



Virtual Learning during Covid 19 Pandemic among Kashmir University Students

Showkat Ahmad Dar^{1*} and P. Sakthivel²

¹Research Scholar of Public Administration, Department of Political Science and Public Administration, Annamalai University, Annamalai nagar, Tamil Nadu, India-608002,

²Professor, Department of Political Science and Public Administration, Annamalai University, Annamalai nagar, Tamil Nadu, India-608002,

Received: 13 May 2022

Revised: 06 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Showkat Ahmad Dar

Research Scholar of Public Administration,
Department of Political Science and Public Administration,
Annamalai University, Annamalai Nagar,
Tamil Nadu, India - 608002,
Email: bitudar07@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Schools, colleges, and universities in Kashmir currently only use traditional teaching methods like classroom lectures. In spite of this, many academic units still use out-dated methods. SARS-CoV-2), a deadly Corona Virus, suddenly emerged on the global scene. Around 32 crore Indian students halted school/college transfers. Change is unavoidable, COVID-19 taught. Since the WHO declared it a pandemic, educational institutions have grown and adopted new technologies. This forced educators worldwide to adopt virtual learning. Many academic institutions unwilling to change their pedagogical approach had to go virtual. Knowledge is a click away in today's fast-paced world. Less physical classrooms and more electronic books have replaced the traditional. Virtual learning is derived from e-learning or Ed-tech. the Covid 19 Pandemic study aims to highlight virtual learning among Kashmir University students. The current study aims to highlight the virtual learning environment among Kashmir University students during the Covid 19 Pandemic.

Keywords: Virtual learning, Corona virus, Socialization, Internet and Impact.

INTRODUCTION

Global economic collapse caused by Corona Virus (Covid-19). That fear is likely to spread globally as a result of this tragedy. Devastating pandemic forced school closures. Several areas are affected globally, and many fear losing the current semester or more. Universities have stopped teaching in-person. Normal teaching will be difficult, say the researchers. Social distancing limits learning opportunities at this stage. Educational units are struggling to cope. We



**Showkat Ahmad Dar and Sakthivel**

see a need for scenario planning in academia (Rieley, 2020). This situation necessitates humanity. Students, teachers, communities, and the nation must be saved urgently. A case for virtual learning these includes accessibility, affordability, flexibility, learning pedagogy, and policy. In rural and remote areas, virtual learning is easily accessible. It is cheaper due to lower transportation, lodging, and overall costs. Online courses allow students to plan their time to complete them. Blended and flipped classrooms combine face-to-face lectures with technology. Students can learn new skills and continue their education at any time (Soykan, 2020). The government recognises the value of virtual learning.

Virtual learning environments employ computers and the internet to teach and learn. They enhance student learning. These are all VLE features. Its benefits are gaining popularity. Virtual learning transformed Kashmiri education. The classroom has no walls. Weak pupils might avoid a crowded classroom and focus on grades. Virtual learning increases self-esteem and fosters learning. Virtual learning decreases student reliance on teachers and boosts confidence (Saklani, 2021) Virtual learning boosts student confidence, motivation, and reinforcement.

Benjamin Franklin, one of America's founding fathers, correctly predicted that education is the best investment. Franklin's investment analysis should enlighten policymakers or rulers. Education, a fundamental human right, is sadly lacking in India, particularly in Kashmir. New Covid-19 changes the scenario. Corona virus Grasim gibbets threaten humanity. It's more feared than death's guardian deity. Rulers must lock down. More than 200 countries invest considerably in education to strengthen their countries by promoting industrious students who want to prove their valour. Covid 19 lacks 4G in the valley (Dar et, al 2020). Imagine the impact on schooling. Some passionate professors find 2G frustrating. Not everyone can afford smart phones in the valley, fostering isolation. Education is key to eliminating regionalism, dogma, and prejudice. We think the globe is uniting like a leopard. To overcome hurdles, we must invest extensively in education. Chinese proverb: Educate people to live 100 years. I hope effective actions are taken to address the issues.

Virtual learning has helped many who struggled with classroom teaching. Understand internet debates and the issue. Can technology replace a teacher? Learning has traditionally occurred in schools. People-skills and social interaction. Schools offer more. A student's instructor is their best friend, advisor, mentor, and supporter. Virtual learning is taught utilising computers and the internet. This contradicts basic education. No one guides, teaches, or makes students learn social skills online (Almarzook et al, 2020) Virtual learning is a novel classroom technology. Some students are tech-savvy, while others struggle. So the teacher had to use technology to her advantage and meet all students' needs. The role of teachers in students' lives has been varied. They inspired students to aspire, dream, and succeed. No robot or AI machine can do this. A machine can't replace a teacher's warmth. The teacher still has to be present in order for students to learn.

RESEARCH METHODOLOGY

The survey was used to gather data on virtual learning among Kashmiri university students during the Covid 19 pandemic. The research used both primary and secondary sources. Purposive sampling was used in both qualitative and quantitative research. Methods of data collection include: Kashmir University students who used virtual learning are surveyed and analysed to see how happy they are with the services. The surveys used a questionnaire to gather data from 200 target respondents in Hindi and English. The study also used official Indian government publications and secondary data from books, journals, and the internet.

RESEARCH OBJECTIVES

- To highlight the strategy of Virtual Learning adopted by Kashmir University students during Covid 19 pandemic.
- To analysis the impact of Virtual Learning.
- Can virtual learning replace a Teacher and develops Socialization?





Showkat Ahmad Dar and Sakhivel

DISCUSSION AND RESULT

Positive impact of COVID-19 on education

Despite the negative effects of COVID-19 on education, Kashmir University is doing its best to support students. The traditional Kashmiri education system was allowed to evolve. Here are some positive impacts:

- 1.COVID-19 has accelerated edtech adoption. Academies adopted blended learning Teaching and learning about technology was urged. Curriculum and pedagogy changed dramatically due to new delivery and assessment methods. It also accommodates large student groups.
- 2.Increasing interest for Learning Management Systems (LMS) among instructive organizations it set out a tremendous freedom for organizations that create and further develop educational management frameworks (Misra, 2020).
- 3.Because students couldn't collect hard copies of study materials during a lockdown, they relied heavily on soft copies for reference.
- 4.Collaboration can be improved in new ways. Faculty/teacher collaborations can also occur globally to benefit from each other (Misra, 2020).
- 5.Intensified use of teleconferences, webinars, and e-conferencing
- 6.A pandemic situation increased people's digital literacy.
- 7.Students can easily share lesson materials and ask questions via email, SMS, phone calls, or social media like Whatsapp or Facebook.
- 8.Teachers and students can connect with peers from all over the world. Their global community adaption.
- 9.Student can better manage their time online during pandemics.
10. Open and distance learning (ODL) was in high demand during the pandemic because it encourages self-learning and allows access to diverse resources.

Negative impact of COVID-19 on education

The COVID-19 outbreak has harmed the education sector. It has had many negative effects on education, as listed below:

1. School closures, exams postponed several boards have already postponed exams. It took longer to get in. Continuity in lockdown caused students to miss nearly 3 months of school in 2020-21, further complicating the situation.
2. COVID-19 has slowed recruiting. Companies may postpone student placements. This pandemic will likely raise unemployment. The pandemic circumstance in India forestalls any government recruitment, and late alumni dread losing bids for employment. As per the Centre for Monitoring Indian Economy, joblessness rose from 8.4% in mid-March to 23% toward the beginning of April (Educationasia.in). Jammu and Kashmir had 43.9% in 2021. Less cash for schooling implies more cash for joblessness (Greater Kashmir, 2021)Not all teachers/students are prepared for the sudden shift from classroom to online learning. For most teachers, online learning is simply delivering lectures via video platforms like Zoom or Google Meet.
3. Limited global employment opportunities due to COVID-19 restrictions. COVID-19 may have brought many Indians home. Thus, recent graduates entering the job market may struggle to find suitable employment. Interviews nearby may cause lockdown. Indians abroad may lose positions. Late graduates in India dread losing propositions for employment because of the pandemic.
4. Parents' increased responsibility to educate their children: Some educated parents can guide, but others may not be able to teach their own children.
5. Nutritional loss due to school closure: The Indian government's Mid-day Meals program me aims to provide better nutrition to school-aged children nationwide. Due to the temporary closure of mid-day meal programmes, students' daily nutrition is severely impacted. Various studies have shown that mid-day meals help increase school enrolment.
6. Digital divide: Numerous students have restricted or no web access and numerous understudies can't bear the cost of a PC, PC, or supporting cell phone at home. As per reports, the lock down has hurt unfortunate





Showkat Ahmad Dar and Sakthivel

- understudies in India who can't investigate web based learning. Thus, using virtual learning during COVID-19 may widen the wealth/poverty and urban/rural divides.
7. Global education: The pandemic has hampered admittance to advanced education. Numerous Indian understudies concentrating on abroad, particularly in the most impacted nations, are presently leaving, and assuming that the circumstance proceeds, the interest for global higher education will decline altogether.
 8. Delay in payment of school and college fees: Most parents will be unemployed during the lockdown, affecting private schools and colleges. Incorporated into today's mainstream higher education.
 9. Government and educational institutions should plan socially distant education. COVID-19 allows 30-40% of students and teachers to work two shifts per day.
 10. Nowadays, having access to technology and the internet is vital. So, to help students continue their education during pandemics, digital capabilities and infrastructure must reach the most remote and poorest communities. Public funds are needed to bridge the internet gap and keep students learning digitally. State governments/private organisations should devise solutions to the digital education issue(Ayob et, al 2021)
 11. Government and stakeholders ought to resolve huge issues related with distance learning systems, for example, giving admittance to web empowered gadgets for handicapped and other underestimated understudies as well as protected learning conditions.

Views of respondents on Prospects and challenges of online Mobile voting in India

Data interpretation Analysis and Questionnaire schedule

The Study embraced survey, a poll used to gather the reaction from 200 objective respondents in both Hindi and English language. The respondents were male as well as female for the most part browsed education area. The three point scale has been embraced for finding the outcome from the respondents viz Y-Yes, N-No and NI: No Idea. The Three point scale is referenced beneath

Analysis and interpretation

This part analyses the students' perceptions and attitudes towards virtual learning during the Covid 19 pandemic. Purposive sampling selected 200 respondents. Education is one independent variable. Interviews were conducted based on variables. Data are tabulated and accurately analysed using simple percentage analysis. The precise outcome was drawn using a survey method. According to the data presented in the table that can be found above, the distribution of respondents in terms of their levels of education can be broken down as follows: among all respondents, 32.5 percent of respondents held a bachelor's degree or higher, 42 percent of respondents held a master's degree or higher, and 25.5 percent of respondents held a doctoral degree or higher.

Table.3 Respondents believed that Kashmir University had made substantial use of virtual learning during the COVID-19 epidemic. This was the perception of respondents in response to a question concerning the topic. Graduates have said that half of them, or 25 percent, have made the transition to online education and are familiar with it. When the same question was posed to postgraduate students, 51 of them, or 25.5%, responded in the affirmative about the use of virtual learning during the epidemic. Neither one of them was aware that there was a question being asked. Only seven of the respondents, or 3.5 percent, stated they were unaware of the use of virtual learning during a pandemic. The majority of respondents (49 percent) claimed they are aware of virtual learning during a pandemic.

Table 4. shows the results from the respondents. When asked if they felt any positive or negative impact of virtual learning, the majority of respondents from all three categories said yes. However, the least percentage of respondents in all three categories said they had no idea. For the question of Can virtual learning replace a teacher and develops socialization? All the three categories 152 (76%) of respondents shared their view that high level awareness about the said question and said that virtual learning can't replace a teacher and the learning of socialization can't be possible through virtual learning. Among all the three categories 34 (17%) of respondents opined very low level of percentage whether virtual learning can replace and teacher and develop socialisation among students. However in aggregate 8 (4%) from all categories of respondents opined no idea about the said question?. The above table 6 shows



**Showkat Ahmad Dar and Sakhthivel**

participants' responses when asked if they had any issues while using virtual learning during the Covid 19 pandemic. In situations like internet blackouts or only 2g services in Kashmir, most graduates said they had difficulty adopting virtual learning. When asked the same question of postgraduate respondents, 51 (25.5%) said that virtual learning was problematic during the Covid 19 pandemic. Among the post-graduate respondents, 55 (27.5%) said yes. However, among all three categories of respondents, 13 (6.5%) said they had no idea.

Analysis of Data

During the COVID-19 epidemic in Kashmir, which is a state that is managed by India, the data analysis showed that all three categories of respondents had a high level of awareness of virtual learning. "Have they noticed any positive or negative effects as a result of their virtual learning experience? The vast majority of postgraduate respondents were aware of the influence that virtual learning had during the COVID-19 pandemic and were willing to offer their perspectives on both the positive and negative effects of virtual learning. The study explores the question, "Can virtual learning replace a teacher and yet foster socialisation?" It demonstrates that the majority of respondents from all three categories are aware of the question, and the majority of those respondents believe that socialisation and teacher replacement cannot be achieved through virtual learning. They claim that getting to know other people is an experiential process that cannot be replicated by virtual learning since it requires physical interaction.

The data presented in the table are in response to the question, "Did they encounter any difficulties when utilising virtual learning during the COVID-19 pandemic?" All of the respondents were irritated during the pandemic in Kashmir because of the low internet connectivity, the availability of just 2G services, and the frequent blocking of internet access for security reasons." Virtual learning during a pandemic, according to the responders across all categories, not only helps them obtain the necessary electronic content for tests but also assists them in preparing for their own exams.

CONCLUSION

According to the above analysis and discussion, students at Kashmir University used virtual learning extensively during the Covid 19 Pandemic. Virtual learning has both positive and negative effects on student communities. Virtual learning penetration is highest among Kashmir university students during Covid 19. They also said that such technological innervations benefit students during a disaster. Virtual learning is very beneficial for students all over the world, but it requires constant internet connectivity. Virtual learning requires privacy, security, and digital literacy, said all respondents. This can help the nation achieve its literacy goal. Also, all three categories agreed that virtual learning is a supplement to traditional learning. Virtual learning thus boosts their self-esteem and encourages them to learn. Virtual learning reduces student dependence on teachers and increases student confidence. Virtual learning also has pedagogical benefits such as increasing student confidence, reinforcement, and motivation. After all, can technology ever replace a teacher in a student's life? Schools have long been a place for students to learn. Interacting with people and learning social skills. The schools have so much more. The teacher is a student's best friend, guide, mentor, and support during their formative years.

A machine will never be able to take the position of an instructor. The instructor will save the day in the event that the system unexpectedly fails owing to a problem with either the software or the hardware. Therefore, even while virtual learning materials have the potential to revolutionise the learning process, they cannot take the position of a qualified instructor. Our state needs to make significant investments in education if it is going to be successful in overcoming any challenges. If you wish to live to be a hundred years old, according to a Chinese saying, you should educate more people. I sincerely hope that decisive and efficient action will be done to address the problems that have been raised.



**Showkat Ahmad Dar and Sakthivel****ACKNOWLEDGEMENT**

We need to thank each and every individual who assisted us with composing this paper. We owe him a great deal. As well as the researchers and writers who had composed papers on a connected point and utilized their references to direct us down a surprising way that permitted us to conveniently complete our article.

FUNDING

Nil

CONFLICT OF INTEREST

Nil

REFERENCES

1. Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: the challenges and opportunities. *Interactive learning environments*, 1-13.
2. Adnan, M., & Anwar, K. (2020). Online Learning amid the COVID-19 Pandemic: Students' Perspectives. *Online Submission*, 2(1), 45-51.
3. Almarzooq, Z. I., Lopes, M., & Kochar, A. (2020). Virtual learning during the COVID-19 pandemic: a disruptive technology in graduate medical education. *Journal of the American College of Cardiology*, 75(20), 2635-2638.
4. Ayub, S. J., & Bhat, W. A. (2021). Education amidst conflict: how Kashmiri society struggles to educate their children during covid-19 pandemic. *Society in the Covid-19 Pandemic*, 201-218.
5. Bhat, S. B. G. A. A. Higher Education and COVID-19: An Exploratory Study of Jammu and Kashmir.
6. Borah, S., & Chitrakar, N. (2022). Impact of Covid-19 on higher education in India: A literature review. *Journal of Positive School Psychology*, 6(2), 4720-4724.
7. Chakraborty, P., Mittal, P., Gupta, M. S., Yadav, S., & Arora, A. (2021). Opinion of students on online education during the COVID-19 pandemic. *Human Behavior and Emerging Technologies*, 3(3), 357-365.
8. Dar, S. A. (2020). Rise and Impact of Covid 19 in India.
9. Dar, S. A., & Lone, N. A. Impact of Covid 19 on Education in India.
10. Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of educational technology systems*, 49(1), 5-22.
11. Dung, D. T. H. (2020). The advantages and disadvantages of virtual learning. *IOSR Journal of Research & Method in Education*, 10(3), 45-48.
12. Fauzi, I., & Khusuma, I. H. S. (2020). Teachers' elementary school in online learning of COVID-19 pandemic conditions. *Jurnal Iqra': Kajian Ilmu Pendidikan*, 5(1), 58-70.
13. Kumar, A., & Pathak, P. (2020). The Pros and Cons of Virtual Learning in India: An Insight During 'Covid Lockdown'. *Adhyayan: A Journal of Management Sciences*, 10(01), 08-13.
14. Mukhtar, K., Javed, K., Arooj, M., & Sethi, A. (2020). Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era. *Pakistan journal of medical sciences*, 36(COVID19-S4), S27.
15. Mushtaq, B., Mir, J. A., & Mushtaq, O. A. (2022). Effectiveness of Online Education during Covid-19 Pandemic in Kashmir According to the Teachers. *Journal of Nurses Voice and Impact (e-ISSN: 2582-7812)*, 6-15.
16. Sahi, A. N., Bibi, T., & Ali, I. The Impact of Online Learning on Teacher-Student Trust at University Level during Pandemic 2020.
17. Saklani, M., Kaur, P., & Sarin, J. (2021). Effectiveness of Virtual Learning on Knowledge of Students Regarding Covid-19 amid Its Rapid Upsurges. In *Advances in Interdisciplinary Engineering* (pp. 327-336). Springer, Singapore.





Showkat Ahmad Dar and Sakthivel

18. Surkhali, B., & Garbuja, C. K. (2020). Virtual learning during COVID-19 pandemic: pros and cons. Journal of Lumbini Medical College, 8(1), 154-155.
19. Tabatabai, S. (2020). Simulations and virtual learning supporting clinical education during the COVID 19 pandemic. Advances in medical education and practice, 11, 513.

Table 1. Views of respondents on Prospects and challenges of online Mobile voting in India

| S. No | Questions | Y | N | NI |
|-------|--|---------------|--------------|--------------|
| 1. | Was virtual learning adopted in Kashmir during Covid 19 pandemic by Students? | 121 (60.5) | 32 (16) | 47 (23.5) |
| 2. | Do you feel any positive or negative impact of Virtual learning? | 132 (66) | 45 (22.5) | 23 (6.5) |
| 3. | Can virtual learning replace a teacher and develops socialization? | 154 (77) | 31 (15.5) | 14 (7) |
| 4. | Do you feel any problem while using virtual learning during Covid 19 pandemic? | 145 (72.5) | 52 (26) | 03 (1.5) |

Table 2 Educational wise classification profile of respondents:

| S. No | Educational level | No of respondents | Percentage |
|-------|---------------------|-------------------|------------|
| 1 | Graduate | 65 | 32.5 |
| 2 | Post Graduate | 84 | 42 |
| 3 | Above Post Graduate | 51 | 25.5 |
| | Total | 200 | 100 |

Table 3. Respondents on Kashmir University

| Variable | Graduate | | | Post Graduate | | | Above post Graduate | | | Total |
|---|------------|-------------|-----------|---------------|-------------|-----------|---------------------|-------------|-------------|-------------|
| | Yes | No | NI | Yes | No | NI | Yes | No | NI | |
| Was virtual learning adopted in Kashmir during Covid 19 pandemic by Students? | 50 (25) | 15 (7.5) | 04 (2) | 51 (25.5) | 11 (5.5) | 04 (2) | 49 (24.5) | 09 (4.5) | 07 (3.5) | 200 100% |

Table 4. Results the respondents

| Variable | Graduate | | | Post Graduate | | | Above post Graduate | | | Total |
|--|------------|-------------|-------------|---------------|-------------|-------------|---------------------|-----------|-------------|-------------|
| | Yes | No | NI | Yes | No | NI | Yes | No | NI | |
| Do you feel any positive or negative impact of Virtual learning? | 50 (25) | 09 (4.5) | 03 (1.5) | 51 (25.5) | 05 (2.5) | 03 (1.5) | 64 (32) | 10 (5) | 05 (2.5) | 200 100% |





Showkat Ahmad Dar and Sakthivel

Table 5. Virtual learning replaces a teacher and develops socialization

| Variable | Graduate | | | Post Graduate | | | Above post Graduate | | | Total |
|--|--------------|-------------|-----------|---------------|-----------|-------------|---------------------|-------------|------------|-------------|
| | Yes | No | NI | Yes | No | NI | Yes | No | NI | |
| Can virtual learning replace a teacher and develops socialization? | 51 (25.5) | 09 (4.5) | 04 (2) | 49 (24.5) | 12 (6) | 07 (3.5) | 50 (25) | 13 (6.5) | 5 (2.5) | 200 100% |

Table: 6. Participants' Responses

| Variable | Graduate | | | Post Graduate | | | Above post Graduate | | | Total |
|---|------------|-----------|----------|---------------|-----------|-------------|---------------------|-------------|-----------|-------------|
| | Yes | No | NI | Yes | No | NI | Yes | No | NI | |
| Do you feel any problem while using virtual learning during Covid 19pandemic? | 54 (27) | 04 (2) | 6 (3) | 51 (25.5) | 12 (6) | 03 (1.5) | 55 (27.5) | 11 (5.5) | 04 (2) | 200 100% |





Influencing Feature Selection for the World of Rehabilitation

K. Arthishwari^{1*}, M. Anand², M. Janaki Rani², S. Srinivasan³ and S. Veena Kirthika⁴

¹Research Scholar, Department of Electronics and Communication Engineering, Dr. M.G.R. Educational and Research Institute, Chennai, Tamil Nadu, India.

²Professor, Department of Electronics and Communication Engineering, Dr. M.G.R. Educational and research Institute Chennai, Tamil Nadu, India.

³Professor, Department of Electronics and Communication Engineering, SIMATS Deemed University, Chennai, Tamil Nadu, India.

⁴Professor, Faculty of Physiotherapy, Dr.M.G.R. Educational and research Institute Chennai, Tamil Nadu, India.

Received: 20 May 2022

Revised: 06 June 2022

Accepted: 06 July 2022

*Address for Correspondence

K. Arthishwari

Research Scholar,

Department of Electronics and Communication Engineering

Dr. M.G.R. Educational and Research Institute,

Chennai, Tamil Nadu, India.

E.Mail: arthishwari@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Artificial intelligence in healthcare is rapidly growing, offering new data analysis options. Machine learning is a sort of artificial intelligence (AI) that can make predictions and has been tested in a range of medical specialties using various approaches such as diagnostic applications, forecasts, and risk factor detection. Because this technology has only recently been introduced in orthopedics, there is a scarcity of data. In this review, we'll look at the types of predictions that Machine Learning models can make in Rehabilitation, as well as the requirements that must be met for this unique method to work. Machine Learning can filter through large amounts of data and identify specific trends and patterns that people may miss. When forecasting the likelihood of a specific result, an algorithm that has been trained on a previous dataset and then applied to new data tries to predict the outcome. The predict function is commonly used to forecast outcomes when employing a model. As they gain experience, machine learning algorithms improve in accuracy and efficiency. This enables them to make better selections. Artificial Intelligence (AI) and, in particular, Machine Learning (ML) have grown in importance in recent years in the context of data analysis and computing, enabling applications to function intelligently. In the fourth industrial revolution, machine learning algorithms are crucial for generating real-world applications. Machine learning algorithms enable systems to learn from their experiences and improve without having to be explicitly designed. Machine learning algorithms find natural patterns in data,





Arthishwari et al.,

giving us insight and supporting us in making better decisions and forecasts. They're used every day to make critical decisions in fields like medical diagnosis, stock trading, and energy load forecasting, among others. Machine learning is a good option for situations where there is a complex task or problem with a lot of data and numerous variables but no set formula or equation. The popularity of these learning approaches is fast increasing, according to Google Trends data collected over the last five years. In the healthcare industry, Machine learning assists in the rapid identification of high-risk patients, near-perfect diagnosis of those patients, the best available guidance, and the prediction of re-admissions. In this project, our software will help track Range of Motion and collect user health profiles, which will then be fed into a Machine Learning model that will help improve patient health at a cheap cost and in a short amount of time. Other aspects that influence a patient's ability to respond positively to an exercise programmed include goal setting, involvement, intrinsic and extrinsic motivation. While age was determined to have a substantial impact on recovery rates, the research also discovered and investigated a few other aspects that may have an impact.

Anxiety, lifestyle, pain, barriers to exercise, lack of understanding of their condition, and difficulties committing to the time required for exercise are some of the primary influencing factors included in our study to decide on the most influencing factors that would be used as input to the Machine learning model. This study advocated the development of a mobile health monitoring and assistance model for chronic illness management, empowering the elderly, reminding people to take their medications on time, exercising regularly, expanding service to underserved areas, and improving health outcomes. It supports a wide range of Physic Rehabilitation-related healthcare conditions. We developed a real-time rehabilitation application that allows patients to track and submit health data while also assisting physicians by suggesting changes to the training routine and highlighting key elements that influence the patient's recovery. Our research focused on making the app's data accessible from any location, at any time. This was accomplished by storing the collected data safely and securely on a Cloud service, especially Google Cloud. Using the aforementioned parameters, the second phase of our research focused on determining the factors/criteria that would influence recuperation time. The data was then subjected to a series of procedures based on the desired goal. After the outliers in the data were weeded out, the appropriate attributes linked to our use case and having an influence on a person's recovery time were discovered. correlation approaches such as Pearson correlation and Sunburst charts visualization For ranking correlations, were used. The features that were found to contribute to the recovery time were Age (25.0%), BMI (21.4%), Lifestyle (17.9%), Frequency of Exercise (14.3%), Range Of Motion (7.14%), Reaction Time (3.57%) and Involvement (10.7%). These features were the most significant ones that were found to be influencing the recovery rate and hence were selected for training the models.

Keywords: BMI, Reaction time, Frequency Of exercise, Machine Learning, Artificial Intelligence, Rehabilitation, Correlation, Pearson Correlation, Involvement, Range of Motion.

INTRODUCTION

In recent years, smart phones have revolutionized medical communication. This modernization allows medical care to be provided when and where it is required. According to recent statistics, half of Smartphone owners use their devices to get health information, with one fifth using health-related apps. There are numerous Smartphone apps available for healthcare professionals, medical students, patients, and the general public. Smartphone usage is on the



**Arthishwari et al.,**

rise in today's globe. Designing a smart application for an Android phone that will help people focus on their health-related concerns and manage their health on a regular basis, as the use of smart phones is fast expanding and people have easy access to them. Aging, insufficient or infrequent physical activity, and/or a poor diet, which can lead to obesity and a number of chronic diseases, are all typical reasons of mobility loss [1]. By routinely checking a person's mobility condition, a smart monitoring and assistance device can assist them in continuing their normal physical activities and workouts. Continuous joint activity and health monitoring can be recorded and extract key parameters for early diagnosis and treatment of mobility-related issues are considered. Musculoskeletal issues have a significant impact on movement and dexterity, resulting in early retirement from job, poor health, and a reduced ability to participate in society. The number of people with musculoskeletal disorders is gradually increasing as a result of population growth and ageing. A person may require the services of a physiotherapist for a variety of reasons. Everyone, it is said, will suffer from physical discomfort at some point in their lives. Everyone may require rehabilitation at some point in their lives due to an injury, surgery, disease, or illness, or because their function has worsened with age. The therapies and tactics chosen for each person are based on their goals and preferences. Rehabilitation must be a part of the overall health system, particularly primary health care, in order to serve more people in need. The musculoskeletal system is made up of bones, muscles, tendons, ligaments, and soft tissues. They work together to sustain your body's weight and help us. to be mobile Injuries, sickness, and ageing can all cause pain, stiffness, and other problems with movement and function [2].

Physiotherapists help people who have been wounded, ill, or incapacitated with mobility and exercise, manual therapy, education, and counseling. They help patients manage pain and avoid disease, keeping people of all ages healthy. The profession supports in development and recovery by allowing people to remain employed while also remaining self-sufficient for as long as possible. Physiotherapists help people who have been wounded, ill, or incapacitated with mobility and exercise, manual therapy, education, and counseling. They help patients manage pain and avoid disease, keeping people of all ages healthy. The profession supports in development and recovery by allowing people to remain employed while also remaining self-sufficient for as long as possible. Rehabilitation is an important health treatment that should be available to everyone at all stages of life. This includes everyone who has musculoskeletal issues. The focus of efforts to strengthen rehabilitation should be on supporting health systems as a whole and incorporating rehabilitation into all levels of health care. A physician can assist in the management of pain and other symptoms, as well as the development of methods for carrying out everyday tasks and improving one's quality of life and to maintain the range of motion of various Joint at its normal Degrees of Motion as shown in the table below.[2]In 2017, the World Health Organization (WHO) launched the Rehabilitation 2030 project, emphasizing the necessity of all stakeholders working together to improve the health system so that quality and timely rehabilitation can be provided by enhancing data collection and rehabilitation research. The World Health Organization (WHO) continues to support nations in putting these measures in place by providing technical help, offering advice and practical tools, and boosting the development of rigorous evidence for musculoskeletal rehabilitation. For health practitioners to successfully interact with and treat a wide range of patient populations, the change to technology-based practice, particularly Smartphone-based applications, is crucial. Therapeutic compliance has been a source of clinical concern since the 1970s due to the prevalence of non-compliance with therapy and rehabilitation programmers. It's feasible that these new technology breakthroughs will help to improve therapy outcomes[3]. Factors that influence a patient's readiness to respond to and accept home exercise programmers as treatment, as well as the potential for healthcare and physiotherapy Smartphone apps to improve the patient-physiotherapist connection and overall rehabilitation. Patients are increasingly using smartphone apps to collect personal data that they can use alone or in partnership with health care experts to make better health decisions. These data can also be shared with healthcare practitioners to aid in higher-level decision-making in the system. We created a rehabilitation app for smartphones.





Arthishwari et al.,

METHODS

An android physio application was developed and was used in the study. Individuals undergoing rehabilitation for various underlying reasons such as fracture, old age, sedentary lifestyle, and deep anguish were randomly selected for the study. Individuals with difficulties in the elbow joint were considered, and close to 1000 samples were gathered, with the data being fed to the cloud for subsequent processing. Individual details were not acquired or maintained for this study because the data was anonymised. Because data obtained in real-world situations today has the potential to change treatment and lives in the future, the rehabilitation community can collaborate on care and outcome evaluation with this application. Not only would the mobile application assist users in recognizing the training programmed allocated to them, but it would also allow them to track their progress. The designed mobile application would not only help them identify the workout programmed assigned to them, but it would also help them assess their range of motion and collect their medical profile, which would help the physician assign a perfect rehabilitation plan for the user to follow in order to aid and accelerate their recovery [4]. It eliminates the problem of clinician-to-user distance by allowing doctors to communicate with patients and deliver care outside of the hospital at any time and from any location. Android phone-based Physio rehabilitation application was used to measure an individual's joint movements. Additionally, data was collected about the individual's health parameters like

- Height
- Weight
- Blood pressure
- Age
- Gender
- Lifestyle
- Range Of Motion
- Pain level
- Reaction time
- Problem type

Feature selection and extraction

The most crucial aspect of constructing a Machine Learning model is feature selection. When creating a predictive model, it is the process of minimizing the number of input variables. The number of input variables should be reduced to lower the computational cost of modeling and, in some situations, to increase the model's performance. The relationship between each input variable and the goal variable is evaluated using statistics, and the input variables with the strongest link with the target variable are selected as shown in Fig. 1 The lines are parallel while there is no interaction, but when there is an interaction, the lines intersect and we select the Features appropriately. Fig. 2 shows a 3D representation of the interdependent characteristics convergent. Although the type of data in both the input and output variables influences the statistical measures used, these procedures can be quick and effective. As a result, a Machine Learning practitioner may find it challenging to choose an acceptable statistical measure for a dataset while performing filter-based feature selection. High-dimensional data processing is a difficult task for both researchers and application developers in machine learning and data science. It reduces model complexity by removing minor or useless features, helping machine learning algorithms to learn faster. By simplifying and generalizing the model while also increasing its accuracy, an accurate and optimal subset of the selected features in a problem domain can reduce the over fitting problem. It has a significant impact on the target machine learning model's effectiveness and efficiency. Feature extraction methods usually provide a better understanding of the data, as well as a strategy to improve prediction accuracy while reducing processing costs and training time. Feature extraction aims to reduce the amount of features in a dataset by generating new ones from old ones and removing the old ones. The majority of the information provided in the original set of features can then be summarized using this new reduced set of features [4].





