detailed, and up-to-date information about the movements and behavior of animals in the wild would improve our ability to study and conserve ecosystems. Deep learning could enable inexpensive, unobtrusive, high-volume, and real-time collection of such information [17]. An existing intrusion detection system named Snort is made more intelligent through the application of machine learning. Optimized versions of algorithms through ensemble SVM along with other variants were tried on the generated traffic of normal and malicious packets at 10 Gbps [18]. Farmers in India face serious threats from pests, natural calamities & damage by animals resulting in lower yields. Crop damage caused by animal attacks is one of the major threats in reducing the crop yield. With the help of machine learning model, we detect the entry of animals and we play sounds to drive those away [19]. This project develops an algorithm to detect animals in the wild. It classifies animals based on their images so we can monitor them more efficiently [20].

An intrusion detection system (IDS) provides a corrective measure by monitoring and accumulating information about system behavior. The optimal performance in IDS is achieved by extricating the most informative features of traffic data in order to reduce computing costs and enhance classification rate. Feature selection within data has become an integral feature of the IDS [21]. A proposed model presents the development of the Internet of Things and Machine-learning technique-based solutions to overcome this problem. Raspberry Pi runs the machine algorithm, which is interfaced with the ESP8266 Wireless Fidelity module, Pi Camera, Buzzer, and LED [22]. The most critical challenge for the security of the Internet of Things (IoT) is to address its security issues. In this paper, we introduce a novel neighborhood search-based swarm optimization (NSBPSO) algorithm to improve the exploitation/exploration of the PSO algorithm [23]. Reconnaissance is vital to keep unapproved individuals from accessing the region as well as to shield the region from animals. This project fosters an algorithm to identify the animals that intrude into the agriculture land. The Yolo v3 algorithms are powerful real-time object detection algorithms [24].

**Proposed Idea**

This idea is not universally applicable and can only be used to preserve crops in areas where monkeys are a problem. This diagram shows all requirement of proposed system in a graphical way. Agent node or Admin, farmer and monkey are actors of the system and shows the relationship between actors ,use case or each other in use case diagram [25] [26] [27]. As depicted in figure 1, a use case diagram of proposed idea. The supervising and advising process for crops protection occurs in two stages. The first step is the supervision, and the second is the recommendation. Monkey planning to destroy the crops within a certain distance of the crop area can be identified during the supervising phase by the admin node, and the recommendation phase can be activated if any monkey is detected. When the admin node is in the recommendation phase, it alerts the farmer whenever there is monkey or the possibility of an attack in the crop field. The agent node takes an eco-friendly action against the identified monkey, scaring it away from the field so it doesn't eat the crops. In addition, the monkey will not be harmed by this







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specific action. A decision-support system (DSS) helps humans in making better decisions and escalates their businesses. They provide end users with visibility into their important decision-making duties. The user-friendly approach aims to enhance the power of thinking to grow production and boost revenue [28]. The acronym "Knowledge-driven DSS" refers to a decision support system that is knowledge-driven and helps with decision making in a specific field. This system is based on the concepts of Knowledge-driven DSS which detects the animal, send the alert message to farmer and trigger the action event sound wave against the monkey.

### Use Case Templates

Table 1, 2, 3, 4, 5 and 6 explains the use case template descriptions in details about the proposed idea.

## MATERIALS AND METHODS

The Methodology is the step by step process to solve a problem we'll pick a problem and study it first. Requirement analysis and collection follow. We will locate the research design flow, follow the model, train, test, and conclude the result of the problem. In order to complete the tasks that are given, technology such as the tools that are listed below is required.

### Data Collection

Data collection ratio based on training and testing approximately is 80:20. we use raw photos and using the labeling tool raw photo converted into bounding box labeling text data set that is given in the example. Train Dataset shows images and equivalent the bounding box labeling (class, center(x), center(y), width, height). Let's take an example of Table 7, S.N 1. Image and corresponding bounding box. Class number=0, center(x) horizontal location of the center of its bounding box =0.3733333333333335, center(y) vertical position of the center of its bounding box =0.5016666666666667, width=0.745 and height =0.9966666666666667. Test Dataset shows images and equivalent the bounding box labeling (class, center(x), center(y), width, height). In Table 7, S.N 2. Image and corresponding bounding box. Class number=0, center(x) horizontal location of the center of its bounding box =0.8102692548528491, center(y) vertical position of the center of its bounding box =0.6435025817555938, width=0.09079524107701942 and height =0.1751290877796902.

### Google Colaboratory

Google Colab is an online platform that makes it possible for anybody to create and run arbitrary Python code through a web browser. The acronym "Colab" refers to the product that was developed by Google Research. This platform excels in the areas of machine learning, data analysis, and teaching.

### Python

Python is a high-level programming language that can be interpreted and is object-oriented. Its use as a scripting language or glue language to connect existing components makes it a very versatile choice. Python's syntax is straightforward and easy to learn, which places an emphasis on readability.

### Twilio

It can be used to create and phone calls, send and receive text messages, and carry out a wide range of other tasks through its application programming interfaces (APIs).

### Roboflow

It gives all of the tools required to convert raw photos into a custom computer vision model. Roboflow Annotate is a self-service annotation tool that is offered with each account.





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### YOLO v7

We use the YOLO v7 (You Only Look Once) Objects detection is a technique that is applied in the domain of computer vision for the goal of recognizing and localizing items that are present inside an image or a video. Using bounding boxes, which are geometric representations of the rectangular regions surrounding the objects, image localization determines where one or more items are supposed to be located in an image. Single or many items can be localized in an image using this technique. Image classification and recognition are subsets of image processing, although they are sometimes confused with this method since they both aim to predict into which category an image or an object in an image will belong [29][30].

## RESULTS AND DISCUSSION

The performance of a classification model (sometimes called a "classifier") on a collection of test data for which the true values are known can be effectively expressed through the use of a confusion matrix, which is a representation of the forecast outcomes of any binary testing. This is due to the fact that the predicted outcomes of every binary test can be defined by using the confusion matrix. This is because, as a matrix, confusion matrices are inherently symmetric.

In figure 2, Accuracy is frequently used as a metric for ranking responses to classification problems. It's a measure of how well predictions have been made relative to the total number of predictions made.

Over all the model Accuracy =  $(TP+TN)/(TP+TN+FP+FN)$   
 $= (0.97+1)/(0.97+1+0.03+0) = 98.5\%$

During in the phase of supervising, as an illustration (in table 8) to detect the monkey in the agricultural area that have the intent of destroying the crops during the supervising phase performed by the admin node with the accuracies are of 94%, 89%, 98% and 85% then activate the recommendation phase. During the recommendation phase, the admin send SMS to the farmer with information regarding any monkey detected in crop area that may have occurred in the agricultural field. The animal is not harmed in any way by the environmentally friendly action called "Beep Sound Wave" that is initiated by the admin against with the monkey that has been identified. This action causes the monkey to flee the crop field without causing any damage to the crops.

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**Table 1: Login**

1.	<b>Login</b>				
1.1	<b>Brief Description</b> This use case describes that a user enters into the system.				
1.2	<b>Actor</b> The following actors interact and participate with the use case: Agent Node or Admin, Farmer				
1.3	<b>Flow of Event</b> <table border="1"> <tr> <td>1.3.1</td> <td><b>Basic flow</b> This use case allows the user to enter into the system. The user enters the valid ID and Password for login.</td> </tr> <tr> <td>1.3.2</td> <td><b>Alternate flow</b> If The user enters the invalid ID or Password for login then user can't enter into the system.</td> </tr> </table>	1.3.1	<b>Basic flow</b> This use case allows the user to enter into the system. The user enters the valid ID and Password for login.	1.3.2	<b>Alternate flow</b> If The user enters the invalid ID or Password for login then user can't enter into the system.
1.3.1	<b>Basic flow</b> This use case allows the user to enter into the system. The user enters the valid ID and Password for login.				
1.3.2	<b>Alternate flow</b> If The user enters the invalid ID or Password for login then user can't enter into the system.				
1.4	<b>Special Requirement</b> Valid Account.				
1.5	<b>Pre-Condition</b> All users must have valid ID and password or account information before entering into the system.				
1.6	<b>Post Condition</b> After clicking the login button and successful execution then user enter into the system. Otherwise no change in the state.				

**Table 2: Supervising**

2.	<b>Supervising</b>				
2.1	<b>Brief Description</b> This use case describes that an agent node or Admin can supervise and control the system.				
2.2	<b>Actor</b> The following actors interact and participate with the use case: Agent Node or Admin				
2.3	<b>Flow of Event</b> <table border="1"> <tr> <td>2.3.1</td> <td><b>Basic flow</b> After Login into the system, This use case allows the Admin to supervise and control the system.</td> </tr> <tr> <td>2.3.2</td> <td><b>Alternate flow</b> If The user is not admin then not allow for supervise and control the system.</td> </tr> </table>	2.3.1	<b>Basic flow</b> After Login into the system, This use case allows the Admin to supervise and control the system.	2.3.2	<b>Alternate flow</b> If The user is not admin then not allow for supervise and control the system.
2.3.1	<b>Basic flow</b> After Login into the system, This use case allows the Admin to supervise and control the system.				
2.3.2	<b>Alternate flow</b> If The user is not admin then not allow for supervise and control the system.				
2.4	<b>Special Requirement</b> Must have Admin power.				
2.5	<b>Pre-Condition</b> User must have valid ID and password or account information and should login as Admin before entering into the system.				
2.6	<b>Post Condition</b> After clicking the Supervising Phase button and successful execution then Agent Node or Admin can supervise and control the system. Otherwise no change in the state.				

**Table 3: Detection**

3.	<b>Detection</b>
3.1	<b>Brief Description</b> This use case describes that an agent node or Admin detect the suspicious animal during supervision the system.





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3.2	<b>Actor</b> The following actors interact and participate with the use case: Agent Node or Admin, Monkey (Animal)			
3.3	<b>Flow of Event</b>			
	<table border="1"> <tr> <td>3.3.1</td> <td><b>Basic flow</b> This use case allows the Agent Node or Admin found any suspicious activity then detect the suspicious animal in the system.</td> </tr> <tr> <td>3.3.2</td> <td><b>Alternate flow</b> If The Agent Node or Admin doesn't found any suspicious activity then not detected.</td> </tr> </table>	3.3.1	<b>Basic flow</b> This use case allows the Agent Node or Admin found any suspicious activity then detect the suspicious animal in the system.	3.3.2
3.3.1	<b>Basic flow</b> This use case allows the Agent Node or Admin found any suspicious activity then detect the suspicious animal in the system.			
3.3.2	<b>Alternate flow</b> If The Agent Node or Admin doesn't found any suspicious activity then not detected.			
3.4	<b>Special Requirement</b> Must be Admin.			
3.5	<b>Pre-Condition</b> Agent Node or Admin must have executed successfully of the supervision Phase before entering Detection of Suspicious Animal use case.			
3.6	<b>Post Condition</b> After clicking the Supervising Phase button and successful execution then Agent Node or Admin can detect the suspicious animal. Otherwise return to previous state.			

**Table 4: Recommendation**

4.	<b>Recommendation</b>			
4.1	<b>Brief Description</b> This use case describes that an agent node or Admin can recommend the treatment for found any suspicious animal during supervision the system.			
4.2	<b>Actor</b> The following actors interact and participate with the use case: Agent Node or Admin			
4.3	<b>Flow of Event</b>			
	<table border="1"> <tr> <td>4.3.1</td> <td><b>Basic flow</b> This use case allows the Agent Node or Admin to recommend the treatment for found any suspicious animal in the system.</td> </tr> <tr> <td>4.3.2</td> <td><b>Alternate flow</b> If The Agent Node or Admin doesn't found any suspicious animal then, return to previous state.</td> </tr> </table>	4.3.1	<b>Basic flow</b> This use case allows the Agent Node or Admin to recommend the treatment for found any suspicious animal in the system.	4.3.2
4.3.1	<b>Basic flow</b> This use case allows the Agent Node or Admin to recommend the treatment for found any suspicious animal in the system.			
4.3.2	<b>Alternate flow</b> If The Agent Node or Admin doesn't found any suspicious animal then, return to previous state.			
4.4	<b>Special Requirement</b> Must be Admin.			
4.5	<b>Pre-Condition</b> Agent Node or Admin must have executed successfully of the supervision Phase and Detected the Suspicious Animal before recommendation phase.			
4.6	<b>Post Condition</b> After clicking the recommendation phase button and successful execution then Agent Node or Admin can recommend the treatment on suspicious animal. Otherwise return to previous state.			

**Table 5: Generate Sound Wave**

5.	<b>Generate Sound Wave</b>
5.1	<b>Brief Description</b> This use case describes that an agent node or Admin can activate the action on the suspicious animal during supervision the system.
5.2	<b>Actor</b> The following actors interact and participate with the use case:



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	Agent Node or Admin, Farmer				
5.3	<p><b>Flow of Event</b></p> <table border="1"> <tr> <td>5.3.1</td> <td> <p><b>Basic flow</b></p> <p>This use case allows the Agent Node or Admin to activate the action on the suspicious animal in the system. And farmer can view that action.</p> </td> </tr> <tr> <td>5.3.2</td> <td> <p><b>Alternate flow</b></p> <p>If The Agent Node or Admin doesn't found any suspicious animal then, return to previous state.</p> </td> </tr> </table>	5.3.1	<p><b>Basic flow</b></p> <p>This use case allows the Agent Node or Admin to activate the action on the suspicious animal in the system. And farmer can view that action.</p>	5.3.2	<p><b>Alternate flow</b></p> <p>If The Agent Node or Admin doesn't found any suspicious animal then, return to previous state.</p>
5.3.1	<p><b>Basic flow</b></p> <p>This use case allows the Agent Node or Admin to activate the action on the suspicious animal in the system. And farmer can view that action.</p>				
5.3.2	<p><b>Alternate flow</b></p> <p>If The Agent Node or Admin doesn't found any suspicious animal then, return to previous state.</p>				
5.4	<p><b>Special Requirement</b></p> <p>Must be Admin and Detection of Suspicious Animal.</p>				
5.5	<p><b>Pre-Condition</b></p> <p>Agent Node or Admin must have executed successfully of the supervision Phase and Detected the Suspicious Animal and recommendation phase executed successfully before Activate Action use case start.</p>				
5.6	<p><b>Post Condition</b></p> <p>After clicking the Activate Action use case button and successful execution of it, then Agent Node or Admin can perform action on suspicious animal. Otherwise return to previous state.</p>				

**Table 6: Generate Alert Message**



6.	<b>Generate Alert Message</b>				
6.1	<p><b>Brief Description</b></p> <p>This use case describes that an agent node or Admin send alert SMS to farmer during supervision the system.</p>				
6.2	<p><b>Actor</b></p> <p>The following actors interact and participate with the use case: Agent Node or Admin, Farmer</p>				
6.3	<p><b>Flow of Event</b></p> <table border="1"> <tr> <td>6.3.1</td> <td> <p><b>Basic flow</b></p> <p>This use case allows the Agent Node or Admin can send alert SMS information and to farmer in the system.</p> </td> </tr> <tr> <td>6.3.2</td> <td> <p><b>Alternate flow</b></p> <p>If The Agent Node or Admin doesn't found any update, return to previous state.</p> </td> </tr> </table>	6.3.1	<p><b>Basic flow</b></p> <p>This use case allows the Agent Node or Admin can send alert SMS information and to farmer in the system.</p>	6.3.2	<p><b>Alternate flow</b></p> <p>If The Agent Node or Admin doesn't found any update, return to previous state.</p>
6.3.1	<p><b>Basic flow</b></p> <p>This use case allows the Agent Node or Admin can send alert SMS information and to farmer in the system.</p>				
6.3.2	<p><b>Alternate flow</b></p> <p>If The Agent Node or Admin doesn't found any update, return to previous state.</p>				
6.4	<p><b>Special Requirement</b></p> <p>Must be Admin.</p>				
6.5	<p><b>Pre-Condition</b></p> <p>Agent Node or Admin must have executed successfully of the supervision Phase and Detected the Suspicious Animal and recommendation phase executed successfully and Activate Action before crop Area Information use case start.</p>				
6.6	<p><b>Post Condition</b></p> <p>After clicking the crop Area Information use case button and successful execution of it, then Agent Node or Admin can send alert SMS to farmer online. And farmer view the update online. Otherwise return to previous state.</p>				





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**Table 7: Test and Train Data Example**

S.N	Raw Image	Bounding Box labelling
1.		0 0.37333333333333335 0.5016666666666667 0.745 0.9966666666666667
2.		0 0.8102692548528491 0.6435025817555938 0.09079524107701942 0.1751290877796902