Arthishwari et al.,

Correlation

Correlation is a statistical measure of linear relationship between two variables. When there are multiple variables and the goal is to find correlation between them all and store them in a suitable data structure, the matrix data structure is used. The correlation coefficient value is a measurement of the line of best fit's strength.

Pearson's Correlation

The Pearson's Correlation coefficient is equal to the product of the two variables' standard deviations divided by their covariance. A product moment is used to define the definition. The Pearson Correlation coefficient is used to determine the strength of a linear relationship between two variables, with $r = 1$ denoting perfect positive correlation and $r = -1$ denoting perfect negative correlation. Pearson's Correlation can be used to investigate the relationship between a feature and the response variable, as well as to choose which features to employ. and is represented by

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \quad \dots \quad \text{Eqn. 1}$$

Pearson's correlation coefficient for predictors like Age, Body Mass Index (BMI) and Frequency of Exercise are shown in Fig. 3, Fig. 4 and Fig. 5 respectively. A heat map is a two-dimensional data visualization in which colors represent values. A basic heat map can provide a quick visual summary of data. Heat maps with more detail assist the viewer to comprehend more complex data sets. Fig. 6 shows the Heat Map using Pearson Correlation.[5] As we see Age, Lifestyle, Involvement, Frequency of Exercise and Range Of Motion have a profound dependence on each other and play a critical role in Recovery.

RESULT

Our research centered on making the data acquired through the app available from anywhere, at any time. This was accomplished by utilizing a Cloud solution, specifically Google Cloud, to safely and securely store the obtained data. The second phase of our research focused on identifying the factors/criteria that would influence recovery time using the aforesaid parameters. The data was then exposed to various steps in accordance with the intended purpose. The appropriate features related to our use case and having an influence on the recovery time for a person were found after the outliers in the data were weeded out. correlation approaches such as Pearson correlation and Sunburst charts visualization For ranking correlations, were used. These features were the most significant ones that were found to be influencing the recovery rate and hence were selected for training the models.

The features that were found to contribute to the recovery time were

- Age
- BMI
- Lifestyle
- Frequency of Exercise
- Range Of Motion
- Reaction Time
- Involvement

and their respective influence on the outcome is given in Table 2 below

DISCUSSION

Medical practitioners all across the world are looking for new ways to aid patients using cutting-edge techniques that take advantage of advances in other sectors of study. Here, we've attempted to apply ground breaking advances





Arthishwari et al.,

in the domains of artificial intelligence and machine learning to medical concerns. We are utilizing the power of Machine Learning to aid in the recovery of the ever-increasing number of diseases and afflictions. The features that were found to contribute to the recovery time were Age (25.0%), BMI (21.4%), Lifestyle (17.9%), Frequency of Exercise (14.3%), Range of Motion (7.14%), Reaction Time (3.57%) and Involvement (10.7%). These features were the most significant ones that were found to be influencing the recovery rate and hence were selected

CONCLUSION

The future generation of physiotherapists will need to be aware of the changing technological landscape in order to make physiotherapy a more participative experience for patients in the ever-changing world of technology and health applications. This will help to increase motivation and make sticking to a home workout routine easier. The new face of physiotherapy software can help patients stick to their treatment programmers by creating an engaging exercise environment that supports self-efficacy and behavior change through improved communication, goal setting, and progress reporting.

REFERENCES

1. Kamel Boulos, M, Brewer, A, Karimkhani, C, Buller, D & Dellavalle, R 2014, 'Mobile medical and health apps: state of the art, concerns, regulatory control and certification', *Journal of Public Health Information*, vol. 5, no. 3, p. 229.
2. Liebesman, J 1993, *The physiology of range of motion in human joints: a critical review*, Toronto, Ontario, Canada.
3. Sarker, IH 2021, 'Machine learning: Algorithms, real-world applications and research directions', *Computer Science*, vol. 2, no. 3, pp. 1-21.
4. Arthishwari, K & Anand, M 2020, 'Design of LSTM-RNN on a sensor based HAR using android phones', *International Journal of Recent Technology and Engineering*, vol. 8, no. 5, pp. 4250-4257.
5. Arthishwari, K, Anand, M, Padmanabhan, K, Janakirani, M & Veena Kirthika, S 2020, 'Smart phone ROM Measurements based on action recognition In Rehabilitation Using Deep Learning', *International Journal of Advanced Science and Technology*, vol. 29, no. 12s, pp. 1257-1267.

Table 1. Normal Range of Motion of various Joints of human body

| Joint | Action | Degrees of Motion |
|----------|-------------------|-------------------|
| Shoulder | Flexion | 160 degrees |
| | Extension | 50 degrees |
| | Abduction | 180 degrees |
| | Internal rotation | 45 degrees |
| | External rotation | 90 degrees |
| Elbow | Flexion | 160 degrees |
| | Extension | 0 degrees |
| Forearm | Pronation | 90 degrees |
| | Supination | 90 degrees |
| Wrist | Flexion | 90 degrees |
| | Extension | 70 degrees |
| | Radial deviation | 20 degrees |
| | Ulnar deviation | 30 degrees |
| Hip | Flexion | 120 degrees |
| | Extension | 0-10 degrees |
| | Abduction | 40 degrees |





Arthishwari et al.,

| | | |
|-------|-------------------------|-------------|
| | Adduction | 15 degrees |
| | Internal rotation | 45 degrees |
| | External rotation | 45 degrees |
| Knee | Flexion | 140 degrees |
| | Extension (hip neutral) | 0 degrees |
| | Extension (hip flexed) | 20 degrees |
| Ankle | Plantarflexion | 45 degrees |
| | Dorsiflexion | 20 degrees |
| Foot | Inversion | 30 degrees |
| | Eversion | 10 degrees |

Table 2. Factors and their Degree of Influence

| Factor | Degree of Influence |
|-----------------------|---------------------|
| Age | 25.0% |
| Reaction Time | 3.57% |
| BMI | 21.4% |
| Lifestyle | 17.9% |
| Frequency of Exercise | 14.3% |
| Involvement | 10.7% |
| Range of Motion | 7.14% |

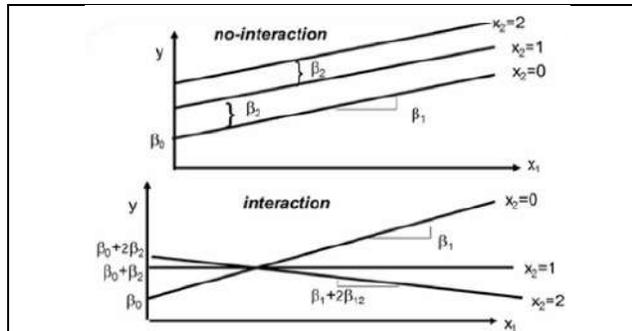


Fig. 1 Feature with and without Interaction

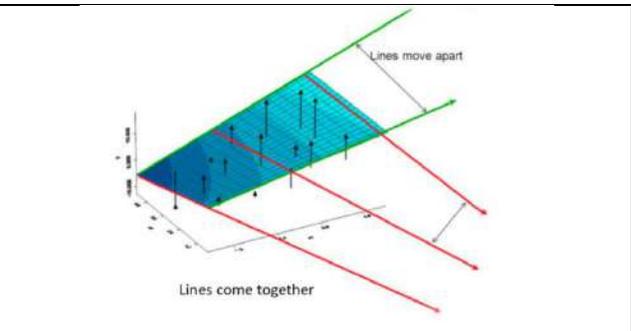


Fig. 2 3D Model of Interdependent Features



Fig. 3 Pearson Plot - Age vs Rate of Recovery



Fig. 4 Pearson Plot- BMI vs Rate of Recovery





Arthishwari et al.,

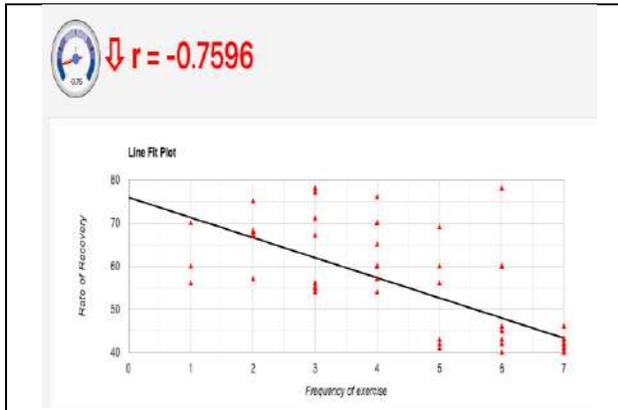


Fig. 5 Pearson Plot- Frequency of Exercise vs Rate of Recovery

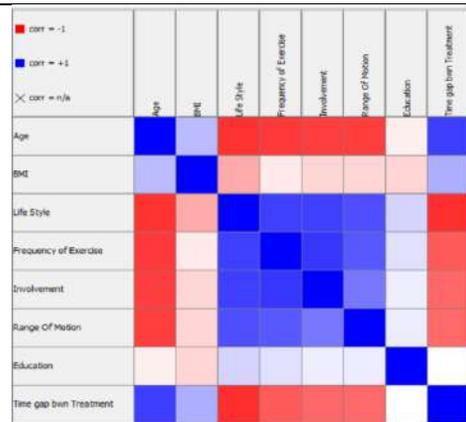


Fig. 6 Heat Map Representation- Pearson Correlation

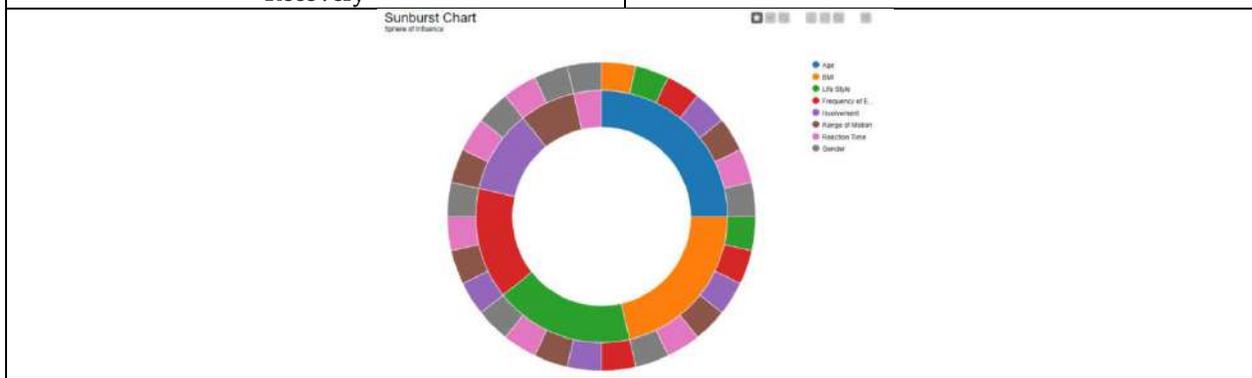


Fig. 7 Sphere of Influence





Financial and Banking Services Industries based on Artificial Intelligence

Manoj Kumara N. V^{1*}, S.Mohana Murali² and Aashish A Gadgil³

¹Associate Professor, Department of Management Sciences, Maharaja Institute of Technology, Mysore, Karnataka, India.

²Lecturer in Commerce, Govt.Degree College Srisailam Project, Nandyal Dist., A.P, India.

³Assistant Professor, Electronics and Communication Engineering, KLA Gogte Institute of Technology, Belagavi, Karnataka, India

Received: 02 May 2022

Revised: 05 June 2022

Accepted: 02 July 2022

*Address for Correspondence

Manoj Kumara N. V

Associate Professor,
Department of Management Sciences,
Maharaja Institute of Technology,
Mysore, Karnataka, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Applications of Artificial Intelligence in Financial services recently been created and deployed, enabling business solutions in both front end and back end operations to improve efficiency and provide an amazing client experience. AI and machine learning are now widely regarded at the same time as the mainly important enablers for achievement a reasonable edge throughout improving executive capability and revolutionising the banking business. This paper will highlight AI's uses and evaluate its applicability in several functional areas of the financial industry, with a focus on banking operations automation and client interaction. It finishes with a look at how banks and financial institutions design their environments and employ computational intelligence to better their operations.

Keywords:- Artificial Intelligence , banking efficiency ,Company, Education ,Financial services,

INTRODUCTION

Computing intelligence along with machine learning contain seen increased require and awareness in the bank and economic services business in recent years, through the prospect that they can improve administrative, advance logical capabilities, and automate business processes such as lending, insurance, fraud recognition, fulfilment and policies, consumer experience, and risk organization[1]. The introduction of deep learning, according [2], has resulted in a boom and is a breakthrough that has permitted better analyses with less human input. To eliminate





Manoj Kumara et al.,

errors and efficiently adapt regulatory and infrastructure changes, AI is presently employed in data mining [3], Recognition of voices, patterns, market research, and investment strategies, and IT system development in the financial arena.

The volume of data (big data - BD) collected by financial sector. The organisations have increased dramatically in recent years, necessitating a need to understand and analyse this data repository in order to improve service. The corporate sector and society are undergoing significant technical advancements, and this new technology (artificial intelligence - AI) has allowed us to look at complicated problems and provide solutions in a timely manner. The phenomena of combining BD with AI is known as "BD AI," and it involves using computational learning to current data to provide insights that aid product and process innovation [4]. Executives in the financial services business find artificial intelligence (AI) to be highly intriguing, but they are also sceptical and apprehensive about its acceptance. Despite the fact that there has been ongoing innovation and investment in computational intelligence around the world, and AI promises to bring faster and smarter better business decisions, customer experiences, and risk management outcomes, there is still a lot of scepticism [5]. This risk can be eliminated if banks and financial institutions take a methodical approach to managing AI models from conception until retirement.

Banking and financial organisations must identify areas of concern and take appropriate efforts to build a route for AI adoption in this rapidly changing business environment. Banking services are highly regulated, necessitating a hybrid of old and current AI frameworks for model management .It remains to be determined is how these changes can be made in a way that allows banks and other financial institutions to effectively and continuously incorporate AI into their operations and judgement, allowing AI's acceptance and benefits to be realised. Cost reductions, greater process efficiency, and improved quality are just a few of the claimed benefits of industry 4.0. This article examines the several computing (SI) tasks in payments and corporate sectors, as well as the benefits they are reaping.

Literature Review

Computational intelligence and mechanism learning are used for a broad variety of application in the bank and economic services Education and Company . Because technology is growing, it is important to understand its stability. Developments must be continuously watched, and the hazards associated with it must be effectively controlled. Highlighted the rise in financial reporting fraud and its costs in recent years. The introduction of computer technology to numerous commercial applications can aid in the detection and prediction of fraud. The application of various AI strategies resulted in a 40 percent increase in bank productivity. AI's diverse set of solutions will aid in the processing of large amounts of data and the completion of cognitive activities that would otherwise require humans. [9] discussed the influence of AI event a bank's commerce to business customer relationship. The study emphasised three implication: New technology the employees to adjust to AI, the impact of AI on your industry, and examining the bottlenecks to AI's impact.

He believes that if executives examine these three consequences, their long-term viability will not be a problem in the future uncertain times. According to David He et al. [10], AI will impact the banking and finance business in three ways: creation, intelligence, and automation in the coming year. It will help people make better decisions, increase automation, develop simulated intelligence, save money, and start new enterprises. Another viewpoint, as offered by Paul Dravis [11], is that of the financial employment market. Some positions will be relocated, others will be reformed, and new employment opportunities will be created, according to him. AI will improve corporate productivity, as well as create and maintain more jobs.

According to the study, banking efficiency will increase by 42 percent by 2027, insurance efficiency will increase by 29 percent, and capital markets efficiency will increase by 56 percent. In the same year, Alison Lui et al. [12] investigated how AI and simulated intelligence may work together to restore trust in the banking and financial sector. The need of collaboration is discussed in the paper in order for businesses and regulators to create flawless regulations and stability. AI's Evolution The history of artificial intelligence may be traced back to the early 1950s, when Allan Turing postulated that humans use knowledge accessible to them and apply reasoning to make





Manoj Kumara et al.,

effective decisions and conquer obstacles, so why couldn't robots do the same. There was little advancement because computing machines and systems were still in their infancy. The computers were able to learn from their previous experiences. Until the 1990s, the focus was on increasing computing power and supplementing it with logic programming, which formed the foundation of commercial artificial intelligence. However, the progress was not encouraging, and AI research and development lost steam. Despite this, AI research has exploded in the recent two decades, beginning with IBM's development of 'Deep Blue,' a computer capable of playing chess with humans. It was the first time a individual aptitude was vanquished by a artificial device when Deep Blue overcome globe supporter .The following diagram depicts AI's future development [13] proposed an AI base representation for recognition furthermore lending decision, based on the environment of risk involved with lending. This concept will allow banks, lending and credit organisations to have complete control over the loan process. This type of AI-based approach will ensure that only the most deserving applications with low credit risk are accepted, while high-risk applications are denied. In most cases, banks use a manual credit evaluation process based on traditional statistical approaches to assess credit eligibility.

Traditional models are used to produce credit ratings, which are then utilised to make lending choices for businesses and consumers. The basic and primary input data points for most credit evaluation models are financial transaction data and payment history with banking and financial organisations. To compute a credit score utilising restricted sets of structured data, the most often utilised classical tools include regression, decision trees, and statistical analysis. However, with the advancement of technology, lending institutions now have access to a plethora of new data sets, including unstructured and semi-structured data sources, primarily from online searches and social networking activity. To compile a comprehensive data set that reflects a holistic perspective of creditworthiness and improve the accuracy of credit and loan decisions, researchers looked at online content consumption, online shipping, and text message activity. According to Stephan et al.[14], the use of machine learning techniques and algorithms opens up new horizons in credit evaluation by combining qualitative characteristics such as spending pattern with ability and willingness to pay. Using incremental data sets, loan applications of varying borrower quality can be segmented efficiently and effectively. It's also worth noting that accessing these new data sets may fall under the purview of data privacy and protection, thus lending institutions should proceed with caution to prevent policy concerns. Nicholas uses an AI-powered virtual assistant to provide great customer service.

In 2022, he proposed the idea of artificial quick agent in favour of economic markets. The future AI bots, which would be a software result base going on heuristics with personality knowledge algorithms, may replicate human intellect in a required situation. Since then, chatbots based on AI have been developed and are widely used in major commercial banks across the world. Banks such as Head Quarters of capital groups are employing chatbots to communicate with consumers and provide personalised experiences. Modern chatbots are computer programmes that engage with clients in their accepted language, together with speech and text. They are built on the notion of Natural Language Processing. These systems use machine learning algorithms with self-learning capabilities to assure continual improvement and give clients with immediate assistance and transaction support. Chatbots have a huge economic impact in the financial services industry. According to Gartner, by the end of 2020, chatbots will handle more than 85 percent of all customer service contacts. Furthermore, according to the Juniper analysis, the deployment of chatbots will result in an annual savings of \$8 billion by 2022.

Insurance AI Applications

Insurance AI Applications In developing economies, insurance is becoming increasingly popular. Underwriting, claim processing, actuaries, and risk assessment are just a few examples of AI usage [16]. Leading insurance companies are also incorporating real-time granular data pertaining to telematics and location-based marketing captured through sensors, connected devices, location tracking, and digital footprints into machine learning algorithms to assess individual pricing and marketing of highly personalised insurance products. Machine learning and natural language processing are the core building blocks of such systems, which learn from claims history data sets and provide claim estimates.





Manoj Kumara et al.,

Furthermore, it reduces the cost of operating as well as the time it takes to process insurance claims. Artificial Intelligence (AI) for Fraud Detection One of the most sought-after applications of AI in the banking and financial services industry is fraud detection. Financial fraud, according to Dahee et al. [17], is defined as the unlawful use of mobile transactions made on mobile devices and platforms as a result of identity theft, which leads to fraudulent activities. Financial fraud can be defined in general terms as the fraudulent use of credit cards or cash cards, false claims against insurance policies, unauthorised transactions, and fund transfers made under a stolen identity.

Artificial intelligence

Artificial intelligence has progressed to the point that machine learning can accurately detect fraudulent transactions. The underlying algorithm analyses historical data in order to construct a sophisticated prediction model. If historical data is insufficient for analysis, it can be supplemented with transaction data that the investigator believes is suspect, as well as typical fraud detection systems. The combined data can then be sent into a multi-layer neural network to create predictive models capable of creating patterns and sets at a level of precision only feasible with deep learning designs and algorithms.

The activities motivation be of tremendous use to financial industry fraud detectives since they give a trustworthy mechanism in the form of a dependable prediction and estimation tool. In the financial industry, AI is being used to address regulatory and compliance challenges. Following the global financial crisis and recession of 2008, banking institution all over the world were forced to focus on regulatory compliance. Banks have been hiring new and more fulfilment officers in order to prevent repeat crises. However, given the massive number of transactions that occur internationally, manual monitoring of compliance processes in a large institution was not practicable. Bart van Liebergen [18] explains how, in the aftermath of the financial crisis, new regulations required financial companies to provide extensive data, including business models and balance sheets.

Financial institutions were required to report substantial exposure, liquidity method, security, and investment levels. Innovative solvency rules, as well as the inclusive resources examination and check and previous narrow obligations, have dramatically expanded reporting requirements. To address this issue, banks are increasingly implementing artificial intelligence systems to manage a number of operations such as anti-money laundering programmes, KYC standards, sanctions list monitoring, card, billing, and payment-related scheme, and most recent universal fulfilment functions. Apart from that, with the use of AI approaches, financial firms are supporting governments in tracing currency laundering, intimidation financing, and last dubious global connections.

Major banks have already begun to use AI systems for this purpose, with additional banks planning to do so in the next two to three years [19]. Suggestions and a Plan of Action With the decreasing costs of server and storage, computing, bandwidth, and processing, new frontiers in risk, data organization, acknowledgment analysis, insurance pooling, and trade through massive amounts of data acquired from enveloping and active outside sensor and smart mobile phone data have opened up. Banking and financial organisations will be able to accurately emulate humans in their decision-making processes thanks to the Internet of Things (IoT) combined with AI and machine learning. However, according to [20], economic institutions be not arranged or able to deal with such shift.

CONCLUSION

Banking technology that enables important technology and backbone to companies, has been a partner of Banking and financial institutions in their pursuit of AI adoption, according to the research. FinTech will continue to prepare themselves for the next level of Internet of Things (IoT), which will be aided by quantum computing's multi-fold rise in the next decades. This change will allow for the establishment of whole new asset classes and technical capabilities, resulting in the development of new banking and financial services business practises and even business models. The company would be present capable to establish new allied businesses by combining information beginning phones, public standard platform, internet behaviours, furthermore billions of latest sensors.





Manoj Kumara et al.,

REFERENCES

1. Bart van Liebergen , Machine Learning: A Revolution in Risk Management and Compliance? , The CAPCO institute Journal of Financial Transformation.
2. Rjoyi kashiwagi, Utilization of Artificial Intelligence in finance, 2015.
3. Hossein Hassani, Xu Huang, and Emmanuel Silva , Digitalisation and Big Data Mining in Banking, 2018.
4. Big data meets artificial intelligence Challenges and implications for the supervision and regulation of financial services , Federal Financial Supervisory Authority BaFin (2018).
5. Jeffrey Brown, Tammi Ling, Ege Gurdeniz, managing next generation artificial intelligence in banking a new paradigm for model management, 2017.
6. John Schindler et.al. ,Artificial intelligence and machine learning in financial services Market developments and financial stability implications , 2017.
7. Jerry W. Lin , Mark I. Hwang and Jack D. Becker , A fuzzy neural network for assessing the risk of fraudulent financial reporting
8. Peter Koning , Artificial Intelligence (AI) for Financial Services Deploying Deep Learning Techniques to Banking, Insurance and Financial Transactions , Similarity White Paper for Stakeholder Engagement.
9. Jonas Uyttendaele , Artificial Intelligence in corporate banking a closer look at the potential impact on e-business processes , 2017.
10. David He, Michael Guo, Jerry Zhou and Venessa Guo , The Impact of AI on financial Job Market , March 2018.
11. Paul Dravis, Artificial Intelligence in Finance: The Road Ahead, 2018.
12. Alison Lui & George William Lamb (2018) Artificial intelligence and augmented intelligence collaboration: regaining trust and confidence in the financial sector, Information & Communications Technology Law,27:3, 267-283.
13. Shorouq Fathi Eletter, Saad Ghaleb Yaseen and Ghaleb Awad Elrefae: Neuro-Based Artificial Intelligence Model for Loan Decisions, American Journal of Economics and Business Administration 2 (1): 27-34, 2010
14. Stefan Lessmann, Bart Baesens, Hsin-Vonn Seow, and Lyn Thomas (2015), "Benchmarking state-of-the art classification algorithms for , credit scoring: An update of research," European Journal of Operational Research 247(1): 124-136
15. Tomaso Poggio, Andrew W. Lo, Blake LeBaron, Nicholas T. Chan, Agent-based Models of Financial Markets: A Comparison with Experimental Markets, October 2001, MIT Sloan School of Management Sloan Working Paper 4195-01
16. Clyde W. Holsapple, Kar Yan Tam and Andrew B. Whinston, Adapting Expert System Technology to Financial Management, Financial Management Vol. 17, No. 3
17. Dahee Choi and Kyungho Lee , An artificial Intelligence Approach to Financial Fraud Detection under Iot Environment: A survey and implementation, security and communication Networks, 2018. [18] Bart van Liebergen, Machine Learning: A Revolution in Risk Management and Compliance, the Capco Institute Journal of Financial Transformation
18. Ben DiPietro, Financial Firms Turn to Artificial Intelligence to Handle Compliance Overload, The Wall Street journal, May 19, 2016
19. Paul Schulte and Gavin Liu, FinTech Is Merging with IoT and AI to Challenge Banks: How Entrenched Interests Can Prepare, The Journal of Alternative Investments Winter 2018, 20 (3) 41-57





On Odd Prime Labeling Union of Some Graphs

T.Malathi^{1*}, K.Balasangu¹ and R.Saravanan²

¹Assistant professor, Department of Mathematics, Thiru Kolanjiappar Government Arts College, Vridhachalam, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Govt. Arts College For Men (Autonomous), Nandanam, Chennai 600035, Tamil Nadu, India.

Received: 07 May 2022

Revised: 06 June 2022

Accepted: 07 July 2022

*Address for Correspondence

T.Malathi,

Assistant professor,

Department of Mathematics,

Thiru Kolanjiappar Government Arts College,

Vridhachalam, Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In this paper, we investigate odd prime labeling for some union related graphs. We also discuss odd prime labeling in the context of some union graphs namely, crown graph, cycle of cycle, brush graph, $(Z-P_n)$ and $S_n \cup K_{1,n}$ odd prime graph.

Keywords: : prime graph, odd prime graph, union of graph.

INTRODUCTION

In this paper, we consider only finite, simple, undirected graph. The graph G has vertex set $V = V(G)$ and the edge set $E = E(G)$. The set of vertices adjacent to a vertex u of G is denoted by $N(u)$. For notation and terminology, we refer to J.A Bondy and U.S.R Murthy [1]. [2] Burton is referred for number of theoretical notations. For more details about the known results on odd prime labeling [6,10]. We need the basic definitions taken from [5 to 9].

“Definition 1.1: If the vertices of the graph assigned values subject to the certain condition then it is known as (vertex) graph labeling.

Definition 1.2: Let $G = (V(G), E(G))$ be a graph with p vertices and q edges. A bijection f mapping from $(G) \rightarrow \{1, 2, 3, 4, \dots, p\}$ is called a prime labeling. If for each edge $e = uv$, $\gcd(f(u), f(v)) = 1$. A graph G which admits prime labelling is called prime graph. An injective function $f : V(G) \rightarrow \{1, 3, 5, \dots, 2n-1\}$ such that for every edge $xy \in E(G)$, $f(x)$ and $f(y)$ are relatively odd prime. A graph G which admits odd prime labeling is called an odd prime graph.

Definition 1.3: Crown graph is corona product of n - cycle and complete graph K_1 .

Definition 1.4: The graph $(Z-P_n)$ is obtained from two path P_n and P'_n of same length n , by joining the i th vertex of p_n





Malathi et al.,

to the $i-1$ the vertex of P'_n . the resulting graph is denoted as $(Z-P_n)$.

Definition 1.5: The sunlet graph S_n is the graph obtained from a cycle C_n attaching a pendent edge at each vertex of the cycle C_n .

Definition 1.6: K_1 with n pendent edges incident with $V(K_1)$ is called a star graph."

MAIN RESULTS

Theorem:2.1 The disconnected graph $C_n \odot K_1 \cup C_n \odot K_1, n \geq 3$ is odd prime graph.

Proof : Let G is a union of double copies of crown graph $C_n \odot K_1$ with total number of vertex set and edge set define $V(G) = \{ u_1, u_2, u_3, \dots, u_n, v_1, v_2, v_3, \dots, v_n \} \cup \{ u'_1, u'_2, u'_3, \dots, u'_n, v'_1, v'_2, v'_3, \dots, v'_n \}, E(G) = \{ u_i v_i, u_n v_n, u_i u_{i+1}, u_1 u_n, u'_i v'_i, u'_n v'_n, u'_i u'_{i+1}, u'_1 v'_n \}, i = 1$ to $n - 1$.

Total number of vertex set is $V(C_n \odot K_1) = 4n$, here n is a positive integer.

Total number of edge set is $E(C_n \odot K_1) = 4n$, here n is a positive integer.

Define $g : V(H) \rightarrow \{1, 3, 5, \dots, 4n\}$ as follows

$$g(u_i) = 4i - 3,$$

$$g(v_i) = 4i - 1,$$

$$g(u'_i) = 4n + 4i - 3,$$

$$g(v'_i) = 4n + 4i - 1,$$

Where i values from 1 to n . In G we have to check the relatively odd prime of $g(u_i), g(v_i), g(u'_i)$ and $g(v'_i)$.

According to this figure,

$$\text{Now } \gcd(g(u_i), g(v_i)) = \gcd(4i - 3, 4i - 1) = 1, \text{ for } i \text{ values } 1 \text{ to } n,$$

$$\gcd(g(u_i), g(u_{i+1})) = \gcd(4i - 3, 4i + 1) = 1, \text{ for } i \text{ values } 1 \text{ to } n - 1,$$

$$\gcd(g(v_i), g(v_{i+1})) = \gcd(4i - 1, 4i + 3) = 1, \text{ for } i \text{ values } 1 \text{ to } n - 1,$$

$$\gcd(g(u'_i), g(v'_i)) = \gcd(4n + 4i - 3, 4n + 4i - 1) = 1, \text{ for } i \text{ values } 1 \text{ to } n,$$

$$\gcd(g(u'_i), g(u'_{i+1})) = \gcd(4n + 4i - 3, 4n + 4i + 1) = 1, \text{ for } i \text{ values } 1 \text{ to } n - 1,$$

$$\gcd(g(v'_i), g(v'_{i+1})) = \gcd(4n + 4i - 1, 4n + 4i + 3) = 1, \text{ for } i \text{ values } 1 \text{ to } n - 1 \text{ and finally hence proved } G \text{ is odd prime graph.}$$

Theorem 2.2: The disconnected graph $C_n(C_n) \cup C_n(C_n)$, is an odd prime graph for n is only odd positive integer

Proof: Let G is a union of double copies of cycle of cycle graph $C_n(C_n) \cup C_n(C_n)$ with total number of vertex set and edge set define $V(G) = \{ u_1, u_2, u_3, \dots, u_n, u'_1, u'_2, u'_3, \dots, u'_n \} \cup \{ v_1, v_2, v_3, \dots, v_n, v'_1, v'_2, v'_3, \dots, v'_n \}$

$$E(G) = \{ u_i u'_i, u_i u_{i+1}, u_1 u_n, u'_i u'_{i+1}, u'_1 u'_n, v_i v'_i, v_i v_{i+1}, v_1 v_n, v'_i v'_{i+1}, v'_1 v'_n \}, i = 1 \text{ to } n - 1.$$

Total number of vertex set is $V(C_n(C_n)) = 4n$, here n is a positive integer.

Total number of edge set is $E(C_n(C_n)) = 6n$, here n is a positive integer.

Define $g : V(C_n(C_n) \cup C_n(C_n)) \rightarrow \{1, 3, 5, \dots, 4n\}$ as follows,

$$g(u_i) = 4i - 3,$$

$$g(u'_i) = 4i - 1,$$

$$g(v_i) = 4n + 4i - 3,$$

$$g(v'_i) = 4n + 4i - 1,$$

Where i values 1 to n . In G we have to check the relatively odd prime of $g(u_i), g(u'_i), g(v_i)$ and $g(v'_i)$. Sum of any two adjacent vertices is divisible by 2. Difference of any two adjacent and vertices is divisible by 2.

According to this figure,

$$\text{Now } \gcd(g(u_i), g(u'_i)) = \gcd(4i - 3, 4i - 1) = 1, i \text{ values } 1 \text{ to } n,$$

$$\gcd(g(u_i), g(u_{i+1})) = \gcd(4i - 3, 4i + 1) = 1, i \text{ values } 1 \text{ to } n - 1,$$

$$\gcd(g(u'_i), g(u'_{i+1})) = \gcd(4i - 1, 4i + 1) = 1, i \text{ values } 1 \text{ to } n - 1,$$

$$\gcd(g(v_i), g(v'_i)) = \gcd(4n + 4i - 3, 4n + 4i - 1) = 1, i \text{ values } 1 \text{ to } n,$$

$$\gcd(g(v_i), g(v_{i+1})) = \gcd(4n + 4i - 3, 4n + 4i + 1) = 1, i \text{ values } 1 \text{ to } n - 1,$$

$$\gcd(g(v'_i), g(v'_{i+1})) = \gcd(4n + 4i - 1, 4n + 4i + 1) = 1, i \text{ values } 1 \text{ to } n - 1 \text{ and finally hence proved } G \text{ is odd prime graph.}$$





Malathi et al.,

Theorem 2. 3: The disconnected graph $D(B_n) \cup D(B_n)$, is an odd prime graph, for all n positive integer.

Proof: Let G is a union of double copies of brush graph $D(B_n) \cup D(B_n)$ vertex set and edge set define $V(G) = \{u_1, u_2, u_3, \dots, u_n, u'_1, u'_2, u'_3, \dots, u'_n\} \cup \{v_1, v_2, v_3, \dots, v_n, v'_1, v'_2, v'_3, \dots, v'_n\}$

$E(G) = \{u_i u'_{i+1}, u_i u_{i+1}, u'_i u'_{i+1}, v_i v'_{i+1}, v_i v_{i+1}, v'_i v'_{i+1}\}, i = 1$ to n

Total number of vertex set is $V(C_n) = 4n$, here n is a positive integer.

Define $g : V(H) \rightarrow \{1, 3, 5, \dots, 4n\}$ as follows

$$g(u_i) = 4i - 3,$$

$$g(u'_i) = 4i - 1,$$

$$g(v_i) = 4n + 4i - 3,$$

$$g(v'_i) = 4n + 4i - 1,$$

Where i values 1 to n . In G we have to check the relatively odd prime of $g(u_i), g(u'_i), g(v_i)$ and $g(v'_i)$. Sum of any two adjacent and non adjacent vertices is divisible by 2. Difference of any two adjacent and non adjacent vertices is divisible by 2.

Now $\gcd(g(u_i), g(u'_i)) = \gcd(4i - 3, 4i - 1) = 1, i$ values 1 to n ,

$\gcd(g(u_i), g(u_{i+1})) = \gcd(4i - 3, 4i + 1) = 1, i$ values 1 to $n - 1$,

$\gcd(g(v_i), g(v'_{i+1})) = \gcd(4n + 4i - 3, 4n + 4i - 1) = 1, i$ values 1 to n ,

$\gcd(g(v_i), g(v_{i+1})) = \gcd(4n + 4i - 3, 4n + 4i + 1) = 1, i$ values 1 to $n - 1$,

and finally hence proved G is odd prime graph.

Theorem 2. 4: The disconnected graph $(Z-P_n) \cup (Z-P_n)$, is an odd prime graph, for all n positive integer

Proof: Let G is a union of double copies of $(Z-P_n)$ graph $(Z-P_n) \cup (Z-P_n)$, vertex set and edge set define $V(G) = \{u_1, u_2, u_3, \dots, u_n, u'_1, u'_2, u'_3, \dots, u'_n\} \cup \{v_1, v_2, v_3, \dots, v_n, v'_1, v'_2, v'_3, \dots, v'_n\}$

$E(G) = \{u_i u'_{i+1}, u_i u_{i+1}, u'_i u'_{i+1}, v_i v'_{i+1}, v_i v_{i+1}, v'_i v'_{i+1}\},$ for $i = 1$ to n

Total number of vertex set is $V(Z-P_n) = 4n$, here n is appositve integer.

Total number of edge set is $V(Z-P_n) = 4n + 4$, here n is appositve integer.

Define $g : V(Z-P_n) \cup (Z-P_n) \rightarrow \{1, 3, 5, \dots, 4n\}$ as follows

$$g(u_i) = 4i - 1,$$

$$g(u'_i) = 4i - 3,$$

$$g(v_i) = 4n + 4i - 1,$$

$$g(v'_i) = 4n + 4i - 3,$$

Where i from values 1 to n . In G we have to check the relatively odd prime of $g(u_i), g(u'_i), g(v_i)$ and $g(v'_i)$. Sum of any two adjacent and non adjacent vertices is divisible by 2. Difference of any two adjacent and non adjacent vertices is divisible by 2.

Now $\gcd(g(u_i), g(u'_{i+1})) = \gcd(4i - 1, 4i - 3) = 1,$ for i values 1 to $n - 1$,

$\gcd(g(u_i), g(u_{i+1})) = \gcd(4i - 1, 4i + 3) = 1, i$ values 1 to $n - 1$,

$\gcd(g(u'_i), g(u'_{i+1})) = \gcd(4i - 3, 4i + 1) = 1, i$ values 1 to $n - 1$,

$\gcd(g(v_i), g(v'_{i+1})) = \gcd(4n + 4i - 1, 4n + 4i - 3) = 1,$ for i values 1 to $n - 1$,

$\gcd(g(v_i), g(v_{i+1})) = \gcd(4n + 4i - 3, 4n + 4i + 1) = 1,$ here i values 1 to $n - 1$,

$\gcd(g(v'_i), g(v'_{i+1})) = \gcd(4n + 4i - 3, 4n + 4i + 1) = 1,$ here i values 1 to $n - 1$,

and finally hence proved G is odd prime graph.

Theorem 2.5: The disconnected graph $(P_n \cup P_n)$ is an odd prime graph, for all n positive integer

Proof: Let G is a path union of double copies of path graph $(P_n \cup P_n)$ vertex set and edge set define $V(G) = \{u_1, u_2, u_3, \dots, u_n\} \cup \{v_1, v_2, v_3, \dots, v_n\}$

$E(G) = \{u_i u_{i+1}, u v_{i+1}\}$ for $i = 1$ to n

Total number of vertex set is $V(P_n) = 2n$, here n is appositve integer.

Total number of edge set is $E(P_n) = 2n - 2$, here n is appositve integer.

Define $g : V(P_n) \cup (P_n) \rightarrow \{1, 3, 5, \dots, 2n\}$ as follows

$$g(u_i) = 2i - 1,$$

$$g(v_i) = g(u_n) + 2i,$$





Malathi et al.,

Where i values 1 to n . In G we have to check the relatively odd prime of $g(u_i)$, $g(v_i)$. Sum of any two adjacent vertices divisible by 2. Difference of any two adjacent vertices is divisible by 2.

Now $\gcd(g(u_i), g(u_{i+1})) = \gcd(2i-1, 2i+1) = 1$, for i values 1 to $n-1$,

$\gcd(g(v_i), g(v_{i+1})) = \gcd(2n+2i+1, 2n+2i+3) = 1$, here i values 1 to $n-1$,

and finally hence proved G is odd prime graph.

Theorem 2.6:

The disconnected graph $S_n \cup K_{1,n}$ is an odd prime graph.

Proof:

Let $V(S_n)$ be a set of vertices $\{u_1, u_2, u_3, \dots, u_n, v_1, v_2, v_3, \dots, v_n\}$ and

$E(S_n)$ be set of edges $\{u_i v_i / 1 \leq i \leq n\} \cup \{u_i u_{i+1} / 1 \leq i \leq n-1\} \cup \{u_1 u_n\}$.

$V(K_{1,n}) = \{x_1, x_2, x_3, \dots, x_n\}$

$E(K_{1,n}) = \{x_1, x_i\}$ for $2 \leq i \leq n$

clearly $V(S_n \cup K_{1,n}) = V(S_n) \cup V(K_{1,n})$

$E(S_n \cup K_{1,n}) = E(S_n) \cup E(K_{1,n})$

$V(S_n \cup K_{1,n}) = 3n+1$

Define $g: V(G) \rightarrow \{1, 3, 5, \dots, 3n+1\}$ as follows

Let $g(u_i) = 4i-3$ for $1 \leq i \leq n-1$

$g(v_i) = 4i-1$ for $1 \leq i \leq n$ and let " p " be the smallest prime number more than $4n+1$."

$g(x_1) = p$,

Let $g(x_i) = 4n+i$ for $2 \leq i \leq k - (4n+1) - 1$,

$g(x_i) = 4n+1+2i$ for $k-4n+1 \leq i \leq n$

Therefore G admits an odd prime labeling. Hence $S_n \cup K_{1,n}$ is an odd prime graph.

CONCLUSION

In this paper, we show that the union of crown, union of cycle of cycle, union of double brush, union of path, $Z-p$, union of sunlet and star are odd prime graph.

REFERENCES

1. J.A. Bondy and U.S.R Murthy, "Graph Theory and Applications", (North - Holland). New York (1976).
2. Burton DM, "Elementary Number Theory" 6th edition, 2007; 1-451`
3. Gallian J.A, "A dynamic survey of graph labelling" 2018; twenty first edition
4. H.C. Fu and K.C dynamic survey of graph labeling", The electronic journal of combinations 16 DS6 (2009)
5. U.M Prajapati & K.P.Shah, " Odd Prime Labeling of Graphs with Duplication Of Graph Elements" Journal of Applied Science and computations
6. Edward samuvel, S.Kalavani, " Prime Labeling to Brush Graph" ,International Journal Of Mathematics Trends and Technology (IJMTT) Volume 55 november 4-march 2018.
7. S.K Patel and Jayesh Vasava, " On Prime Labeling On Some Union Graphs", Kragujevac Journal of Mathematics Volume 42(3) (2018).
8. S.K Patel, A N Kansagara, " On Prime Labeling On Some Union Graphs, International Journal Of Scientific Research in Mathematical statistical Science Volume 6 november 4-february 2019.
9. S. Meena and A.Ezhil, Total Prime for Some Graphs, International Journal Of Research in Advent Technology, Voi.7, No 1. January 2019
10. K.Balasangu and T.Malathi, "Prime Labeling For Some Bistar Related Graphs" AIP Conference Proceeding 2364, 020002(2021).





Malathi et al.,

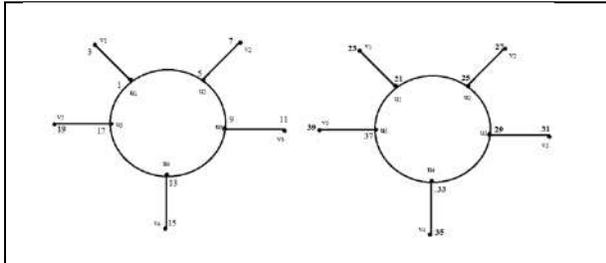


Figure 1 : Union of $C_n \odot K_1$ and $C_n \odot .K_1$ odd prime graph.

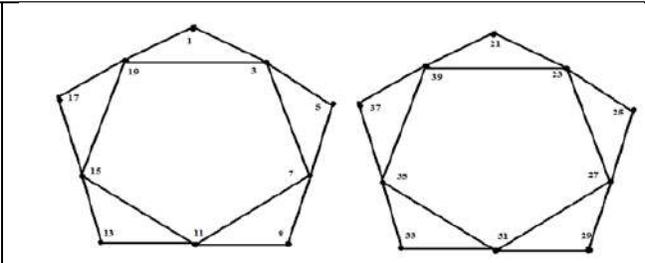


Figure 2 : Union of $C_n(C_n)$ and $C_n(C_n)$ odd prime graph

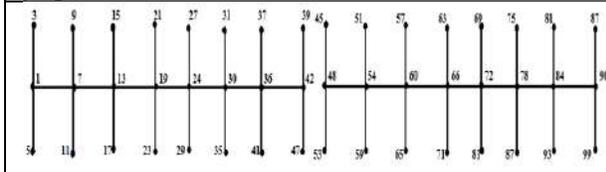


Figure 3: Union of $D(B_5)$ and $D(B_5)$ odd prime graph.

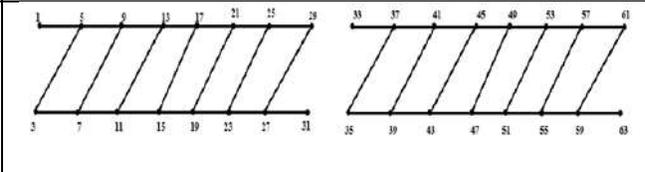


Figure 4: Union of $Z-P_8$ and $Z-P_8$ odd prime graph

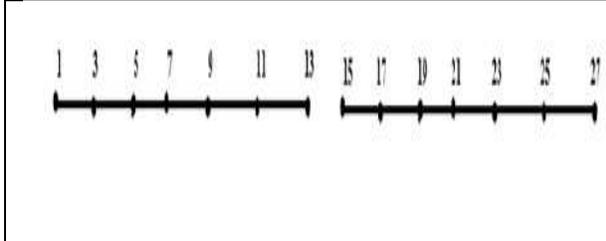


Figure 5: Union of path P_7 and star P_7 odd prime graph

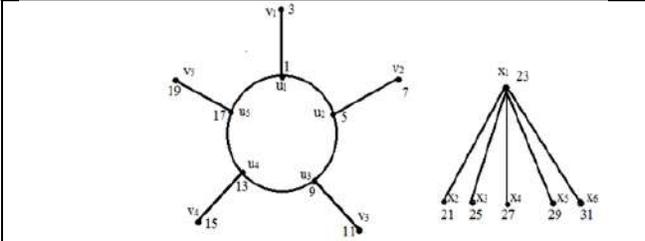


Figure 6: Union of sunlet S_5 and star $k_{1,5}$ odd prime graph





A New Approach for Interior and Closure Sets in Bitopological Spaces

T.Siva Subramania Raja^{1*}, S. Usharani², S. Saranya³ and A. Pandi⁴

¹Assistant Professor, PG and Research Department of Mathematics, National College (Autonomous), Tiruchirapalli, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Sri Vijay Vidyalaya College of Arts and Science, Nallampalli, Dharmapuri, Tamil Nadu, India.

³Assistant Professor, Department of Mathematics (CA), Mannar Thirumalai Naicker College, Madurai, Tamil Nadu, India.

⁴Assistant Professor, Department of Mathematics, Rathinam Technical Campus, Coimbatore - 21, Tamil Nadu, India.

Received: 29 Apr 2022

Revised: 13 Jun 2022

Accepted: 02 July 2022

*Address for Correspondence

T.Siva Subramania Raja

Assistant Professor,

PG and Research Department of Mathematics,

National College (Autonomous), T

iruchirapalli, Tamil Nadu, India.

Email: sivasumatrix@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In this paper, we introduce $(1,2)^*-\tilde{Y}$ -interior and $(1,2)^*-\tilde{Y}$ -closure sets in bitopological spaces.

2010 Mathematics Subject Classification: 54E55

Keywords: $(1,2)^*-\tilde{Y}$ -interior, $(1,2)^*-\tilde{Y}$ -closure, $(1,2)^*-\tilde{Y}$ -closed, $(1,2)^*-\tilde{Y}$ -open.

INTRODUCTION

J. C. Kelly [4], introduced the bitopological spaces, Levine [5], introduced the g-closed sets in topology. Andrijevic [1], In 1986 the introduced semi-preopen sets, Bhattacharya et. al. the introduced the semi-generalized closed sets in topology. The notion of $(1,2)^*-\tilde{Y}$ -interior is defined and some of its basic properties are studied. Also, we introduce the concept of $(1,2)^*-\tilde{Y}$ -closure in bitopological spaces using the notions of $(1,2)^*-\tilde{Y}$ -closed sets, and we obtain some related results. For any $A \subseteq X$, it is proved that the complement of $(1,2)^*-\tilde{Y}$ -interior of A is the $(1,2)^*-\tilde{Y}$ -closure of the complement of A. In this paper, we introduce $(1,2)^*-\tilde{Y}$ -interior and $(1,2)^*-\tilde{Y}$ -closure sets in bitopological spaces.





PRELIMINARIES

Throughout this paper $(X, \tau_{1,2})$ or X will always denote bitopological spaces. When H is a subset of $\tau_{1,2}\text{-cl}(H)$ and $\tau_{1,2}\text{-int}(H)$ denote the $\tau_{1,2}$ -closure and $\tau_{1,2}$ -interior set of H respectively.

We recall some known definitions are needed in the paper.

Definition 2.1

Let H be a subset of X . Then H is said to be $\tau_{1,2}$ -open [6] if $H = P \cup Q$ where $P \in \tau_1$ and $Q \in \tau_2$.

The complement of $\tau_{1,2}$ -open set is called $\tau_{1,2}$ -closed.

Notice that $\tau_{1,2}$ -open sets need not necessarily form a topology.

Definition 2.2 [6]

Let H be a subset of X . Then

- (i) the $\tau_{1,2}$ -closure of H , denoted by $\tau_{1,2}\text{-cl}(H)$, is defined as $\bigcap \{F : H \subseteq F \text{ and } F \text{ is } \tau_{1,2}\text{-closed}\}$.
- (ii) the $\tau_{1,2}$ -interior of H , denoted by $\tau_{1,2}\text{-int}(H)$, is defined as $\bigcup \{F : F \subseteq H \text{ and } F \text{ is } \tau_{1,2}\text{-open}\}$.

Definition 2.3

A subset H of a space X is called $(1,2)^*$ -semi-open [7] if $H \subseteq \tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(H))$;

The complement of $(1,2)^*$ -semi-open set is called $(1,2)^*$ -semi-closed set;

The $(1,2)^*$ -semi closure of the set H is defined as the intersection of all $(1,2)^*$ -semi-closed sets containing in H and is denoted by $(1,2)^*\text{-scl}(H)$.

Definition 2.4

A subset H of a space X is called:

- (i) $(1,2)^*$ -semi-generalized closed (briefly, $(1,2)^*\text{-sg-cld}$) set [7] if $(1,2)^*\text{-scl}(H) \subseteq U$ whenever $H \subseteq U$ and U is $(1,2)^*$ -semi-open in X .

The complement of $(1,2)^*\text{-sg-cld}$ set is called $(1,2)^*\text{-sg-open}$ set;

- (ii) $(1,2)^*\text{-generalized semi-closed}$ (briefly, $(1,2)^*\text{-gs-cld}$) set [7] if $(1,2)^*\text{-scl}(H) \subseteq U$ whenever $H \subseteq U$ and U is $\tau_{1,2}$ -open in X .

The complement of $(1,2)^*\text{-gs-cld}$ set is called $(1,2)^*\text{-gs-open}$ set;

- (iii) $(1,2)^*\text{-}\hat{g}$ -closed set [8] (= $(1,2)^*\text{-}\omega$ -closed set [8]) if $\tau_{1,2}\text{-cl}(H) \subseteq U$ whenever $H \subseteq U$ and U is $(1,2)^*$ -semi-open in X .

The complement of $(1,2)^*\text{-}\hat{g}$ -closed set is called $(1,2)^*\text{-}\hat{g}$ -open set;

Definition 2.5[9] A subset H of X is called a $(1,2)^*\text{-}\hat{Y}$ -closed (briefly, $(1,2)^*\text{-}\hat{Y}$ -cld) set if $\tau_{1,2}\text{-cl}(H) \subseteq U$ whenever $H \subseteq U$ and U is $(1,2)^*\text{-gs-open}$ in X .

The complement of the $(1,2)^*\text{-}\hat{Y}$ -closed (briefly, $(1,2)^*\text{-}\hat{Y}$ -cld) set is $(1,2)^*\text{-}\hat{Y}$ -open set.

Remark 2.6

- (i) Every $\tau_{1,2}$ -open set is $(1,2)^*\text{-}\hat{Y}$ -open but not conversely [2].
- (ii) Every $\tau_{1,2}$ -closed set is $(1,2)^*\text{-}\hat{Y}$ -closed but not conversely [2].
- (iii) Every $(1,2)^*\text{-}\hat{Y}$ -closed set is $(1,2)^*\text{-}\omega$ -closed but not conversely [2].

$(1,2)^*\text{-}\hat{Y}$ -INTERIOR

We introduce the following definition.

Definition 3.1

For any $H \subseteq X$, $(1,2)^*\text{-}\hat{Y}\text{-int}(H)$ is defined as the union of all $(1,2)^*\text{-}\hat{Y}$ -open sets contained in H . i.e., $(1,2)^*\text{-}\hat{Y}\text{-int}(H) = \bigcup \{G : G \subseteq H \text{ and } G \text{ is } (1,2)^*\text{-}\hat{Y}\text{-open}\}$.





Siva Subramania Raja et al.,

Lemma 3.2

For any $H \subseteq X$, $\tau_{1,2}\text{-int}(H) \subseteq (1,2)^*\text{-}\hat{Y}\text{-int}(H) \subseteq H$.

Proof

It is obviously.

Proposition 3.3

For any $H \subseteq X$,

- (i) $(1,2)^*\text{-}\hat{Y}\text{-int}(H)$ is the largest $(1,2)^*\text{-}\hat{Y}\text{-open}$ set contained in H .
- (ii) H is $(1,2)^*\text{-}\hat{Y}\text{-open}$ if and only if $(1,2)^*\text{-}\hat{Y}\text{-int}(H) = H$.

Proof

It is obviously.

Proposition 3.4

For any subsets H and P of X ,

- (i) $(1,2)^*\text{-}\hat{Y}\text{-int}(H \cap P) = (1,2)^*\text{-}\hat{Y}\text{-int}(H) \cap (1,2)^*\text{-}\hat{Y}\text{-int}(P)$.
- (ii) $(1,2)^*\text{-}\hat{Y}\text{-int}(H \cup P) \supseteq (1,2)^*\text{-}\hat{Y}\text{-int}(H) \cup (1,2)^*\text{-}\hat{Y}\text{-int}(P)$.
- (iii) If $H \subseteq P$, then $(1,2)^*\text{-}\hat{Y}\text{-int}(H) \subseteq (1,2)^*\text{-}\hat{Y}\text{-int}(P)$.
- (iv) $(1,2)^*\text{-}\hat{Y}\text{-int}(X) = X$ and $(1,2)^*\text{-}\hat{Y}\text{-int}(\emptyset) = \emptyset$.

Proof

It is obviously.

$(1,2)^*\text{-}\hat{Y}\text{-CLOSURE}$

In this section, we define $(1,2)^*\text{-}\hat{Y}\text{-closure}$ of a set and we prove that $(1,2)^*\text{-}\hat{Y}\text{-closure}$ is a Kuratowski closure operator on X .

Definition 4.1

For every set $H \subseteq X$, we define the $(1,2)^*\text{-}\hat{Y}\text{-closure}$ of H to be the intersection of all $(1,2)^*\text{-}\hat{Y}\text{-closed}$ sets containing H . In symbols, $(1,2)^*\text{-}\hat{Y}\text{-cl}(H) = \bigcap \{F : H \subseteq F \in (1,2)^*\text{-}\hat{Y}C(X)\}$.

Lemma 4.2

For any $H \subseteq X$, $H \subseteq (1,2)^*\text{-}\hat{Y}\text{-cl}(H) \subseteq \tau_{1,2}\text{-cl}(H)$.

Proof

It is obviously.

Remark 4.3

Both containment relations in Lemma 4.2 may be proper as seen from the following example.

Example 4.4

Let $X = \{a, b, c\}$ and $\tau_1 = \{\emptyset, X\}$, $\tau_2 = \{\emptyset, \{a, b\}, X\}$ with $\tau_{1,2} = \{\emptyset, \{a, b\}, X\}$. Let $H = \{a\}$. Then $(1,2)^*\text{-}\hat{Y}\text{-cl}(H) = \{a, c\}$ and so $H \subset (1,2)^*\text{-}\hat{Y}\text{-cl}(H) \subset \tau_{1,2}\text{-cl}(H)$.

Lemma 4.5

For any $H \subseteq X$, $(1,2)^*\text{-}\omega\text{-cl}(H) \subseteq (1,2)^*\text{-}\hat{Y}\text{-cl}(H)$, where $(1,2)^*\text{-}\omega\text{-cl}(H)$ is given by $(1,2)^*\text{-}\omega\text{-cl}(H) = \bigcap \{F : H \subseteq F \in (1,2)^*\text{-}\omega C(X)\}$.





Siva Subramania Raja et al.,

Proof

It is obviously.

Remark 4.6

Containment relation in the above Lemma 4.5 may be proper as seen from the following example.

Example 4.7

Let $X = \{a, b, c, d\}$ and $\tau_1 = \{\emptyset, \{a\}, X\}$, $\tau_2 = \{\emptyset, \{b, c\}, X\}$ with $\tau_{1,2} = \{\emptyset, \{a\}, \{b, c\}, \{a, b, c\}, X\}$. Then $(1,2)^*\text{-}\dot{\Upsilon}C(X) = \{\emptyset, \{d\}, \{a, d\}, \{b, c, d\}, X\}$ and $(1,2)^*\text{-}\omega C(X) = \{\emptyset, \{d\}, \{a, d\}, \{b, d\}, \{c, d\}, \{a, b, d\}, \{a, c, d\}, \{b, c, d\}, X\}$. Let $H = \{b, d\}$. Then $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) = \{b, c, d\}$ and $(1,2)^*\text{-}\omega\text{-cl}(H) = \{b, d\}$. So, $(1,2)^*\text{-}\omega\text{-cl}(H) \subset (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$.

Theorem 4.8

$(1,2)^*\text{-}\dot{\Upsilon}$ -closure is a Kuratowski closure operator on X .

Proof

(i) $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(\emptyset) = \emptyset$.

(ii) $H \subseteq (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$, by Lemma 4.2.

(iii) Let $A_1 \cup A_2 \subseteq F \in (1,2)^*\text{-}\dot{\Upsilon}C(X)$, then $A_i \subseteq F$ and by Definition 4.1, $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_i) \subseteq F$ for $i = 1, 2$. Therefore $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1) \cup (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_2) \subseteq \cap \{F : A_1 \cup A_2 \subseteq F \in (1,2)^*\text{-}\dot{\Upsilon}C(X)\} = (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1 \cup A_2)$. To prove the reverse inclusion, let $x \in (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1 \cup A_2)$ and suppose that $x \notin (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1) \cup (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_2)$. Then there exists $(1,2)^*\text{-}\dot{\Upsilon}$ -closed sets F_1 and F_2 with $A_1 \subseteq F_1$, $A_2 \subseteq F_2$ and $x \notin F_1 \cup F_2$. We have $A_1 \cup A_2 \subseteq F_1 \cup F_2$ and $F_1 \cup F_2$ is an $(1,2)^*\text{-}\dot{\Upsilon}$ -closed set by Proposition 3.3 such that $x \notin F_1 \cup F_2$. Thus $x \notin (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1 \cup A_2)$ which is a contradiction to $x \in (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1 \cup A_2)$. Hence $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1 \cup A_2) = (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_1) \cup (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(A_2)$.

(iv) Let $H \subseteq F \in (1,2)^*\text{-}\dot{\Upsilon}C(X)$. Then by Definition 4.1, $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) \subseteq F$ and $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}((1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)) \subseteq F$. Since $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}((1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)) \subseteq F$, we have $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}((1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)) \subseteq \cap \{F : H \subseteq F \in (1,2)^*\text{-}\dot{\Upsilon}C(X)\} = (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$. By Lemma 4.2, $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) \subseteq (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}((1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H))$ and therefore, $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}((1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)) = (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$. Hence, $(1,2)^*\text{-}\dot{\Upsilon}$ -closure is a Kuratowski operator on X .

Lemma 4.9

For an $x \in X$, $x \in (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$ if and only if $V \cap H \neq \emptyset$ for every $(1,2)^*\text{-}\dot{\Upsilon}$ -open set V containing x .

Proof

Let $x \in (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$ for any $x \in X$. To prove $V \cap H \neq \emptyset$ for every $(1,2)^*\text{-}\dot{\Upsilon}$ -open set V containing x . Prove the result by contradiction. Suppose there exists a $(1,2)^*\text{-}\dot{\Upsilon}$ -open set V containing x such that $V \cap H = \emptyset$. Then $H \subseteq V^c$ and V^c is $(1,2)^*\text{-}\dot{\Upsilon}$ -closed. We have $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) \subseteq V^c$. This shows that $x \notin (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$ which is a contradiction. Hence $V \cap H \neq \emptyset$ for every $(1,2)^*\text{-}\dot{\Upsilon}$ -open set V containing x . Conversely, let $V \cap H \neq \emptyset$ for every $(1,2)^*\text{-}\dot{\Upsilon}$ -open set V containing x . To prove $x \in (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$. We prove the result by contradiction. Suppose $x \notin (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$. Then there exists a $(1,2)^*\text{-}\dot{\Upsilon}$ -closed set F containing H such that $x \notin F$. Then $x \in F^c$ and F^c is $(1,2)^*\text{-}\dot{\Upsilon}$ -open. Also $F^c \cap H = \emptyset$, which is a contradiction to the hypothesis. Hence $x \in (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$.

Proposition 4.10

For any $H \subseteq X$, the following hold:

- (i) $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H)$ is the smallest $(1,2)^*\text{-}\dot{\Upsilon}$ -closed set containing H .
- (ii) H is $(1,2)^*\text{-}\dot{\Upsilon}$ -closed if and only if $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) = H$.

Proposition 4.11

For any two subsets H and P of X , the following hold:

- (i) If $H \subseteq P$, then $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) \subseteq (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(P)$.
- (ii) $(1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H \cap P) \subseteq (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(H) \cap (1,2)^*\text{-}\dot{\Upsilon}\text{-cl}(P)$.