**Table 8: Monkey Detection with accuracy**



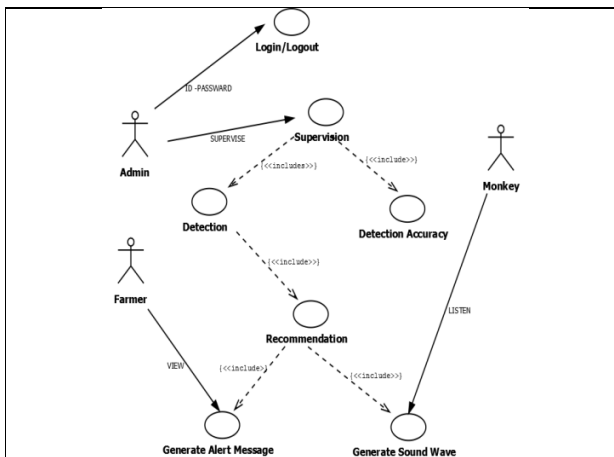
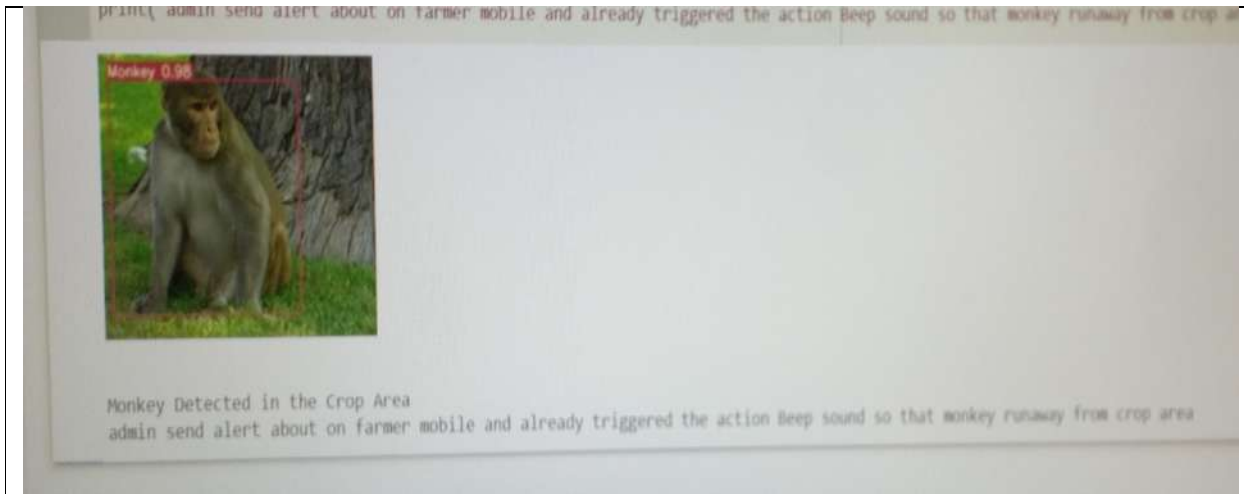


Figure 1: Use Case Diagram



Figure 2: Confusion Matrix







## Comparing the Effects of Specific Core Muscle Training and High-Intensity Interval Training on Running Economy among Marathon Runners with Nonspecific Low Back Pain – A Non-Randomized Control Trial.

Siddharth N. Joshi<sup>1\*</sup>, Rameshchandra K. Chavada<sup>2</sup> and Kalpesh G. Vasani<sup>3</sup>

<sup>1</sup>Ph.D Scholar, Faculty of Physiotherapy, Parul University, Gujarat, India

<sup>2</sup>Professor and Head, Dept. of Medicine, Parul University, Gujarat, India.

<sup>3</sup>Professor and Principal i/c, Shri D.M.Patel College of Physiotherapy, Amreli, Gujarat, India.

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### \*Address for Correspondence

**Siddharth N. Joshi**

Ph.D Scholar,

Faculty of Physiotherapy,

Parul University, Gujarat, India

E. Mail: dr.siddharthjoshi@yahoo.com



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### ABSTRACT

This study aims to investigate and compare the impact of 4-week specific core muscle training and high-intensity interval training in improving the total running time among marathon runners. The study was performed with 32 athletes suffering from chronic nonspecific low back pain (CNSLBP) within the age range of 18-24 years. The samples were divided into two groups namely the specific core muscle training group (SCMT) and high-intensity interval training (HIIT) randomly using the random table method. Total running time (TRT) was tracked using total running time measured using a mobile app called "Strava". The between-group analysis showed that there was a significant difference between the post-test 2 values (taken after 4 weeks) but not for the pre-test and post-test 1 (taken after 2 weeks). Within-group analysis of TRT showed that there was no significant difference between the temporal values in SCMT group ( $F=0.237$ ,  $P=0.7998$ ), whereas there was a significant difference between found in the HIIT group ( $F=21.58$ ,  $p<0.001$ ). From the current study we suggest HIIT as an effective intervention in the management of CNSLBP which is a tough condition to treat in elite athletes.

**Keywords:** Marathon runners, Chronic nonspecific low back pain, high-intensity interval training, core strengthening, total running time.)

### INTRODUCTION

Running economy is a controversial topic and it is very subjective once however, it has become very quantitative these days. Studies have shown that core function is related to running kinematics and respiratory work. Core



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muscles allow optimal force production, to control, support, and move extremities.(Forlizziet al., 2022)Proper core exercise may result in an improvement in core endurance, respiration, and movement efficiency. However, not all studies have supported these findings. Conventionally, core muscle strengthening is taught in lying or as an open kinematic exercise targeting the muscles of the lower back, abdominals, and hip extensors.(Kwon et al., 2013)There is an inconsistency in the findings of these studies may stem from differences in core training programs, core training durations, or even participants. The treatment of chronic nonspecific low back pain (CNSLBP) using physiotherapeutic modalities comprises a multidimensional treatment method where exercises play a vital role. The exercises not only attest to the low back and other specific regions but to the entire body (Koes et al., 2010; Oliveira et al., 2018). Studies comparing various physical therapy programs in CNSLBP have not been able to demonstrate clearly which is the best intervention as there are so many confounding variables. Most often pain and disability are the primary outcome measures but not performance, particularly in a population like athletes. (Owen et al., 2020; Wewege et al., 2018). As a result, clinical guidelines lack instructions or give conflicting recommendations regarding the preferred exercise mode in this population(Searle et al., 2015)above all the effect of various exercise programs in enhancing athletic performance is poor(van Middelkoop et al., 2010). There are limited studies and controversial findings on this topic. This study aims to investigate and compare the impact of 4-week specific core muscle training and high intensity interval training in improving the total running time among the marathon runners.

## METHODOLOGY

The study was performed with 32 athletes who were selected conveniently from an Ahmadabad sports academy. The subjects were all suffering from CNSLBA (determined by a sports physiotherapist). All the athletes were professionals within the age range of 18-24 years. Both male and female athletes were recruited after they provided informed consent. The study was approved by the institutional ethical committee at Madhav University. The subjects were excluded if they had a serious injury, fracture, or any history of low back surgery or any other surgery in the past two years. The subjects were also excluded from this 4 week's study if they had any upcoming events to participate in during the intervention period. The samples were divided into two groups namely specific core muscle training group (SCMT) and high-intensity interval training (HIIT) randomly using random table method.

### SCMT Group Intervention

The subjects were treated using lumbar core stabilisation exercises, strengthening for the hip muscles bilaterally and for the abdominal toning. The exercisers were given mostly as open kinematic exercises using the weight cuffs, boots, therabands and body weight. Closed kinetic chain exercises like the sit to stand, squatting, step up exercises were also included. The subjects were treated for one session of 60 minutes a day, for 3 days in a week for 4 consecutive weeks.

### HIIT Group Intervention

The subjects in this group were treated with high intensity exercises that was provided by a trained physiotherapist. Each training session of the HIIT exercise program comprises of treadmill running and Bicycle Ergometer for 30 min duration thrice a week with exercise performed at 60% to 75% of maximal Heart rate (HR max = 220 - Age). Warm-up phase -10 min, Exercise phase - 30 min, Cool-down phase - 5 min.

### Outcome Measure

Total running time (TRT) was tracked using total running time measured using a mobile app called "Strava". Strava application had been used in the current research based on the previous literature done by Kyuhyun et al in 2021, which had proved the application to be very effective in tracking the movements of the athletes and helps in maintaining an objective log. (Fischer et al., 2022). Earlier Starve was proved to be effective by West et al in cyclists and runners to document their activities and offer analysis and improvise on their performance. It geographically maps the route taken and records the pace achieved. Once a task is accomplished this data is transferred onto the application and website which enables analysis of the activity, energy uptake, speed achieved, speed over various





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distances, and heart rate. (Lee & Sener, 2021) The outcome measure was used at base line measuring the last one month running time as baseline value, followed by second week of intervention and then at the end of four week of intervention.

### Statistical Analysis

Statistical analysis was performed using SPSS software version 23 with a confidence interval of 95% and significance level of 0.05. The demographic data were assessed for the baseline homogeneity using chi square and independent t-test. Distribution was analysed using Kolmogorov Smirnov test and confirmed by Shapiro Wilk test. The within group analysis was done using repeated measures ANOVA and the between group analysis was done using independent t-test. Post Hoc analysis was done using Tukey HSD.

## RESULTS

The basic demographic data of the athletes and their homogeneity analysis is presented in table 1. The distribution analysis performed using both the valid test showed that the data was normally distributed and hence a parametric analysis was done for the TRT. The analysis proves that there was no significant difference between the groups identified except for the sex difference which was higher in the HIIT group. The between-group analysis of pre-test values of TRT was performed using an independent sample t-test and it is presented in table 2. Within group analysis of TRT showed that there was no significant difference between the temporal values in SCMT group ( $F=0.237$ ,  $P=0.7998$ ), whereas there was significant difference between found in the HIIT group ( $F=21.58$ ,  $p<0.001$ ). In the post hoc analysis of HIIT it was revealed that there was no significant difference between the baseline value and post test 1 ( $p=0.107$ ), but there was a marginal significant difference between the post test 1 and post-test 2 ( $P=0.041$ ). There was a high significant difference found between the pre test and the post-test 2 ( $P<0.001$ ). The within group performance difference is plotted in the box plot (Figure-1)

## DISCUSSION

In the current study the main uniqueness is that the intervention duration is unequal. The HIIT group was treated only for a duration 30 minutes of HIIT training and the SCMT group was provided with 60 minutes of intervention. The novelty of the study lies in the research question which doubts the conventional way of teaching athletes with a specific exercise and wasting the training time. There are many studies that has proved that specific intervention may not be effective in the management of nonspecific pain even though they may be effective in the treatment of discogenic pain or spot traumatic rehabilitation. (van Middelkoop *et al.*, 2010) The study results are consistent with previous study which reported the benefits of HIIT in treating CNSLBA (Verbrugge *et al.*, 2020). However the intervention is not been tested on the marathon runners so far and to our knowledge this will be the first study to illustrate that. The possible reason for a better pain reduction with HIIT in this study might be because it attests to the whole-body muscles unlike the SCMT which targets the back, abdominals and the hip joint. Non specific low back pain when it becomes chronic involves an number of psychological issues in a bio-psych-social model. It is well proved that whole body exercises work at the central sensitisation and reduces pain. (Geneen *et al.*, 2017; Searle *et al.*, 2015) The current study results show that there was no significant improvement in the running time when the specific muscles were targeted but the changes happened after the second week in the HIIT group which is understandable. The groups were similar at the time of treatment except for the sex distribution which was also in the favour of SCMT group with more male athletes. The main limitations in this study is the small sample and lack of random selection of the athletes from the population. There was no blinding done as that was not feasible due to the interaction between the athletes as it was a single centre study. The future studies can focus on repeating the study using larger samples and compare the prognosis of performance with pain, disability and quality of life.





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## CONCLUSION

From the current study we suggest HIIT as an effective intervention in the management of CNSLBP which is a tough condition to treat in elite athletes. Having said this the results should be verified with more samples and robust research methods using more objective tools in future.

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**Table 1 – demographic data of both the groups and homogeneity analysis.**

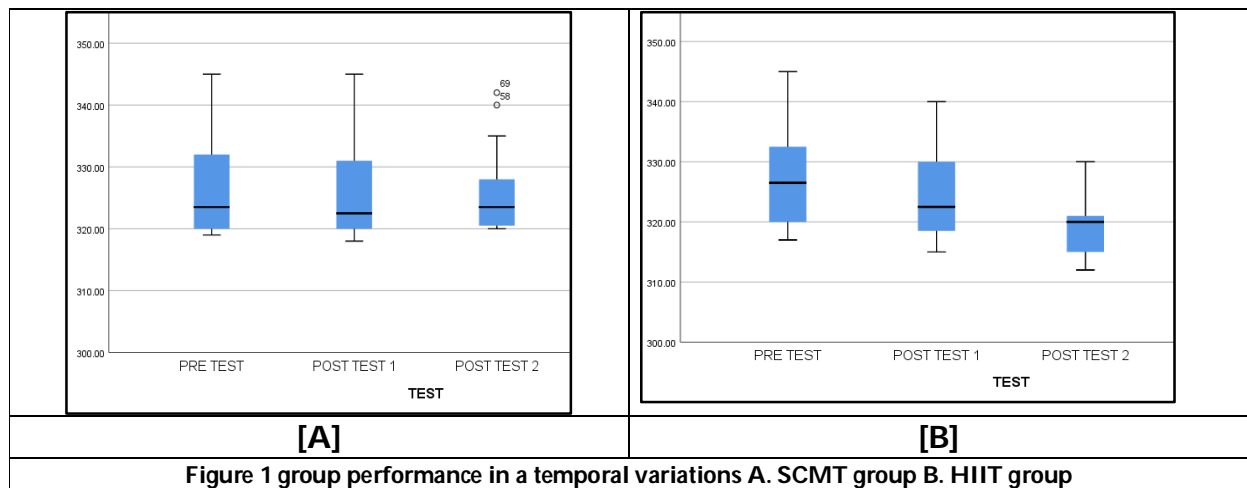
Demographic criteria	SCMT	HIIT	Significance
Numbers	16	16	-
Age*	22.4 (2.45)	21.56 (4.21)	0.701 <sup>a</sup>
Sex	Male – 12 Female – 4	Male – 08 Female – 08	0.001 <sup>b</sup>
Years of experience*	4.5(2.9)	5.2(1.2)	0.227 <sup>a</sup>
BMI*	22.2 (0.6)	23.8 (0.8)	0.478 <sup>a</sup>
Frequency of low back pain in past	3.9 (1.2) months	4.1 (0.8) Month	0.621 <sup>a</sup>

a- Independent t-test, b- chi square test

**Table 2 – Between group analysis of temporal values of TNT**

	GROUP	N	Mean (SD)	F value	T value	P value
PRE-TEST	SCMT	16	331.90(7.43)	0.36	-0.318	0.821
	HIIT	16	332.71(6.39)			
PRE-TEST	SCMT	16	331.24(5.13)	0.520	0.112	0.474
	HIIT	16	330.2.82 (5.39)			
PRE-TEST	SCMT	16	328.29(7.73)	4.98	6.88	0.021*
	HIIT	16	321.71 (6.69)			

SD- standard deviation, SCMT - specific core muscle training group, HIIT - high-intensity interval training  
\*significant difference p<0.005





## A Study on Self-Supervised Learning based Feature Generalization

Divya J C<sup>1\*</sup>, Mirnalinee T T<sup>2</sup>, Bhuvana J<sup>3</sup>

<sup>1</sup>Research Scholar, Department of Computer Science and Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, India.

<sup>2</sup>Professor, Department of Computer Science and Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, India.

<sup>3</sup>Associate Professor, Department of Computer Science and Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, India.

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### \*Address for Correspondence

**Divya J C**

Research Scholar,

Department of Computer Science and Engineering,

Sri Sivasubramaniya Nadar College of Engineering,

Chennai, Tamil Nadu, India.

E. Mail: divyajc@ssn.edu.in



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### ABSTRACT

Deep learning has accomplished massive improvement in a variety of fields, but requires expensive annotations on large datasets. Supervised learning usually requires a large quantity of labeled data. Getting good quality labeled data is an expensive and time-consuming task. But the unlabeled data are numerous and easily available. Self-Supervised Learning (SSL) is a machine learning process where the features are efficiently learned from the data itself. Other learning techniques cannot be used effectively in applications such as video anomaly detection. SSL plays a major role in such applications since most of the data are unlabeled. The objective of this paper is to characterize pretext tasks for feature generalization across multiple domains. These features were able to represent and capture various discriminative patterns in the target domain. Through this study it was observed that the different pretext tasks such as generative, predictive and contrastive can be used for the generation of missing regions based on context, predictions and image transformations. This enables us to identify the invariances and regularities in the downstream task. These feature generalizations will solve the problem of scarcity of labeled data for learning the patterns from the data.

**Keywords:** Self-supervised learning, pretext task, downstream task, domain generalization, pseudo label





## INTRODUCTION

Psychologists and learning experts have developed numerous definitions of intelligence over the years. Despite the variations, they all highlight the importance of being flexible and able to accomplish objectives in a variety of situations [1]. Recent research has emphasized the significance of transfer learning and domain generalization in artificial intelligence, which utilizes these criteria. In fact, the underlying training distributions (also known as source) and test (also known as target) data are invariably different in many practical applications, necessitating the use of reliable and flexible solutions. The majority of existing approaches to visual domains are supervised learning-based. With the same goal of generating those feature embeddings, self-supervised learning that captures visual invariances and regularities is addressed as an alternative research area.