Siva Subramania Raja et al.,

Theorem 4.12

Let H be any subset of X . Then

$$(i) ((1,2)^*\text{-}\hat{Y}\text{-int}(H))^c = (1,2)^*\text{-}\hat{Y}\text{-cl}(H^c).$$

$$(ii) (1,2)^*\text{-}\hat{Y}\text{-int}(H) = ((1,2)^*\text{-}\hat{Y}\text{-cl}(H^c))^c.$$

$$(iii) (1,2)^*\text{-}\hat{Y}\text{-cl}(H) = ((1,2)^*\text{-}\hat{Y}\text{-int}(H^c))^c.$$

Proof

(i) Let $x \in ((1,2)^*\text{-}\hat{Y}\text{-int}(H))^c$. Then $x \notin (1,2)^*\text{-}\hat{Y}\text{-int}(H)$. That is, every $(1,2)^*\text{-}\hat{Y}$ -open set U containing x is such that $U \not\subseteq H$. That is, every $(1,2)^*\text{-}\hat{Y}$ -open set U containing x is such that $U \cap H^c \neq \emptyset$. By Lemma 4.9, $x \in (1,2)^*\text{-}\hat{Y}\text{-cl}(H^c)$ and therefore $((1,2)^*\text{-}\hat{Y}\text{-int}(H))^c \subseteq (1,2)^*\text{-}\hat{Y}\text{-cl}(H^c)$. Conversely, let $x \in (1,2)^*\text{-}\hat{Y}\text{-cl}(H^c)$. Then by Lemma 4.9, every $(1,2)^*\text{-}\hat{Y}$ -open set U containing x is such that $U \cap H^c \neq \emptyset$. That is, every $(1,2)^*\text{-}\hat{Y}$ -open set U containing x is such that $U \not\subseteq H$. This implies by Definition 3.1, $x \notin (1,2)^*\text{-}\hat{Y}\text{-int}(H)$. That is, $x \in ((1,2)^*\text{-}\hat{Y}\text{-int}(H))^c$ and so $(1,2)^*\text{-}\hat{Y}\text{-cl}(H^c) \subseteq ((1,2)^*\text{-}\hat{Y}\text{-int}(H))^c$. Thus $((1,2)^*\text{-}\hat{Y}\text{-int}(H))^c = (1,2)^*\text{-}\hat{Y}\text{-cl}(H^c)$.

(ii) Follows by taking complements in (i).

(iii) Follows by replacing H by H^c in (i).

REFERENCES

1. Andrijevic, D.: Semi-preopen sets, Mat. Vesnik, 38(1986), 24-32.
2. Banumathi, K., Gowri, H., Saranya, A., and Pandi, A.: Properties of $(1,2)^*\text{-}\hat{Y}$ -closed Sets in bitopological Spaces, Indian Journal of Natural Sciences, 12 (68) (2021) 34955-34960.
3. Bhattacharya, P. and Lahiri, B. K.: Semi-generalized closed sets in topology, Indian J. Math., 29(3)(1987), 375-382.
4. Kelly, J.C. :Bitopological spaces, Proc.LondonMath.Soc., 3(13)(1963), 71-89.
5. Levine, N.: Generalized closed sets in topology, Rend. Circ. Math. Palermo, 19(2)(1970), 89-96.
6. LellisThivagar, M., Ravi, O. and Abd El-Monsef, M. E.: Remarks on bitopological $(1,2)^*\text{-}$ quotient mappings, J. Egypt Math. Soc., 16(1) (2008), 17-25.
7. Ravi, O. and Lellis Thivagar, M.: A bitopological $(1,2)^*\text{-}$ semi-generalized continuous smaps, Bull. Malays. Math. Sci. Soc., (2), 29(1) (2006), 79-88.
8. Ravi, O., Pandi, A., Pious Missier, S. and Salai Parkunan, T.: Remarks on bitopological $(1,2)^*\text{-r}\omega$ -Homeomorphisms, International Journal of Mathematical Archive, 2(4) (2011), 465-475.
9. Revathi, P., ShanmugaVadivu, C., Kavitha, K., Banumathi, K. and Pandi, A.: $(1,2)^*\text{-}\hat{Y}$ -Closed Sets in Bitopological Spaces, International Journal of Scientific Research and Engineering Development, 4(3) (2021), 328-333.





Psychological Impact of Patient Isocenter Shift Implemented on First 3 Days Compared with 4th Day in Radiotherapy

Rajesh.R¹, Shanmukhappa B. Kaginelli², Bhavya Shree P³ and Deepa L. Hungund⁴

¹Sr. Medical Physicist, Narayana Multispecialty, Hospital, Mysore, Karnataka, India.

²Associate Professor, Division of Medical Physics, School of Life Sciences, JSS AHER, Mysore, Karnataka, India.

³Assistant Professor, Division of Medical Physics, School of Life Sciences, JSS AHER, Mysore, Karnataka, India.

⁴Assistant Professor, Division of Cognitive Neurosciences and Psychology, JSS AHER, Mysore, Karnataka, India.

Received: 08 June 2022

Revised: 20 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Rajesh.R,

Sr. Medical Physicist,

Narayana Multispecialty,

Hospital, Mysore,

Karnataka, India.

Email: rajesh.r04@narayanahealth.org.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Radiation therapy is one of the means of cancer treatment. Innovation of technology has advanced to the point where cancer now can be considered a curable disease when detected at early stage. Though expertise, technology, advances, and research provide patients new hope, but psychological relief is still a hazy area. Almost all cancer patients report experiencing psychological distress at some point during their treatment. So, the present study aims to investigate the impact or importance of psychological factor affecting patient isocenter shift. EPID images for iso-center shift verification was measured with Elekta Compact Linear Accelerator. The detailed setup, study and results are discussed in the light of existing Psychological Impact of Patient Isocenter Shift implemented on first 03 days when compared with 4th day in Radiotherapy.

Keywords: Linear accelerating machine (Elekta), TPS, PTV, CT, MV EPID imaging, Tumor Iso centre and psychological factor





INTRODUCTION

Radiation therapy is one of the means of cancer treatment. Innovation of technology has advanced to the point where cancer now can be considered a curable disease when detected at early stage. Though expertise, technology, advances, and research provide patients new hope, but psychological relief is still a hazy area. Almost all cancer patients report experiencing psychological distress at some point during their treatment [1]. Nearly all patients being treated for cancer report feeling physically and psychologically upset at different times during their therapy and especially, depression is the most common psychological side effect that cancer patients deal with and as well anxiety levels are high during the first few visits to radiation oncology, especially before the treatment begins [2][3][4][5]. Up to one-third of patients receiving radiation therapy have unmet psychosocial necessities in terms of treatment information, emotional and spiritual support, physical symptom management, isolation in the radiation therapy room, anxious by looking at the treatment unit and lack of family and friend involvement [7]. These unmet needs can result in refusal to undergo radiation therapy, affecting patient isocenter shift while undergoing treatment, treatment delays, reduced compliance, lack of physical body support, low adherence to medical advice, declined quality of life and reduced satisfaction with services.

Cancer is a complex disease, which grow locally and possess the capacity to metastasis to different organs in the body. Cancer continues to be a major disease and the number of cancer cases are projected to be more than double worldwide in the next 20-40 years and surpass heart disease as the leading cause of death. Radiotherapy often forms a part of the treatment for the patient due to its minimally invasive nature. Radiation remains as most widely used or utilized treatment modalities in the clinical management of cancer. Patients with localized malignant tumors are treated with radiation at some point in the course of their disease. Radiation therapy is delivered in a course of multiple fractions over several weeks to reduce the normal cell toxicity.

With a wide range of cancer types, there is a variety of approaches to treat cancer. The most common forms of treatment are surgery, chemotherapy and radiotherapy. During the treatment, ionizing radiation is delivered by a linear accelerator (LINAC) to those precisely defined treatment fields on the patient to shrink the cancerous cells. With its compact and efficient design, the LINAC offers excellent versatility for use in radiotherapy through isocentric mounting and provides either electrons or mega voltage X ray therapy with a wide range of energies.

MATERIALS AND METHODS

In the present study, Elekta Compact Linear Accelerator with MV EPID for patient set up verification was used to record the iso-center shift with respect to tumor iso-center. Treatment is planned by using TPS (Treatment Planning System) with beam iso-center. The co-ordinates of X- lateral (Left and right), Y- Longitude (In and Out) and Z- Vertical (Up and Down) are calculated from the Computerized Tomography image (CT-image) respectively. Calculated co-ordinates are obtained from TPS and generated in EPID imaging system. Shift is applied on the first 3 days of treatment from the CT iso-center and accordingly imaging is recorded and values are averaged for the forth coming fractions.

Patient Selection

In the present study, 15 patients were selected out of which 05 are with Pelvis cases (involving Ca cervix, Ca Rectum, Ca Prostat, Ca Bladder and Ca Anal canal), 05 with Head and Neck case (Ca tongue, Ca hard pallet, Ca soft pallet, Ca nasopharynx, Ca tonsils) and 05 with Brain case (all cases of brain tumors).



Rajesh *et al.*,

RESULTS AND DISCUSSION

Table 1, 2 and 3 shows the respective patient iso-center shift achieved when delivering the radiation dose (Radiotherapy). The above tables reveal the iso-centric shift data obtained by EPID imaging system from pelvis, head & neck, and brain cases from all the three directions of X, Y and Z with respect to 1st to 4th day. The obtained results can be inferred that due to psychosocial discomfort during the initial period of treatment, in the present study, the readings of iso-centric positioning shift are recorded high which in turn has difficulty in proper dosage delivery for the therapy in the cases. And gradually, with the knowledge of disease, awareness of treatment and psychological support by the therapist/technologists, the iso-centric shift variation decreased day by day compared to beginning days of the treatment.

CONCLUSION

Radiation therapists/technologists are the only health care professionals who are in direct contact with patients throughout treatment [8]. Due to time constraints, the therapists/technologists are unable to guide and provide the awareness of the treatment and psychological support to the patients. So, the present study concludes that there is a need of the professional counsellors or the psychotherapists to provide pre and post counselling about the disease management and treatment as well as psychological support and requirement to the cancer patients.

REFERENCES

1. Understanding patient psychosocial issues. *Radiat Ther*, 21, 96-99. Mitchell, D., & Lozano, R. (2012).
2. The prevalence, detection and intervention for depression and anxiety in oncology. *J Radiother Pract* 2012; 11: 33–43. Boothroyd DA, Hodgson D.
3. Psychological Reactions to Radiation Therapy: Reconsideration of the Adaptive Aspects of Anxiety, *J Pers Soc Psychol*. 1985 Apr; 48(4): 1024–1032. Barbara L. Andersen and Hamed H. Tewfik
4. Impact of Radiotherapy on Psychological, Financial, and Sexual Aspects in Post mastectomy Carcinoma Breast Patients: A Prospective Study and Management, *Asia Pac J Oncol Nurs*. 2017 Jan-Mar; 4(1): 69–76. Neelam Sharma, MD Radiotherapy and Abhishek Purkayastha
5. Psychological distress and intervention in cancer patients treated with radiotherapy, *Radiol Oncol* 2004; 38(3): 193-203. Mojca Šoštarič, Lilijana Šprah
6. Correlation between Psychosocial Distress and Quality of Life in Patients with Nasopharyngeal Carcinoma following Radiotherapy, *Journal of Oncology*, Volume 06 Aug 2018, Xiaolan Wang, Yue Lv, Wen Li, Chen Gan et. al.
7. Psychosomatic symptoms affect radiotherapy setup errors in early breast cancer patients, *Chin J Cancer Res*. 2021 Jun 30; 33(3): 323–330, Yi He, Chang Gao, Ying Pang, Jixiang Chen and Lili Tang.
8. Do radiation therapists feel able to routinely screen for symptoms and distress in people with cancer: barriers impacting practice, *J Med Radiat Sci* 00 (2021) 1–9, Belinda L. Arnold, Georgia Halkett, Haryana Dhillon, Afaf Girgis.

Table1 Pelvis Cases

| Case | 1st Day (mm) | 2nd Day (mm) | 3rd Day (mm) | 4th Day (mm) |
|------|--------------------------|---------------------------|---------------------------|---------------------------|
| 1 | X=0.18, Y=0.80, Z=0.82 | X= 0.24, Y=0.39, Z=0.36 | X=0.15, Y=0.05, Z=-0.38 | X=0.20, Y=0.12, Z=-0.34 |
| 2 | X= 0.45, Y=-0.35, Z=0.44 | X= 0.30, Y=-0.13, Z=-0.11 | X=0.10, Y=-0.22, Z=0.15 | X=0.20, Y=-0.20, Z=0.18 |
| 3 | X= 0.45, Y=0.36, Z=0.16 | X= 0.35, Y=0.30, Z=0.10. | X= 0.28, Y=0.32, Z=0.23 | X= 0.30, Y=0.25, Z=0.18 |
| 4 | X= -0.30, Y=0.99, Z=0.33 | X= 0.59, Y=-0.58, Z=-0.55 | X= 0.60, Y=-0.22, Z=-0.10 | X= 0.67, Y=-0.39, Z=-0.22 |
| 5 | X= -0.24, Y=0.09, Z=0.68 | X= 0.39, Y=-0.30, Z=-0.39 | X= 0.24, Y=0.16, Z= -0.21 | X= 0.26, Y=0.30, Z= -0.36 |





Rajesh et al.,

Table 2 Head and Neck Cases

| Case | 1st Day (mm) | 2nd Day (mm) | 3 rd Day (mm) | 4 th Day (mm) |
|------|---------------------------|----------------------------|---------------------------|--------------------------|
| 1 | X= 0.17, Y=0.03, Z=0.15 | X= 0.0, Y= -0.11, Z=0.07 | X=0.0, Y=-0.02, Z=-0.00 | X=0.14, Y=-0.10, Z=-0.17 |
| 2 | X= 0.13, Y=-0.21, Z=-0.37 | X= 0.17, Y=-0.07, Z=-0.12 | X=0.02, Y=-0.11, Z=0.28 | X=0.21, Y=-0.19, Z=-0.25 |
| 3 | X= 0.03, Y=-0.43, Z=0.00 | X= 0.0, Y=0.10, Z=-0.11 | X= 0.10, Y=-0.12, Z=0.05 | X=0.22, Y=-0.19, Z=0.11 |
| 4 | X= 0.54, Y=-0.50, Z=-0.38 | X= 0.32, Y=-0.07, Z=-0.15 | X= 0.07, Y=-0.10, Z=-0.01 | X=0.22, Y=-0.17, Z=-0.23 |
| 5 | X= 0.10, Y=0.03, Z=-0.33 | X= -0.06, Y=-0.09, Z=-0.23 | X= 0.0, Y=-0.03, Z= -0.20 | X=0.02, Y=-0.11, Z=-0.18 |

Table 3 Brain Cases

| Case | 1st Day (mm) | 2nd Day (mm) | 3 rd Day (mm) | 4 th Day (mm) |
|------|---------------------------|---------------------------|---------------------------|---------------------------|
| 1 | X= 0.25, Y=-0.36, Z=-0.18 | X= 0.06, Y=-0.22, Z=-0.03 | X=0.07, Y=0.11, Z=-0.09 | X=0.13, Y=0.21, Z=-0.18 |
| 2 | X= 0.07, Y=-0.59, Z=0.00 | X= 0.02, Y=-0.39, Z=0.00 | X=-0.03, Y=-0.24, Z=-0.05 | X=-0.10, Y=-0.26, Z=-0.16 |
| 3 | X= 0.42, Y=-0.58, Z=0.06 | X= 0.24, Y=-0.40, Z=0.00 | X= 0.12, Y=-0.27, Z=0.17 | X= 0.19, Y=-0.30, Z=0.10 |
| 4 | X= 0.27, Y=-0.03, Z=0.01 | X= 0.07, Y=0.02, Z=0.05 | X= 0.00, Y=0.0, Z=0.00 | X= 0.1, Y=0.12, Z=0.09 |
| 5 | X= 0.38, Y=0.02, Z=0.00 | X= 0.28, Y=0.06, Z=-0.10 | X= 0.0, Y=0.08, Z= -0.16 | X= 0.15, Y=0.12, Z= -0.21 |





Enhanced Information Extraction from Agriculture Practices

M. Rajasekar^{1*} and Angelina Geetha² and K. Manikandaboopathy³

¹Research Scholar, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India.

²Professor, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India.

³Assistant Professor (S.G.), Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India.

Received: 04 May 2022

Revised: 03 June 2022

Accepted: 05 July 2022

*Address for Correspondence

M. Rajasekar

Research Scholar,

Hindustan Institute of Technology and Science,

Padur, Chennai, Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Agricultural Information is one of the leading requirements in the current booming organic agricultural revolution. Nowadays youngsters are not aware of that the procedure and practices for the farming field. Information Extraction of internet resources is growing field in the Artificial Intelligence. The information extraction task implemented by machine learning algorithms to improve the accuracy and performance of the task. This paper precedes the agricultural practices into a systematic information portal. By using machine learning classification model naive bayes classifier the information extraction task. The evaluation results prove that the naive bayes classification model gives good accuracy(80%) and F-score (0.81).

Keywords: Agricultural, extraction, Artificial, accuracy(80%) and F-score (0.81).

INTRODUCTION

Agriculture has the potential to address the world's hunger crisis. Agriculture is rapidly evolving in tandem with human growth. This study aims to depict the farming strategies used by farmers to produce everyday food items such as cereals, pulses, vegetables, fruits, grains, oil seeds, and so on. This is a test attempt to depict the steps to be followed for the growing of the above-mentioned items. Information extraction plays a critical function in natural language processing applications. In the process of text classification, the supervised machine learning algorithm Naive bayes theorem is applied. The recommended methodology has been established in this research to extract knowledge from raw text documents. The proposed system is capable of extracting data for the provided keywords.



**Rajasekar et al.,****Agriculture information extraction**

Many applications have been developed by various researchers employing the information extraction method. Agriculture, on the other hand, is a highly uncommon topic. In the field of research, information extraction in agriculture is also a critical milestone. India is a multilingual country with agriculture serving as its backbone. Agriculture, on the other hand, is a declining field in India. This study is an attempt to provide a cent of help for farmers and formers. As follows, this research Endeavour provides a wealth of knowledge regarding cultivation: Botanical name, family, native location, economic value Seed treatment, Nursery preparation, Nursery management, Main field preparation, Seedling treatment, Transplantation, Fertilizer management, Weed management, Water management, Climate, Soil, Types of Cultivation, Seed treatment, Nursery preparation, Nursery management, Main field preparation, Seedling treatment, Transplantation, Fertilizer management, Weed management, Water management Direct sown paddled, Sowing, Season, Variety, Seed Rate, Rain field rice cultivation, Field preparation, Pest and Diseases, Seed rate and seed treatment, after cultivation, Intercrop, Harvest, Yield, Marketing Facilities. It provides information by providing keywords.

Literature Review

Information extraction process is a successful language processing technology to acquire knowledge from unstructured text documents

Research Gap

On the basis of all of the preceding study, a gap in the field of agriculture has been identified. For information extraction from Tamil text documents, the machine learning technique, the supervised model, and the Nave Bayes theorem are not present.

Objectives

- To build an advanced corpus in the field of agriculture
- To build NLP related information in the field of agriculture (POS Tagging, Morphological Analysis, Named Entity Recognition)
- To build a relation extraction framework
- To use Nave Bayes to obtain the highest accuracy of extracted data

Present work

Literature, Social Media, Science, Agriculture, Engineering, General, Bio Medicine, Business, Research Articles, and so on are all examples of information extraction processes. The Agriculture practise notion will be extracted from a raw text document in Tamil and presented in a technical manner in the suggested research activity. Natural language processing approaches were utilised to solve this challenge. The identifiers are predefined keys that are used to classify text objects or tokens from text documents. Machine learning's most well-known project is text classification.

Text classification

The technique of assigning tags or categories to text based on its content is known as text categorization [4]. It's a fundamental and well-known problem in Natural Language Processing (NLP), with numerous applications including sentiment analysis, spam mail identification, and subject analysis [4].

The IT industry is awash in unstructured data in the form of raw text. E books, social media content, web pages, news, survey responses, chat messages, and e-mails are all examples of electronic books. In all of the foregoing sources, text can be unstructured or semi-structured. However, users are unable to access that text in the manner or structure that they require. It is both cost economical and time demanding to supply the text in the user's preferred format. For a well-known language like English, this approach is substantially more difficult. The text extraction procedure in India, a multilingual country, is significantly more difficult in regional languages that are understood by the people who live in that region. The needed knowledge (text) is taken from the southern ancient language Tamil in this study project.





Rajasekar *et al.*,

How Does Text Classification Work?

Manual and automatic text categorization are two methods for text classification [4]. Manual: A human can evaluate the raw text's exact content and categorise it appropriately. Automatic / Machine Learning: natural language processing techniques are used to classify text, which is quicker and less expensive.

There are many automatic text classification methods, they are as follows:

- Rules based classification
- Machine Learning based classification
- Hybrid method

Rules based classification

The rules to be used on the go to classify text into predefined groupings. When the system recognises the word, it compares the content to the predetermined group tags to determine which is the best match for the current word. There are a few drawbacks to this strategy. Deep learning regarding domain knowledge is time costly, and the rules must be reconstructed periodically.

Machine learning base classification

The machine learning categorization method employs historical observations rather than manually generated criteria. This method will classify the text into the predicted group based on the previously identified instances in the training material.

Representation of words as vectors

The development of a classifier for the set of training data is the first stage in the machine learning approach. The specified set of words has been converted to a vector representation.

For example,

If we have the words "The, cat, cow, rat, is, running, fast, with, calf, bad, not, basketball" in our corpus and the sentence "The cow is with calf" in the testing data set, As a result, the vector representation (1,0,1,0,1,0,0,1,1,0,0,0). The vector format is then passed on to the feature extraction module, which uses a machine learning method to create a classification model.

Machine learning algorithms

The list of commonly used machine learning algorithms for text classification are,

- Decision Trees
- Naive-Bayes classifier
- Support Vector Machines
- K Nearest Neighbors
- Fuzzy C-Means

Decision Trees

This is a method for classifying text from a raw text document that uses supervised machine learning. The data or sentence is continually separated according to a parameter[5] in this method. Decision nodes and leaves are the two entities that define the tree. The data to be split is represented by the decision nodes, while the decisions or ultimate outcome is represented by the leaf nodes.

Naïve Bayes classifier

This is a straightforward "probabilistic classifier" based on the Bayes theorem and strong assumptions about the characteristics or groups[6]. The conditional probability, according to Baye's theorem, can be as follows:





Rajasekar et al.,

$$p(C_k | X) = \frac{p(C_k)p(x|C_k)}{p(x)}$$

the equation can be written as

$$posterior = \frac{prior \times likelihood}{evidence}$$

Support Vector Machines

A supervised machine learning algorithm is the support vector machine (SVM). It's primarily used to solve categorization challenges. Each data item is represented as a point in n-dimensional space, with each data item's value, and the machine does classification by locating the hyper-plane [7].

K nearest Neighbors

K- nearest neighbor algorithm, can be used for classification and regression predictive problems [8]. The K NN algorithm can be understand by the following example. The accompanying diagram shows the distribution of red circles (RC) and green squares (GS). The issue is determining the blue star's group (BS). The "K" is the closest neighbour from whom to take a vote, K=3. In the plane, three elements can be used to make a circle. From the K value 3, get the greatest number of features. It's three red circles (RC). As a result, the blue star will be grouped with the red circle.

Fuzzy C- Means

Fuzzy C-means (FCM) is a method for classification which allows one part of data to belong to two or more groups[9]. It is based on minimization of the following objective function:

$$\arg \min_C \sum_{i=1}^n \sum_{j=1}^c w_{ij}^m \| \mathbf{x}_i - \mathbf{c}_j \|^2,$$

Where,

$$w_{ij} = \frac{1}{\sum_{k=1}^c \left(\frac{\| \mathbf{x}_i - \mathbf{c}_j \|}{\| \mathbf{x}_i - \mathbf{c}_k \|} \right)^{\frac{2}{m-1}}}$$

Text extraction from Agriculture Practices

The Agriculture practise text documents in Tamil language are used in the suggested research activity to extract beneficial information for all farmers to overcome their doubts in the cultivation process by employing keywords. The source data is raw text, and the information is extracted using a supervised machine learning process called the Naive Bayes algorithm.

Why Naive bayes theorem?

- Light to train, requires minimal training data.
- Easily updateable if more training data is added
- Can be used for binary and multi-class classification issues
- Requires less memory
- Its performance is quite good even in critical situations





Rajasekar et al.,

Basics of Natural Language processing for Text

Tokenization

The sentence is remodeled into number of words. These words are considered as basic elements to generate the extraction model. The input sentence is as follows Figure.5.

Normalization

From the list of words in the word set, each word is to be normalized, as remove punctuation marks, removing stops words and inflection of the root words. Normalization is the process to trim the words into roots by removing articulation through crumbing unnecessary characters[10]. In this Normalization process the system will remove the meyyazhuthukkaL, dot letters in Tamil languages, except, (ன், ல், ண், ம், ள், ழ், ள்), and special characters, (.,,;,:,",',-;) Figure shows the input and output view of normalization.

Morphological Analysis

Morphology is the study of word formation, how words are built from root pieces. The term morphological analysis is to analyzing the words into their linguistic components such that, prefix, postfix, inflection[11]. The figure 8. Shows the process of morphological analysis.

POS Tagging

The POS Tagging is the processing of assign the suitable parts of speech tag to a word in the documents. The morphologically rich language Tamil, POS Tagging is not easy. The Bureau of Indian Standards has registered for standardization of POS Tags for Indian language on 2010. There are 47 Tags for Tamil language.

Ambiguity

A word can behave more than one POS tag is called ambiguity. For Example,

Book the Ticket – the word book is verb

The book is on the Table – the same word book is noun

To solve this ambiguity problem, need machine learning method to get most probable

POS tag for the given word. The supervised machine learning method Naïve Bayes thorem is used to classify the words.

Naïve Bayes Thorem

Finding the most probable result, the equation is,

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Finding the Probability of Event A, when Event B is True

P(A) – Priori Probability (Probability of event before event B)

P(A|B) - Posterior Probability (Probability of event after event B is true)

POS Tagging for the Agriculture practices data documents

By using naïve bayes thorem, the pos tagging was done for the agriculture practices documents.

| | |
|------------|--------------|
| வேர்ச்சொல் | சொல் வகை |
| விதை | பெயர்ச்சொல் |
| மற்ற | பெயரடைச்சொல் |
| மண் | பெயர்ச்சொல் |
| மூலம் | பெயரடைச்சொல் |
| பரவ | வினைச்சொல் |



M. Rajasekar *et al.*,

| | |
|----------------|--------------------------|
| பூசணம் | பெயர்ச்சொல் |
| நோய் | பெயர்ச்சொல் |
| தடு | வினைச்சொல் |
| 45 | எண்கள் |
| நாள் | பெயர்ச்சொல் |
| வரை | வினையடைச்சொல் |
| பயிர் | பெயர்ச்சொல் |
| பாதுகாக்க | வினைச்சொல் |
| கார்பெண்ட்சிம் | பிறமொழிச்சொல் |
| அல்லது | இணைப்பி |
| டிரைசைக்ளோசோல் | பிறமொழிச்சொல் |
| அல்லது | இணைப்பி |
| பைரோகுயிலான் | பிறமொழிச்சொல் |
| மருந்து | பெயர்ச்சொல் |
| ஒரு | அளவடை |
| கிலோ | பெயர்ச்சொல் |
| விதை | பெயர்ச்சொல் |
| 2 | எண்கள் |
| கிராம் | பெயர்ச்சொல் |
| என்று | நிறப்பு இணைப்புச்சொல் |
| அளவு | பெயர்ச்சொல் |
| 1 | எண்கள் |

Number of POS tagged word list is given below.

| POS வகை | எண் |
|---------------|------|
| பெயர்ச்சொல் | 2478 |
| பெயரடைச்சொல் | 46 |
| வினைச்சொல் | 119 |
| வினையடைச்சொல் | 28 |
| எண்கள் | 52 |
| அளவடை | 37 |
| பிறமொழிச்சொல் | 66 |

Named Entity Tagging

From POS tagged words, the noun words are taken to tag named entity tagging. The noun words are classified as some general categories. Some categories (NE) are,





Rajasekar et al.,

அத்தியாவசியம் வகை, அளவு, காலம், நோய், பயிர், மருந்து

Example tagged words,

| அத்தியாவசியம் வகை | அளவு வகை | காலம் வகை | நோய் வகை | பயிர் வகை | மருந்து வகை |
|-------------------|----------|-----------|----------|-----------|----------------|
| மண் | கிலோ | நாள் | பூசணம் | விதை | மருந்து |
| நீர் | கிராம் | மணி | நோய் | பயிர் | கொல்லி |
| நீர் | அளவு | நேரம் | பூசணம் | விதை | கார்பெண்ட்சிம் |
| | லிட்டர் | இரவு | | உயிர் | டிரைசைக்ளோசோல் |
| | கிலோ | | | விதை | பைரோகுயிலான் |
| | கிராம் | | | விதை | சூடோமோனாஸ் |
| | அளவு | | | | ப்ரூரசன்ஸ் |
| | லிட்டர் | | | | |

Findings and Discussion

The information extraction framework is designed as Question answer pattern. It is done with crops categorization and practice categorization. That is as follows.

Crop Categorization

The crops are categorized as their usage, types and place of cropping. The crops are categorized as, Cereals, Millets, Pulses, Oilseeds, Fibre Crops, Sugar Crop, Tuber Crops, Vegetable Crops, Fruit Crops, Spices and Condiments, Plantation Crops, Narcotics and Medicinal Crops, Flower Crops. The following figure shows how crops are categorized. The Practices are categorized as, The final crop category is linked with practices wise as follows, The information extraction framework for the crop details and practices are shown in the figure 12.

Evaluation

The evaluation is to check the extraction process of whole Information extraction framework. It is the process of check the extracted data with actual available data. The evaluation method used in the proposed research is, Precision, Recall and F-Score. The formulas for the above factors are,

$$Precision = \frac{\text{No. of Retrived relevant documents}}{\text{Total no. of retrived documents}}$$

$$Recall = \frac{\text{No. of Retrived relevant documents}}{\text{Total no. of relevant documents}}$$

$$F\ Score = \frac{2 \times Precision \times Recall}{(Precision + Recall)}$$

Training and Testing data

For the testing and evaluation of the retrieved documents, we have to train the model to extract the information before the final use. The training data has set of documents with all the key features to train the model. Probably the training set will give more result. After training data implementation, the actual real data is to be giving to the framework to get relevant results. The final findings of the training and testing information is given below.

Evaluation report

By verifying the report of the evaluation, the testing documents given more likely results of training documents. So, the information extraction framework has given more probable results.





Rajasekar et al.,

CONCLUSION

The information extraction framework for the purpose of extraction of data from Crops and Practices is designed. It is implemented with the help of machine learning technologies and probability methods to give most probable results. It has been trained with pre defined data sets to learn the actual data. And it has been tested with the real world data. It has above 80 percentage of accuracy in the evaluation process. In future this has been extended for the purpose of integrated agriculture, animal's bird's information extraction.

REFERENCES

1. Betina, J & Antony, Betina & G S, Mahalakshmi. (2013). Patti Vaithiyam – An Information Extraction System for Traditional Tamil Medicines.
2. Milosevic, N., Gregson, C., Hernandez, R. et al. A framework for information extraction from tables in biomedical literature. *IJDAR* 22, 55–78 (2019).
3. M. Rajasekar and A. Udhayakumar, ""E MARUTHUVACHI" – INFORMATION EXTRACTION FRAMEWORK FOR DATA ABOUT OBSTETRICS AND GYNECOLOGY IN TAMIL," 2018 2nd International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2018 2nd International Conference on, 2018, pp. 399-407, doi: 10.1109/I-SMAC.2018.8653655.
4. <https://monkeylearn.com/text-classification/>
5. <https://www.xoriant.com/blog/product-engineering/decision-trees-machine-learning-algorithm.html>
6. https://en.wikipedia.org/wiki/Naive_Bayes_classifier
7. <https://www.analyticsvidhya.com/blog/2017/09/understaing-support-vector-machine-example-code/>
8. <https://www.analyticsvidhya.com/blog/2018/03/introduction-k-neighbours-algorithm-clustering/>
9. https://en.wikipedia.org/wiki/Fuzzy_clustering
10. <https://towardsdatascience.com/machine-learning-text-processing-1d5a2d638958>
11. <https://www.slideshare.net/akshatapandey/morphological-analysis-47051109>
12. <https://www.quora.com/What-are-the-advantages-of-using-a-naive-Bayes-for-classification>

Table 1. Review List

| Year | Name | Research Work | Methods & Materials |
|------|--|---|--|
| 2014 | ArunaDevi, K. et al, International Journal for Scientific Research & Development Vol. 2, Issue 05, 2014 ISSN (online): 2321-0613 | A Novel Approach on Tamil Text Classification Using C-Feature | C- Feature, Conditional Probability |
| 2015 | Sanjanasri J.P et al, 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI), August 2015 | A computational framework for Tamil document classification using Random Kitchen Sink | Conditional Random Fields for Classification |
| 2015 | J. Betina Antony et, al, 2015 | Information Extraction System for Traditional Tamil Medicines | User defined rules |
| 2016 | T Vaishnavi et al, International Journal of Computer Technology & Applications, Vol 7(3),448-452 | Individual Document Keyword Extraction for Tamil | Conditional Random Fields for Segmentation |
| 2017 | Sindhuja Gopalan et al, Computación y Sistemas, Vol. 21, No. 4, 2017, pp. 749–75 | Cause and Effect Extraction from Biomedical Corpus | Explicit Discourse Connective Markers |





Rajasekar et al.,

| | | | |
|------|--|---|--|
| 2018 | M. Rajasekar Et.al, 2018 | "E Maruthuvachi" – Information Extraction Framework for Data about Obstetrics and Gynecology in Tamil | Indexed Method |
| 2019 | Milosevic Et.al., 2019 | A framework for information extraction from tables in biomedical literature | Integrated Method with CRF and Clustering Method |
| 2019 | C N Subalalitha et al, Sādhanā (2019) 44:156 | Information extraction framework for Kurunthogai | UNL - Knowledge Base |

Table 2. Final evaluation result

| Document Type | No. of Retrieved relevant documents | Total No. of retrieved documents | No. Retrieved relevant documents | Total no. of relevant documents | Precision | Recall | F- Score |
|---------------|-------------------------------------|----------------------------------|----------------------------------|---------------------------------|-----------|----------|----------|
| Training | 137 | 148 | 137 | 142 | 0.925676 | 0.964789 | 0.944828 |
| Testing | 114 | 148 | 114 | 131 | 0.77027 | 0.870229 | 0.817204 |

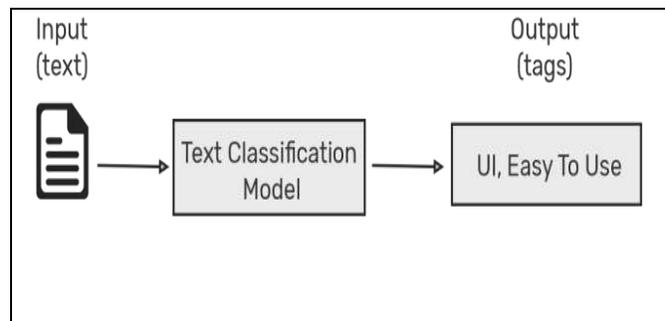


Figure 1. Text Classification

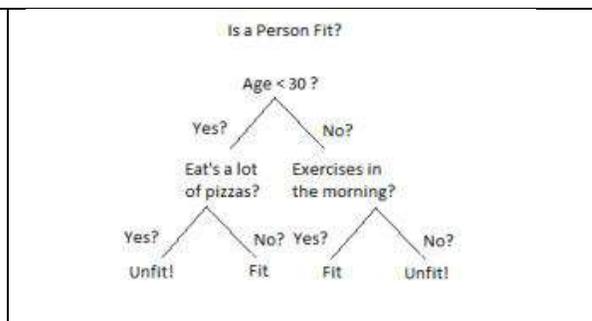


Figure 2. Decision Tree

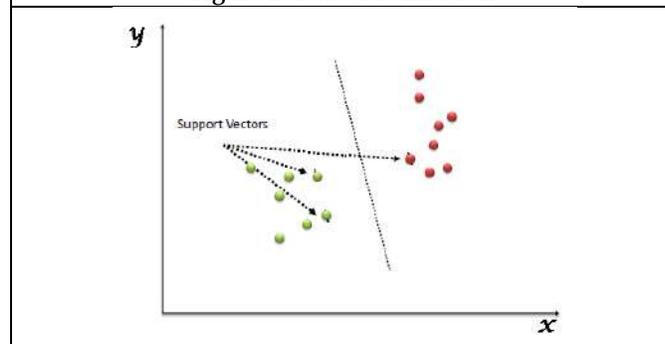


Figure 3. SVM Model

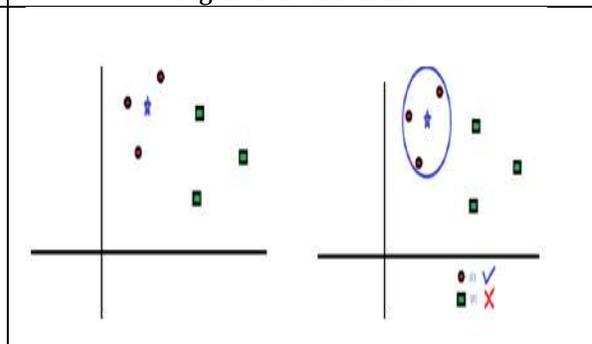
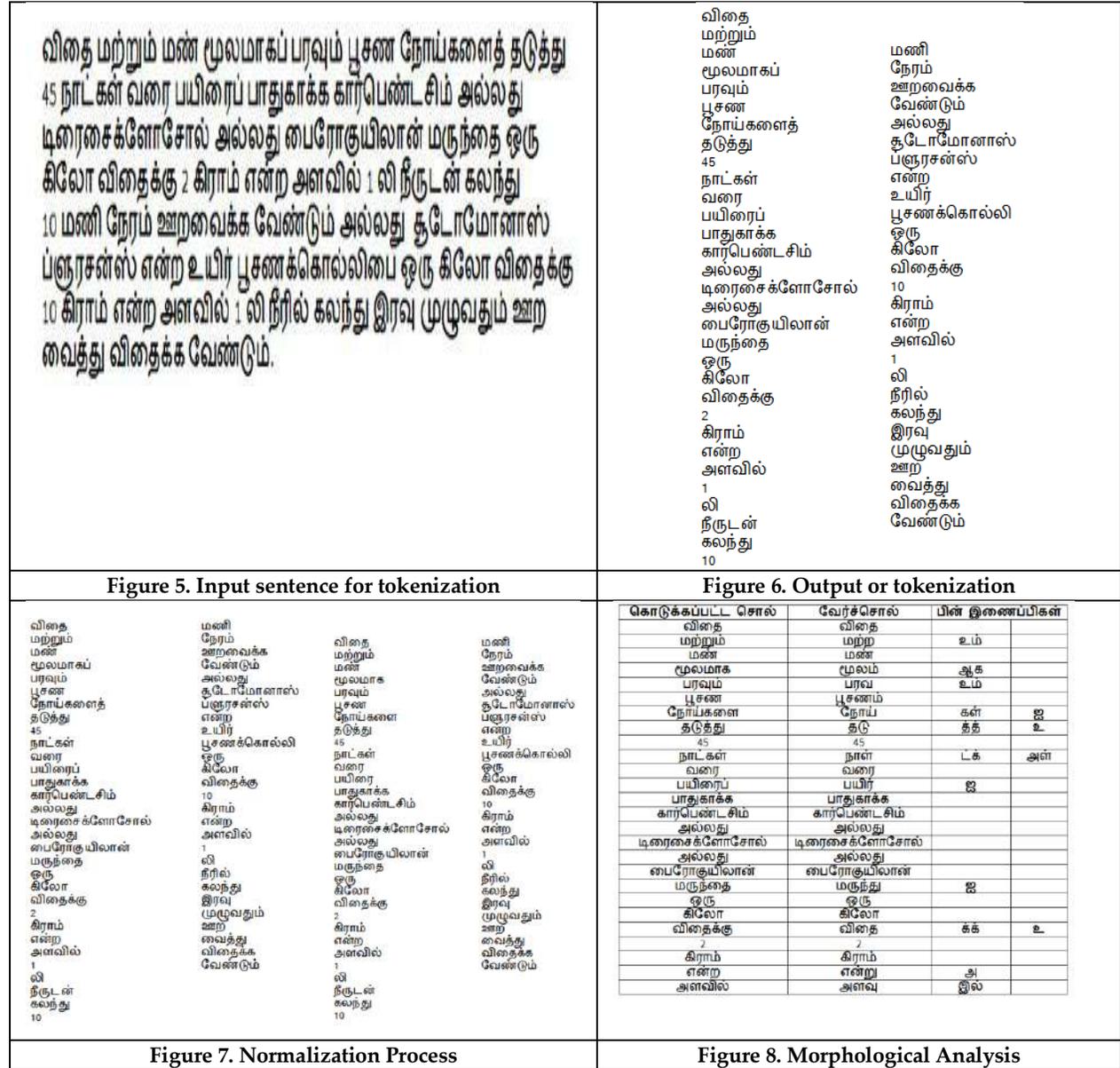


Figure 4. KNN algorithm





Rajasekar et al.,





M. Rajasekar et al.,

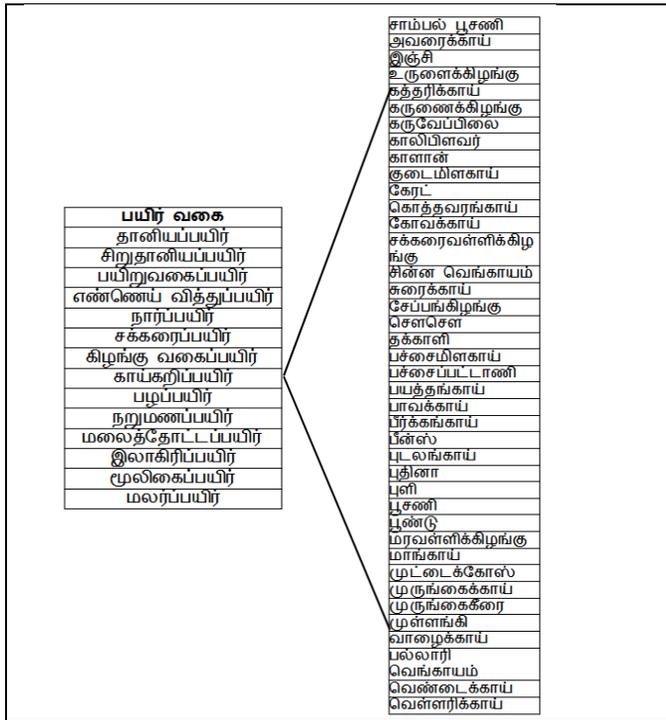


Figure 9. Crop Categorization

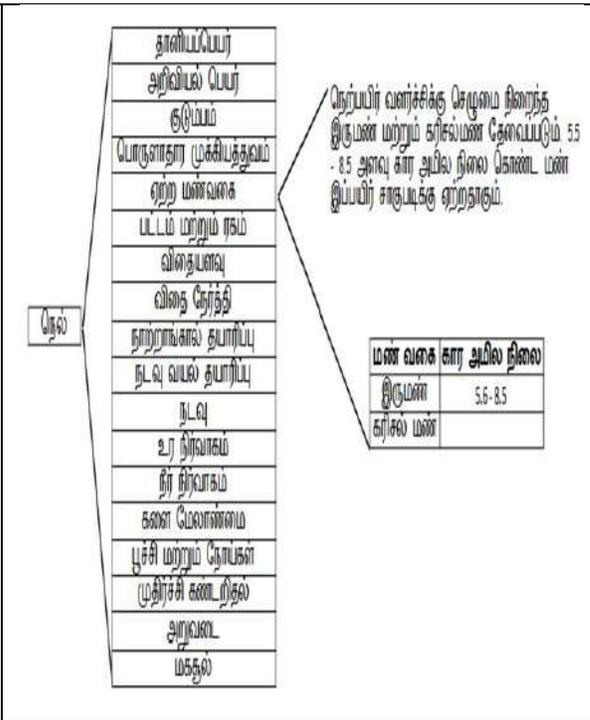


Figure 10. Individual Data Extraction

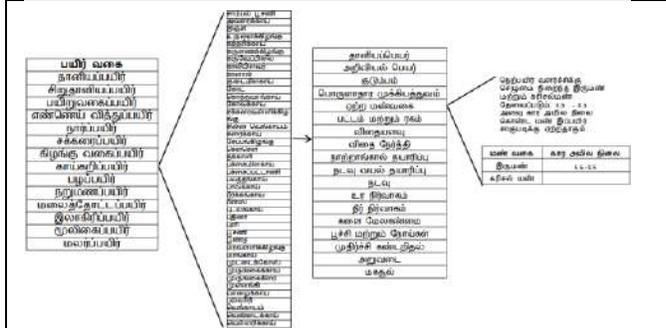


Figure 11. Final Information Extraction

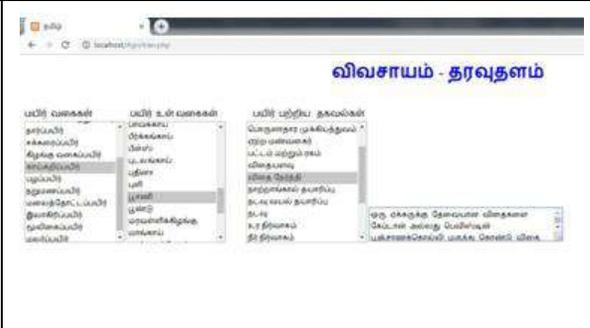


Figure 12. IE Framework for Crops & Practices

The following chart will give the final findings of the information extraction framework.



Figure 12. Evaluation Chart





Formulation and Evaluation of Effervescent Floating Tablets of Metformin HCL using Fenugreek Extract

Anjuna Prakashan^{1*}, Saisudha Sekar¹ and Senthil Rajan²

¹Assistant Professor, Department of Pharmaceutics, Swami Vivekanandha College of Pharmacy, Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India.

²Professor and Head, Department of Pharmaceutics, Swami Vivekanandha College of Pharmacy, Elayampalayam, Tiruchengode, Namakkal, Tamil Nadu, India.

Received: 21 Apr 2022

Revised: 18 May 2022

Accepted: 02 July 2022

*Address for Correspondence

Anjuna Prakashan

Assistant Professor,

Department of Pharmaceutics,

Swami Vivekanandha College of Pharmacy,

Elayampalayam, Tiruchengode,

Namakkal, Tamil Nadu, India.

Email: anjunaprakashan12@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The present research study was aimed at the formulation and evaluation of effervescent floating tablets of metformin HCL using fenugreek extract. The fenugreek extract was prepared by using the ethanol extraction method. Floating tablet containing fenugreek extract, metformin HCL, sodium bicarbonate, citric acid, talc, and magnesium stearate were prepared by direct compression method. The different formulations were prepared and evaluated for physicochemical parameters like hardness, thickness, friability, weight variation, drug content, disintegration, buoyancy time, *In-vitro* dissolution study, and kinetic studies. The optimized formulation was selected on the basis of buoyancy time and *In-vitro* drug release studies. The optimized formulation was found to be F6 which buoyancy time was less than 1 min and the tablet was maintained floating condition throughout the study. While *In-vitro* study released 97.21% of drugs. The promising potential of ethanolic extract of fenugreek using a tablet can be formulated as an approach to increase gastro retentive time and thereby improve bioavailability.

Keywords: Fenugreek extract, floating tablet, buoyancy time, Gastroretentive.





Anjuna Prakashan et al.,

INTRODUCTION

Gastro retentive drug delivery systems are developed to be retained in the stomach for a prolonged time and release their active ingredients and thereby facilitate sustained and prolonged infusion of the drug into the upper part of the gastrointestinal tract [1]. To formulate a successful gastro retentive drug delivery system, several techniques are currently used such as floating drug delivery systems, low-density systems, raft systems incorporating alginate gel, bio adhesive or mucoadhesive systems, high-density systems, super porous hydrogel, and magnetic systems. Among these, the floating dosage forms have been most commonly used [2]. Floating drug delivery systems (FDDS) were developed to keep medications in the stomach and are applicable for drugs with poor solubility and stability in intestinal fluids. The rationale behind FDDS is making the dosage form less dense than the gastric fluids to make it float on them. FDDS are hydro-dynamically controlled low-density systems with adequate buoyancy to float over the gastric contents and remain buoyant in the stomach without impacting the gastric emptying rate for a prolonged period. This results in improved gastric residence time and good control over plasma drug concentration changes. The concept of buoyant preparation is a simple and practical way for increasing the dosage form's gastric residence time and ensuring sustained drug release [3]. Extending the gastric retention of a delivery system is desirable for acquiring greater therapeutic efficacy of the drug substance in certain cases [4].

The first-line drug for the treatment of type 2 diabetes is Metformin [5]. It is also employed in the treatment of polycystic ovary syndrome. Metformin is a biguanide antihyperglycemic agent. It operates by lowering glucose production by the liver, by boosting the insulin sensitivity of body tissues [6] and by raising GDF15 secretion, which reduces appetite and caloric intake [7,8,9]. Literature reviews show that most gastric retention tablet formulations of metformin hydrochloride were manufactured using a wet granulation process. In the present study, the formulation has been developed using the direct compression method. Thus, the formulation materialized in the present study can be more economical as compared to the formulation developed in the prior studies [10].

Hydroxypropyl methylcellulose (HPMC) cellulose ethers are water-soluble polymers emanated from cellulose, used as important binding ingredients in the pharmaceutical processes. HPMC polymers are considered versatile binders because they work well with soluble and insoluble drugs and at high and low doses [11]. Though HPMC has been employed as a rate-controlling polymer in controlled formulations, HPMC, when utilized independently, may show an initial burst release for very soluble drugs. This behavior has been attributed to the immediate dissolution of the drug from the surface near the surface of the matrix, while the polymer experiences hydration to form a protective gel layer [12]. Majority of studies on natural polymers in drug delivery systems are centered on polysaccharides and proteins [13]. Many substances are used as natural, synthetic and semi-synthetic polymers but mucilage of natural origin is more favored over synthetic and semi-synthetic substances because they are comparatively inexpensive, abundantly available, non-toxic and non-irritating in nature [14]. *Trigonella foenum-graecum* L. (Fenugreek) belongs to the Leguminosae family. In clinical, pharmacological and biological studies, extracts from fenugreek seeds are said to have glucose and lipid-lowering properties, as well as antioxidant and anti-inflammatory effects. Phytochemical studies on *T. foenum-graecum* demonstrated that carbohydrates and mucilage's (mainly galactomannans), proteins, fixed oils, flavonoids, and saponins were the major components of the seeds [15,16].

Since Fenugreek seeds produce high viscosity mucilage at low concentration levels, the present research intended to evaluate the binding effects of this fenugreek extract in tableting [17]. A tablet binder or binding agents are the substances that are added either dry or in liquid form during wet granulation to form granules or to promote cohesive compacts for directly compressed tablets [18]. They are crucial in ensuring that pellets, granules, and tablets maintain their shape until they reach their intended target by keeping all ingredients together in any solid dosage form. Choosing the right binder is crucial in maintaining the integrity of the tablet [19].





Anjuna Prakashan *et al.*,

A potential fenugreek-based drug (Fenfurol®) was compared to Metformin in a clinical trial. The results showed that fenfurol in combination with metformin yielded better results than metformin alone [20]. Hence fenugreek extract can also be used along with antidiabetic drugs such as Metformin. This study aimed to investigate the possibility of using Fenugreek extract as a tablet binder in a direct compression process replacing HPMC. In the present work, floating tablets of Metformin hydrochloride were prepared by an effervescent approach using Fenugreek extract as the binder. The study aimed to evaluate the effect of fenugreek extract as a binder on drug release and buoyancy.

MATERIALS AND METHODS

Fenugreek seeds were procured from the local market. Metformin HCL was obtained by Enaltec Chemistry Applied, Pithampur, and Mumbai, India. Talc, Magnesium stearate, Citric acid, Sodium bicarbonate, Ethylcellulose were obtained from Loba Chem., India. Different instruments viz; Monsanto Hardness Tester, Roche Friabilator, Vernier Caliper, Disintegration apparatus, dissolution apparatus (Veego, Mumbai), UV spectrophotometer (Shimadzu, Japan).

Extraction of fenugreek seed

A 100 gm of crushed fenugreek seed was soaked in 500 ml of distilled water and boiled at 60°C for 4 hours using magnetic stirrer to maintain heat and stirring continuously to thick mass was obtained. It was kept aside overnight at room temperature. The mucilage was filter by using muslin cloth. Then mucilage was washed with 300 ml of absolute alcohol. The precipitated mucilage was filtered using vacuum filtration. The separated mucilage was rewashed with 200 ml of acetone. This treatment to remove pigments and to deactivate enzyme. After filtration, filtrate was dried in hot air oven at 60°C for 6 hours. The dried mucilage was to make the fine powder using mortar and pestle and it is passed through the sieve no 120.

Identification test

The extracted fenugreek seeds was test for identification. To determine the presences of mucilage (Ruthenium red test), carbohydrates (Molisch's test), starch (Iodine test), Alkaloids (Dragendroff's test), protein and amino acids (Ninhydrin test), glycosides (Keller Killiani test).

Physiochemical characterization of extract

The extracted powder was evaluated for solubility, swelling index, and pH

Fourier transform infrared (FTIR) spectroscopy of extract

Fenugreek seed extract was analyzed using Shimadzu, Japan. Samples were prepared by KBr pellet method, one part of the sample and three part of the KBr pellet were taken in mortar and triturated. The small amount of sample was taken in pellet maker and compressed at pressure 10Kg/cm² using hydraulic press. Compressed pellet was scanned at transmittance range of 4000cm⁻¹ – 400⁻¹.

Swelling index

1g of extract was taken 25ml of ground glass stoppered cylinder graduated over a height of 120 to 130mm in 0.5 divisions to this 25ml of water was added and this was shaken vigorously every 10min once for 1 hour and then allowed to stand for 24hr.

Characterization of drug and excipients

Preformulation study on Metformin HCL

The metformin HCL was subjected to various preformulation studies like solubility, pH, description, Loss on drying.





Anjuna Prakashan *et al.*,

(FTIR) – Metformin HCL

The IR absorption spectra of the pure drug and with different excipients were taken in the range of 4000-400cm² KBr pellet method. One part of the sample and three-part of the KBr pellet were taken in mortar and triturated. A small amount of sample was taken in pellet maker and compressed at pressure 10Kg/cm² using a hydraulic press.

pH stability testing of the drug

Weighed quantities of the drug (0.5g) was dissolved in different solvents like 0.1M hydrochloric acid (pH 1.2), Acid buffer (pH4.5), Phosphate buffer (pH6.8).

Standard calibration curve of metformin HCL

Solution ranging from 2 to 4 µg/ml were prepared in phosphate buffer (pH6.8). Absorbance was measured for each solution at λ_{max} of 233nm, using Shimadzu, Japan UV Spectrophotometer.

Preparation of floating tablet of met for min HCL using extract

All the formulations were prepared by direct compression method using extract, drug, and excipients. Accurately weighed quantities of extract, drug, and all other ingredients were individually passed through sieve no 60. All the ingredients were mixed thoroughly by triturating up to 15mins. The powder mixture was lubricated with magnesium stearate and talc. It obtained was compressed using rotary tablet punching machine16 station (cadmach).

Pre-compression parameters

The prepared powder blend was evaluated for various parameters like Tapped density, Angle of repose, Bulk density, Carr's index, and Hausner's ratio. After evaluation of powder blend, the tablets were compressed using rotary tablet punching machine16 station (cadmach).

Post-compression parameters

The prepared floating tablets of metformin HCL were evaluated for weight variation, hardness, thickness, friability, disintegration, and drug content. And also evaluated for floating behaviors such as total floating time, floating lag time, and swelling index.

In-vitro dissolution study of metformin HCL using fenugreek extract

900 ml of 0.1 HCL was placed in the vessel and the USP apparatus type II paddle method. The medium was allowed to equilibrate to temp 37±0.5°C. The apparatus was operated for 12 hours at 50rpm. At definite time intervals, 5ml of the fluid was withdrawn, and again 5ml of fresh buffer was replaced. Suitable dilution was done with the dissolution fluid and the samples were analyzed spectrophotometrically at 233nm.

RESULTS AND DISCUSSION

FTIR Spectroscopy of Fenugreek Extract

The FTIR spectra of isolated fenugreek extract are shown in Figure 1. It showed characteristic peaks of –OH between 3510.8 and 3156.3 cm⁻¹, –CH₃ at 2934 cm⁻¹, –CH stretching between 2922 and 2856 cm⁻¹, ether linkage at 1450-1400 cm⁻¹, and –CO stretching at 1018 cm⁻¹. These findings confirmed that the isolated seed extract was fenugreek starch extract

CHARACTERIZATION OF DRUG AND EXCIPIENTS

FTIR spectroscopy of Metformin HCL

A high intense stretching frequency occurring at 3376.79 cm⁻¹, medium stretching at 3119.90 cm⁻¹, 2932 cm⁻¹ and 1636.91 cm⁻¹, 1143 cm⁻¹, 867 cm⁻¹, 677 cm⁻¹, 540 cm⁻¹ correspond to –NH stretching, symmetric N-H stretching, (CH₃)₂N absorption, N-H deformation C-N stretching NH₂ rocking, C-H out of plane bending and C-N-C deformation present in Metformin HCL.





Anjuna Prakashan *et al.*,

Preparation of floating tablet of metformin HCL using fenugreek extract (Table 3:)

Precompression parameters of powder (Table 4)

Post compression parameters of floating tablet of metformin hcl using fenugreek extract (Table 5)

Evaluation of floating behaviour (Table 6)

In-vitro dissolution study of floating tablet of metformin HCL using fenugreek extract (Table 7)

Kinetics of drug release

The *in vitro* dissolution data of optimized formula F6 was fitted into different kinetic models like zero order, first order, Higuchi & Korsemeyer Peppas model. Where Korsemeyer Peppas kinetic model with a Regression coefficient R^2 -value 0.9869 was found to be fairly linear as indicated by highest regression value. To study the mechanism of drug release, the drug release data was fitted to Korsemeyer Peppas model. Diffusion exponent “n” value was 0.744 which >0.49 . The results shows that the drug release from the formulation was by Non-Fickian Diffusion.

Comparison of Optimized Formulation with Marketed Formulation

The marketed formulation showed 94% drug release in 12h, whereas the optimized formulation F6 showed 97.2% drug release in 12h. Comparison study with marketed product of Glyciphage SR 500, has showed that optimized formulation F6 is having better release in comparison to the marketed product. The optimized formulation F6 remained floatable in 0.1N HCl for 12 h. hence, it having more advantage over marketed formulation that it increases absorption of Metformin HCl. Thus it is concluded that floating tablet of metformin HCl gives almost complete drug release over 12h.

CONCLUSION

This study has shown the potential of Fenugreek extract to act as a binding agent in the formulation of floating tablets. From this study, it is concluded that fenugreek extract can be used as a binder in the formulation of floating tablets since the primary ingredient fenugreek is inexpensive, devoid of toxicity, biocompatible, biodegradable, easy to manufacture, they can be used in place of currently marketed binders like HPMC. The prepared floating tablets were evaluated for their physicochemical properties such as tablet dimensions, hardness, friability, weight variation, Content uniformity, floating time, *in-vitro* drug release. *In-vitro* drug release was carried out in 0.1N HCl and it showed 97% drug release at 12h compared to marketed formulation. Formulation F6 fitted to Korsemeyer Peppas kinetics and the n value was 0.744 indicating non-fickian diffusion. Formulation F6 showed good floating behavior (buoyancy time less than 1 min), along with controlled-release compared to other formulations. The combination of sodium bicarbonate, citric acid, and fenugreek extract can be used as promising components for developing gastro retentive drug delivery system. Along with this Fenugreek is proven to have antidiabetic properties, thus it can also be used for the formulation of antidiabetic drugs. The above study thus indicates the promising potential of fenugreek extract floating tablets compared to conventional dosage forms.

ACKNOWLEDGMENTS

The authors are thankful to the management of Swami Vivekanandha College of Pharmacy for their support and access to online resources for the research work.

Conflict of Interest

The authors declare no conflict of interest.





Anjuna Prakashan et al.,

REFERENCES

1. Dehghan MH, Khan FN. Gastro retentive drug delivery systems: A patent perspective. *Int J Health Res.* 2009;2:23–44
2. Mathur P, Saroha K, Syan N, Verma S, Kumar V. Floating drug delivery systems: An innovative acceptable approach in gastroretentive drug delivery. *Arch ApplSci Res.* 2010; 2:257–70.
3. Arora S, Ahuja A. Floating drug delivery system: a review. *J AAPS PharmSciTech* 2005; 6:372–90.
4. Kydonieus A. *Controlled release technologies.* 2nd Ed. New York: Marcel Dekker; 1991. p. 109.
5. *Clinical Obesity* (2nd ed.). Oxford: John Wiley & Sons. 2008. p. 262. ISBN 978-0-470-98708-7. Archived from the original on 8 September 2017
6. "Metformin Hydrochloride". The American Society of Health-System Pharmacists. Archived from the original on 24 December 2016. Retrieved 2 January 2017.
7. Coll, AP; Chen, M; Taskar, P; Rimmington, D; Patel, S; Tadross, JA; Cimino, I; Yang, M; Welsh, P; Virtue, S; Goldspink, DA; Miedzybrodzka, EL; Konopka, AR; Esponda, RR; Huang, JT; Tung, YCL; Rodriguez-Cuenca, S; Tomaz, RA; Harding, HP; Melvin, A; Yeo, GSH; Preiss, D; Vidal-Puig, A; Vallier, L; Nair, KS; Wareham, NJ; Ron, D; Gribble, FM; Reimann, F; Sattar, N; Savage, DB; Allan, BB; O'Rahilly, S (February 2020). "GDF15 mediates the effects of metformin on body weight and energy balance". *Nature.* 578 (7795): 444–448. doi:10.1038/s41586-019-1911-y
8. Day, Emily A.; Ford, Rebecca J.; Smith, Brennan K.; Mohammadi-Shemirani, Pedrum; Morrow, Marisa R.; Gutgesell, Robert M.; Lu, Rachel; Raphenya, Amogelang R.; Kabiri, Mostafa; McArthur, Andrew G.; McInnes, Natalia; Hess, Sibylle; Paré, Guillaume; Gerstein, Hertzfel C.; Steinberg, Gregory R. (December 2019). "Metformin-induced increases in GDF15 are important for suppressing appetite and promoting weight loss". *Nature Metabolism.* 1 (12): 1202–1208. doi:10.1038/s42255-019-0146-4
9. Pappachan JM, Viswanath AK (January 2017). "Medical Management of Diabetes: Do We Have Realistic Targets?" *Current Diabetes Reports.* 17 (1): 4. doi: 10.1007/s11892-017-0828-9. PMID 28101792. S2CID 10289148
10. Gharti KP, Budhathoki U, Thapa P, Bhargava A. Formulation in vitro evaluation of floating tablets of hydroxypropyl methylcellulose and polyethylene oxide using ranitidine hydrochloride as a model drug. *Journal of Young Pharmacists.* 2012 Oct 1;4(4):201-8
11. Jain K.K. Springer Science & Business Media; 2008. *Drug Delivery Systems.*
12. Gusler G, Berner B, Chau M, Padua A, inventors. DepoMed Inc., assignee. Optimal polymer mixtures for gastric retentive tablets. United States Patent 6723340. 2004 Apr 20;
13. Tripathy, S., Promod, K., Banthia A.K. (2004). Novel delivery system for aceclofenac. Scientific abstract, 56th Indian Pharmaceutical Congress, pp: A71.
14. Poddar, S.S., Saini, C.R., Paresh, A., Singh, R. (2004). The microencapsulation of ibuprofen by gelatin-carrageenan complex coacervation. Scientific abstract, 56th Indian Pharmaceutical Congress, pp: AP111.
15. Ghedira K, Goetz P. Le Jeune R. Fenugrec: *Trigonella foenum-graecum* L. (Fabaceae ex. Leguminosae). *Phytother* 2010; 8:180-184.
16. . Wichtl M. *Teedrogen.* Translated by: Bisset NG. Stuttgart: Medpharm Scientific Publishers; 2000. p. 203-205.
17. Tavakoli N, Varshosaz J, Ghannadi A, Bavarsad N. Evaluation of *Trigonella foenum-graecum* seeds gum as a novel tablet binder. *Seeds.* 2012; 3:4.
18. Lachman, Lieberman, H.A. and Kanig, J.L., *The Theory and Practice of Industrial Pharmacy,* Lea and Febiger, New York, 15th edition., 2013.
19. Tablet binder : types and examples with concentration. <https://pharmaeducation.net/tablet-binder/>
20. Verma N, Usman K, Patel N, Jain A, Dhakre S, Swaroop A, Bagchi M, Kumar P, Preuss HG and Bagchi D: A multicenter clinical study to determine the efficacy of a novel fenugreek seed (*Trigonella foenum-graecum*) extract (Fenfuro™) in patients with type 2 diabetes. *Food Nutr Res.* 60(32382)2016.