In many computer vision applications, such as image classification, object recognition, and picture segmentation, deep learning techniques have achieved state-of-the-art performance, but they demand expensive annotations on big datasets. Since the effectiveness of deep neural networks frequently depends on the availability of a huge amount of labeled data that is expensive to obtain, learning with limited labeled data has developed many problems [13]. This has led to advancements in a variety of subfields, such as transfer learning, semi-supervised, weakly supervised, unsupervised, and self-supervised learning. Unsupervised learning is becoming more popular as a method to discover effective feature representations without having to manually annotate a dataset. A machine could learn complex features from unlabeled data using unsupervised learning. The other approach for addressing the lack of annotated datasets is the use of transfer learning (TL). This approach makes use of research that focuses on the application and retention of information for solving problems in many but related domains. This data transfer technique can improve performance while minimizing use costs. Despite this advantage, the original and target tasks must be from the same domain for this method of learning to be effective. Pre-training on a source task and fine-tuning on a target/downstream task are the two methodologies that constitute TL and SSL. The pre-trained weights are used to initialise the model's weights in the target task when the architectures of the source and target tasks are the same [3].

The main difference between TL and SSL is that SSL learns features from unlabeled data, TL pre-trains on annotated data. The classification and recognition using supervised learning is domain specific. So, there is a demand for feature representation to generalize classification and recognition, to simulate human perception. Feature representation can be learned in one of two ways via unsupervised learning: generative learning or SSL. In the first, feature representations are learned through images acting as a method of latent embedding. To accomplish this, these methods frequently use auto-encoders, adversarial learning, or jointly modelled representations and data. The drawback of generative methods is that they only function in pixel space. The number of resources required for this is high because it calls for extensive detail that may not be required for representation learning itself. Self-supervised learning, or SSL, is becoming prominent as a solution to these issues because it does not require manual annotation in order to learn representations and can use unlabeled data for training [3]. The domains of computer vision and natural language processing are generally preferred for using SSL. The issue of data labeling is being addressed by an emerging technology called SSL. It is a technique of machine learning where the model learns itself by using one part of the information to anticipate the other portion and accurately provide the labels. SSL generates labels without human input by generating the labels on its own.

Since SSL is a hybrid approach, it makes use of both supervised and unsupervised learning during the pre-training fine-tuning stage [3]. In order to achieve this, SSL generates a supervisory signal from unlabeled data that it uses to learn representations in the absence of annotated data. As a result, annotated data is no longer necessary. Models can be trained using supervised learning in SSL by using annotations made from the actual raw data. Researchers have been drawn to SSL because of its improved model generalization and data efficiency. Feature representation can be learned in one of two ways using unsupervised learning: generative learning or SSL. In the first, feature representations are learned through latent embedding in the form of image representations. To accomplish this, these



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methods frequently use auto-encoders, adversarial learning, or jointly modelled representations and data. As generative approaches work in pixel space, this is a disadvantage, which is resource-intensive because it demands intricate detail that may not be required for representation learning itself.

### Self Supervised Learning

A paradigm called self-supervised learning was developed to learn visual features from massive amounts of unlabeled data [1]. The process begins with a pretext task that uses defined data features to automatically generate labels. This task includes recovering some of the knowledge that has already been manually removed from the images (such as the colour, orientation, and patch order). A network that has been trained to capture important semantic knowledge does so in its initial layers. The second stage of the learning process includes transferring the self-supervised learned model of those initial layers to a supervised downstream task while the final part of the network is being newly trained (such as classification or detection). Recent research on self-supervised learning focuses on the development of new pretext tasks or combining several of them, then comparing their initialization performance to utilizing supervised models as in conventional transfer learning. Without any human annotation, self-supervised learning aims to learn complex representations from unlabeled data. This can be done by trying to predict that when using parts of the data as labels. Pretext tasks are the formulations that help in the learning of representations. The model will learn useful representations by obtaining pre-training on the pretext task. With just a minimal amount of labelled training data, the model is then fine-tuned for subsequent tasks including image classification, object detection, and semantic segmentation. Without the use of semantic annotations, self-supervised learning from images seeks to build semantically meaningful visual representations via pretext tasks [20].

With the objective of attaining potent deep feature learning without the need for sizable annotated datasets, self-supervised representation learning techniques strive to reduce the limitations of annotation, which is one of the major obstacles to the practical use of deep learning [2]. The issue of data labelling is being addressed by an emerging technology called SSL. It is a technique of machine learning where the model trains itself by using one portion of the data to anticipate the other portion and accurately provide the labels. SSL generates labels without human involvement by generating the labels on its own. In the SSL learning task, a deep neural network (DNN) is needed to predict one part of the input data or a label that may be obtained from it programmatically, given another part of the input. In contrast, supervised learning asks the DNN to predict a target output that has been manually provided, while generative modelling instructs the DNN to determine the density of the input data or to discover a data generator [2]. The major way that self-supervised algorithms differ is in how they define the generated labels that will be used for prediction. SSL is done in two stages.

The pretext task, which is the first stage of SSL, is performed to learn visual representations with the goal of applying such representations to subsequent tasks. The pretext contains image rotation, inpainting, colorization in grayscale, relative position, etc. Based on some data attributes, the pretext task's pseudo labels are automatically generated [10]. Through supervised learning, it generates labels from the data itself and learns representations. After this learning is completed, the model adapts the learned representations from the pretext task to the downstream task. The second stage is the downstream task, which is the technique through which the pretext model's knowledge is transferred to the downstream tasks. It may involve tasks like object recognition and classification.

### Feature Representation

The acquisition of labelled data is costly and time-consuming for many applications. Thus, machine learning has long sought to utilise unlabeled data during training. This is addressed by self-supervised learning, which proposes an auxiliary task that is independent to the supervised task but still related to it. SSL's major objective is to prevent time-consuming and expensive data annotations. Most SSL algorithms learn representations on the basis of convolutional neural networks (CNNs) and ResNet, which are used in the field extensively. A softmax classifier is generated by CNNs, which produce a fully connected layer as the output after combining convolutional and pooling layers. CNNs are frequently used in sentiment analysis, recommender systems, object detection, and picture recognition. They are prioritised by researchers because they can recognize features without human supervision.





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Deeper models (as ResNet) might contribute in the learning of better representations for the pretext problem because the objective is to learn from a large unlabeled dataset. But for applications, shallow models (as AlexNet) are preferred for downstream tasks. Research shows that self-supervised representations are compatible with their supervised counterparts. On an unlabeled dataset, the feature extractor completes a pre-text task. Generic representations are subsequently computed by this extractor for additional downstream tasks like object detection and classification. Similar accuracy values between SSL and supervised classifications have been discovered in recent research in this field, particularly when the size of the annotated training set is minimal.

### Pretext Tasks

Without any human annotation, self-supervised learning aims to learn complex representations from unlabeled data. This can be done by trying to predict that when using portions of the data as labels. Pretext tasks are the formulations that help in the learning of representations. The model will learn useful representations by obtaining pre-training on the pretext task. With just a minimal amount of labeled training, the model is then fine-tuned for downstream tasks including image classification, object detection, and semantic segmentation. Pretext tasks are pre-designed tasks that the networks must solve in order to learn new visual features. Using pseudo labels to learn representations of the data is a key technique. The attributes discovered in the data are used to automatically produce these pseudo labels. By receiving supervisory signals straight from the data without the need for manual annotations, the model learns automatically [3]. Pseudo labels are those that are generated based on the data structure for pretext tasks and are utilised in pretext tasks. The process of using the labeled data model to predict labels for unlabeled data is known as pseudo labeling. Any downstream computer vision tasks like classification, segmentation, detection, etc. can be performed using the learnt model from the pretext task.

Pretext tasks may be generative, contrastive, predictive, or a combination of these. Through pretext tasks, SSL learns representations. Designing a suitable pretext task requires domain knowledge. As pretext tasks may be generated for any sort of data, including audio, text, image, and video [3], this is the important element of SSL. It can be grayscale images, predicting a missing pixel, rotation, patch context and jigsaw puzzles [4]. Many research has been done to learn transferable representation for video-related downstream tasks, such as action recognition and video retrieval, as a result of the effectiveness of self-supervised image representation learning [19]. The distinct temporal information of videos is learned and the frame sequence ordering is used as their pretext task.

### Generative Pretext Tasks

#### Image Inpainting

Convolutional neural networks are trained in context encoders, which are similar to auto-encoders in that they are trained to generate the content of any visual region in relation to its surroundings. In order to accomplish this task successfully, context encoders must identify all of the image's information and create a feasible hypothesis for the missing data (s). An image with a missing region is used to train a convolutional neural network to regress to the missing pixel values. This is called the context encoder because it consists of an encoder that transforms an image's context into a compact latent feature representation and a decoder that makes use of that representation to generate the content of the missing image. [8]. A dataset that generates patches that are semantically similar to the original patch is used to extract nearest neighbour contexts after the context of an image patch is encoded on the encoder side. It fills in the realistic image content on the decoder side [14]. With initial random weights, the network is trained from scratch for context prediction. The pretext task is to reconstruct a missing part of the image, and the data is trained by discarding random regions from images. The model must recognize the complete image's content in order to provide a realistic substitute for the missing part.

#### Image Colorization

To improve the aesthetic and perceptual quality of grayscale images or video frames, image colorization is the process of estimating RGB colors. Because of the various imaging conditions that need to be handled by a single algorithm, colorization of images is a challenging task [9]. The colorization issue inherits the usual challenges associated with image enhancement, such as changing illumination, altering viewpoints, and occlusions. Early





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colorization architectures were plain networks with a fundamental architecture that layered convolutional layers without any, or naive, skip connections, similar to other CNN tasks. To learn the features, the convolutional neural networks are trained to colorize grayscale images. The scale invariant feature transform (SIFT) is used for image feature learning and is used as a feature extractor in classifiers [16]. The training data is a pair of color and grayscale images. The pretext task is to predict the colors of the objects in the grayscale images. The model needs to understand the objects in images and paint them with a suitable color.

### Predictive Pretext Tasks

#### Geometric Transformation

One of the most prevalent pretext tasks, predicting rotations has a simple architecture and requires low sampling. By training convolutional networks to recognise the geometric transformations performed to the input image, the image features in geometric transformation are learned. The training set consists of images that have been rotated by 0, 90, 180, and 270 degrees. These rotated images are given to the network, which uses a simple 4-way classification to determine what kind of rotation was performed to the image [7]. The label for self-supervised learning is the direction in which the image rotates. Here, the pretext task is to train the model how to predict the imposed rotation degree. To determine the degree of rotation, the model must recognize the orientation and structure of the objects in the images. To determine the direction of rotation, the rotated image is fed into the entire network. The above model is used for feature extraction after the self-supervised network has been trained. Scatternet and ResNet are used to extract the image features. The convolutional network is then fed the image features, and the image classification labels are obtained.

#### Context Prediction

Context prediction is a class of SSL in which the model can effectively predict the position of image patches; to achieve this, the model has to determine which group these image patches belong to, with respect to the spatial context. [3]. In the model developed in [6], it predicts the range between a second patch selected at random from the eight regions around the central patch. The training data is the multiple patches extracted from the images. The pretext task is to train a model to predict the relationship between the patches. The model needs to understand the spatial context of images, in order to predict the relative positions between the patches [6]. Each patch is fed into a convolutional neural network designed on the AlexNet architecture, where weights are distributed among the appropriate layers in both models before being combined into a fully connected layer. Any spatial configuration's probability can be predicted by a softmax final layer. In order to reduce overfitting, gaps were created between patches. These gaps randomly jittered each patch site by up to seven pixels, scaling down some images and discarding colour information to prevent chromatic aberrations.

### Contrastive Pretext Tasks

#### SimCLR

Contrastive learning is a discriminative technique that aims to distribute various samples and cluster closely related ones together. It is a simplified approach for contrastive learning of visual representations [18]. SimCLR learns representations by maximizing agreement between several augmented interpretations of the same data example using a contrastive loss in the latent space. There are four major components in SimCLR:

1. A stochastic data augmentation module that changes any given data example at random to provide two correlated views of the same example, which is regarded as a positive pair and can be used to supplement data in many different ways.
2. From augmented data samples, a neural network base encoder  $f(\cdot)$  extracts representation vectors.
3. A simple neural network projection head called  $g(\cdot)$ , which maps representations to the space where contrastive loss is applied.
4. A contrastive prediction task's defined contrastive loss function.

The contrastive prediction task is defined on pairs of augmented examples obtained from a minibatch of  $N$  examples that is randomly picked, yielding  $2N$  data points. Negative samples are not specifically sampled. The other  $2(N-1)$  enhanced examples in a minibatch are instead considered as negative examples when a positive pair is provided.





### Contrastive Predictive Coding

A learning methodology contrastive predictive coding (CPC) is applied to build up useful representations from high-dimensional data. The basic idea behind this model is to determine how to represent the shared information that exists between various components of the (high-dimensional) signal [17]. It also filters out localised noise and low-level information at the same time. Next step prediction-based methods in time series and high-dimensional modelling take advantage of the signal's local smoothness. The amount of shared information decreases significantly as we forecast further into the future, forcing the model to infer more global structure. CPC is a technique that combines predictive coding, which tries to predict future data, with a probabilistic contrastive loss. As a result, slow features can be extracted that optimise the mutual information of observations made over a long-time frame.

### Multiple Pretext Tasks

In order to perform better than learning each task separately, multi-task learning is a learning paradigm that simultaneously solves many tasks while sharing partial parameters [11]. Various techniques have been suggested for associating various pretext tasks and obtaining better representations in the context of self-supervised learning. In [12], the authors have presented system that simultaneously solves four different pretext-tasks on specialised multi-task networks by regulating the domain gap caused by various input spaces for each pretext-task. Three pretext-tasks (depth, edge, and surface normal prediction task) are used in the technique and are defined using synthetic 3D data. Combining both actual and synthetic images, a model is trained using these pretext-tasks and the target task.

### Downstream Tasks

Pretext tasks provides the model the opportunity to obtain important feature representations or model weights that it can apply to subsequent tasks. These tasks are application-specific and use pretext task knowledge. In computer vision, these processes include pose estimation, object detection, image segmentation, and image classification. Evaluation of learned feature representations and model representations is essential to ensure quality. To do this, users have the choice of using a linear classifier or fine-tuning. [3]. A new model is trained, updating all weights, using the model weights from the previous task as initialization. While the weights of the other datasets are fixed, a small labelled dataset is trained with a linear classifier using a pretext task to perform a future task. Despite having a small labelled dataset, the downstream task still requires one to perform efficiently. The deep learning model will underperform if we try to address the downstream task without the use of the pretext task after training it with a limited set of labelled data. The self-supervised pretexts rely on able to take advantage of the data structure, which differs widely across modalities and can thus affect how efficient they are. Various forms of masked prediction and transformation prediction have been attempted in images, but instance discrimination and clustering have been the primary factors of recent developments in these modalities.

### Domain Generalization and Adaptation

A number of approaches have been developed, mostly in two scenarios: Domain Generalization (DG) and Domain Adaptation (DA), to deal with domain shift [1]. In DG, the target is unknown at the time of training; however, the learning process can generally use a variety of labelled sources to construct a model that is adaptable to any new, unexplored domain. The goal of DA learning is to generalise to the given specified target set by using both the labelled source data and the unlabeled target data. Self-supervised learning by definition does not require manual annotation and, when available in the context of domain adaptation, can make use of unlabeled target data. For most DG approaches, the source domain label is known, however in multi-source DA, it may not be. There are three main solutions for both DG and DA.

The main goal of feature-level strategies is to reduce various domain shift measures in order to learn domain invariant data representations. It is also possible to minimise the domain shift by training a domain classifier and altering the optimization to point the features toward maximal domain confusion. Generating domain-shared embedding spaces has also been done using deep autoencoders and metric learning. These DG techniques involve use of the accessibility to the domain label for each sample as well as the availability of disparate sources.



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In order to search for more consistent minima of the objective function, model-level strategies either change the way the data are loaded with ad hoc episodes or they alter existing learning algorithms. In addition to these primary methods, other methods to find and discard domain-specific signatures include the use of low-rank network parameter decomposition, domain alignment layers, or aggregation layers. To generate new images, data-level techniques use various iterations of the Generative Adversarial Networks. In reality, creating source- or target-like source-like target images helps in reducing the domain gap.

**Generalization of Pretext Tasks**

With large datasets there may be issues with data imbalance, lack of generalization and difficulty in optimization. SSL addresses these problems by improving the performance by increasing the accuracy and reducing the error rate even when the datasets are small. To perform efficiently on different domains, the model has to be generalized based on SSL. The model can be generalized by identifying invariances and regularities through autonomous learning. Apply the SSL techniques to two different target dataset types to determine whether the SSL techniques are domain-specifically generalizable. Pretrained representations generated from a single source dataset can be applied to classify two separate target dataset types: the ones that are significantly different from the source dataset and ones that are similar to it. SSL performs automatic supervisory signal generation to enable the algorithm in completing a specific task. Generative and discriminative methods can both be used to build representations from unlabeled data. The prediction accuracy determines whether SSL based models can be generalized. Learning invariant representations is essential for generalization performance such that the model's recognition performance is unaltered by variability in the high-dimensional images. [15]. Consideration of prediction confidence for target domains that vary enormously from the source domain is essential in the invariance property of SSL representations [5]. The considerations are:

- a decision is made regarding the semantic identity of an image via an SSL-based model.
- the extent to which the input image is used in the decision-making processes
- if the representation invariance of an SSL-based model influences its ability to focus

If the model performs well on the target dataset after being tuned, the pretrained representations are generalizable. The invariance feature of the fine-tuned model must be recognized for generalizability. A DL model's visual representations are invariant because the probability distribution of the data (features and semantic identity) is invariant to transformations (such as translation, rotation, reflection, and scale change). A further notion of invariance is a model's ability to make accurate predictions despite changes in the background and overall illumination. The attribution technique is used by the framework to learn the invariance property. A network's evaluation of an input for prediction is represented by attribution. When the target data's domain is significantly different, generalizability decreases.

**CONCLUSION**

In order to reduce the cost of annotating huge datasets, self-supervised learning techniques have achieved remarkable results in the learning of high-level semantic visual representations from unlabeled data. The selection of pretext tasks can greatly impact the performance of the downstream task. This paper has discussed the different pretext tasks such as generative, predictive and contrastive that can be selected based on the representations to be learned and the properties needed in the representations. The model performs well on the target dataset and the pretrained representations are generalizable after fine-tuning. A domain shift may occur in real-world situations, which significantly affects the model's generalization ability. The predictions of a model are considered to be invariant if they remain the same regardless of changes made to the input or the background. SSL resolves this problem through domain generalization and overcomes the domain shift issues by explicitly or implicitly extracting aspects that are domain-invariant. This can be utilized for self-supervised representation learning with multi-modal sources such as video-audio and video-text.





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## Social Entrepreneurship in Value Creation and Empathy through Social Media during COVID-19 Pandemic

Jackson Khumukcham<sup>1</sup>, Pravin Kumar<sup>1</sup>, Amit Kumar<sup>2</sup> and Anupreet Singh Tiwana<sup>3\*</sup>.

<sup>1</sup>Assistant Professor, Department of Social Entrepreneurship, Madras School of Social Work, Chennai, Tamil Nadu, India.

<sup>2</sup>Research Scholar, Tata Institute of Social Sciences, Mumbai, M.H, India

<sup>3</sup>Assistant Professor, Department of Geography, Mata Gujri College (Autonomous), Fatehgarh Sahib, Punjab, India; Research Affiliation: Tata Institute of Social Sciences, Mumbai, M.H, India

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### \*Address for Correspondence

#### Anupreet Singh Tiwana

Assistant Professor,

Department of Geography,

Mata Gujri College (Autonomous),

Fatehgarh Sahib, Punjab, India;

Research Affiliation: Tata Institute of Social Sciences,

Mumbai, M.H, India

E.Mail: writetotiwana@gmail.com



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### ABSTRACT

The dissolution and evolution of entrepreneurial ventures have been witnessed during the unprecedented socio-economic crisis of the COVID-19 pandemic. This research article investigates the adaptive capabilities of social entrepreneurship, particularly focusing on social enterprises that have effectively seen the crisis as an opportunity for innovation and growth. It explicitly emphasises online-based enterprises that deliver products during lockdown periods. Employing a case study methodology, this research unveils the context-sensitive and empathetic strategies employed by social entrepreneurs in delivering services to customers. It highlights their intrinsic role in addressing societal needs amidst such instability. This paper argues that in crisis situations like COVID-19, the resilience-embedded innovative business models of social enterprises, integrated with social media platforms, have the potential to address the needs and requirements of customers. Furthermore, the social value incorporated within social enterprises directs social entrepreneurs to deliver services imbued with empathy, even within containment zones. Importantly, this exploration validates that social entrepreneurs maintain their core values and empathy even amidst the pandemic. Despite geographical and contextual limitations, this study exemplifies social enterprises as beacons of resilience, innovation, and human-centric approaches, possessing crisis management strategies in the face of adversity and disasters.

**Keywords:** Social entrepreneurship, Social Enterprises, COVID-19, Social media platforms, Value creation.





## INTRODUCTION

The detection of the COVID-19 virus traced back to Wuhan, China, in December 2019, swiftly crossed geopolitical boundaries, with its first manifestation in Kerala, India, on January 27, 2020. The virus's rapid proliferation led to declared a pandemic and alerted to take precautions and curbing measures by international bodies, including the World Health Organisation, necessitating global action to stem the tide. Accordingly, India orchestrated nationwide lockdowns during the first and second waves, either entirely or in states. This unforeseen crisis affected the social, economic, and health fabric, thrusting society into a maelstrom of pressing challenges bereft of clear-cut solutions [1]. Consequently, the entire population of India encountered socio-economic disasters that affected livelihoods, and millions lost their jobs (mostly in unorganised sectors). On top of that, the unavailability of medicine to treat COVID-19 affected patients makes people panic. Such situations put people into a condition of stress and anxiety. The Government of India made a series of efforts to address such a situation. However, it became short across the country in health and socio-economic spheres. Even the NGOs were contributing using their limited resources, but it was too huge to handle such a challenging situation during the pandemic. Moreover, efforts to supply ration by local volunteers and elected representatives could not meet everyday requirements. On top of that, because of the reduction in supply and delivery channels, numerous small, medium, and large businesses encountered significant difficulties in ensuring their survival and meeting the market's demands. Depending on the pieces of evidence, World Economic Forum[2] reported that many start-ups had shuttered their doors and terminated their full-time employee contracts. Such a scenario ignited a zeal to understand the role of social entrepreneurship in developing a pragmatic approach to pandemic situations and how social entrepreneurs took advantage of these opportunities.

The reason behind the enthusiasm for this paper stems from the fact that, amidst such uncertainty, there are Reports indicating that the COVID-19 crisis has provided opportunities for entrepreneurial activities. . For instance: Weaver (2020) asserted that various socio-economic implications of the COVID-19 pandemic provide multiple opportunities for social innovation and entrepreneurship [3]. The crisis posed by the episode of COVID-19 put entrepreneurs in the zone of being proactive towards change [4]. Across the globe, social entrepreneurs demonstrated to be a distinct breed during this time (e.g. Bacq & Lumpkin, 2020). With the progress of time, literature is filled up, mainly citing the role of social entrepreneurship during the COVID-19 crisis period. Kamaludin et al. (2022)[5] highlighted a sustainable social entrepreneurship approach in addressing socio-economic and market needs during COVID-19. Basit & Ejaz (2023)[6] posited that social entrepreneurs are proven impactful leaders that can spark positive societal change by providing solutions and ensuring - social welfare, job creation, and economic improvement during COVID-19. Moreover, authors like Kamran et al. (2022)[7] validate that social entrepreneurs as catalysts contribute to social value creation and opportunity identification. However, there is a paucity of literature that describes the role of social entrepreneurship during the COVID-19 pandemic in regions where various ethnic communities reside, such as Manipur, India. It is not well documented how social entrepreneurs create social value and meet market demands in such contexts. Therefore, this study aims to investigate and explore these aspects of social entrepreneurship.

Nevertheless, the domain of social entrepreneurship is a big ocean. In this paper, we are mindful of contextualising the understanding of social entrepreneurship within the study domain, especially the uncertainty in society and the market. Therefore, for this study, we propagate *social entrepreneurship as a business endeavour carried out by social entrepreneurs to address the uncertain situation in society as well as in the market with its goal of creating social value and meeting society's needs*. Besides, this study is limited to channelling social entrepreneurship with social enterprises that adopted online delivery business models using digital/or social media platforms. Incongruent with this, authors like Ibáñez, Guerrero, Yáñez-Valdés and Barros-Celume (2022)[8] claimed that digital-based social entrepreneurship (incorporated digital technologies) emerged as a new phenomenon and provided impactful performance during the pandemic. Furthermore, this study explores how social entrepreneurs create value while delivering products and services through online social media platforms and satisfy people's needs (for those in contentment and non-contentment zones). So, this study is significant in contributing knowledge domain of COVID-19 and the role of social entrepreneurship.





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In this paper, scenarios are elucidated about the pandemic's societal repercussions and the emergence of social enterprises as a restorative conduit to intricately explore the multifaceted realm of social entrepreneurship, particularly emphasising its role amidst the lockdown induced by COVID-19. The endeavour then broadens to conceptualise the nexus between social entrepreneurship and social media. Subsequently, the narrative is woven around the value creation dimension within the social entrepreneurship framework. In the methodology section, the exegesis delves into the methodological visualisation of the research, providing a clear explanation of the data collection and analysis processes. The paper then culminates with an informed discussion and conclusion, encapsulating the insights and implications drawn from the analysis.

### COVID-19 and the Interface of Social Entrepreneurship

If we examine the first-hand information gathered during the pandemic, reports have been compiled regarding total and partial lockdowns associated with COVID-19 that caused numerous businesses to go down and prevented people from coming out of their homes. The consequences of COVID-19 manufactured a devastating economic and societal scenario that created uncertainties around the globe, which can be seen in stock market volatility, economic uncertainty, and subjective uncertainty in business expectations [9]. There has been a decrease in economic activities (especially business activities)[10], which has affected the supply chain and a decrease in consumer spending[11], causing gaps in supply and demand. Moreover, such an unprecedented COVID-19 crisis affects entrepreneurs as citizens as well as business owners (Liu *et al.*, 2017, as in Ratten, 2020)[12]. From various corners, shreds of evidence were piling up, informing: entrepreneurs are facing challenges in adapting to the new environment created by COVID-19 and responding to uncertainties[4]. Various dimensions and aspects where COVID-19 impacts entrepreneurship can be seen in (a) economic-based uncertainties; (b) financial domain - entrepreneurial finance acutely affected; (c) service industries - tourism and hospitality; (d) disruption of business - disrupt small businesses from losing jobs to the closure of the business. Observing such realities, authors like Liguori and Pittz (2020)[13] shout for new strategies for a business to survive and thrive during a pandemic. Many researchers engaging in ground reporting of the impact of COVID-19 on entrepreneurship have suggested various approaches (Fig. 1) that must be focused on to address the crisis and uncertainty brought by the COVID-19 breakout.

In this line, Ratten (2020) confirmed that entrepreneurship positively influenced the global business environment during COVID-19. In all probability, it is acknowledged that innovatively deploying solutions to address the global crisis by social entrepreneurs achieves positive social outcomes[1]. They transformed COVID-19 surrounding challenges into opportunities and brought new arrangements to society as well as in the market[8]. For instance: Digital Social Entrepreneurship. With its altruistic facet, social entrepreneurs and enterprises amalgamate innovative approaches for a social cause in public circles by providing solutions that address societal needs — enabling society to build a new 'normal' [19]. Oberoi *et al.* (2021) further reveal the leadership taken by the social entrepreneur during the COVID-19 crisis in various features such as holism – social entrepreneur views the crisis as a whole with all the sub-components and those facets affecting the issue; solution-focused – looking forward to solving the problem with maintaining social justice and consciences; optimism – social entrepreneur makes bold vision, bold decision and carries out entrepreneurial activities where other people are uncertain; resilience – the ability to recover and bounce back during the situation like COVID-19 crisis; empathy – social entrepreneurs have the skill to position oneself in the place of another person and understand needs; and creativity – dynamics in bringing new ideas, come up with new patterns and possibilities that others may not imagine.

Notwithstanding it, even though social entrepreneur faces challenges during the COVID-19 episode, there is no doubt that this pandemic has given many entrepreneurs opportunities (e.g. Adedeji & Olanipekun, 2022)[20]. Considering the prevalent COVID-19 period, there was a rise in social entrepreneurship activities in many places[21]. So, it can be said that social entrepreneurship and its feature for innovation and converting the problem into opportunities make a way to solve issues raised by the COVID-19 crisis. Concerning the business model, Kamaludin *et al.* (2022) mentioned a pivoting approach to change that business direction strategy by restructuring its resources and activities during COVID-19. They added pivoting as a sustainable approach for social enterprises. However, one







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should not think that everything is going well with social entrepreneurs. There is evidence of mental health challenges like stress and depression with them[22].

### **Social Entrepreneurship and Social Media**

Indicating the exogenous crisis of COVID-19, Ibáñez *et al.* (2022) revealed that social entrepreneurship through digital platforms impacts society and reaches out to people in all possible ways. So, digital social entrepreneurship has the potential to meet the needs and can generate social impacts globally by addressing the COVID-19 situation. Therefore, social media is an effective tool to cope with the COVID-19 pandemic - by advertising and publicising their goods and services[23]. One of the favouring factors for social media platforms during the COVID-19 period is to bridge the customer with products/and services; increasing in accessing to connect; and change the behaviour of the customer using social media where they can get information about the products/services and take the decision of buying and what to ignore[24]. However, entrepreneurs should know how to use social media platforms properly and utilise them correctly[25].

The internet allows businesses, especially small and mid-size in developing nations, to broaden their horizons and increase their markets[26]. As the internet is common to everyone, it makes people connect easily through social network platforms like Facebook and Whatsapp. On top of that, Web 2.0 provides users with a platform to express their satisfaction or dissatisfaction with products/services [27]. Popularly, social media refer to 'social networking' and 'Web 2.0,' where user can share content and network among/within the community[26]. It changes how people use the information and how entrepreneurs adopt it. This platform has enough potential to influence society and build social relationships. Through this platform, the process of getting information about customers is revolutionised by connecting with and engaging the target audience. Indeed, the outgrowth of social media platforms on the World Wide Web (WWW) revolutionises global social interconnections[26]. So, it is wise for social entrepreneurs to grasp this opportunity. It allows businesses to build brand name recognition, operational infrastructure, information and customer relationships – to develop (new) markets and distribution channels. From this parlance, social media can be a source for meeting entrepreneurial goals[28]. It allows all enterprises and small businesses to get space to grow by incorporating Web 2.0 technology. It has become a central attraction point for many social entrepreneurs and academic scholars, especially after the outbreak of COVID-19.

Social entrepreneurship has become a new phenomenon in the business environment for reaching out to a large population and helping build partnerships and increase contacts with customers - entrepreneurs use social media marketing on various internet platforms to acquire and retain existing ones[26]. Furthermore, for small businesses, adapting the internet allows them to connect with other people and get relief from the cost of marketing[29]. It allows enterprises to communicate with existing and potential customers and engage with them by building a sense of community[30]. Wang *et al.* (2020)[31] informed that social media enables entrepreneurs to gain knowledge about consumers and mobilise resources to advance their ventures and manage customer relationships. Consequently, it brings changes in the philosophy of marketing, mainly consumer-centric, where – customisation of products and interactive marketing become prevalent practices[27]. Besides, customer information gathered from social media is important in driving innovation and enables businesses to discover innovative ways to conduct business and develop new products/services[32]. Social media encourages social entrepreneurship to achieve its social mission through various options such as – effective communication, customer relationship management, innovation and marketing[25]. Apparently, under the purview of social enterprises, the adoption of social media is increasingly significant and productive[33]. Whether it is large or small social enterprises, in developing countries, social enterprises are increasingly using social media for building social capital, building relationships with customers and procuring raw materials[33], and as a tool to connect with their customers and build a relationship[34].

### **Social Entrepreneurship and Value Creation**

Social entrepreneurs leverage unique resource combinations to exploit opportunities and create a meaningful impact on the market. They focus on developing value-creation strategies that revolutionise traditional approaches and ensure that each outcome generates social value. In this context, Thorgren & Omoredede (2018)[35] propagate social





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entrepreneurship as a social value-creation process in which resources are combined in new ways to meet social needs. Value creation is popularised from the Schumpeterian approach involving significant innovation and technological advancement [36]. The word 'value' refers to the specific quality of service perceived by users concerning their needs. The purpose of value creation is transforming inputs into products and services, offering the right value to customers in an entrepreneurial set-up[37]. The value creation approach implements product design and configures it in a way that meets customers' needs. According to Ormiston and Seymour (2011), value can be seen in various forms, social value – related to personal relationships; natural value – value concerning the protection or repair of natural ecosystems; cultural value – refers to cultural capital; and creative value – concern on subjective social relations and systems. Under the umbrella of social entrepreneurship, entrepreneurs identify opportunities to develop social value and take action to bring (a new) stable equilibrium under an uncertain environment[38]. Besides, various scholars are found to visualised value creation under the purview of social entrepreneurship in various ways, i.e. social entrepreneurs combine elements like social value creation and social innovation[39], create social value by taking advantage of opportunities through employing innovation[40]; creating social value is linked with characteristics of innovativeness, proactiveness and risk-taking [41]; and social value creation through commercial activities and market-based activities [1]. Such literature instigates the recognition of value creation in social entrepreneurship. In this line, Ratten (2020) asserted that social entrepreneurship and value co-creation are suitable approaches to address problems caused by COVID-19.