Anjuna Prakashan *et al.*,

Table 1: Physicochemical characterization of Fenugreek seed extract

| PARAMETERS | RESULT |
|--|---|
| State | Amorphous powder |
| Odor | No characteristic odor |
| Taste | Tasteless |
| Color | Off white- cream-yellow color |
| Identification | |
| a) Test for starch | The appearance of blue-black colour |
| b) Test for carbohydrate (Mollish's test) | The appearance of violet ring at the junction of two liquids |
| c) Test for tannins (Ferric chloride test) | - |
| d) Test for alkaloids | - |
| e) Test for glycosides | - |
| f) Test for mucilages | + |
| g) Test for steroids and sterols | - |
| h) Test for proteins and aminoacids | - |
| pH (1%w/v) | 5.6 |
| Swelling index | 35 |
| Solubility | Quickly dissolves in warm water, forms viscous colloidal solution, insoluble in ether, acetone, chloroform, ethanol |

Table 2: Characterization of Metformin hydrochloride

| Sl No | Methods | Results |
|-------|-----------------|------------------------------|
| 1. | Description | White and crystalline powder |
| 2. | Solubility | 100 mg/ml |
| 3. | pH(1% solution) | 6.5 |
| 4. | Loss on drying | 0.2 |

Table 3: Composition of Metformin HCl floating tablet using Fenugreek extract

| INGREDIENTS | F1(mg) | F2(mg) | F3(mg) | F4(mg) | F5(mg) | F6(mg) |
|--------------------|--------|--------|--------|--------|--------|--------|
| Metformin | 300 | 300 | 300 | 300 | 300 | 300 |
| Fenugreek Extract | 50 | 60 | 70 | 80 | 90 | 100 |
| Ethyl cellulose | 20 | 20 | 20 | 20 | 20 | 20 |
| Sodium bicarbonate | 99 | 89 | 79 | 69 | 59 | 49 |
| Citric acid | 25 | 25 | 25 | 25 | 25 | 25 |
| Magnesium stearate | 2 | 2 | 2 | 2 | 2 | 2 |
| Talc | 4 | 4 | 4 | 4 | 4 | 4 |
| Total weight | 500 | 500 | 500 | 500 | 500 | 500 |



Anjuna Prakashan *et al.*,

Table 4 : Preformulation studies

| PARAMETERS | F1 | F2 | F3 | F4 | F5 | F6 |
|-----------------|------------|------------|------------|------------|------------|------------|
| Angle of repose | 27°34' | 24°50' | 26°84' | 27°41' | 30°60' | 25°12' |
| Hausner ratio | 0.11 | 0.13 | 0.11 | 0.12 | 0.14 | 0.11 |
| Carr's index | 15.92±0.65 | 15.87±0.65 | 15.54±0.58 | 15.91±0.55 | 15.54±0.24 | 15.08±0.65 |
| Tapped density | 0.55 | 0.50 | 0.49 | 0.53 | 0.55 | 0.54 |
| Bulk density | 0.76 | 0.78 | 0.77 | 0.67 | 0.7 | 0.75 |

Table 5: Post compression Parameters

| Parameters | F1 | F2 | F3 | F4 | F5 | F6 |
|--------------------------------|------------|------------|------------|------------|------------|-------------|
| Hardness (kg/cm ²) | 4.3±0.4 | 4.6±0.2 | 4.2±0.5 | 4.4±0.5 | 4.7±0.1 | 5.2±0.4 |
| Thickness | 4.2±0.2 | 4.4±0.7 | 4.1±0.1 | 4.6±0.5 | 5.1±0.8 | 4.9±0.5 |
| Drug content (%) | 99.43±0.15 | 99.41±0.56 | 99.94±0.77 | 99.69±0.54 | 99.12±0.04 | 100.44±0.06 |
| Weight variation (mg) % | 2.12±0.18 | 2.35±0.66 | 3.15±0.37 | 2.67±0.83 | 3.13±0.11 | 2.10±0.44 |
| Friability (%) | 0.51±0.49 | 0.49±0.17 | 0.52±0.34 | 0.58±0.47 | 0.42±0.25 | 0.38 + 0.04 |
| Disintegration time (sec) | 74 | 58 | 95 | 110 | 75 | 85 |

Table 7: *In-vitro* dissolution studies

| Time(sec) | F1 | F2 | F3 | F4 | F5 | F6 |
|-----------|------------|------------|------------|------------|------------|------------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 15.8±0.07 | 17.09±0.33 | 19.07±0.05 | 14.12±0.55 | 9.66±0.03 | 10.24±0.06 |
| 60 | 29.5±0.04 | 25.1±0.056 | 32.32±0.08 | 28.43±0.63 | 12.1±0.07 | 14.36±0.04 |
| 120 | 35.1±0.03 | 44.8±0.03 | 48.7±0.04 | 34.3±0.09 | 18.03±0.6 | 22.66±0.2 |
| 240 | 47.9±0.07 | 58.5±0.02 | 51.3±0.065 | 40.7±0.04 | 33.5±0.4 | 36.43±0.13 |
| 360 | 58.01±0.08 | 65.78±0.07 | 56.5±0.034 | 52.4±0.02 | 51.6±0.6 | 57.11±0.09 |
| 480 | 69.05±0.34 | 77.34±0.01 | 69.2±0.04 | 67.8±0.06 | 72.3±0.4 | 79.68±0.7 |
| 600 | 76.8±0.07 | 82.43±0.05 | 72.3±0.05 | 78.33±0.04 | 83.5±0.7 | 86.37±0.06 |
| 720 | 87.5±0.05 | 90.01±0.08 | 86.08±0.07 | 89.8±0.066 | 92.8±0.040 | 97.21±0.05 |

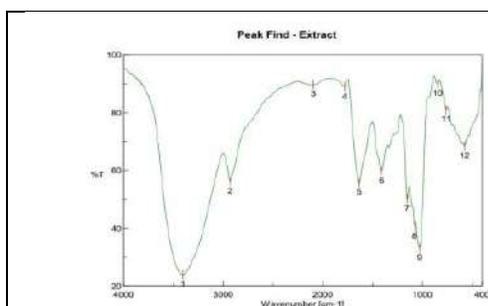


Fig 1. FTIR of Fenugreek extract

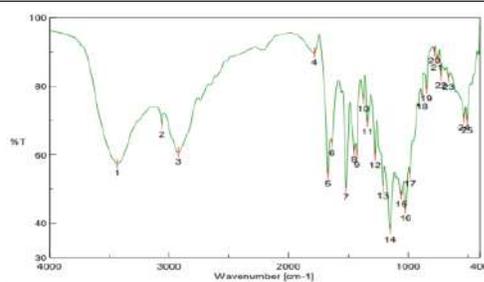


Fig 2. FTIR of Metformin HCl





Anjuna Prakashan et al.,

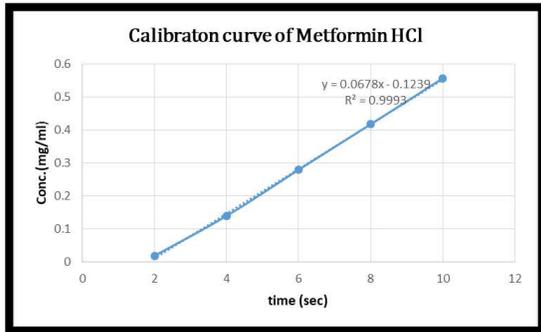


Fig 3. Calibration curve of Metformin HCl

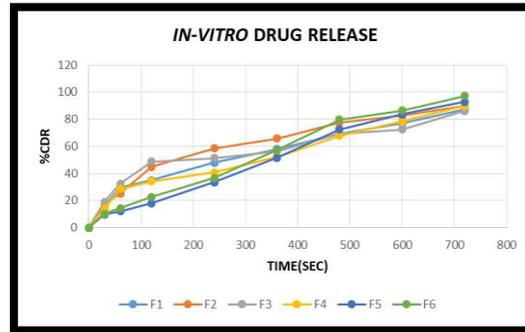


Fig.4 Comparison of *in-vitro* drug release of all the batches (F1-F6)

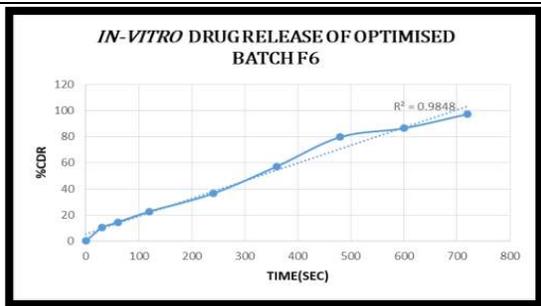


Fig 5 *In-vitro* drug release of optimized batch F6

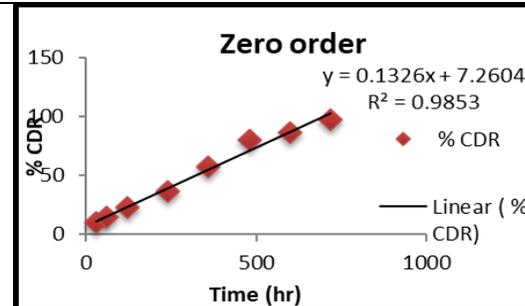


Fig 6. Zero order kinetic

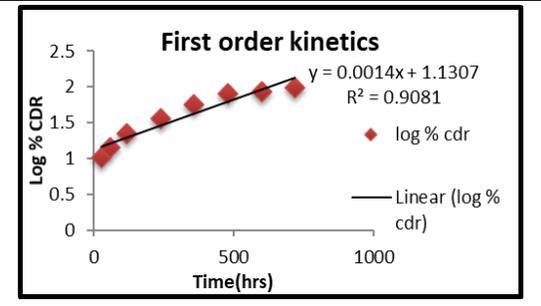


Fig.7. First order kinetics

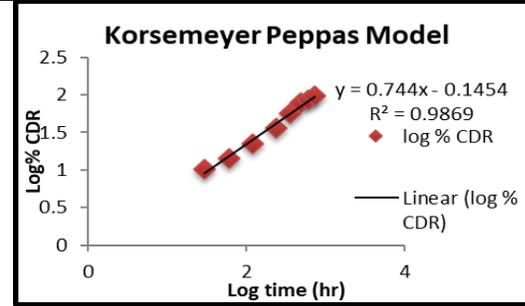


Fig. 8. Korsmeyer Peppas model

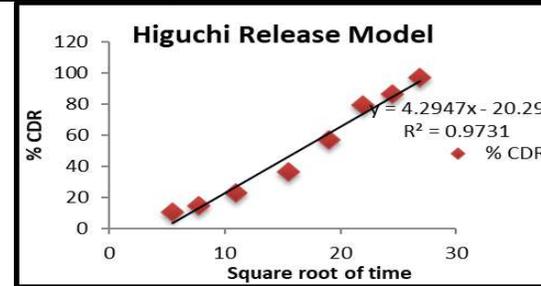


Fig.9. Higuchi release model

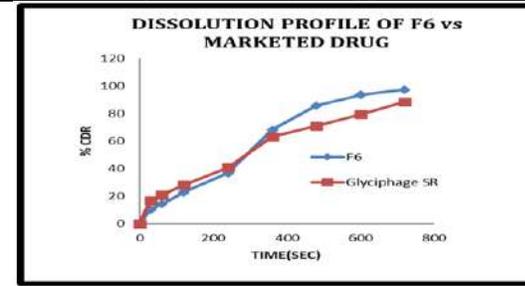


Fig.10. Comparison of dissolution profile of F6 Vs. marketed drug





Anjuna Prakashan et al.,



Fig. 11. Fenugreek mucilage



Fig. 12. Vacuum filtration



Fig 13. Dried powder extract of fenugreek extract



Fig. 14. Metformin HCL Floating tablet with fenugreek extract

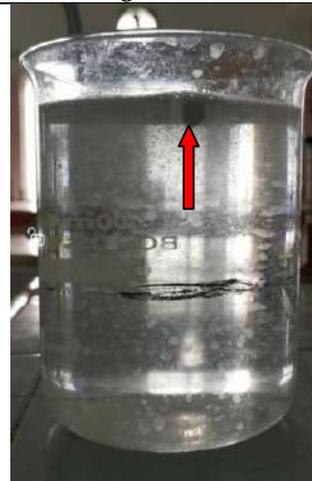


Fig. 14. Floating behaviour of Metformin HCL floating tablet containing fenugreek extract





Standardization of Siddha Formulations of *Syzygium cumini*

S. Ruby^{1*}, V. Vishnupriyan², S. Jeevan Nithish², S. Manoj Kumar² and K. Annamala²

¹Associate Professor, Department of Pharmaceutical Chemistry, Vinayaka Mission's College of Pharmacy, Vinayaka Missions Research Foundation (DU) Salem, Tamil Nadu, India.

²B.Pharmacy, Vinayaka Mission's College of Pharmacy, Vinayaka Missions Research Foundation (DU) Salem, Tamil Nadu, India.

Received: 02 May 2022

Revised: 13 June 2022

Accepted: 02 July 2022

*Address for Correspondence

S. Ruby

Associate Professor,
Department of Pharmaceutical Chemistry,
Vinayaka Mission's College of Pharmacy,
Vinayaka Missions Research Foundation (DU),
Salem, Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of the study is to prepare and standardize the Siddha formulation- *Syzygium cumini* (L.). Initially, the literary evidence of *Syzygium cumini* (L.) and its ingredients were reviewed.. Organoleptic characters like appearance, colour, taste and odour of *Syzygium cumini* (L.) was noted. *Syzygium cumini* (L.) was screened for total ash value, acid insoluble ash, to estimate the quality of study drug. Preliminary Phytochemical evaluation of *Syzygium cumini* (L.) was carried out following the standard procedure. The results of the preliminary phytochemical test showed that alkaloids, flavonoids, glycosides, phenols, tannins, saponins were present in aqueous extract and ethanolic extract of *Syzygium cumini* (L.). The functional groups are identified by FTIR-Spectroscopic method.

Keywords: Jamun seed powder, Phytochemicals, FTIR, Ash content.

INTRODUCTION

The definition of pharmacognosy implies a particular knowledge of methods of identification and evaluation of drugs. *Syzygium cumini* (L.) synonyms such as *Syzygium cumini* (L.) Druce, *Eugenia jambolana* Lam., *Syzygium jambolanum* DC, belonging to the family Myrtaceae, is a large evergreen tree up to 30 m in height and a girth of 3.6 m with a bole up to 15m found throughout India up to an altitude of 1,800 m 1. It has been valued in Ayurveda and Unani system of medication for possessing variety of therapeutic properties.



**Ruby et al.,**

According to Ayurveda, its bark is acrid, sweet, digestive and astringent to the bowels, Anthelmintic, good for sore throat, bronchitis, asthma, thirst, dysentery, blood impurities and to cure ulcers. In Unani medicine system the ash of leaves is used to strengthen the teeth and the gums, the seeds are astringent, diuretic, stop urinary discharge and are a remedy for diabetes and the barks show good wound healing properties. *Syzygium cumini* is a medicinal plant, whose parts were pharmacologically proved to possess hypoglycemic, antibacterial, anti-HIV activity, anti-diarrhea effects and anti-inflammatory activity.

The use of herbal medicine due to toxicity and side effects of allopathic medicines, has led to sudden increase in the number of herbal drug manufacturers. The proper authentication of herbal raw materials is critically important to the safety and efficacy of herbal medicines. The WHO has stressed the importance of adopting current methodologies and applying appropriate norms and standards to assure quality control of medicinal plant products. Herb authentication is a quality control procedure that assures that the correct plant species and plant parts are utilized as raw materials in herbal medications. India has the potential to become a key player in the development of standardized, medically effective ayurvedic medicines [1].

MATERIALS AND METHODS

Sample

Three formulations of *Syzygium* were procured from the Salem District Tamil Nadu. Sample A, Sample B, Sample C.

Physical and Microscopic Studies

All the formulations studied were brown (various shades observed) in color, had an aromatic odor, were bitter to taste and had a coarse texture. The mono herbal formulations A, B and C showed the presence of Parenchyma cells deposited with pectin and numerous oval Starch grains isolated or in clusters of 4-5 grains.

QUALITATIVE AND QUANTITATIVE ANALYSIS OF PHYTOCHEMICALS

Qualitative analysis

3g of each formulation weigh and mixed with 50ml of water and ethanol kept in it overnight then filtered through using filter paper. The filtered solution was performed below procedure. The phytochemical analysis was carried out on all three extracts, which were generated using three separate extraction procedures as reported by Brain and colleagues. Turner is a well-known figure in (1975) [2].

Preliminary Qualitative Analysis

Test for Alkaloids

Mayer's test

To a few ml of plant sample extract, two drops of Mayer's reagent are added along the sides of test tube. Appearance of white creamy precipitate indicates the presence of alkaloids.

Wagner's test

A few drops of Wagner's reagent are added to few ml of plant extract along the sides of test tube. A reddish- Brown precipitate confirms the test as positive.

Test for Amino acids:

The extract is dissolved in 10 ml of distilled water and filtered through Whatman No.1 filter paper and the filtrate are subjected to test for Amino acids.



**Ruby et al.,****Ninhydrin test**

Two drops of ninhydrin solution (10 mg of ninhydrin in 200 ml of acetone) are added to 2 ml of aqueous filtrate. Appearance of purple colour indicates the presence of amino acids.

Test for Carbohydrates**Molisch's test**

To 2 ml of plant sample extract, two drops of alcoholic solution of α -naphthol are added. The mixture is shaken well and few drops of concentrated sulphuric acid is added slowly along the sides of test tube. A violet ring indicates the presence of carbohydrates.

Benedict's test

To 0.5 ml of filtrate, 0.5 ml of Benedict's reagent is added. The mixture is heated on a boiling water bath for 2 minutes. A characteristic coloured precipitate indicates the presence of sugar.

Test for Fixed oils and Fats**Spot test**

A small quantity of extract is pressed between two filter papers. Oil stain on the paper indicates the presence of fixed oils.

Saponification test

A few drops of 0.5 N alcoholic potassium hydroxide solution is added to a small quantity of extract along with a drop of phenolphthalein. The mixture is heated on a water bath for 2 hours. Formation of soap or partial neutralization of alkali indicates the presence of fixed oils and fats.

Test for Glycosides

For 50 mg of extract is hydrolysed with concentrated hydrochloric acid for 2 hours on a water bath, filtered and the hydrolysate is subjected to the following tests.

Borntrager's test

To 2 ml of filtered hydrolysate, 3 ml of chloroform is added and shaken, chloroform layer is separated and 10% ammonia solution is added to it. Pink colour indicates presence of glycosides.

Legal's test

50 mg of extract is dissolved in pyridine; sodium nitroprusside solution is added and made alkaline using 10% NaOH. Presence of glycoside is indicated by pink colour.

Test for Phenolic compounds and Tannins**Ferric Chloride test**

The extract (50 mg) is dissolved in 5 ml of distilled water. To this few drops of neutral 5% ferric chloride solution are added. A dark green colour indicates the presence of phenolic compound.

Gelatin test

The extract (50 mg) is dissolved in 5 ml of distilled water and 2 ml of 1% solution of Gelatin containing 10% NaCl is added to it. White precipitate indicates the presence of phenolic compounds

Lead acetate test

The extract (50 mg) is dissolved in of distilled water and to this 3 ml of 10% lead acetate solution is added. A bulky white precipitate indicates the presence of phenolic compounds.



**Ruby et al.,****Alkaline reagent test**

An aqueous solution of the extract is treated with 10% ammonium hydroxide solution. Yellow fluorescence indicates the presence of flavonoids.

Magnesium and Hydrochloric acid reduction

The extract (50 mg) is dissolved in 5 ml of alcohol and few fragments of magnesium ribbon and concentrated hydrochloric acid (drop wise) are added. If any pink to crimson colour presence develops of flavonol glycosides is inferred.

Test for Phytosterols**Libermann-Burchard's test**

The extract (50 mg) is dissolved in 2 ml acetic anhydride. To this, 1 or 2 drops of concentrated sulphuric acid are added slowly along the sides of the test tube. An array of colour change shows the presence of phytosterols.

Test for Proteins

The extract (100 mg) is dissolved in 10 ml of distilled water and filtered through Whatmann No.1 filter paper and the filtrate is subjected to test for proteins.

Millon's test

To 2 ml of filtrate few drops of Millon's reagent are added. A white precipitate indicates the presence of proteins.

Biuret test

2 ml of filtrate is treated with 1 drop of 2% copper sulphate solution. To this 1 ml of ethanol (95%) is added, followed by excess of potassium hydroxide pellets. Pink colour ethanolic layer indicates the presence of protein.

Test for Saponins:

The extract (50 mg) is diluted with distilled water and made up to 20 ml. The suspension is shaken in a graduated cylinder for 15 minutes. A two cm layer of foam indicates the presence of saponins.

Test for Gum and Mucilage:

The extract (100 mg) is dissolved in 10 ml of distilled water and to this 2 ml of absolute alcohol is added with constant stirring. White or cloudy precipitate indicates the presence of Gums and Mucilage's.

Test for Volatile oil:

For volatile oil estimation 50 mg of powdered material (crude drug) is taken and subjected to hydro- distillation. The distillate is collected in graduate tube of the assembly, wherein the aqueous portion automatically separated out from the volatile oil.

ASH CONTENT**Total ash content**

Dried powder was accurately weighed (5.0g) in a tarred Silica dish and incinerated completely in a muffle furnace at 500° C in 2 hours and ash became white grey in colour (i.e. Carbon free ash). Ash was cooled in desiccators and weighed. The process was repeated (ignition, cooling and weighing) for constant weight [3,4].

Acid insoluble ash

After cooling, 25mL of dilute HCl was added, and was covered with watch glass and boiled on a water bath for 5 minutes. It was allowed to cool, and was filtered through Whatmann filter paper No.41. The residue was then washed with hot water till washings were free from chloride (no white ppt with AgNO₃ solution). The filter paper



**Ruby et al.,**

and the residue were put in a Hot air oven till dried completely. The process was repeated (ignition, cooling and weighing) for constant weight [5].

Water soluble ash

After cooling, boiled the total ash for 5 minutes with 25 ml of water. It was allowed to cool, and was filtered through Whatmann filter paper No.41. The residue was then washed with hot water till washings were free from chloride. The filter paper and the residue were put in a Hot air oven till dried completely. The process was repeated (ignition, cooling and weighing) for constant weight [5].

ANTIMICROBIAL ACTIVITY OF ETHANOLIC EXTRACTS

2 g of each formulation was extracted with 50 ml of ethanol for 48 hours using the Soxhlet Extractor 14. The extract obtained was filtered and ethanol was evaporated using Rota evaporator. Semisolid Extract obtained was then diluted with sterile de-ionized water (1:10 & 1:20). Antimicrobial activity of 0.2 ml of the aqueous dilutions was tested in duplicates against *E.coli*, *S.typhi*, *C.albicans*, *K.pneumonia*, *S. aureus*. Inhibition zone sizes were measured in mm after incubation for 24 hours at 37°C. Sterile distilled water (processed using entirely the same procedure) was run along with the samples as a control⁶

FTIR SPECTROSCOPIC ANALYSIS

The resulting spectrum is a molecular fingerprint of the material, representing molecule absorption. No two chemical configurations create the same infrared spectrum, just like a fingerprint. The 4000–400 cm⁻¹ mid-infrared spectrum may be roughly divided into four regions, and the nature of a group frequency can be determined in general by the region in which it is found.

The following are the generalised regions:

- The X–H stretching region (4000–2500 cm⁻¹)
- The triple-bond region (2500–2000 cm⁻¹)
- The double-bond region (2000–1500 cm⁻¹)
- The fingerprint region (1500–600 cm⁻¹)

The fundamental vibrations in the 4000–2500 cm⁻¹ region are generally due to O–H, C–H and N–H stretching. O–H stretching produces a broad band that occurs in the range 3700–3600 cm⁻¹. By comparison with standard values N–H stretching is usually observed between 3400 and 3300 cm⁻¹. Principle bands observed in the range 700–600cm⁻¹ are due to out of plane =C–H bending. Carbonyl stretching is one of the easiest absorptions to recognize in an infrared spectrum. It is usually the most intense band in the spectrum and depending on the type of C=O bond, occurs in the 1830–1650 cm⁻¹ region. Functional groups were identified in Ultrasonicated jamun seeds extract by comparing corresponding functional group peak absorption value at a particular wave number with FT-IR Standards. Functional groups identified were listed in Table 4 along with standard FT-IR wavenumber range (Stuart B, 2004).

RESULTS AND DISCUSSION

Jamun has been found to contain phytochemicals including alkaloids, flavonoids, glycosides, phenols, tannins, saponins. Fig 1: Showing “+” results of (a) Presence of Phenols (b) Presence of Tannins (Gelatin test) (c) Presence of Flavonoids (Lead acetate test) (d) Presence of Alkaloids (Wagner’s Test).

The powdered seed of *Syzygium cumini* was subjected to evaluate its total ash, acid insoluble ash, water-soluble ash value, water and ethanol soluble extractive values, loss on drying and moisture content. Total ash content was found sample A (2.8%), sample B (6%) and sample C (4.6%) indicates that the plant has moderate mineral elements. Acid insoluble ash was sample A (2.5%), sample B (2.3%) and sample C (2.2%) respectively. Water soluble was sample A (1.3%), sample B (1.5%) and sample C (1.7%) respectively. The above determination was found some insoluble matters that were suspect as sand was mixed with the formulation that are harmful to human. The above three





Ruby et al.,

formulation sample A and sample C small amount of sand was determined, sample B had large amount of sand was determined.

CONCLUSION

The jamun seed, *Syzygium cumini* (L.), includes a wide range of secondary metabolites such as alkaloids, flavonoids, terpenoids, steroids, tannins, saponins, and reducing sugars, all of which play an important role in disease prevention. The existence of varied secondary metabolites is responsible for the antidiabetic, anti-inflammatory, antiviral, antibacterial, analgesic, anti-oxidant, and anti-abortifacient properties of various plant components. Plant phytochemical study is also vital, as are pharmaceutical businesses looking for new medications to cure various disorders. The current study examines several phytochemical extraction strategies. It also exposes a number of medicinally essential bioactive substances found in jamun seeds, demonstrating that they can be used as a traditional medicine to treat a variety of ailments. Against harmful organisms, all of the samples had a good antibacterial profile. According to antimicrobial activity sample A shows good antimicrobial content and less ash content compared to sample B and Sample C. Hence it proves the *Syzygium cumini* (L.) of the sample A may show the standardized marketed formulation.

REFERENCES

1. K. S. Chitnisset al 2011 Evaluation of *syzygium cumini* linn. Seed formulations available in the market using spectrophotometric and chromatographic techniques.
2. Brain KR, Turner TD. The practical evaluation of phytopharmaceuticals, right- science technical, 1st Ed, Bristol Britain, 1975, 144.
3. Koley, T.K., K. Barman and R. Asery. 2011. Nutraceutical properties of jamun (*Syzygium cumini* L.) and its processed products. Ind. Food Ind.30: 43-46.
4. Ahamed raza et al 2015 Proximate Composition of Jamun (*Syzygium cumini*) Fruit and Seed.
5. Ajazuddin et al 2010 Evaluation of physicochemical and phytochemical properties of Safoof-E-Sana, a Unani polyherbal formulation.
6. Oliveira, Furtado, Filho, Martins, Bastos, Cunha, Silva. Antimicrobial activity of *Syzygium cumini* (myrtaceae) leaves extract. Brazilian Journal of Microbiology 2007; 38: 381-384.
7. Stuart B. Spectral analysis. Infrared spectroscopy: fundamentals and applications 2004; 45-70.4

Table 1 : Phytochemical Screening of the Extraction

| TEST FOF DETECTION | WATER EXTRACT | | | ETHANOL EXTRACT | | |
|---------------------------------|---------------|---|---|-----------------|---|---|
| | A | B | C | A | B | C |
| 1. Test for Alkaloids | | | | | | |
| a. Mayer' s test | - | - | - | + | + | + |
| b. Wagner' s test | + | - | + | + | + | + |
| 2. Test for Amino acids | | | | | | |
| a. Ninhydrin test | - | - | - | - | - | - |
| 3. Test for Carbohydrates | | | | | | |
| a. Molish' s test | - | - | - | - | - | - |
| b. Benedict' s test | - | - | - | - | - | - |
| 4. Test for Fixed oils and Fats | | | | | | |
| a. Spot test | - | - | - | - | - | - |
| b. Saponification test | - | - | - | - | - | - |
| 5. Test for Glycosides | | | | | | |
| a. Borntrager' s test | + | + | + | + | + | + |





Ruby et al.,

| | | | | | | |
|---|---|---|---|---|---|---|
| b. Legal's test | + | + | + | + | + | + |
| 6. Test for Phenolic compounds and Tannins | | | | | | |
| a. Ferric Chloride test | - | - | - | - | - | - |
| b. gelatin test | + | + | + | + | + | + |
| c. Lead acetate test | + | + | + | + | + | + |
| d. Alkaline reagent test | + | + | - | + | - | - |
| e. Magnesium and Hydrochloric acid reduction | - | - | - | - | - | - |
| 7. Test for phytosterols | | | | | | |
| a. Libermann-Burchard's test | - | - | - | - | - | - |
| 8. Test for Proteins | | | | | | |
| a. Millon's test | - | - | - | - | - | - |
| b. Biuret test | - | - | - | - | - | - |
| 9. Test for Saponins | + | + | + | + | + | + |
| 10. Test for gum and Mucilages | - | - | - | - | - | - |
| 11. Test for volatile oil | - | - | - | - | - | - |

Table 2 : Table for ash value % CONTENT

| Parameters | sample A | Sample B | Sample C |
|--------------------|----------|----------|----------|
| Total ash | 2.8 | 6 | 4.6 |
| Acid Insoluble Ash | 2.1 | 2.3 | 2.2 |
| Water Soluble Ash | 1.3 | 1.5 | 1.7 |

Table 3 : Antimicrobial Activity of the Ethanolic Extract of Jamun Formulations (1:10 dilution)

| AGAINST PATHOGENIC ISOLATES | | | |
|------------------------------|---------------------------|----|--|
| | Name of the Test Organism | | Diameter of Zone of Inhibition (in mm) |
| | A | B | C |
| <i>Salmonella typhi</i> | 32 | 21 | 18 |
| <i>Escherichia coli</i> | 25 | 28 | 12 |
| <i>Staphylococcus aureus</i> | 14 | 16 | 20 |
| <i>Klebsiella pneumonia</i> | 24 | 22 | 20 |
| <i>Candida albicans</i> | 35 | 27 | 34 |





Ruby et al.,

Table 4: The functional group identified in formulated drug by FTIR Analysis

| Wave Number (cm-1) | | | Wave number | Functional groups Identified |
|--------------------|---------|---------|-------------|-------------------------------------|
| A | B | C | Range(cm-1) | |
| 754.90 | 760.0 | 756.46 | 700–600 | Alkynes =C–H bending (out of plane) |
| 1023.23 | 1008.55 | 1006.32 | 1100 | C–O stretching band (Ether) |
| 1205.90 | 1149.32 | 1148.17 | 1275–1000 | In-plane C–H bending (Aromatic) |
| 1327.35 | 1313.40 | 1320.75 | 1300–1400 | Adultrance |
| 1608.49 | 1605.38 | 1605.38 | 1680–1600 | C=C stretching |
| 1608.49 | 1605.38 | 1605.38 | 1680–1600 | C=C stretching(Alkene) |



Fig 1:Phytochemical test result

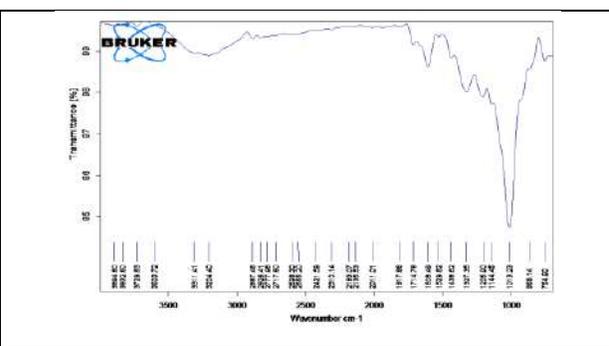


Fig 2: IR Spectrum for sample a FTIR spectrums

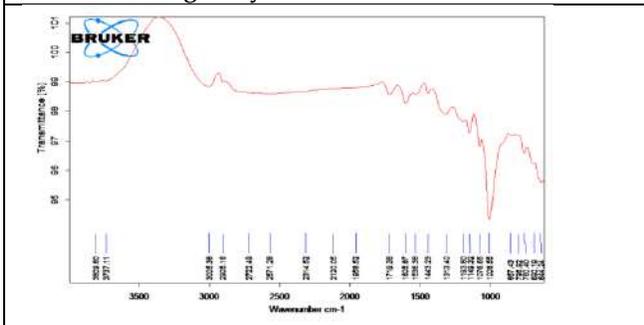


Fig 3: IR Spectrum For Sample B

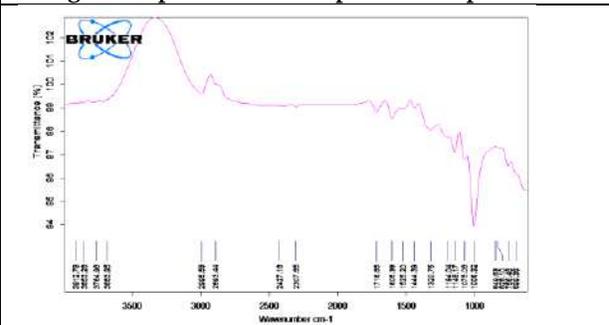


Fig 4: IR Spectrum for Sample C





Chemistry in the Treatment of COVID – 19

Shaik Annar*

Lecturer in Chemistry, MRR Govt. Degree College Udayagiri, Vikrama Shimhapuri University, Nellore, Andhra Pradesh, India.