Furthermore, social entrepreneurship provides innovative forms of value creation[42], where value creation can be seen from innovation and technological approaches[36]. According to Priem (2007)[43], value creation involves innovation that establishes or increases the consumer's valuation of the benefits of consumption. Priem added that when value is created, the consumer exhibits: (i) willingness to pay for a novel benefit; (ii) willingness to pay more for something perceived to be better; (iii) will choose to receive a previously available benefit at a lower unit cost. It allows customising the products or services to accommodate the requirements during a crisis[4]. Therefore, social innovation is central to (new) social value creation[44]. To create social value, social entrepreneurs create impacts that result in social capital through technology-based innovations[45]. Given the established perception surrounding social entrepreneurship and its connection to value creation and the COVID-19 pandemic, this study deems it pertinent to incorporate the perspectives above.

## METHODOLOGY

This section visualises the rationale for choosing a qualitative case study and the strategies employed to collect data and analysis. For this study, the qualitative case study approach has been convinced as it can potentially incorporate perspectives of the 'actors' in the case under consideration [46]. As this study is based on scarce literature, both primary (empirical data) and secondary sources (e.g. existing literature and news information) have been reckoned. Data was collected during April and May 2021, during the second lockdown in the Indian state of Manipur. The empirical data were collected through telephonic one-to-one conversations with social entrepreneurs with online food and grocery delivery enterprises in Imphal, Manipur. CEOs of five (5) social enterprises responded by showing consent to participate in the interview. All the enterprises have been chosen based on criteria set for this study: the enterprises actively performing entrepreneurial activities during the COVID-19 lockdown and those delivering or providing services to both containment zones as the non-affected communities. All the interviews lasted for around 60 mins to 120 mins. The conversation medium was the Manipuri language (the local language of Manipur). After seeking consent from CEOs, interviews were recorded on mobile during the conversation. The recorded Mp3 files were transcribed manually using Microsoft Word. Using Microsoft-excel, a thematic data analysis approach has been adopted for analysing the data, where themes and subthemes are developed according to the coded data set. The relevant themes that have emerged around this study's objective were considered. The names of the social entrepreneur and their enterprises are kept confidential due to ethical purposes.





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### Data and Findings

Social entrepreneurs in this study are found to have a prime focus on creating social value during the delivery of the product/services with the blend of empathy and through changing business strategies from time to time. They have their own delivery strategy and frequently change product lists and prices of products. All the social enterprises interviewed started their enterprises by investing their own capital and infrastructure. One among them started by doing a fish farm on his own cultivated land. As his cultivated land is wetland, he decided to invest in converting to a fishery firm. He invested his own capital money of around 2 Lakhs rupees, and he started his venture. Initially, he started supplying bulk fish to retailers by going to nearby towns and markets. Then, he broadened his enterprise to the capital city, Imphal. With the advent of the COVID-19 episode, he started delivering fish (an online mode business). With fish, he adds chicken and vegetables to his product list. He uses social media platforms such as – Facebook and WhatsApp for advertisement, marketing and taking orders from customers. Another enterprise started its functioning with the online delivery of electronic commodities and cosmetics products. However, due to being unable to enter the market in front of global giants like Amazon and Flipkart, the business model has shifted to an online food delivery business. This enterprise delivers meat as one of the major items. The third enterprise was running a vegetable shop in a colony nearby to the main highway of Imphal. During the outbreak of COVID-19, he converted his business to an online delivery model. The other two enterprises (fourth and fifth) opened ration and grocery shops in their locality. Their ration shop was filled with varieties of pulses and vegetables. When the COVID-19 lockdown came, they faced challenges selling products through human-to-human contact. They moved to online payment mode and circulated item lists of groceries on Facebook and WhatsApp. Likewise, they shifted their traditional business activities to online delivery mode. The commonality among all the entrepreneurs under study is that they deliver their products in containment zones as well as non-contentment zones. Rather than comparing these social enterprises, the focus has been on constructing a meaningful analysis that aligns with the objective of this paper. The following sections will provide contextualised evidence of the themes that emerge from the raw data. The arrangement of themes has been made based on the objectives set for this paper.

### Continuous efforts to access the market and meet the needs

With the advent of the COVID-19 crisis, the Manipur state government imposed lockdown zone-wise and district-wise with strict SOP (Standard operating procedure) guidelines. Such lockdowns slowly disrupt economic activities as well as daily living. On the one hand, people were restricted in their homes; on the other hand, their demands for eating items and daily consumption were increasing. However, the majority compromised on buying only the required commodities. During such market conditions, entrepreneurs (respondents of this study) make continuous efforts to meet the market requirement during the pandemic and retain in the market. It can be traced from the narrative shared by one of the entrepreneurs:

*The business we are doing during corona time is challenging. It is totally different from normal days. The government keeps changing the SOP, and we must keep changing our way of doing business according to the SOP. For us, to reach out to brothers and sisters is the primary concern.*

There are days when police interrupt during delivery of the products. It is not that entrepreneurs are complaining about police for doing their job, but due to frequent changes in SOPs and the declarations of the containment Zone, problems arose during delivery. Besides understanding the market and the scope of capturing local customer segments, entrepreneurs are found to identify gaps and work on the opportunities that come out of the gaps. This is substantiated by the narratives of one of the entrepreneurs:

*We cannot compete with Amazon and Flipkart. However, I realised that there are some products they will not conquer in the local market. For Manipuris, we do not prefer old meat that is kept in the freezer. Here, people want very fresh meat that is just cut from the fresh one. That makes the taste to them. So, the market I am looking for delivery in this time is in this area.*



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Another entrepreneur also shared the opportunity that was exploited during the COVID-19 lockdown. He found the scope of doing business on local vegetable items during the lockdown. According to him:

*Due to the lockdown, the vegetable that comes in a load of trucks in Manipur from Assam is not coming. Those trucks bring peas that are not available in large quantities in Manipur. There are also products such as large amounts of cauliflower, cabbage, big-size brinjal, tomato and beans, etc., brought by trucks. Such products are available in minimal quantity during lockdown time. Therefore, locally available vegetables are sold more during this time. I took vegetables from farmers at wholesale rates and delivered them to Imphal. Now, delivering online mode through taking orders.*

From their narratives, one thing is very clear that entrepreneurs are making continuous innovative strategies to reach the customer and meet their requirements. All the entrepreneurs are retaining their market by entering the areas where they identified gaps in the existing market. Rather than looking at competition with other businesses, they are looking more at retaining their market and how they meet the requirement of the existing gap.

**Empathy, pricing and concern**

Imposing lockdown across the state cut out market linkages that resulted in hikes in prices of most basic commodities – it includes vegetables, ration, meat and fruits. Nevertheless, despite the price rise, entrepreneurs are concerned about lowering the profit margin of the items they deliver so that COVID-19-affected people in the contentment zone can afford to pay. One of the entrepreneurs said:

*For me, my sole purpose is to sell products at the lowest rate so that everyone can afford to pay in such an uncertain situation. For instance: during the lockdown of the first wave, for 1 kg. of tunghanbi (Tilapia fish), the rate was 270 rupees. I have decided to lower the rate by announcing 220 rupees per kg. Listening to the news of the offer, many people started to order.*

However, it is not that entrepreneurs would keep the price lower throughout the year. According to one of the entrepreneurs, they only give the price concession during the COVID-19 lockdown period. They will again normalise the price and come at a similar level with others on normal days. Nevertheless, during the COVID-19 lockdown period, they even provided special concessions for delivering the products to those identified as frontline workers. One of the narratives stated that:

*There is a special offer for frontline worriers, like media people, nurses, doctors and police. And I never take delivery charges from them. In such critical situations, what they are doing is very important to us. So, we should recognise them.*

For general people, they took delivery charges on fish, vegetables and chicken. They gave differences in delivery charges also. One of them provides free delivery charges to those areas where the delivery was the nearby location to the enterprise. Furthermore, they keep charges for areas located away from the enterprise.

**Social media, meeting customer's needs and maintaining SOPs**

On average, they (social enterprises) get 40-50 orders during lockdown days, which they could deliver only 25-30 a day. Most of the orders come through a Facebook post. Apart from Facebook, they circulate information on product lists with a price daily through WhatsApp. WhatsApp circulation was done using personal contacts; some reached out through suggestions/referrals from friends. These orders are coming from known people like – friends and relatives. Many of their friends and relatives also shared the information with others - to their known friends. There are also customers who, once they get better delivery service, that person become the regular customer. As many orders come from COVID-19 patient families who were staying in the contentment zone, often by understanding the value of the order placed by the people, entrepreneurs go for delivery by maintaining SOPs guidelines provided by the State Government. Their viewpoint emphasised the importance of prioritising the safety of both customers and themselves. They recognised the significance of strictly following hygiene protocols, including using masks and sanitisers, and maintaining social distancing, as a top priority. Besides, they also trained the delivery boys to follow



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the SOPs and other required procedures like – maintaining social distancing while exchanging money and products. In this context, one of the entrepreneurs said:

*As the lockdown situation worsened, people could not come out of their houses. I shifted my traditional product-selling model to online mode at this time due to the corona situation. Those people who do not want to come out of their homes placed the order. I started to deliver for them. They are also human beings like me; they have to eat for survival. Due to corona, they cannot come out of their home and cannot eat what they want. So, I must understand that. By keeping the required protocol, either my delivery boy or I deliver the products ordered from contaminant zones.*

Along the same line, the narratives of other entrepreneurs give a picture of their concern towards the customer.

*In the second wave of the corona, I started to put more varieties of fish in my fish firm and sell out. However, due to the lockdown, I put up pictures of common carp (fish) on my Facebook post with my enterprise name and contact details. Also, I put dry fish by making it available for online delivery. Then people started to like the products. With that, by understanding people's needs, I began to explore the option of vegetables. It was during May 2021 when I was going for delivery using my bike. During that time, the order came to deliver fish from those houses who are in quarantine. On the way, through Whatsapp calling, there was a request made by known friends (customer) "If you are coming to deliver fish, as we are in quarantine, we are not able to come out, so, if possible, bring some vegetables if you get some on the way. It was a long time ago, and we did not have green vegetables. So, please bring for us." Hearing that, I took some vegetables from the way. From that day, I started to sell vegetables, also. I started to procure vegetables from nearby villages.*

It is astonishing to find that in their entrepreneurial activities; entrepreneurs blend with empathy, understanding the customer's condition and anticipation rather than thinking about earning a profit. On top of that, entrepreneur educates and makes understand their assistant-cum-delivery boys to empathise with people. Furthermore, to meet the SOP requirement and ensure the customers' safety, they are trained with proper guidelines, which the government provides occasionally. In this regard, one of the entrepreneurs said:

*Now, I am employing a delivery boy. He is the driver of my vehicle also. He helps in procuring vegetables from villages. Moreover, I am hiring two of my family members to package the products. Whenever the order is received on WhatsApp or Facebook, they go for delivery. They take sanitiser with them and put on a mask. For payment, we choose the Google payment method. However, there are cases of returning balance money in cash; in those cases, we maintain the gap and apply sanitiser to the money before we give and after we receive it. Look, death is inevitable, and those who are in the containment zones might die, and if they do not eat, they will die. So, if we can do something for them, it is the hour's need. We do not think that it is a horrifying one. Otherwise, we are maintaining all the formalities of SOP.*

Despite the risks posed by the COVID-19 pandemic, entrepreneurship has demonstrated its ability to thrive even in precarious circumstances, showing a willingness to take risks in challenging situations. Having said that, entrepreneurs have the confidence to continue their venture on regular days with more added to the menu on their delivery list. They have a plan to broaden their area of coverage for the delivery. However, it is found that their motive for delivery is not merely for the sake of earning profit. They claim to be frontline workers. According to them, they are a kind of frontline workers helping COVID-19 infected patients and their families during such crises by providing products of day-to-day requirements such as green vegetables. On top of that, activities like procuring green vegetables by going to the rural/hilly areas and delivering the products are heroic. However, as SOP did not mention giving relief to the online delivery services, they faced harassment from the police. They found that police are less sensitive in dealing with such situations. They even face problems in convincing local people to go to delivery.



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## DISCUSSIONS

This study illustrates how social entrepreneurs integrate empathy into their approach to effectively address uncertain circumstances and fulfil customer requirements during the lockdown period imposed by the COVID-19 lockdown period. This paper asserts that in crises like COVID-19, social entrepreneurship can take an avatar to address uncertain situations and touch the hearts of thousands of people – creating value and incorporating innovation (flexibility in doing business). It can be highlighted that during the COVID-19 episode, such an empathy-embedded innovative business model can better address the need and requirements of customers sensitively. Undoubtedly, social entrepreneurship can develop a new approach to a social problem[47] and work towards achieving a more balanced world. Social entrepreneurship incorporates multidimensional concepts depending on the context research taken[48]; rather than generalising any business model, the such study should be done region-wise and context-specific. This study does not fully stand with Jagongo and Kinyua's (2013) proposition about information-rich websites to develop relationships with customers and effective marketing as one should not overwhelm luxury and high-profile websites and social media marketing. There are various approaches to using social media platforms. This study showed a different perspective on using social media. Entrepreneurs in this study have a soft approach to social media. Without investing money in making websites, this study revealed that there are possibilities to collaborate traditional marketing approach with a soft blend of social media platforms using an available platform like WhatsApp and Facebook. Considering the motive of doing an online delivery business model by entrepreneurs, this study does not look congruent with Goel (2008)[49] because not every social media-oriented business model reaches the international market. Furthermore, this study is congruent with Wang et al. (2020) that using social media influences entrepreneurial entry. Considering the overall motive of entrepreneurs, it is consistent with Al-Taai (2021)[50] that empathy and moral obligation are prevalent in shaping entrepreneurial intentions, especially during the COVID-19 period.

Nonetheless, this paper is congruent with Oprica's (2013)[51] views that social entrepreneurs' wise use of social media platforms benefits social networking. Apart from this paper's focus area, this study indirectly indicates resilience involved in business models (e.g. Oberoi et al., 2021). Entrepreneurial intervention during the pandemic period supports the understanding of authors like Ferri and Urbano (2011)[52]. However, this empirical evidence ignites a query: Does all social entrepreneurship set up positively impacted during the COVID-19 period? In this context, we agree with Weaver (2020) that short and long-term resilience and crisis management strategies should be implemented. There is a requirement from policymakers to support those social entrepreneurs who are working at the grassroots level. The scope must be given to such social entrepreneurs by creating ecosystems incorporating innovation and technology. However, this study contradicts the core philosophy that Giones et al. (2020)[53] suggest - activities that do not fund revenues should be limited or discontinued due to the uncertainty of this pandemic. Even we found, Kuckertz et al. (2020) prediction that 'regions that have high levels of entrepreneurship pre-crisis would overcome this shock' is very generic.

## CONCLUSION

This study emphasises that social entrepreneurship should prioritise value creation and innovation while possessing the potential for adaptability and contextualisation, serving as valuable lessons for practitioners in the field. The research findings highlight the importance of empathy as an essential quality for social entrepreneurs, particularly in challenging conditions such as the COVID-19 pandemic. On top of that, this study proves that social entrepreneurs, in the worst-case scenario, will not compromise their values and ethics. One can find that the simple strategy with low investment can employ a generally available social media platform strategy for value creation and delivering services online. Social entrepreneurs can make valuable contributions and adjust their strategies during this crisis by continually exploring alternative suppliers, optimising delivery routes, and adapting to ever-changing circumstances. In other words, this study displays the adaptation of an innovative social entrepreneurship business





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model during COVID-19. The implications of this study hold the potential to contribute to academic literature, particularly in the areas of social entrepreneurship, social media, and the COVID-19 pandemic. It offers an opportunity to validate existing theories or provide further evidence within the current domain, thus expanding our understanding of these fields. To further advance this field of study, there is an opportunity for academics to conduct further research by expanding the sample size. A comprehensive understanding can be developed by broadening the scope of research to encompass digital ethnography. That may be of significance to add value to this proposed research field by extending the analysis to a broader sample.

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**Fig. 1. Suggested Measures for addressing the crisis and uncertainties created by COVID-19 in the domain of entrepreneurship.**

Domains	Aspects and indicators
Responding to the crisis	<ul style="list-style-type: none"> <li>● social response that incorporates value co-creation</li> <li>● entrepreneurial action to help alleviate the pandemic situation</li> <li>● resilience to obtain new entrepreneurial opportunities</li> </ul>
Innovation orientation	<ul style="list-style-type: none"> <li>● new approaches are needed for a business to survive and thrive</li> <li>● innovative thinking to meet sudden social change</li> </ul>
Policy lever concern	<ul style="list-style-type: none"> <li>● policy level concern and decision-making on emphasising social entrepreneurship (as a problem-solving approach)</li> <li>● policymakers need to enable inter-organisational networks to boost cooperation about COVID-19-related entrepreneurship projects</li> <li>● strategic policy interventions to support the firms most affected by crisis events</li> </ul>
Support system and encouraging social entrepreneurship	<ul style="list-style-type: none"> <li>● emphasis on securing an investment from investors</li> <li>● fostering and encouraging social entrepreneurship</li> </ul>

Source: McMullen & Shepherd (2006)[14]; Kuckertz et al. (2020)[15]; Kawamorita et al. (2020)[16]; Ratten (2020)[4]; Liguori & Pittz (2020)[13]; Brown et al. (2020)[17]; World Health Organisation (2020)[18].





## Prevalence of Stress and Its Effect on Quality of Life in Working Female - a Survey Study

Manali N. Pawar<sup>1</sup> and Advita Neville Deepak<sup>2\*</sup>

<sup>1</sup>MPT Scholar, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

<sup>2</sup>Ph.D Scholar and Associate Professor, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

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### \*Address for Correspondence

#### Advita Neville Deepak

Ph.D Scholar and Associate Professor,  
Parul Institute of Physiotherapy,  
Parul University, Vadodara, Gujarat, India.  
E. Mail: [advita.deepak@paruluniversity.ac.in](mailto:advita.deepak@paruluniversity.ac.in)



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### ABSTRACT

Stress is a major issue in today's world, affecting people's physical and mental health. "A situation in which the organism's homeostasis is threatened or the organism perceives a situation as threatening is termed as stress". Women are more likely than males to report an increase in their stress levels. Females are often more likely than men to experience stress-related physical and mental symptoms. Working women in India are experiencing increasing levels of stress. The aim of the study is to determine effect of stress on quality of life in working females. Total 132 females from Vadodara city were selected according to inclusion and exclusion criteria. Each participants were given informed consent form and were screened for stress and quality of life using perceived stress scale -10 and SF-36 respectively. Data was analyzed using SPSS software 20.0 and Microsoft excel. There was significant stress was observed in the females. Majority females were having medium stress i.e.77%, and significant correlation was found was found among stress and quality of life showing mental health maximally affected i.e. 66.99%. It is concluded that majority of middle age women i.e. 27-35 age is 45.45% participated in the study, and 77% were affected with medium perceived stress and their quality of life were affected with relation with perceived stress. Hence, the study concluded that Perceived stress significantly affect quality of life in working female.

**Keywords:** Perceived stress scale, SF-36, working females.





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## INTRODUCTION

The term "stress" is neutral. It is not inherently harmful. But stress turns into distress when unfavorable outcomes cause it. Because distress is typically linked to heart illness, alcoholism, drug abuse, marital issues, absenteeism, etc., it is the distress form of stress that needs analysis and coping mechanisms [1]. According to the World Health Organization, stress is a major issue in today's world, affecting people's physical and mental health. "A situation in which the organism's homeostasis is threatened or the organism perceives a situation as threatening is termed as stress" [2]. Psychological stress has a negative impact on a variety of physical and mental health outcomes [3]. Stress has a very individualized character. Some people can handle stress well and thrive in the presence of several environmental stresses [1]. stress induce tension, making it difficult to adapt to a certain condition, thereby causing psychological burden. Furthermore, because stress also leads to interpersonal conflict, the vicious cycle of suffering is repeated. Therefore, prolonged exposure to excessive stress may affect quality of life by exposure to anxiety and other stressful diseases [4].

Women are more likely than males to report an increase in their stress levels. Females are often more likely than men to experience stress-related physical and mental symptoms [5]. With the advancement of industrialization and urbanization, the status of women has evolved, resulting in higher levels of stress; stress was found to be prevalent in 37 percent of working women in India, while anxiety was found to be prevalent in 40 percent. [5]. Today's workforce has been compressed in a stressful working environment that primarily includes facing deadlines, targets, crammed meetings, unrealistic workloads and other possible stress- causing events. This workplace stress directly affects employees' physical and mental health as well as workplace productivity [2]. Working women in India are experiencing increasing levels of stress [6].

Due to the sheer overburden of job at home or at work, stress among working women becomes a severe problem. Family troubles, work-life balance at home and at the office, and family issues are all significant sources of stress for women in the workplace. Dealing with both family and job difficulties has led in an increase in stress levels among women [7]. Work-family conflict has been found to be more common in women, although the gender difference in European countries is currently small. Women still perform most of the domestic work in families. Both having children and providing informal care to elderly relatives may increase the experience of work-family conflict. One negative consequence of work-family conflict suggested by previous research is that women may reduce their contribution in work domain and that in turn may hinder career advancement [9,8]. According to research, the prevalence of occupational stress is negatively associated to health-related quality of life (QoL), which is influenced by the work-related environment, and ranges from 8.5 percent to 26.4 percent[10]. Hence, the purpose of the study is to find the prevalence of the stress and its effect on quality of life in working females.

## METHODOLOGY

A cross sectional study was done on age group between 18-45 years old working females of Vadodara city. Selection of subject was based on inclusion and exclusion criteria. Inclusion criteria were working females of age between 18 to 45 and those who were willing to participate in the study. Subject having any musculoskeletal, neurological and cardiopulmonary deficit, physically & mentally challenged, pregnant women, subjects having severe visual disability and visual field defects, subject having significant perceptual, cognitive, or communication impairments were excluded from the study. A total of 132 females were randomly included in the study. All subjects were provided with the consent form including demographic data before conducting study. Stress was calculated via perceived stress scale -10 questionnaire and quality of life was calculated via SF-36. Participants were explained prior about the study method, significance and questionnaire filled.





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## RESULT AND DISCUSSION

In the current study 132 participants were included according to inclusion criteria. Data was analyzed using SPSS software 20.0 and Microsoft excel. Mean age of participants is 30.53. the age group of between 18-26 were 33.33%, 27-35 were 45.45% and 36-45 were 21.21%. Data regarding PSS-10 was taken, out of which maximum participants were under 0-13 (medium perceived stress) i.e. 77%, 12.12% under 14-26 (high perceived stress) and 10.60% under 27-40 (low perceived stress). Mean and SD of PSS-10 is 19.80 and 5.400 respectively.

Data regarding SF-36 suggest, mean of various domains of SF-36 i.e. physical functioning (PF) is 62.71, role limitations as a result of physical health (RP) is 48.09, bodily pain (BP) is 53.91, general health perceptions (GH) is 54.23, vitality (VT) is 52.21, social functioning (SF) is 59.66, role limitations as a result of emotional problems (RE) is 42.49, and mental health (MH) is 66.99. Which shows affection of quality of life in working females. Maximum affection was found in physical health and role limitations as a result of emotional problems. In the current study, lower- and middle-aged women were found to be more affected with perceived stress compared to older working females. Quality of life of one with lower and middle age were more affected. Kersh. K *et al* suggested that, role proficiency, workload, work environment, and responsibility are important correlates of occupational stress. Thus, the findings of the study suggest that reinforcing occupational skills training, improving the work-related environment, reducing workload and developing a positive attitude toward the job may be effective ways to improve overall QoL [11].

## CONCLUSION

It is concluded that majority of middle age women i.e. 27-35 age is 45.45% participated in the study, and 77% were affected with medium perceived stress and their quality of life were affected with relation with perceived stress. Hence, the study concluded that Perceived stress significantly affect quality of life in working female.

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		Age	pss	PF	RL	BP	SF	GMH	RLE	VEF	GHP	HCLY
N	Valid	132	132	131	131	131	131	131	131	131	131	34
	Missing	0	0	1	1	1	1	1	1	1	1	98
Mean		30.5379	19.8030	62.7191	48.0916	53.9122	59.6649	66.9924	42.4908	52.2137	54.2366	66.9118
Std. Error of Mean		.55617	.47007	1.30579	2.62137	1.67516	1.44035	1.11897	3.00168	1.68510	1.21097	4.56687
Median		29.5000	20.0000	61.1100	50.0000	47.5000	62.5000	68.0000	33.3300	55.0000	55.0000	50.0000
Mode		25.00 <sup>a</sup>	15.00	61.11	75.00	45.00	75.00	72.00	.00 <sup>a</sup>	60.00	70.00	50.00
Std. Deviation		6.38988	5.40065	14.94546	30.00294	19.17305	16.48557	12.80715	34.35584	19.28691	13.86020	26.62918
Range		31.00	23.00	61.11	100.00	77.50	50.00	64.00	100.00	85.00	65.00	75.00
Minimum		19.00	7.00	33.33	0.00	22.50	37.50	28.00	0.00	5.00	15.00	25.00
Maximum		50.00	30.00	94.44	100.00	100.00	87.50	92.00	100.00	90.00	80.00	100.00
Percent iles	25	26.0000	15.2500	50.0000	25.0000	45.0000	37.8000	64.0000	0.0000	45.0000	40.0000	50.0000
	50	29.5000	20.0000	61.1100	50.0000	47.5000	62.5000	68.0000	33.3300	55.0000	55.0000	50.0000
	75	35.0000	24.0000	72.2200	75.0000	67.5000	75.0000	72.0000	66.6600	65.0000	70.0000	100.0000

a. Multiple modes exist. The smallest value is shown

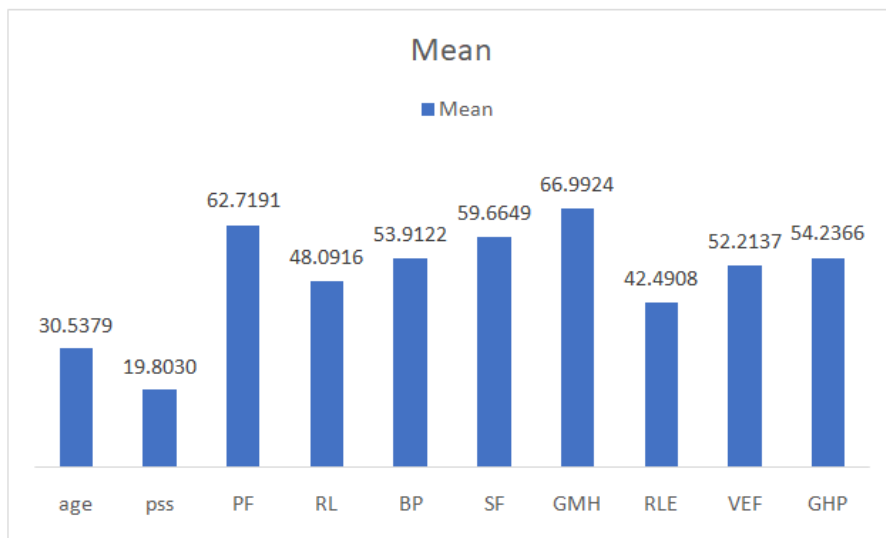


Fig. 1. Mean





## An Integrated Review on Construction and Demolition Waste Management in India: Most Recent Developments and Way Forward

Ritu Gulati<sup>1</sup>, Farheen Bano<sup>2</sup> and Samreen Bano<sup>3</sup>\*

<sup>1</sup>Associate Professor, Faculty of Architecture & Planning, AKTU, Lucknow, India,

<sup>2</sup>Assistant Professor, Faculty of Architecture & Planning, AKTU, Lucknow, India,

<sup>3</sup>Research Assistant, Faculty of Architecture & Planning, AKTU, Lucknow, India,

Received: 15 Feb 2023

Revised: 20 Apr 2023

Accepted: 23 May 2023

### \*Address for Correspondence

#### Samreen Bano

Research Assistant,

Faculty of Architecture & Planning,

AKTU, Lucknow, India,

E.Mail: samreenbano1az786@gmail.com



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### ABSTRACT

Expansion of housing stocks under PMAY Yojna, the booming Indian construction industry, exigency for alternatives of natural resources and undesirable landfills have spurred the construction and demolition (C& D) waste management and recycling activities across India in quest of alternative construction materials that are sustainable & affordable. Literature claims for C& D waste quantity estimation, characterisation, handling, generation sources, on-site & remote recycling and segregation to be vital for C& D waste management across the country. Studies indicate an absence of a clear C& D waste estimate or standard assessment sources owing to improper management. This study represents the review on most recent C& D waste management scenario in India along with a discussion upon shortcomings and opportunities to develop a robust system for estimation, handling and material recovery. This study also aims to examine the most recent practices and data pertaining to C&D waste management and recent attempts from the side of various stakeholders involved to assist the policies and schemes. The study reveals that the estimate done by Technology, information, forecasting and assessment council (TIFAC) long time ago in 2001 is being referred to date by many official agencies. The study also reveals that Concrete and masonry wastes being the significant constituent of C& D waste could be utilised widespread. Segregation of C& D waste at generation stage, which is not being practiced sincerely in the nation could effectively contribute to C&D waste management and recycling. Replacing disposal with recycling could eradicate environmental concerns and support circular economy. Lack of reward-penalty policy and awareness had been the reason for low interest amongst stakeholders toward waste minimisation and recycling. A robust framework at regional level for a planned C&D waste management, recycling facilities at city level and researches in that direction are a





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way forward. The paper concludes with the discussion on opportunities for C&D waste management and recycling.

**Keywords:** C&D waste recovery, Undesired landfills, Sustainable construction practices, Green-building materials.

## INTRODUCTION

The celerity with which green building movement in India is rising has led the thinkers and industrialists to come up with the alternative solutions for building construction materials to support the circular economy and address environmental issues. There is a huge concern amongst policy makers and urban local bodies about the growing issue of improper handling of Construction and Demolition (C&D) waste and their recycling options. Most of the lower quantum of C&D waste in India find its way into nearest municipal bins, which is posing a challenge for the other decomposable solid wastes by making it heavy unnecessarily or it eventually become the part of street and choke drains. Absence of a robust management system for C&D waste has posed serious environmental concerns. The estimates for quantum of C&D waste being generated nationwide is also not clearly known to counter address the issues aforementioned. There is a clear absence of any recent official estimate for C&D waste quantum as most of the agencies are referring figures estimated long ago in 2001(). Similar pattern has been observed at urban local level where record keeping are not being performed in explicit manner. Studies to meet the challenges and opportunities in view of the prevailing C&D waste management is thus imperative. In comparison to the developed countries, lack of penal action against improper C&D waste disposal & segregation at the generation point are the areas where India is lacking in terms of C&D waste management. Absence of a planned scheme within the construction industry for early management of construction waste has become a reason for higher quantum of waste generation.

Need for research Government has stimulated the management and recycling process of C&D waste lately by introducing guidelines, policies and recycling facility proposals yet they are lacking support in terms of researches, database, and frameworks. On the other hand, Contractors and Industry professionals have also reported lacking knowledge about C&D waste minimisation and recycling options in form of handbooks/manuals for direct implementations. Diverse nature of the construction industry and involvement of multiple stakeholders including informal sector presently require capacity building and knowledge dissemination in the aforementioned area. This paper aims a comprehensive analysis of the current practices of C&D waste management in India along with quantity estimations and recycling related challenges.

### C&D Waste Generation and Quantity Estimation

An approximate reliable figure for annual waste generation quantity is always necessary in order to develop: waste management plan, predict recycling potentials, develop adequate infrastructure for landfill and planning. However, figures estimated by various formal agencies for quantum of C&D waste generated in India annually varies greatly (refer table1) (Central Pollution Control Board (CPCB), 2017; Centre for Science & Environment (CSE), n.d.; Technology, Information, Forecasting and Assessment Council (TIFAC), 2001; Ministry of environment and forest (MoEF), 2010; Building Material and Technology Promotion Council (BMTPC), 2013), due to the absence any formal agency involvement of at generation flow stages. In addition, the huge variation in the projections are due to the assumptions and limitations belonging to the individual method chosen, scale of application and availability of related data.

Site visit method, waste generation rate method, lifetime analysis method, classification system accumulation method and variables modelling method are few of the methods which are implemented frequently in past for C&D waste estimations (Wu et al., 2014). Government institutions carry out estimation of C&D waste following



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approaches that involve assembling data from local authorities. However, the quantity estimates at the generators, urban local bodies and city level are not being documented explicitly due to the involvement of informal agencies prior to the waste reaching out the formal authorities and unavailability of a formal waste management plan for quantity handling. The exact amount of annual waste generation and projections thus remains questionable at both regional and national level. Oddly, there are no official sources for standard assessment of waste quantum in India like most of the developing countries in order to support the application of solid waste management schemes and rules formulated in 2016. From the intensive review, it could be pointed out that all the acclaimed agencies like BMTPC, CPCB, GIZ and CSE are still referencing the estimates developed by TIFAC long ago in 2001 for the C&D waste quantum, which predicts the quantum to be in order of 12-15 million tonnes annually (TIFAC, 2001). In point of fact, the performance audit of 'Management of Waste in India' by Comptroller and Auditor General (CAG) in 2008 revealed that "No estimates or even guesstimates exist for construction and demolition waste" in the country (CSE, 2013). However, a recent study in 2019 has estimated the waste quantity for the country to be in order of 150 million tonnes using 'Model Flow Analysis' and 'Generation Method' (Jain et al., 2019), which could not be standardised for the country as it has calculated the quantum based on the assumptions such as housing units in India get demolished following their age as per government norms and that the C&D waste generation rate (Kg/sq.mt) is precisely known and static.