Received: 06 May 2022

Revised: 10 June 2022

Accepted: 02 July 2022

*Address for Correspondence

Shaik Annar,

Lecturer in Chemistry, MRR Govt. Degree College

Udayagiri, Vikrama Shimhapuri University,

Nellore, Andhra Pradesh, India.

Email: skannar1973@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The present world is facing a new deadly challenge from a pandemic disease (COVID-19), which is caused by a coronavirus named SARS-COV-2. To date, no drug or vaccine can treat COVID-19 completely, but some drugs have been used primarily, and they are in different stages of clinical trials. In parallel, plasma therapy has been found fruitful to some extent too and number of vaccine trials is going on. This review article discussed and compared those drugs which are running ahead in COVID-19 treatments and side effects of drugs used. In this review, we have discussed the clinical studies of drugs suggested by Food and Drug Administration (FDA) and WHO and compared their efficacy in the treatment of COVID-19.

Keywords: Antiviral drugs, COVID-19, Pandemic, SARS-CoV-2.

INTRODUCTION

Coronavirus disease – 2019 (Covid –19) is caused by SARS – COV-2. It is a newly emergent coronavirus, that was first recognized in Wuhan city, China, in Dec-2019. In the middle of Feb 2020, the WHO has declared COVID-19 as a public health emergency, and announced it as a pandemic disease. It is a betacoronavirus closely linked to the SARS virus. Epidemiology and virologic studies suggest that transmission mainly occurs from symptomatic people to others by close contact through respiratory droplets, by direct contact with infected persons.

Symptoms and risk factors associated with Covid-19

1. Most persons experience fever (83- 99%), Cough (59-82%), fatigue (44-70%) , anorexia (40-84%), shortness of breath (31-40%) , myalgias (11-35%).
2. Other non – symptoms such as sore throat, nasal congestion, head-ache, diarrhea, nausea and vomiting, have also been reported.



**Shaik Annar**

3. Loss of smell (anosmia) or loss of taste (ageusia) preceding the onset of respiratory symptoms has also been reported.

Implementation of appropriate IPC(Infection Prevention and Control) measures

Infection Prevention and Control is a critical and integral part of clinical management of patients.

1. **Instructions for patients** :- Ask the suspected patient to wear a medical mask and direct the patient to separate isolation room. Instruct all patients to cover nose and mouth during coughing or sneezing with tissue.
2. **Apply standard precautions** :- Standard precautions include hand hygiene and the use of Personal Protective Equipment(PPT) when risk of splashes or in contact with patient's blood, body fluids, secretions and non-intact skin.
3. **Covid - 19 Drug Therapy** :- There is no single effective drug for treating COVID-19 completely, but some antiviral drugs have already been approached for treating COVID-19. The following drugs are used in various stages in the treatment of Covid-19.

A)Remdesivire B) Lapinavir and Ratonavir C) Tocilizumab D) Hydroxy Chloroquine E) Chloroquine F) Ivermectin G) Favipiravir H) Azithromycin I) Corticosteroids .

Remdesivir

Remdesivire is a broad – spectrum antiviral with in vitro activity against Coronaviruses. It is U.S FDA (Food and Drug Administration) approved for use in adults and pediatric patients (12 years and older and weighing at least 40kg) to treat Covid-19. Its chemical formula $C_{27}H_{35}N_6O_8P$ and molecular weight is 602.6. It is used for therapy of severe novel coronavirus disease 2019 (Covid- 19) caused by severe acute respiratory syndrome (SARS) Coronavirus 2 infection. It is sold under the brand name Veklury. It is administered via injection in to a vein. It was originally developed to treat hepatitis – C, and was subsequently investigated for Ebola virus disease and Marburg virus infections. Remdesivir is a prodrug (A prodrug is a medication or compound that, after administration, is metabolized in to a pharmacologically active drug) that is intended to allow intracellular delivery of GS- 441524 (GS-441524 is a nucleoside analogue antiviral drug which was developed by Gilead Sciences) monophosphate and subsequent biotransformation into GS-441524 triphosphate, a ribonucleotide analogue inhibitor of viral RNA polymerase. The first COVID -19 patient received remdesivir in late January 2020. "That was in response to a compassionate request for one of the first identified (COVID-19) patients in the US", says Anu Osinusi, Vice President of virology at Gilead Sciences. More than 50 countries have now approved either conditionally or fully, remdesivir for patients with severe Covid-19.

A recent study has demonstrated that remdesivir *in vitro* shows inhibition of SARS-CoV-2 replication in Vero E6 cells 2 hours after administration. Results showed 68% of patients with oxygen support had clinical improvement with remdesivir therapy, and total mortality rate was 13%. A recent press release by Gilead on July 10, 2020, has shown that patients with remdesivir treatment had significant improvement of clinical status and reduced 62% mortality rate compared to the control group. A clinical trial by NIAID has shown an adverse effect that was observed in 21.1% patients. Common non - severe adverse effects include anemia, acute kidney injury, hyperglycemia, decreased eGFR or creatinine renal clearance or increased blood clearance.

Lopinavir and Ritonavir

Lopinavir and Ritonavir are protease inhibitors. They reduce the viral replication in the host cell. Lopinavir and Ritonavir, both drugs undergo CYP450 metabolism, but Ritonavir showed to significantly inhibit CYP450 metabolism. As a result, it enhances the action of lopinavir. In a human trial, it has been observed that combination therapy of lopinavir or ritonavir decreases the viral load, improves the clinical condition.

Molecular Formula

$C_{74}H_{96}N_{10}O_{10}S_2$. Molecular Weight : 1349.7g/mol





Shaik Annar

IUPAC Name

(2S)-N-[(2S,4S,5S)-5-[[2-(2,6-dimethylphenoxy)acetyl]amino]-4-hydroxy-1,6-diphenylhexan-2-yl]-3-methyl-2-(2-oxo-1,3-diazinan-1-yl)butanamide;1,3-thiazol-5-ylmethylN-[(2S,3S,5S)-3-hydroxy-5-[[[(2S)-3-methyl-2-[[methyl-(2-propan-2-yl-1,3-thiazol-4-yl)methyl]carbamoyl]amino]butanoyl]amino]-1,6-diphenylhexan-2-yl]carbamate. The most common adverse effects for this drug combination include lymphopenia, nausea, leucopenia, thrombocytopenia and vomiting in SARS - CoV-2 patients. Also, diarrhea, fever, nausea.

Tocilizumab

COVID-19 pandemic has affected more than 25 million people and caused 847602 deaths so far. There is no single antiviral drug or vaccine with proven efficacy to treat or prevent human Coronavirus (SARS-Cov-2) infection. Tocilizumab is recombinant humanized monoclonal antibody that binds to both membrane bound as well as soluble forms of the IL-6 receptor. Initially, Tocilizumab was identified and used for multiple rheumatological diseases and in chimeric antigen receptor T (CART) cell therapies. Apart from the apparent safety and efficacy end points , the role of drug interaction of the Tocilizumab should be considered. Tocilizumab is a cytochrome P₄₅₀ enzyme inducer and may decrease the serum concentration of cytochrome P₄₅₀ 3A4 substrates. In conclusion, Tocilizumab has been upcoming as a drug to watch , but it is associated with its own share of adverse effects.

IUPAC name :- 5-[(E)-2-(4-hydroxyphenyl)ethenyl] benzene-1,3-diol

Molecular Weight : 228.2

Chloroquine (CLQ) and E. Hydroxy Chloroquine (CLQ-OH) :-

Chloroquine is an old drug that has been used worldwide for more than 75 years to treat Malaria. *In vitro* study showed that Chloroquine or its more active derivative , hydroxyl Chloroquine can reduce SARS-CoV replication. Chloroquine and hydroxyl Chloroquine can decrease endosomal and lysosomal functions by increasing their pH.

Azithromycin

Azithromycin (AZ) is a broad - spectrum antibiotic, primarily used for the treatment of respiratory, enteric, and genitourinary bacterial infections. Several studies found that the putative antiviral properties acidic environment is a must for endosome maturation and function. Chemically as a weak base, AZ preferentially accumulates intracellularly in endosomal vesicles and lysosomes, which could increase pH levels, and able to block endocytosis and viral genetic shedding from lysosomes, thereby limits the viral replication.

IUPAC Name: [2R-(2R,3S,4R,5R,8R,10R,11R,12S,13S,14R)]-13-[2,6-Dideoxy-3-C-methyl-3-O-methyl- α -L-ribohexopyranosyl)oxy]-2-ethyl-3,4,10-trihydroxy-3,5,6,8,10,12,14-heptamethyl-11-[[3,4,6,trideoxy-3-(dimethylamino)- β -D-xylo-hexopyranosyloxy]-1-oxa-6-azacyclopentadecan-15-one.

Chemical formula - C₃₈H₇₂N₂O₁₂

Ivermectin

Ivermectin is a Food and Drug Administration (FDA) approved anti parasitic drug that is used to treat several neglected tropical diseases, including onchocerciasis, helminthiasis, and scabies. Reports from *in vitro* studies suggest that ivermectin acts by inhibiting the host importin alpha/beta-1 nuclear transport proteins, which are part of a key intracellular transport process that viruses hijack to enhance infection by suppressing the host's antiviral response. In addition, ivermectin docking may interfere with the attachment of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) spike protein to the human cell membrane. Ivermectin is thought to be a host-directed agent, which may be the basis for its broad-spectrum activity *in vitro* against the viruses that cause dengue, Zika, HIV, and yellow fever. Ivermectin is generally well tolerated. Adverse effects may include dizziness, pruritis, nausea, or diarrhea. Neurological adverse effects have been reported with the use of ivermectin for the treatment of onchocerciasis and other parasitic diseases, but it is not clear whether these adverse effects were caused by ivermectin or the underlying conditions. Ivermectin is a minor cytochrome P 3A4 substrate and a p-glycoprotein substrate. Ivermectin is generally given on an empty stomach with water; however, administering ivermectin with





Shaik Annar

food increases its bioavailability. William Campbell and Santoshi Omura won the 2015 Nobel prize in Physiology or Medicine for its discovery and applications.

IUPAC name- A mixture of Ivermectin Component B1a(2aE,4E,8E)-(5'S,6S,6'R,7S,11R,13R,15S,17aR,20R,20aR,20bS)-6'-(S)-sec-butyl-3',4',5',6,6',7,10,11,14,15,17a,20,20a,20b-tetradecahydro-20,20b-dihydroxy-5',6,8,19-tetramethyl-17-oxospiro[11,15-methano-2H,13H,17H-furo[4,3,2-pq][2,6]-benzodioxacyclooctadecin-13,2'-[2H]pyran]-7-yl-2,6-dideoxy-4-O-(2,6-dideoxy-3-O-methyl- α -l-arabino-hexopyranosyl)-3-O-methyl- α -l-arabino-hexopyranoside) and Ivermectin Component B1b(2aE,4E,8E)-(5'S,6S,6'R,7S,11R,13R,15S,17aR,20R,20aR,20bS)-3',4',5',6,6',7,10,11,14,15,17a,20,20a,20b-tetradecahydro-20,20b-dihydroxy-6'-isopropyl-5',6,8,19-tetramethyl-17-oxospiro[11,15-methano-2H,13H,17H-furo[4,3,2-pq][2,6]-benzodioxacyclooctadecin-13,2'-[2H]pyran]-7-yl-2,6-dideoxy-4-O-(2,6-dideoxy-3-O-methyl- α -l-arabino-hexopyranosyl)-3-O-methyl- α -l-arabino-hexopyranoside)

Molecular Formula: A mixture of Ivermectin Component B1a (C₄₈H₇₄O₁₄) and Ivermectin Component B1b (C₄₇H₇₂O₁₄).

Favipiravir

Favipiravir is a broad-spectrum antiviral with in vitro activity against RNA viruses. It is a RNA dependant RNA polymerase (RdRp) inhibitor that inhibits viral RNA synthesis. Its IUPAC name is 6-fluoro-3-hydroxypyrazine-2-carboxamide. Molecular formula C₅H₄FN₃O₂ and molecular mass is 157.1 g/mole. It is an antiviral medication used to treat influenza in Japan. It is sold under the brand name Avigan. It is also being studied to treat a number of other viral infections, including SARS-CoV-2 and it is a prodrug that is metabolized to its active form, favipiravir-ribofuranosyl-5'-triphosphate. It has been authorized for treating COVID-19 in several Countries including Japan, Russia, Turkey, India and Thailand, under emergency provisions.

Corticosteroids

The rationale for the use of corticosteroids is to decrease the host inflammatory responses in the lungs, which may lead to acute lung injury and acute respiratory distress syndrome (ARDS). Corticosteroids are a class of steroid hormones that are produced in the adrenal cortex of vertebrates, as well as the synthetic analogues of these hormones. Two main classes of corticosteroids, glucocorticoids and mineralocorticoids, are involved in a wide range of physiological processes, including stress response, immune response, and regulation of inflammation, carbohydrate metabolism, protein catabolism, blood electrolyte levels, and behavior. Some common naturally occurring steroid hormones are cortisol (C₂₁H₃₀O₅), corticosterone (C₂₁H₃₀O₄), cortisone (C₂₁H₂₈O₅) and aldosterone (C₂₁H₂₈O₅). The main corticosteroids produced by the adrenal cortex are cortisol and aldosterone.

CONCLUSION

The COVID-19 pandemic represents the greatest global public health crisis of this generation and, potentially, since the pandemic influenza outbreak of 1918. The speed and volume of clinical trials launched to investigate potential therapies for COVID-19 highlight both the need and capability to produce high-quality evidence even in the middle of a pandemic. No therapies have been shown effective to date.

REFERENCES

1. Zhu N, Zhang D, Wang W, et al; China Novel Coronavirus Investigation and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;382(8):727-733. doi:10.1056/NEJMoa2001017.
2. World Health Organization. Clinical management of severe acute respiratory infection when novel coronavirus (nCoV) infection is suspected [https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected).





Shaik Annar

3. CDC Website: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html>.
4. FDA Website: <https://www.fda.gov/emergency-preparedness-and-response/mcm-issues/coronavirus-disease-2019-covid-19>.
5. Chu CM, Cheng VCC, Hung IFN, et al. Role of lopinavir/ritonavir in the treatment of SARS: Initial virological and clinical findings. *Thorax* 2004;59(3):252–256. PMID: 1498565.
6. Khailany RA, Safdar M, Ozaslan M. Genomic characterization of a novel SARS-CoV-2. *Gene Rep* 2020; 19: 100682. <http://dx.doi.org/10.1016/j.genrep.2020.100682> PMID: 32300673 Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; 395(10223): 497-506. [http://dx.doi.org/10.1016/S0140-6736\(20\)30183-5](http://dx.doi.org/10.1016/S0140-6736(20)30183-5) PMID: 31986264
7. Gorbalenya AE, Baker SC, Baric RS, et al. Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol* 2020; 5(4): 536-44. <http://dx.doi.org/10.1038/s41564-020-0695-z> PMID: 32123347.
8. Hoffmann M, Kleine-Weber H, Schroeder S, et al. SARS-CoV-2 Cell Entry Depends on ACE2 and TMPRSS2 and Is Blocked by a Clinically Proven Protease Inhibitor. *Cell* 2020; 181(2): 271-280.e8. <http://dx.doi.org/10.1016/j.cell.2020.02.052> PMID: 32142651.
9. Lu R, Zhao X, Li J, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *Lancet* 2020; 395(10224): 565-74. [http://dx.doi.org/10.1016/S0140-6736\(20\)30251-8](http://dx.doi.org/10.1016/S0140-6736(20)30251-8) PMID: 320071451.
10. Ramireddy A, Chugh H, Reinier K, et al. Experience With Hy-[45] droxychloroquine and Azithromycin in the Coronavirus Disease 2019 Pandemic: Implications for QT Interval Monitoring. *J Am Heart Assoc* 2020; 9(12): e017144.

Table 01. Properties of Chloroquine Hydroxy Chloroquine

| Property | Chloroquine | Hydroxy Chloroquine |
|------------------|---|--|
| Chemical formula | C ₁₈ H ₂₆ ClN ₃ | C ₁₈ H ₂₆ ClN ₃ O |
| Molecular weight | 319.8 | 335.9 |
| IUPAC name | (RS)-N'-(7-chloroquinolin-4-yl)-N,N-diethyl-pentane-1,4 diamine | (RS)-2-[[4-[(7-chloroquinolin-4-yl)amino]pentyl](ethyl)amino]ethanol |

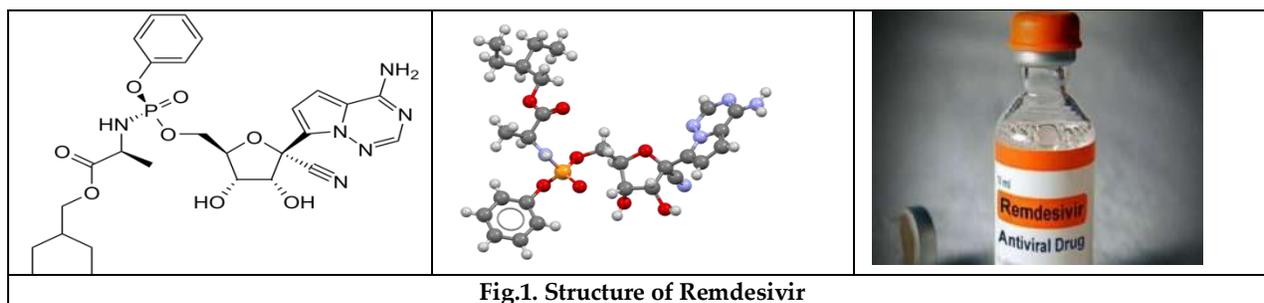


Fig.1. Structure of Remdesivir





Shaik Annar

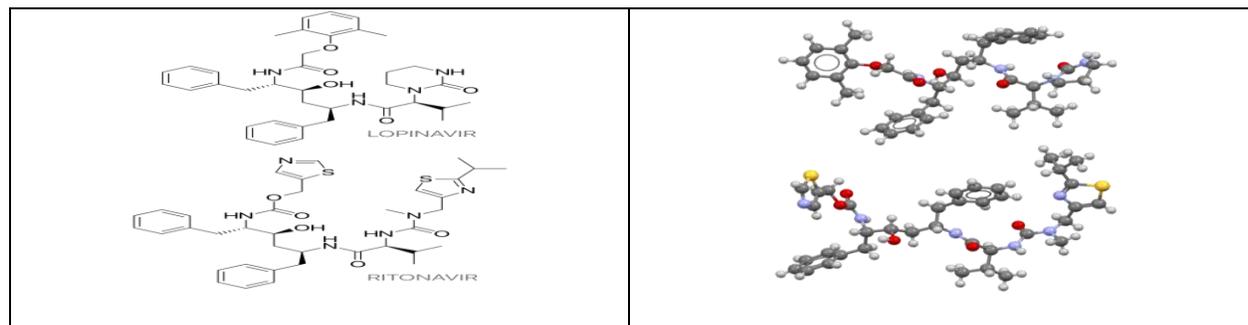


Fig. 2. Structures of Lopinavir and Ritonavir

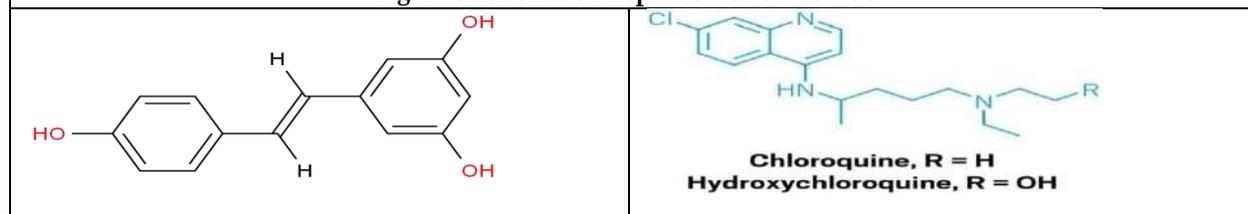


Fig.3. Structure of Tocilizumab

Fig.4. Structures of CLQ and CLQ-OH :-

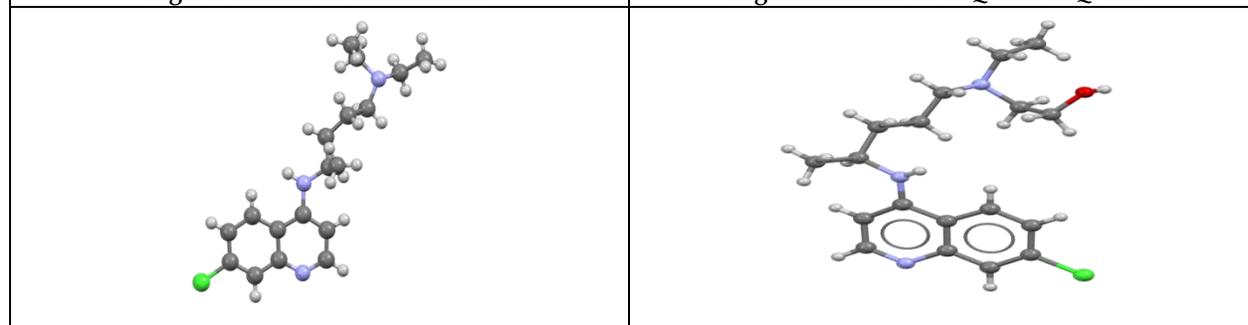


Fig.5. Chloroquine Hydroxy Chloroquine

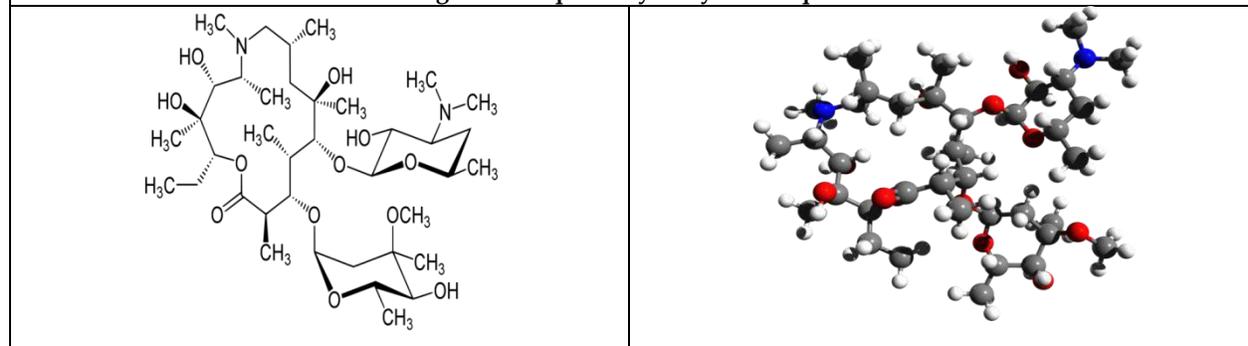


Fig.6. Structure of Azithromycin





Shaik Annar

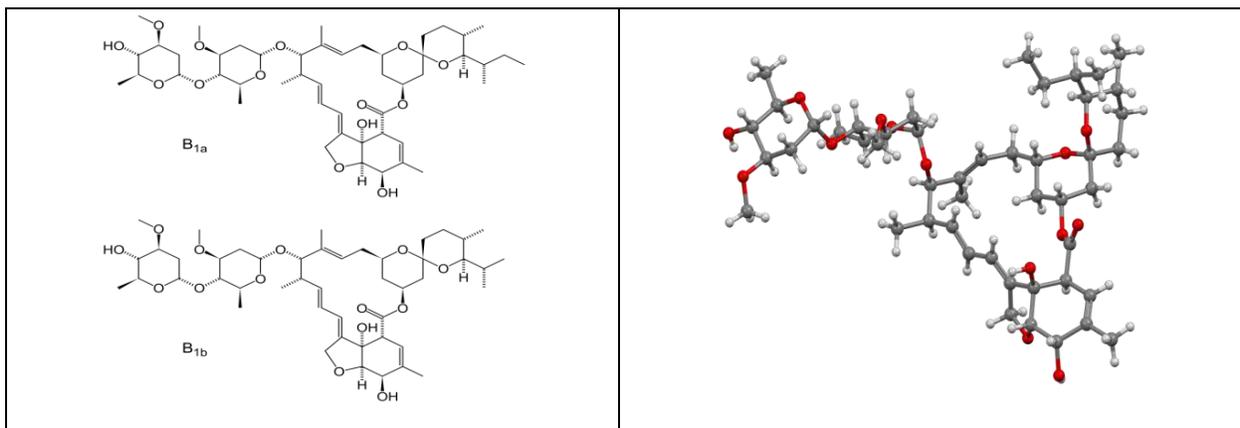


Fig.7. Structure of Ivermectin

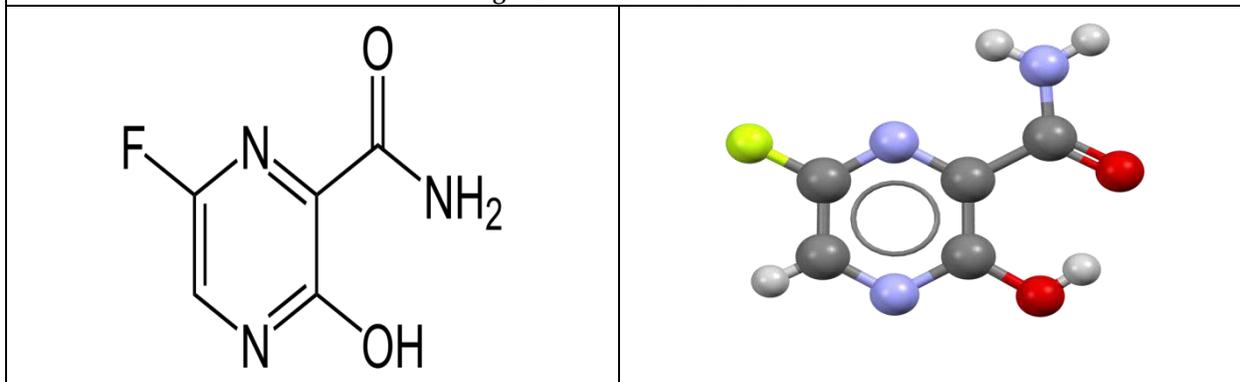


Fig.8. Structure of Favipiravir

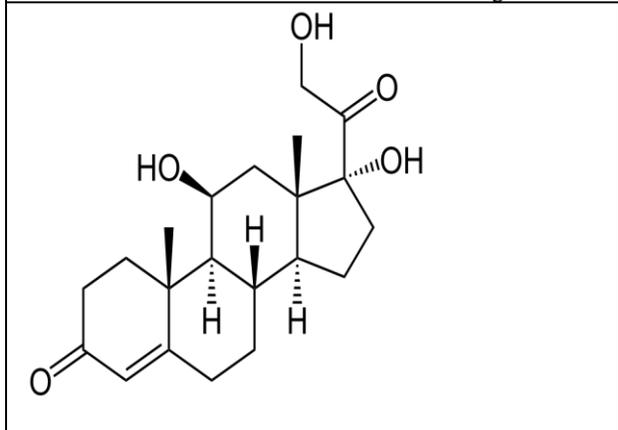


Fig.9. Cortisol

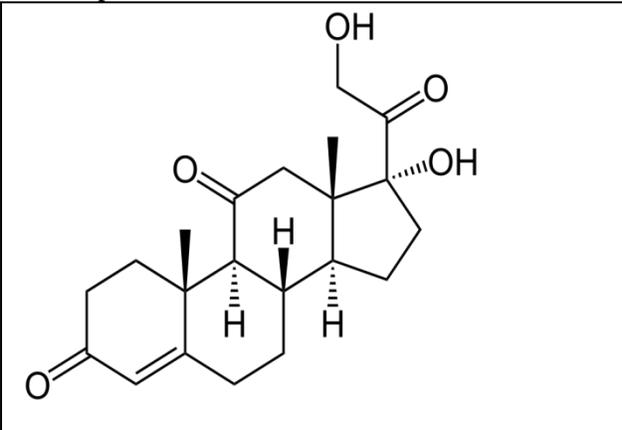


Fig.10. Cortisone





Use of Online Teaching-Learning Platforms during COVID 19: Exploring the Experiences of Higher Secondary School Students

Reecha Jrall^{1*} and Kiran²

¹Research Scholar, Dept. of Educational Studies, Central University of Jammu, Samba, Jammu and Kashmir, India.

²Assistant Professor, Dept. of Educational Studies, Central University of Jammu, Samba, Jammu and Kashmir, India.

Received: 29 Mar 2022

Revised: 13 Jun 2022

Accepted: 02 July 2022

*Address for Correspondence

Reecha Jrall

Research scholar,
Dept. of Educational Studies,
Central University of Jammu, Samba,
Jammu And Kashmir, India.
Email: reechajrall@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The outbreak of covid-19 pandemic has affected drastically the social processes, systems and structure by influencing the life at a large. This new era in human life has emphasized the need to review the existing mechanisms and fabric of social life. Education sector by virtue of being a social system has also undergone a process of change. For keeping the system of education alive and moving, the system has taken a major shift towards online learning and teaching. Teaching -Learning has totally transformed its traditional forms. This transformation insists both teacher and students to be more technology friendly. For delivery and reception of learning, the expertise and comfort in using online mechanisms of teaching learning were expected. In the backdrops, the present paper attempt to explore the nature and types of online learning platforms, directions in the usage of online learning platforms quality and experiences of higher secondary students with online teaching-learning platforms during COVID 19 pandemic situations. The paper, in this way, provide ideas of the level of exposure and ease in use of online teaching-learning platforms by higher secondary students to ensure and pace up their learning during the pandemic era.

Keywords: online teaching- learning platforms, experiences of secondary school students, COVID 19 pandemic, awareness of online learning platforms.