All the literature and agencies albeit are unanimous with the inference that C&D waste makes around 30% of the total solid waste generated in India (BMTPC, 2018). This indicates a high construction and demolition rate in the country, especially the demolition waste, as the contribution of demolition waste in C&D waste is almost 10 times of the Construction waste (Jain et al., 2021; CSE, n.d.). Furthermore, estimates indicate that new construction produces 11% waste in residential and 6% in non-residential works while renovation produces 55% and 36% respectively (BMTPC, 2018). Demolition produces maximum waste as 34% in residential and 58% in non-residential (BMTPC, 2018). As a thumb rule, 40-60 kg per sq.m. is the C & D waste in new construction so also in repair and renovation while in demolition it is 300-500 kg per sq.m. (BMTPC, 2018). The Quantity per unit area (Kg/sq.mt) figures however could not be generalised for individual C&D activity or on a regional scale as the quantum and composition of C & D waste varies with project typology, location and C&D techniques. The quantity estimates at country scale is vital for the allotment of funds and resources for efficient waste handling. However, the fact that management and recycling of C&D waste is required to be done at city level first cannot be ignored as the government in their recent guidelines (Solid Waste Management Rules, 2016) has proposed the initiation of waste management by setting up recycling facilities at local level. Past studies indicate that there are fewer attempts for quantity estimates at urban local level as compared to that on the country scale, this deaccelerate the waste management activities initiated by most recent schemes and waste management plans launched by the government at local level recently. Latest report indicates that substantial amount of C&D Waste is being utilized by informal sector, resulting in ambiguity in the waste quantity estimation at local and central level (CSE, 2020). As a way forward, it is worth mentioning that a robust system at city level for comprehensive assessment and quantification of C&D waste generation at urban local bodies is imperative to eradicate the uncertainty in the quantum of C&D waste generation. Formation of easily accessible databases of buildings and their physical & legal attributes is one of the strategies to achieve it (CSE, 2020). The waste management plans envisioned by ULBs to be mandated must also include directions for the contractors on site for appropriate handling of C&D waste quantity generated. This should also be followed by the capacity building and educating as the organisation has involvement of several informal sector and varied stakeholders.

A comparison of C&D waste generation among Indian cities showed Mumbai to be the highest waste generator followed by Bhopal owing to the lack of a robust management system and high population growth resulting in huge C&D activities within the city (refer chart 1). A comparison on a global scale indicates a low Per capita generation of C&D waste in India as compared to Japan. In addition, the contribution of India in overall C&D waste generation is lower in comparison to Asian giants in the area like Japan and China (refer fig1). This estimation deviates with the World Bank report, which says that the Asian countries produce around 1000kg of waste per capita per year, it means the figure stated by the MoEF is very less than the reported figure by World Bank (Gayakwad & Sasane, 2015). This suggests that India is underestimating the construction and demolition waste handling.





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Construction and Demolition Waste are the building materials, debris and rubble that are produced in the process of construction, remodelling, repair, or demolition of any civil structure. Wastes such as e-wastes, infectious wastes or hazardous wastes are not included within C&D wastes. Natural Calamities like Earthquake also contribute to large quantities of C&D waste Generations. One of the first recycling facility in India at Burari, New Delhi has reported the major constituents of waste produced from a typical C&D activity in India as concrete, mortar, soil, bricks, wood, asphalt, Sand, Plastic and metal. Where, brick, masonry, soil, sand and gravel account for over 60% of total waste (CPCB, 2017; Job & Wilson, 2013). One Such report claims for the Concrete and Masonry making up to 90% of the total C&D waste in India (Bhattacharya. S.K., 2013). Other estimations from various Indian agencies are listed in Table 2 & Chart 2. It could be evidently concluded from the reports that concrete and masonry will always account to at least 60% of the overall sum of C&D waste collection anywhere in India.

Minor components of C&D wastes could include Conduits (iron, plastic); pipes (GI, iron, plastic); electrical fixtures (copper or aluminium wiring, wooden baton, Bakelite or plastic switches, wire insulation); panels (wooden, laminated); glazed tiles; glass panes. (Swachh Bharat mission municipal solid waste management manual, 2016). The composition of waste of the individual C&D activity however depends on the type of the civil structure. If the structure is a flyover or a bridge, the composition will be majorly concrete and steel and if the structure is a residential building then the composition will vary and will have concrete, steel, wood, tiles, bricks, and plastic as major constituents. Furthermore, the percentage and composition of waste components also varies with individual construction and the demolition activity and location.

**Generation source of C&D Waste Components**

During construction activity excessive cement mix or concrete left after work is attributable to the rejection, demolition caused by change in design or wrong workmanship. Concrete appears in two forms in the waste i.e. reinforced concrete (Structural elements of building) and foundations (non-reinforced concrete). Excavation produces topsoil, clay, sand, and gravel. This may be either re-used as filler at the same site after completion of excavation work or moved. Large quantum of bricks and masonry mixed with cement, mortar or lime arise as waste during demolition. Stone arises during excavations or by demolition of old buildings. Metal waste is generated during demolition in the form of pipes, conduits, and light sheet material used in ventilation system, wires, sanitary fittings and as reinforcement in the concrete. Metals are recovered and recycled by re-melting. Timber if in good condition from beams, window frames, doors, partitions and other fittings is reused. However, wood used in construction is often treated with chemicals to prevent termite infestation and warrants special care during disposal. Other problems associated to wood waste are inclusion of jointing, nails, screws and fixings. Miscellaneous materials that arise as waste include glass, plastic, paper, etc. (Ponnada. P, 2015)

**Existing Models and Management Scenario of C&D Waste in India and Way Forward**

Management of the solid wastes which are sent to the landfill sites from various construction activities is the responsibility of municipal bodies or health officers. Hard core material from demolition operation is required for landfill activities to provide daily cover over domestic waste, bulk fill capping, hard standings etc. Some municipal corporations require demolition waste for their landfill activities, while others want to minimise it to prolong useful life of landfill sites. However, all respondents are unanimous that in the long run, recycling of waste from construction industry is necessary in view of limited landfill space and increasing quantum of demolition waste. In India, Different constituents of waste are not segregated prior to disposal. For the segregation of these wastes, municipal authorities incur cost of Rs.60 to Rs.80 per Ton of waste. Presently they are not levying any charges for this waste segregation. Builders/ Owners bear the cost of transportation, which is at present between Rs.250-500 per truckload depending on the distance of demolition site from landfill area. Though directives exist for disposal of waste to landfill areas, penal action against violators is practically not being taken. Presently management of waste from construction industry in India comprises of the following elements: Re-use of materials salvaged in good



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condition during demolition, metal items being sent for re-melting through scrap dealers, disposal of other items to low lying sites, donating or saving materials for reuse as free alternative to paying disposal fees. Recycling fees are generally lower than disposal fees, tax deductions from donating materials to non-profits helps local government meet their goal of reducing disposal by 50% and Creates business and product opportunities associated with recycled materials that could add to the growth of the circular economy. (Ponnada. P, 2015) Lower quantum of C&D waste from individual house construction or demolition find its way into nearby municipal bin or storage depots, making the municipal waste heavy, degrading quality of municipal waste and making it difficult for further treatment like composting. About 10-20 % find its way into surface drains, choking them. As a common Practice in India, Waste Generators dispose their waste on the streets and in open instead of making space for them within premises until transported, which disturb the daily commuters and poses serious environmental issues (World Bank, 2008). A large quantity of C&D waste in India are also being dumped into forests, streams, river and empty lands that has resulted in erosion, well contamination, water table disturbance, and has posed undesirable environmental effects. More often, private contractors remove C&D waste to privately owned low-lying land for a price or dump it in an unauthorized way along roads or other public land. This increased unscientific dumping is putting severe pressure on scarce urban land and is resulting into reducing life spans of landfill. (Miranda et al., 2017).

Segregation being a crucial step should be encouraged right from the generation stage at the generators to support the 3R policy of waste management. Project specific Waste management plan at the early design phase could also be an efficient strategy to manage the construction waste generations throughout the stages. Waste quantity expected to be generated from a C&D activity cannot be avoided but minimised through early stage planning. Waste generation under strict supervision for small housing projects on contract range from 3-7%. In larger projects headed by professional team waste is limited within 3%. Demolition contractors can recover 25% from old buildings to as high as 75% from new ones with planned demolition. Metal wastes recovered from Pipes, Sanitary fittings, Ducts, and Conduits are easy to segregate and are usually collected by informal sector for their recycling through melting. (Dadhich et al., n.d.; Ponnada. P, 2015), While the concrete and masonry are not usually recycled and mostly become the part of landfill due to lack of segregation workforce and machineries available. Brickbats, top soil, clay, sand and gravel from excavations are either utilised as filler at the same site or moved to the other site (refer fig3). Green building codes in India provide various guidelines for preservation of top soil during the construction activities recognizing the importance of top soil and important minerals, which were overlooked earlier like the other C&D waste components. The codes also emphasises on utilisation & management of construction wastes. Such regulations are required to be the part of common construction practices and management rules rather than being restricted to mere Green building certifications.

There is a huge workforce from informal sector available in India which can be guided and informed to assist the segregation and transport, where the management is lacking and resulting into the ignorance of potential waste. Separation of C & D waste could be promoted at source and an institutional mechanism for waste collection could be established involving informal sector who can be trained to separate the waste into categories and also do some amount of use, reuse and reprocessing like making tiles from crushed construction debris. (Gayakwad & Sasane, 2015). Charges should be levied on C & D waste generators. Environmental friendly technologies should be adopted for waste utilization of C & D waste. There should be easy access to the information regarding C & D generation, legislative & regulatory framework and procedures to all stakeholders & common public.

**Recycling Scenario of C&D waste in India and Utilisation of Recycled Products**

In general, 90-95% of the total construction material waste can be recycled (Miranda et al., 2017). At present, only 5% of the total C&D waste generated in India is being processed (MoUD, 2000). Considering the amount of C & D wastes in India to be 10 - 12 million tonnes produced annually and the proportion of concrete as 23 to 35% of total waste, 30% percent of C & D wastes of 12 million tonnes as concrete, and 50% of the concrete as coarse aggregate, the total available recycled concrete aggregate (RCA) in India is of the order of 1.8 million tonnes annually (Guidelines on Environmental Management of C & D Wastes (CPCB), 2017). This quantity can contribute greatly to the circular



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economy replacing the new materials and their high relative cost. Various surveys conducted on reasons for less usage of recycling processes in India have revealed that, 70% of respondents have lack of awareness regarding recycling techniques, 30% of the respondents have indicated that they are not even aware of recycling possibilities, 67% of respondents from user industry have indicated non-availability of recycled product as one reason for not using it. The response of industries which had the knowledge and technical know-how of using recycled product indicates that presently there are no specifications available in the Indian standard codes for the use of recycled material in construction. Studies recommend establishment of quality standards for recycled aggregate materials and recycled aggregate concrete. This would help in setting up a target product quality for producers and assure the user of a minimum quality requirement, thus encouraging them to use it (Raju et al., 2019).

Earlier, construction agencies like CPWD stated that Indian laws only permits the use of naturally sourced building material. The IS: 323-1970 Indian standard specification related to aggregates for concrete, laid down by the Bureau of Indian Standards (BIS), stipulated that concrete can be made only with naturally accessed materials. Thus, construction agencies cited this rule to avoid using recycled C&D waste. The standard for coarse and fine aggregates for use in concrete was revised in January 2016, permitting the use of recycled aggregates up to 25% in plain concrete, 20% in reinforced concrete of M-25 or lower grade and up to 100% in lean concretes of grade less than M-15. National Building Code (NBC) of India 2016 in chapter 'Approach to Sustainability', states that, Recycled Coarse Aggregate(RCA) may be used in concrete for bulk fills, bank protection, base/fill of drainage structures, pavements, sidewalks, curbs and gutters etc. and up to 30 percent of natural crushed coarse aggregate can be replaced by the recycled concrete aggregate. This percentage can be increased up to 50% for pavements and other areas which are under pure compression. Use of recycled aggregate as sub-base for road construction is widely accepted in most countries. (Savarnya A., 2017)

The first recycling facility at Burari, New Delhi in India, paved the way by utilizing the C&D waste majorly into paver blocks. Recycled aggregate are also being used currently as general bulk fill, sub-base material in road construction, fills in drainage projects and for making new concrete. Ministry of Urban Development vide circular dated June 28, 2012, directed states to set-up such facilities in all cities with a population of over 10 lakhs to establish environment friendly C&D recycling facilities. The MoUD report (Technical Aspects of Processing and Treatment of Municipal Solid Waste) and Swachh Bharat Mission (MoUD 2016) also recognizes the need for C&D waste management.

Despite the recent buzz around green constructions, client specifications do not make special mention for use of materials re-cycled from waste and debris as imperative. Lower cost of disposal of waste from construction industry to landfill also has a direct bearing on recycling operations. Lack of any penalty for dumping or incentives to adopt recycling is another reason for these initiatives moving at a snail's pace. Yet, there have been some initiatives across the country that is worth mentioning albeit having a small impact. The Building Material and Technology Promotion Council (BMTPC), an apex body that promotes development and use of innovative building materials and technologies, has a scheme called Performance Appraisal Certification Scheme (PACS). New products manufactured by using recycled waste in fact, any new product, system or technique not covered so far by the (Bureau Indian Standard) BIS can be certified under this scheme after evaluation. It has been used to certify new construction material (such as bamboo). Materials can also be recycled onsite into new construction or offsite at a C&D processor. Typical materials recycled from building sites includes metal, lumber, asphalt, pavement, concrete, roofing materials and wallboard. Recycling saves money by minimizing disposal costs and replacing fresh materials at some extent (refer chart 3). The materials which are obtained after recycling of waste materials, can be used with natural materials to make concrete and also as manufactured sand with the natural sand in cement mortar.

### Overview of Indian Policies

A comparison of the state policies of India, China and USA clears the vision for the directions that require attention from India with reference to neighbouring and developed country (refer table 4) (Yogesh. S., 2021). A lack of incentive and reward policy for waste minimisation has been noted in India with respect to the developing countries.

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In a similar manner, developed countries have more stringent policies for waste recycling and segregation. The take back system from manufacturers and landfill bans are also the areas where India should be looking for an action. Measures like the ban on dumping debris at open spaces, the riverbed, nullahs and quarries like one shown by Pune Municipal Corporation (PMC), charging a fine of Rs 25,000 for violations by the urban local body, are some recent strict steps observed in the direction.

## CONCLUSION

- Leaving the task of segregation solely onto the municipal authority or local body should be avoided and major segregation should take place at the generators to ease the process of further recycling/upcycling.
- Promotion drives from real estate for recycled products are required to be encouraged.
- The engineers in charge could be expected to take responsibility of the waste management implementation at site followed by the contractor.
- Solid waste management rule' 2016 does not discuss in detail about how to segregate at site or ways in which the generated debris could be utilised. Separate Codes and Guidelines for the C&D waste should be framed as it is there for the e waste and hazardous waste.
- Local authorities should be responsible for arranging the collection, recycling and disposal infrastructure of C&D waste, either on their own, or through other agencies. In such cases, the costs will be borne by the owners. There should be charges for disposal in landfills, which should be sufficiently high to encourage processing and recycling of C&D wastes.
- In view of above, there is urgent need to take following measures:
  - Sensitization/ dissemination/ capacity building towards utilization of construction & demolition waste.
  - Preparation and implementation of techno-legal regime including legislations, guidance, penalties etc. for disposal of building & construction waste.
  - Delineation of dumping areas for pre-selection, treatment, transport of RCA.
  - National level support on research studies on RCA.
  - Preparation of techno-financial regime, financial support for introducing RCA in construction including assistance in transportation, establishing recycling plant etc.
  - Preparation of database on utilization of recycled materials and easily accessible physical & legal attributes of buildings.
  - Formulation of guidelines, specifications and codal provisions.
  - Preparation of list of experts available in this field who can provide knowhow and technology on totality basis.
  - Incentives on using recycled aggregate concrete-subsidy or tax exemptions.
  - Creating awareness & dissemination of information is essential to build public opinion and in still confidence in favour of recycling option.
  - Quality control framework to keep a check on new and innovative products being developed from recycled waste.
  - Systematic framework for clear quantity estimations at urban local bodies on city level is expected to be targeted sooner from formal authorities for effective C&D waste management. -Stakeholders like contractors and engineer's awareness about the government programs and initiatives in the direction of C&D waste management.
  - Informal sector playing an active role could be educated about the possible prospects of recycling and C&D waste management.
  - Project specific C&D waste management schemes at early stage of construction or demolition and preference of recycled materials as green materials from green building experts could be an effective way to minimize, monitor and control C&D waste quantum and promote recycling process in the country.
  - Guidelines, manuals and standards for recycled materials are imperative to encourage and boost its usage amongst industry professionals.
  - Policy specific reforms that are imperative for India includes encouragement of incentives and rewards for waste minimization similar to USA & China and more stringent policies for C&D waste recycling and segregation.

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-Easy access to the information regarding C & D generation, legislative and regulatory framework and procedures to all stakeholders and common public Penalties for dumping/disposal and incentives for using recycled materials.

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**Table1. C&D Waste Quantity Estimations by Various Indian Agencies**

Source (Agency)	Quantity Estimated(MT)	Year
TIFAC	12-15	2001
MoEF	10-12	2010
BMTPC	165-175	2005-2013
CPCB	12	-
MoUD	10-12	2000
CSE	625	-
GIZ	716	2015

Source:Compiled by Author





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Table 2: Composition of C&amp;D Waste

Components of C&D Waste	TIFAC, 2001 (%)	MCD Survey (%)	Survey IL&FS (%)
Soil/Sand, Gravel	36	43	41
Bitumen	2	-	-
Metal	5	-	0.4
Concrete	23	35	-
Wood	2	2	1.5
Other	1	1	7.6

Source: TIFAC and MCD Surveys

Table 3: Review of Indian Policies

Category	Factors affecting C&D Waste	India	China	U.S.A
Reduce	Waste Management Websites -Exchange websites for potentially hazardous materials	--	++	+
	Tax rebates, for pollution savings or energy efficiencies	++	++	+
	clean city creditability reward for neighbourhoods and cities for sustainable techniques	--	+	++
	Enhancing on-site waste management plan to minimize waste	++	++	++
	waste minimization design	++	++	++
	Adopting low waste construction technologies, handling and packaging	++	+-	++
	Establishing tipping fees for processing of waste receiving facilities	++	++	++
	Environmental compliance procedure for waste generation	++	+-	++
	Dematerialisation and resource efficiency	+	-	++
	Regulatory control on disposal collection and treatment	++	++	++
Recycling	Recycling target/goal	+	++	++
	Material Identification at site	++	++	++
	Subsidised recycling	+-	-	++
	Energy recovery target/goal	+	+	++
Reuse	Reuse target/goal	++	++	++
	Selective removal of accessible materials that are hazardous	++	+	++
	Selective removal of accessible materials with obvious sales value	+-	++	++
	Backfilling operations	++	++	++





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<b>Rethink</b>	Tradable permits allow trading of emissions among various polluters	-	+	++
	Favour procurement of material containing recycled materials	++	+	++
	Research grants to simulate technology development	-	++	++
	Take-back systems, manufacturers take back used salvage for packaging	--	++	++
	Insurance pools, rearrangements of insured parties to enable pollution risks to be covered	-	-	++
	Knowledge sharing	++	++	++
	Procurement transparency	++	++	++
	Approval from authorities before demolition	++	++	++
	Training workers for efficient working	++	-	++
	Providing guidelines on effective waste management methods	++	++	++
	Levy charges on C&D waste generators	++	++	++
	Environmentally compatible post recovery	++	++	++
	Landfill bans on combustible material	--	--	++
	Cradle to Grave	+-	++	++
	Detailed calculation and analysis potential of waste generated from facilities	++	++	++
	Waste Audits	++	++	++
	Project based waste management planning	++	-	++
	Addressing management of C&D waste separately	++	++	++
	Fine for deviation from waste handling plan or rules and regulation	++	++	++

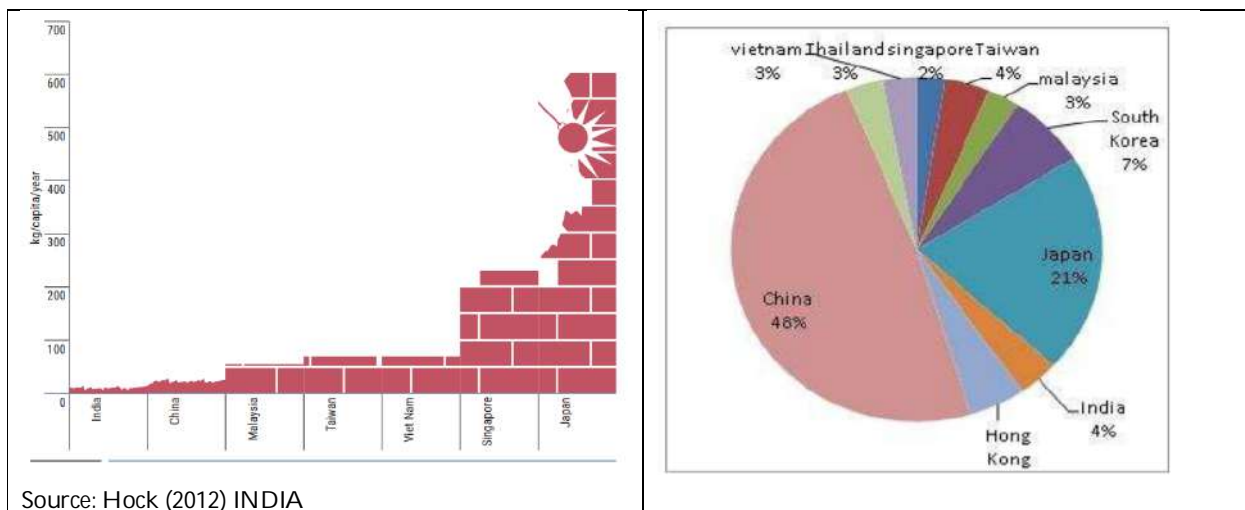
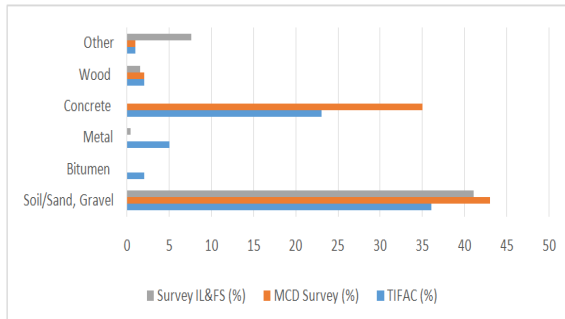


Fig. 1: Estimates of C&D Wastes in Some Asian Countries Asian institute of Technology, Report on reduce, reuse recycle (3R) practices in construction and demolition waste management in Asia Thailand, May 2008, 81 p.)





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Source: Author

Fig. 2. Source: S.K. Bhattacharyya, et al. (DST Project), Demolition Wastes as Raw Materials for Sustainable Construction Products, CSIR-CBRI News Letter, Vol-33 No-2 April-June 2013, pp.

Fig. 3: Utilization of Construction waste of AAC blocks as fillers under Basement Ramp at same site (Shalimar Iridium, Lucknow)

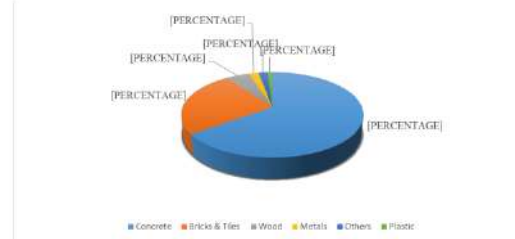
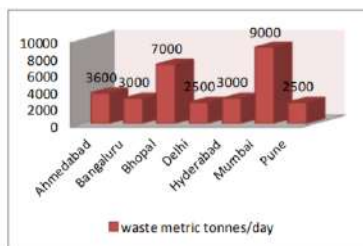


Chart 1: Waste Generated in Indian Cities  
Source: nexusnovus.com

Chart 2: Composition of C&D Waste

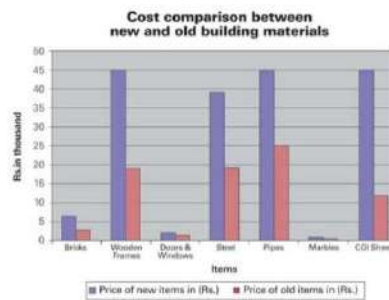


Chart 3: Cost comparison between new and old building materials





## The Chemistry of Caries: Remineralisation and Demineralisation - an Overview

Vanita Dattatraya Revankar<sup>1\*</sup>, Manoharan Subhashini<sup>2</sup> and Assmee Mohammed Noon<sup>1</sup>

<sup>1</sup>Associate Professor, Department of Conservative Dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamil Nadu, India.

<sup>2</sup>Assistant Professor, Department of Conservative dentistry and Endodontics, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be university), Salem, Tamil Nadu, India.

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### \*Address for Correspondence

#### Vanita Dattatraya Revankar

Associate Professor,  
Department of Conservative Dentistry and Endodontics,  
Vinayaka Mission's Sankarachariyar Dental College,  
Vinayaka Mission's Research Foundation (Deemed to be university),  
Salem, Tamil Nadu, India.  
E. Mail: dr.vanita99@gmail.com



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### ABSTRACT

Enamel, dentin, cementum, and bone are only a few examples of the unique hybrid biological tissues created by living organisms through the dynamic, intricate, and constant process of biomineralization. process of biomineralization. In order to create innovative scaffolds and develop treatments for disorders linked to mineralization, it is crucial to comprehend the mineral deposition process. This article provides a thorough evaluation of the hypotheses that describe various mechanisms and factors that may act as agonists and antagonists of mineralization. Bone and teeth are both subject to demineralization during the course of a person's lifetime because of the anatomical positioning and arrangement of teeth. Since teeth are constantly exposed to food, drink, and the microbiota in the mouth, they exhibit a remarkable resistance to localised demineralization that is unmatched by bone. The mechanisms by which the processes of demineralization and remineralization in teeth and bone occur are also thoroughly discussed, as are the cutting-edge therapies and technologies that either stop or hasten the process.

**Keywords:** Demineralization, Remineralization, Teeth and Calcium phosphates





## INTRODUCTION

Natural organic and inorganic composites include enamel, dentin, cement, and bone. Human teeth have ectodermal enamel that is different from the specialised connective tissues that make up bone, cementum, and dentin. In specialised connective tissues (bone, cementum, and dentin), collagen type I makes up up to 90% of the organic material whereas noncollagenous proteins make up the remaining portion [1]. On the other hand, enamel mostly consists of noncollagenous protein and has very little to no collagen (90 percent amelogenin) [2]. Apatite ( $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ) from biological sources is one of the hard tissues' inorganic constituents. Compared to cementum (45%) and dentin (45%), enamel (90%) and bone (90%), these materials are more inorganic (70 percent) [3]. One of the most common disorders that has harmed people's oral health globally is dental caries [6]. Dental caries is a chronic, infectious illness that is irreversible and affects the mineralized dental structures. It develops dynamically and through a variety of different mechanisms. It affects both primary and permanent teeth. The dynamic processes of demineralization and remineralization lead to dental caries [8]. Cavitations will form with the initial carious lesion appearing as a white spot lesion when the demineralization process is stronger than the remineralization process [9]. Dental caries is defined as the localised destruction of vulnerable dental laborious tissues by acidic by products from microbial fermentation of food macromolecules.

The surfaces of the teeth are covered by a biofilm of microorganisms that includes both aerobic and anaerobic flora. Mutant streptococci and lactobacilli are particularly responsible for the development of dental caries due to their capacity to produce acid when exposed to dietary carbohydrates such as plant material, glucose, fruit sugar, etc. By demineralizing inorganic components and destroying organic ones that are naturally present in enamel and dentin, this acid causes both. The white spot lesion on enamel surface is the first obvious evidence of demineralization, which is actually caused by the loss of metal and phosphate ions. When the body lacks metal, it pulls it from sources just like the teeth. This will cause dental issues, as well as weak roots, irritated gums, brittle teeth and cavity [10]. Saliva and gingival crevicular fluid are mostly composed of the ions calcium, phosphate, and fluoride. The presence of these minerals helps to maintain equilibrium between the mineral content of teeth and mouth fluids at neutral pH levels.

### Demineralisation

When the pH of the oral fluids falls below 5.5, the hydroxyapatite (HA) crystals dissolve, releasing calcium and phosphate ions from the tooth surface into the oral fluids. This process is known as demineralization [11]. Tooth demineralisation is the loss of minerals from dental enamel in the form of mineral ions. It's the "dissolving of enamel," to put it another way. By eliminating a large number of mineral ions, the structural integrity of hydroxyapatite latticework can be retained. When an excess of minerals dissolve from the latticework of hydroxyapatite, a 'cavity' forms (loss of crystalline latticework structure) [12]. Hydroxyapatite is in equilibrium with the local environment in a neutral environment, notably saliva which is saturated with  $\text{Ca}^{2+}$  and  $(\text{P}_04)^{3-}$  ions. At or below pH 5.5, hydroxyapatite (HA) reacts with hydrogen ions (since this is the critical pH for hydroxyapatite). The phosphate groups in the aqueous environment immediately next to the enamel crystal surface react preferentially with  $\text{H}^+$ . The procedure is known as  $(\text{P}_04)^{3-}$  to  $(\text{HP}_04)^{2-}$  conversion.  $\text{H}^+$  is added and the  $\text{H}^+$  is buffered at the same time. The  $(\text{HP}_04)^{2-}$ , on the other hand does not contribute to the typical HA equilibrium because it contains  $\text{P}_04$  rather than  $\text{HP}_04$  and so destroys the HA crystal [13]. Even after bacteria have invaded dentin, dietary substrate continues to feed the demineralization process. A demineralization front forms before bacterial invasion as a result of bacterial acid dissolving the hydroxyapatite of deeper dentin. As demineralization advances, dentin colour and texture change. The colour will become darker due to bacterial byproducts and stains from food and beverages. The enamel will gradually erode and weaken if the lesion is allowed to progress into the dentin, leading to a significant cavity that will eventually self-clean. A hard, leathery floor that is largely passive on the cavity may then form as a result of the caries process slowing down [14]. When the pH level at the surface of the tooth is higher than what can be balanced by remineralisation. The initial enamel lesion nevertheless happens because it is not low enough to prevent surface remineralization. Acid ions make extensive inroads into the prism sheath porosities, leading to





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subsurface demineralization. Dental enamel's strength and hardness are impacted by the remineralization and demineralization processes.

### Remineralization [15-19]

The remineralisation process can be induced by different remineralising agents in oral fluid and thus demineralization process can be arrested [15]. The process of remineralisation involves strengthening of the lattice work by restoring lost mineral ions in the tooth structure [16]. The main catalyst for remineralization is the passive transfer of calcium and phosphate ions from saliva or plaque below their concentration gradient at neutral pH in the absence of acid challenge. When fluorapatite (FAP) or fluoridated hydroxyapatite (F-OHAp) precipitates on already-existing demineralized crystallites or forms new crystallites, the soluble calcium phosphate phases are changed into a solid phase that is less acid soluble. Unlike the re-mineralizing mechanisms in bone and dentin, which depend on soft tissues and cellular biological processes, this re-mineralization process is a natural chemically inorganic process. Since fluoride increases the driving power for mineral precipitation, it has long been recognised that fluoride inhibits lesion demineralization and promotes consolidation through crystal development. Fluoride has a great affinity for positive ions such as calcium due to its anionic character. In its tooth-bound state, fluoride incorporated during enamel maturation is stable and does not play a significant role in the re-mineralization process, whereas ambient free fluoride levels have been implicated as the major determinants in promoting remineralization of enamel lesions. As a result, the post-eruptive effect of a topically applied fluoride, through varnishes, dentifrices or mouthwashes, is essential in modulating the dynamic equilibrium at the tooth's surface promoting re-mineralization of demineralized lesions. Remineralization occurs both during the decay process and at neutral pH scales, when minerals precipitate from oral fluids in the enamel defects. It is widely known how halides contribute to the precipitation of inorganic phosphate.

Although lesion re-mineralization occurs by the regrowth of mineral crystals, physio-chemically the process is substantially more challenging. For the production of new crystals, a good saturation greater than that of the oral fluids is essential. Dentin and enamel differ in structure and chemistry, interfering with one another when there is a cavity. The primary mineral component of the tooth structure is hydroxyapatite, which has the atomic number 20. A 96% w/w inorganic matrix, organic components like proteins and lipids, and 4% w/w water are combined to form enamel. The physio-chemical and mechanical properties of crystals can be changed by adding trace elements. Therefore, for instance, adding metal will increase the solubility of hydroxyapatite crystals, or metal makes the substrata more porous, and halide makes the tooth structure more resistant to acid assault. When compared to enamel, dentin has higher acid porosity and a larger area of tiny crystallites, which accelerate dentine's rate of disintegration. A paradigm shift in caries care has occurred as a result of the realisation that noncavitated caries lesions can be stopped and reversed. As a result, a sizable portion of caries research has been devoted to creating fresh and improved remineralizing therapies. The most significant treatment now available to encourage lesion remineralization is still regarded as fluoride. The standard of care for caries prevention and management is likely to change as novel therapies are developed and current management regimens are improved.

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