**Reecha Jrall and Kiran**

INTRODUCTION

The main purpose of education is to shape up the personality of an individual and to make him/her a contributing individual. Education facilitates a person in achieving his or her goal in life. Whenever a change occurred in the world it affects the education system and ways and mechanisms of teaching and learning. COVID- 19 has exerted a drastic and detrimental impact on the whole world. In spite of all the odds and challenges, the pandemic has taught us so many positive things. All educational institutions schools colleges and universities were closed due to the imposed lockdown after the COVID- 19 outbreak. And the world was left with no other choice but to rely on online teaching – learning to minimize the loss of learning due to loss of opportunity for direct face to face contact. Although education sector accepted a change and it clears a way to online learning and e- learning. E –learning is very accessible and effective way for students as they can attend their classes at their home, and it is also need of an hour. Because of COVID -19 the school students were suffering from extreme hardships. Teachers had used the variety of e-learning and teaching platforms during COVID 19 pandemic situation. Students and teachers confronts with various new e- learning and e-teaching tools. Smart phones, laptops, and internet were the major platforms of the e-learning and e-teaching system, especially when the schools and all institutions were closed. The outbreak of COVID- 19 brought a huge wave of transformations in teaching learning process. Though it kept the teacher and students away from the regular classrooms, but the advents of this pandemic impelled the teachers to explore the latest techniques and tools to carry out the process of reception and delivery of information. Before the accession of COVID -19 school students were not habitual of using online learning platform, during the pandemic situation, teachers as well as students also explored the variety of learning platforms. Though there were initial hitches involved in exploration of online learning platforms. but gradually teachers and students surmount these barriers. The detailed reflections over the problem have been made in the consequent sections of the paper.

Impingement of COVID- 19 on Education System

Outburst of COVID – 19 has affected the academics and institutions and they are adopting the refreshing strategies to cope up the situation by switching to online mode, extended dates of applications or postponed their regular schedules courses. United Nations Educational, Scientific and Cultural Organization (UNESCO) claimed that over eight million learner from all over the world have been affected during pandemic, one in five learners couldn't attend school, one in four could not attend higher education classes, and over 102 countries had ordered nationwide school closures while 11 had implemented localized school closure. The pandemic posed many challenges to the school education that includes rise in dropouts, learning losses and digital divide and these challenges common to both government and private schools. The annual status of education report conclude that about five point three percent of rural children lie between the age group 6-10 yrs had not enrolled in schools as compared to the enrollment in 2018 which was 1.8 percent (Ramaswamy, 2021). ASER report 2020 reported that 5, 9251 dropout rates increased during the pandemic especially at the primary level. Teaching became more challenging during the pandemic intervention and school closure, many teachers face difficulty to deliver lesson on digital platforms because for many of them online teaching is novel experience, along with online teaching teachers were burdened with covid 19 duties that affect them in many ways (Kundu and Sonawane ,2020).

Evident Impact of COVID- 19 on Education System

Since the last week of March 2021, all schools, colleges, and universities have been closed. Classroom learning has completely stopped, and the education of primary and secondary school students has suffered. The physical presence teacher has flipped over to completely virtual presence for the first time. 2021. Face to face and classroom teaching stopped completely and primary and secondary school students education got huge setback. The physical presence teacher is flipped to virtual presence, in the beginning phase of COVID 19 all educational institutions face difficulty to how to tackle this process. Both students and teachers find themselves in a bind. They do not know what to do, but thanks to technology and it is the only support to continue the teaching and learning process.



**Reecha Jrall and Kiran****Delay/Postponement of Examination**

Due to complete lockdown it was impossible to conduct board class exams and in March and April this pandemic was spreading rapidly. Due to the emergence of pandemic social distancing and mask become mandatory. ICSE, CBSE and state Board had taken decision that there would be no exam for board classes in 2020. But for the 2021 session, CBSE issued notification that the mid- term/pre board examinations or internal assessment test act as a base for the promotion of the students to next classes. Situation is not conducive at present time also, for 2022, CBSE adopted two board examinations that may be online or offline according to the relative environment (Banchariya 2021). When there was complete lockdown all council examinations, entrance test, competitive examinations etc. come to halt due to pandemic situation. Some state boards promoted their students in board examinations on the basis of internal online and CBSE conducted online examinations.

Extension of Academic Schedule

School examinations and results delayed because of pandemic, and it was utmost important for health and security of both teachers and students. Due to the pandemic situation higher authorities of schools and higher education extended their academic calendar. (Islam, 2021) NCERT released an extended calendar for home based activities for various subjects at secondary level. And UGC already extended the new academic session from June to October. The examinations conducted online, and duration also reduced from 3 hours to two hours.

Non-Availability of Study Material in Physical Form

As we all know that before lockdown government schools provided students with text books free of cost. But due to the shift in the learning system amid of pandemic many learners are without textbooks. Due to lockdown publishing house could not printed books, so students could not get textbooks in the market.

Struggle in Completion of Notified Syllabi

Most of the academic session had gone in complete lockdown and there was no scope to completion of the syllabus. PSCWA National Chairman Shamael Ahmad said, "Schools have completely switched to online teaching, but children are not accustomed to online learning. E-learning materials cannot suppress the importance of textbooks. Long-term use of mobile phones and computers is affecting children's health. The renewal of educational institutions Openness is still uncertain. Under given conditions, the availability of textbooks will help students learn better and effectively use their time at home.'

ONLINE LEARNING IN RESCUE OF LEARNING AMID COVID-19

There is no doubt that COVID -19 intricate very deeply in our lives. There is irreparable loss of lives. But it taught us that change is vital for the survival of organisms and organizations also. An education system is also one of the witnesses of this change as it transformed from traditional to online teaching and learning. There are various benefits of an online learning that students are equipped with these benefits includes- students got an opportunity to learn from their vantage (Goel, Devraj, and Saroja 2020). They develop self learning styles and become smart learners and due to online interactions with the teachers, their communications skills improved successfully. Students are at the verge of exploring new methods of learning other than traditional teaching. Learning methods are now revamped from rote learning to experiential and individualized learning. One of the most important advantages of online learning is for the geographically isolated learners (Islam 2021) as they can avail the regular virtual classroom with teacher at their doorsteps without any time and boundary barriers.

Rationale of the Study

Exposure of higher education students in e-learning/online learning has already been registered in some form or other before pandemic also. But the school students were not habitual to the online classes, especially in the Jammu and Kashmir state where there are so much technological issues like the problem in the connectivity of internet. The internet problems in Jammu and Kashmir bring a lot of trouble in online classes. Due Abrogation of 370 and 35a on



**Reecha Jrall and Kiran**

August 5, 2019 there were great agitations among the residents and due to security issues internet services were totally restricted in the Jammu and Kashmir. However it gets restored at 2G internet. Following the abrogation of 370 articles and imposed lockdown in august 2019 worsened the situation in Jammu and Kashmir. J&K students remained out of school for many months. The advent of pandemic transformed the whole process of teaching-learning, educational institutions across the country switch to online education. While the people of J&K scuffled with 2G internet connectivity. It was impossible to carry out online classes through this slow internet connectivity. With the 2G connectivity it was strenuous for the students to interact with teachers and ingress study material. But students are always excited to try something new as the new learning techniques and teachers are trying their best level to teach the students. Although school students faces some hurdles during online classes and e learning but they are also getting the knowledge about the new e learning tools and become efficient in using them. In March 21, 2020 the union HRD Minister of India shared various e-learning platforms by the ministry of India that could help students to maximize and continue the students learning during the Covid 19 phase that include Diksha portal, Swayam, NROER, E-Pathshala, swayam prabha etc for student, teachers and teacher educators etc. Alharthi (2016) evaluated the perceptions and awareness of teachers about the online learning or e-learning tools. He selected 22 teachers from the educational department in Saudi Arabia.

The result of the study revealed that English teachers were aware about the various online learning tools and they handle it effectively but sometime the constraints also exist like internet connectivity, lack of skills and training, unavailability of tools etc. Selvam (2016) conducted a study to check the awareness fo online learning among post graduate students. Pandey. Ogunmola &Enbeyle, (2020) carried out study on flip of traditional teaching learning to totally online teaching learning during lockdown period and study concluded that students prefer online learning and multimedia means of studies. Khan, Vivek & NabiKhojah, 2021, find out the perception of students on online learning during the covid -19 phase. The data was collected from the university students of two university of Delhi. The result of the study revealed that students accepted the e-learning as new phase of learning and they also have positive perception towards e-learning. The investigator carried out the study to check the level of awareness of various online learning tools among higher secondary school student before and during the lockdown period. Pandey &Pandey analyzed literature on ICT in teaching and learning in India. The study revealed that there is positive impact of ICT in teaching and learning. Investigator also concluded that use of ICT is lesser in developing countries like India as compared to developed countries. Zalat and Hamed (2021) conducted study on teaching staff and found that most of the staff members (88%) agreed that giving the online classes and the technological skills increase the educational value of the experience of the college staff. Majority of the participants agreed on perceived usefulness, perceived ease of use, and acceptance of e-learning.

The lack of computers and computer labs, obstructions in the internet connectivity were the highest barriers to e-learning. Azliza Yacob et al, 2012 in their experimental study exposed 200 students to e-learning. Multiple regression analysis was used and results show that students have significant awareness towards e-learning in education. Blogs, discussion boards, wikis and 3D virtual tools were used to engage students in their learning (Gregory&Tyrrell, 2017). Participants know e-learning and e-learning platforms but lacked adequate training. The computer literacy was low and most schools lacked adequate ICT laboratories and reliable internet negatively affects e-learning adoption (Nygorm, 2017). Mpungose, (2020) interviewed 26 students joining online curriculum studies and findings yielded that students considered digital divide as hindrance to realizing the full potential in online study system. Priya, sansaka, & charan (2020) explored that most of the students considered online mode of teaching and learning as satisfied mode. But there is need of improvement in the student and teacher interaction.

METHODOLOGY OF STUDY

Objectives of the study

To explore the level of awareness in use of online learning platforms among the higher secondary school students.
To identify the various patterns in use of online learning platforms of the higher secondary school students.



**Reecha Jral and Kiran****Sample of the study**

The sample for the study was 100 higher secondary school students of Jammu district.

Sampling technique employed

The incidental sampling technique was employed for the selection of the sample.

Methodology of the study

Investigator used the descriptive method for the collection of data.

Tool Employed

A questionnaire was developed for the collection of data. The investigator mailed Google forms to the higher secondary school students.

Analysis of data and result reporting

Analysis and interpretation of data is vital part of the research procedure. The investigator used frequency and percentage for data analysis and interpretation. The data was categorized for interpretation and objective –wise findings in the following themes

1. Frequency and accessibility to different E-learning platforms.
2. Awareness of exploration of E- learning platform before lockdown period.
3. Awareness and extent of usage of e-learning platform after lockdown period.
4. Highlight the change in awareness and usage of E-learning platforms after gaining experiences during lockdown.

It is evident from the table 1 (that is given in last page) that the most frequently tool used by the students was what's app. 49% students frequently used what's app as learning tool. The clarity over what's app being the most usable learning tool has been provided consequently by the exploration of degree of ease in use of platform. What's app outshined the other learning platforms in term of ease and accessibility with a close competition from you tube. The ease and accessibility of using what's app is more as the platform provides peers and teachers interactivity in what's app teachers can take classes students and initiate discussions and share any type of content that includes text audio, video graphics etc in the what's app. Student can access any type of content according to his or her choice. As what's app can be easily downloaded and everyone can use what's app effectively due to being an established tool of quick communication. The table 2. (given in the last page) depicted that students were largely aware about the already established platforms for online learning such as what's app and mails before lockdown period. They also reported exposure in using you tube for learning purpose. But students have very little knowledge about the Google meet and Google classroom and this might be due the reason that their teachers never use these tools for teaching purpose before lockdown period. Another reason for more awareness about what's app, mails and you tube as these tools are easy to use and students use these tools for the social purpose also. As these are the social networking sites so students take maximum use of these sources.

EXPLANATIONS**G meet**

From the table 3 (given in the last page) it is clear that 65.3% students knew that through g mail we can join classes on g meet whereas 34.7% students had no knowledge about it. 58.3 % students were acquainted about how the content is present on the g meet app. whereas 41.7% students were not sure about it. Table also depicted that 77.6% students known the operational specification of the app and they know how to ask questions and set the camera and microphone during classes.



**Reecha Jrall and Kiran****Google classroom**

The table depicted that 78.7% students responded positively that classes Google classroom can be joined by our g mails but 21.3% students responded that g mail is not required for Google classroom. Only 23.4% students knew how content is presented, assignments posted and video lessons are inserted in Google classroom and 76.6% did not know about it. 53.2 % students were aware about the operational specifications of Google classroom whereas 46.8% were not aware about it.

You tube

The table shows that 61.7% students responded that g mail is required option for you tube whereas 38.3% students responded that g mail is not required for you tube. 77.1% students know how to attend the classes through you tube. 77.1% students know the technicalities of you tube which require to make videos on you tube.

What's app

From the above table it is clear that 98% students know that we don't need g mail for what's app and they know how to use what's app for learning purpose. 81.3% respondents were familiar with the content presentation on what's app for educational purpose. 86.6% students were known about operational specifications of what's app it means they know to attend classes, access learning content send by teachers etc on what's app. overall the above table shows a drastic increase in ease of handling online learning platforms (mainly synchronous) by the students due to continuous exposure during COVID -19 pandemic situation. From the table 4 it becomes clear that awareness and usage of online learning tools has increased after the lockdown period. Only 20.4% students were known about the g meet app before lockdown but after lockdown period its usage increased for learning purpose and 70.7% students are now aware about G-meet and used it for attending classes after lockdown period. Google- classroom awareness also enhanced after lockdown period from 25.5% to 54.58%. Before lockdown usage of you tube for learning purpose was 36.2% but its awareness and usage increased as online classes were started during lockdown period and 73% students aware and use Google classroom for learning. There was little bit decrease in usage of what's app for learning purpose this may be because of other tools like g meet, Google classroom etc. also came into existence for taking classes during lockdown period. But from the table it is also reflected that what's app was the most frequently used app before and after lockdown period. This may be due to its ease of functioning and downloading and as we know that you tube and what's app are social networking sites and it also used by the students for social purposes.

CONCLUSION

There were two main objectives of the study first is to explore the level of awareness in use of online learning platforms among the higher secondary school students and the findings of the study affirmed that the usage and awareness of various online tools is enhanced in teaching learning after the accession of COVID-19 pandemic. What's app outshined the other learning platforms in term of ease and accessibility with a close competition from you tube. The study also reflected that students are hundred percent aware about what's app as learning tool and was used for the learning purpose before the lockdown and COVID 19 phase. The second objective of the study was "To identify the various patterns in use of online learning platforms of the higher secondary school students" and results of the study manifested that 53.2 % students were aware about the operational specifications of Google classroom whereas 46.8% were not aware about it. 77.1% students know the technicalities of you tube which require to make videos on you tube. 86.6% students were known about operational specifications of what's app it means they know to attend classes, access learning content send by teachers etc on what's app. Now various online tools for learning and taking classes come into existence like zoom classes, Google classroom, laptop screen recorder, X recorder for mobile, Ekstep, lark, ding talk, etc. no doubt the outburst of pandemic kept the student and teachers away from physical classrooms but it also help them to explore the other avenues for teaching and learning.





Reecha Jrall and Kiran

ACKNOWLEDGEMENT

The author thanks to her supervisor Dr. Kiran for her valuable support and constant encouragement and the authors were thankful to secondary school students.

REFERENCES

1. Ramaswamy, N. (2021, October). The impact of COVID-19 on school education and the road to recovery. KGMP. Retrieved from <https://home.kpmg/in/en/home/insights/2021/10/nep-covid-19-school-education-assessments.html> 6-11-2021
2. Banchariya, S. (2021, August 30). States boards undecided on CBSE's two-board exams policy in 2022. The Indian Express. www.indianexpress.com. Retrieved on 5-4-2021
3. Islam, N. (2021). Online teaching- learning: a tool for continuing education. *university news*, 59(43).
4. Kund, P. & Sonawane, S. (2020) Impact of COVID-19 on School Education in India: What are the Budgetary Implications? Policy brief. DOI:10.13140/RG.2.2.24088.01283 on 9-11-2021
5. Khandelwal, K. (2021, May 10). Covid-19 and the Year-long Internet Restrictions in Jammu & Kashmir. The London school of economics and political science. Retrieved on 18-12-2021 <https://blogs.lse.ac.uk/southasia/>
6. K. Alharthi. (2016). Evaluating The Awareness And Perceptions Of English Teachers In Using E-Learning Tools For Teaching In Saudi High Schools. *British Journal of English Linguistics* , 4(5), 16-34. Retrieved on 6-4-2021.
7. Selvam, SK. (2016). Awareness of Online Learning Among Post Graduate Students: A Study. *Issues and Ideas in Education* 4(2), 151-162. Retrieved on 5-5-2021
8. Khan, M.A.; Vivek; Nabi, M.K.; Khojah, M.; Tahir, M. (2021). Students' Perception towards E-Learning during COVID-19 Pandemic in India: An Empirical Study. *Sustainability* 13(1), 57. Retrieved from <https://dx.doi.org/10.3390/su13010057> MDPI 11-7-2021
9. Pandey, D., Ogunmola, G. A., Enbeyle, W., Abdullahi, M., Pandey, B. K., & Pramanik, S. (2021). COVID-19: A Framework for Effective Delivering of Online Classes During Lockdown. *Human Arenas*, 1-15. Retrieved from <https://doi.org/10.1007/s42087-021-00196-0> on 11-11-2021
10. Zalat, M.M., Hamed, M.S., Bolbol, S.A., (2021). The experiences, challenges, and acceptance of e-learning as a tool for teaching during the COVID-19 pandemic among university medical staff. *PLoS ONE* 16(3). Retrieved from 10.1371/journal.pone.0248758 on 11-11-2021
11. Yacob et al. (2012). Student Awareness Towards E-Learning In Education. *Procedia - Social and Behavioral Sciences* 67, 93 – 101. Retrieved from <https://doi.org/10.1016/j.sbspro.2012.11.310> on 5-5-2021
12. Gregory, S., Bannister-Tyrrell, M. (2017). Digital learner presence and online teaching tools: higher cognitive requirements of online learners for effective learning. *RPTTEL* 12 (18). Retrieved from <https://doi.org/10.1186/s41039-017-0059-3> on 6-4-2021.
13. Mpungose, C.B. Emergent transition from face-to-face to online learning in a South African University in the context of the Coronavirus pandemic. *Humanit Soc Sci Commun* 7, 113 (2020). Retrieved from <https://doi.org/10.1057/s41599-020-00603-x> on 11-7-2021
14. Priya, V., Sansaka, K., & Charan, S. L. (2020). Awareness On Digital Educational Tools For Virtual Teaching And Interactive Learning - A Questionnaire Survey. *European Journal of Molecular & Clinical Medicine*, 7(1), 764-771. Retrieved on 5-4-2021
15. Jayadevi. A. P. (2020) "Cognitive And Emotive Aspects Of Learning Population Education Among Students In Chennai", *International Journal of Research -GRANTHAALAYAH*, 8 (2) retrieved from <https://doi.org/10.29121/granthaalayah.v8.i2.2020.206> on 6-4-2021
16. Paul N., Albert Arthur Qua-E. , Brandford. B., Valentina A., (2017). The Awareness and Use of Electronic Learning Platforms: A Case of a Developing Country. *World Journal of Computer Application and Technology*, 5(2), 13 - 23. Retrieved from DOI: 10.13189/wjcat.2017.050201 on 5-5-2021





Reecha Jrall and Kiran

17. Menon, S. (2020, November 18), Education in India needs an overhaul retrieved from <https://idronline.org/state-of-school> on 5-4-2021

Table 1 depicting frequency and accessibility to different online tools

| Platforms | G- meet | What’s app | You tube | Google classroom | G mail | Zoom | Instagram | Microsoft |
|----------------------------|---------|------------|----------|------------------|--------|-------|-----------|-----------|
| Frequency to used | 10.2% | 49% | 10.2% | 2% | - | 24.5% | 2% | 2% |
| Accessible and easy to use | 8.2% | 40.8% | 42.9% | - | - | 8.2% | - | - |

Table 2. Awareness of e-platform for learning before lockdown period

| E – Platforms | G-Meet | Google classroom | You tube | Mails | What’s app |
|-------------------|--------|------------------|----------|-------|------------|
| Lack of awareness | 79.6% | 74.5 | 63.8 | - | - |
| awareness | 20.4 | 25.5 | 36.2% | 100% | 100% |

Table 3. showing Awareness and extent of usage of E-learning platform for learning purpose after lockdown

| E- LEARNING PLATFORMS | | | | | |
|--|-----------------------|--------|------------------|----------|------------|
| FOCUSED AREA OF E-TOOL FOR LEARNING | OPTIONS | G-meet | Google classroom | You tube | What’s app |
| Knowledge of joining classes online | Directly | 18.4% | 37% | 23.9% | 85.1% |
| | Through link/+ button | 81.6% | 63% | 76.1% | 14.9% |
| Knowledge of accessing online platform via mail id | Yes | 65.3% | 78.7% | 61.7% | 2% |
| | No | 34.7% | 21.3% | 38.3% | 98% |
| Knowledge of content presentation | Yes | 58.3% | 23.4% | 77.1% | 81.3% |
| | Not sure | 41.7% | | | |
| | No | | 76.6% | 22.9% | 18.7% |
| Acquaintance with the operational specificity of the e-learning platform | Yes | 77.6% | 53.2% | 77.1% | 86.6% |
| | No | 22.4% | 46.8% | 22.9% | 13.4% |

Table 4. Comparison of awareness and usage of online tools by students after and before lockdown period

| TOOLS | | G-meet | Google classroom | You tube | What’s app |
|---------------------|-----------------------|--------|------------------|----------|------------|
| AWARENESS AND USAGE | BEFORE LOCKDOWN | 20.4% | 25.5% | 36.2% | 100% |
| | AFTER LOCKDOWN PERIOD | 70.7% | 54.58% | 73% | 87.75% |
| | DIFFERENCE | 50.3% | 29.08% | 36.8% | 12.25 |





Reecha Jrall and Kiran

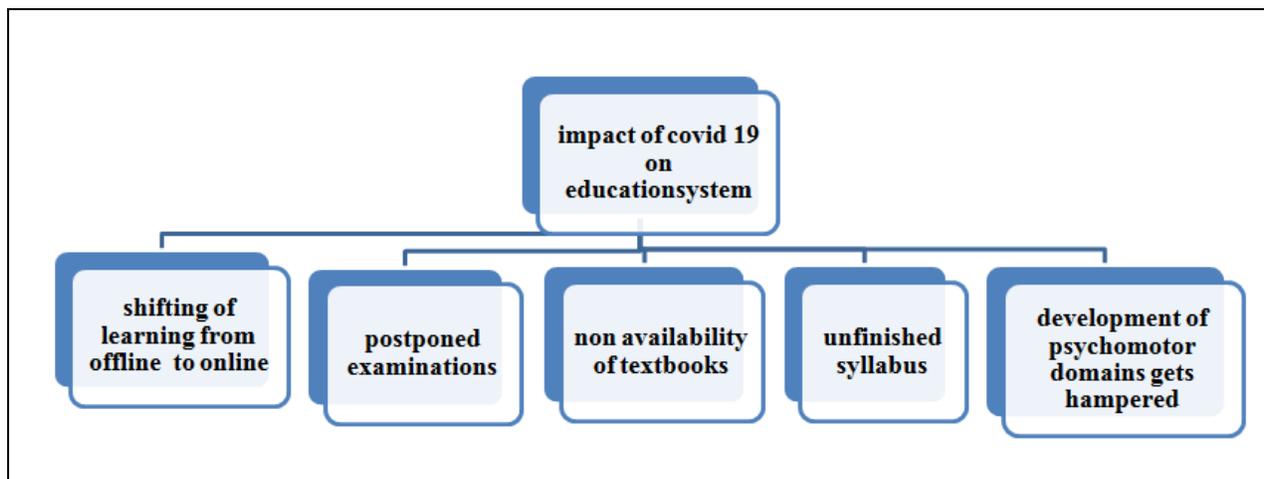


Figure 1. Showing the impact of COVID 19 on education system

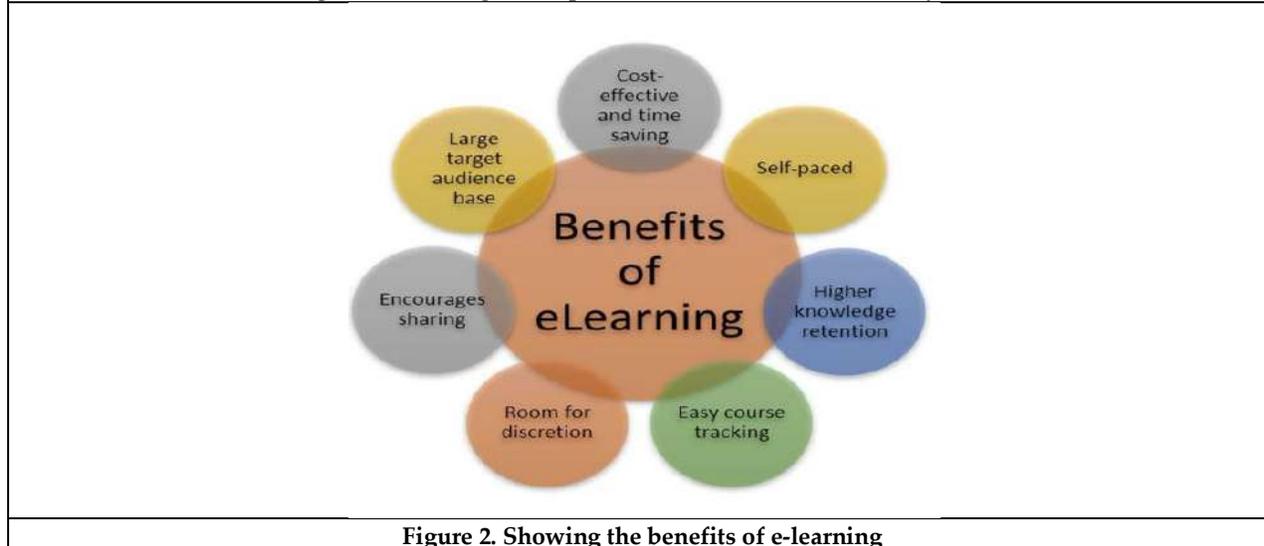


Figure 2. Showing the benefits of e-learning





***Vibrio owensii* and *Vibrio hyugaensis*- Potential Bioluminescent Bacteriae as Environmental Biosensors**

J. Esther Mereen^{1*} and Jemma Hermelin Jesy Diaz²

¹Ph.D Research Scholar (Reg. No. 19212212192017), Department of Zoology, St. Mary's College (Autonomous), Thoothukudi, Affiliated to Manonmaniam Sundaranar University, Abhishekapatti, Tirunelveli -627 012, Tamil Nadu, India.

²Assistant Professor of Zoology, St. Mary's College (Autonomous), Thoothukudi. Affiliated to Manonmaniam Sundaranar University, Abhishekapatti, Tirunelveli - 627 012, Tamil Nadu, India

Received: 01 Apr 2022

Revised: 10 Jun 2022

Accepted: 02 July 2022

***Address for Correspondence**

J. Esther Mereen

Ph.D Research Scholar (Reg. No. 19212212192017),

Department of Zoology, St. Mary's College (Autonomous),

Thoothukudi, Affiliated to Manonmaniam Sundaranar University,

Abhishekapatti, Tirunelveli -627 012, Tamil Nadu, India.

Email: esthermereen@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Among the various natural phenomenon exhibited by organisms, bioluminescence is most notable. Bacterial bioluminescence is caused due to the reaction of luciferin molecules with oxygen. The production of living light by bacteria has been widely used as a tool for detection of pollutants. In the present study, *Vibrio owensii* and *Vibrio hyugaensis* isolated from Thoothukudi coast were used to detect inorganic and organic pollutants namely copper, lead, chromium, detergent and pesticide. The various pollutants were exposed to the bacteria and the results were noted for about 150 min. Photographs of the cultures were taken at a time interval of 30 min and transferred to the Batch Macro Measure of ImageJ software that gave the intensity of luminescence in terms of Measured Light Units (MLU). Though the luminescence exhibited by the bacteria reached its peak in 150 min without the addition of pollutants, it was noted that the luminescence decreased drastically on the exposure of pollutants. This proved that bioluminescent bacteria can be used as a biosensor for rapid detection of environmental pollutants.

Keywords: *V. owensii*, *V. hyugaensis*, biosensor, bioluminescence, environmental pollutants.

INTRODUCTION

Bioluminescence is a natural phenomenon of production of light by living organisms that involves chemical reactions. The purpose of producing bioluminescence varies from organism to organism, generally as a defense



**Esther Mereen and Jemma Hermelin Jesy Diaz**

mechanism, predation, mating, etc. [1] Bioluminescent bacteria are commonly found in ocean water, there they generally prevail in the digestive tracts of marine fishes, persist as parasites in crustaceans and insects or as light organ symbionts in teleost fishes and squids[2]. The major organisms capable of exhibiting bioluminescence comprises of four bacterial genera: *Vibrio*, *Photobacterium*, *Shewanella* and *Photorhabdus*[3]. Among these, the members of Vibrionaceae are well documented for understanding the underlying mechanism of bacterial bioluminescence [4]. Luminescent bacteria are unique among bioluminescent organisms. Their bioluminescence intensity is an indicator of their metabolic activity, which can directly reflect the influence of environmental factors on cell viability. Moreover, the whole bioluminescence process is totally gene encoded without the addition of extra substrates. As a result, bacterial bioluminescence has been a powerful tool for whole-cell biosensors and bio-reporters in bioanalysis of environmental pollutants [5]. Bioengineering of the genes which are responsible for bioluminescence also have potential environmental applications [6]. There is a major risk and threat to public health due to an increase in pollutants. Hence there is an urgent need to monitor toxic pollutants in the environment. The following study shows a rapid and versatile technique to detect such toxins in the surrounding using bioluminescent bacteria isolated from Thoothukudi coast.

MATERIALS AND METHODS**Collection of samples**

The marine water samples were collected from Thoothukudi coast, Tamil Nadu, India. Sampling was done by taking proper aseptic measures and stored at 4°C for further use. The samples were processed for isolation of marine luminescent bacteria.

Preparation of Luminescent Agar

For isolation purpose, optimization of media for luminescent bacterial growth is a very important parameter. A modified luminescent agar (LA) [7] was used in this study. The composition of Luminescent agar is as follows: 8g of dehydrated nutrient broth, 30g of Sodium chloride, 5g of Calcium carbonate, 15g of bacteriological agar and 10 ml of Glycerol in 1 litre of distilled water. The same composition except agar was used to prepare Luminescent broth (LB). The media was autoclaved at 121°C for 15 minutes.

Isolation and Identification of Bioluminescent Bacteria

The collected marine water samples were added to the LA medium through pour plate method and incubated at about 20°C for 24 hrs. Luminescent colonies were identified by observing the plates in a dark room. Two glowing colonies (LUM01 & LUM02) were randomly picked up specifically and re-streaked onto LA plates and incubated again at 20°C for 24 hours. They were further purified by sub-culturing in luminescent agar plates following standard bacterial isolation by repeated streaking on luminescent agar and stored in the refrigerator for further use. The isolated colonies were identified by 16s rRNA sequencing.

Reagents and Materials

For the detection of pollutants by the bioluminescent bacteria, three heavy metals namely copper sulphate, potassium dichromate and lead nitrate were used along with a detergent and an organic pesticide (liquid form). All the heavy metal solutions and the detergent were prepared in 1g/litre concentration. The detergent used in the experiment consists of 40% sodium carbonate, 7% alkyl benzene sulphonate, 10% alkyl sulphate and 1% of cellulose enzyme. Organic pesticide was purchased from a local store which contained 2.5% of Pyrethrin. All aqueous solutions were prepared using deionizer water unless otherwise stated.

Culturing conditions

The biosensing capability of the bacteria against the pollutants was analyzed using two methods namely the broth method and plate culture method. For solid plates, a colony of the bacteria was selected using a sterile wooden stick and streaked across the plate. For liquid culture, a loopful of bacteria was inoculated in a 5ml LB medium in a test



**Esther Mereen and Jemma Hermelin Jesy Diaz**

tube. Subsequent liquid cultures were inoculated directly from this stock, 0.5ml to each 50ml conical flasks. Cultures were aerated continuously by shaking at 150rpm and kept at room temperature for a minimum period of 12 hours to reach peak luminescence [8].

Addition of Pollutants

0.5ml of all the five samples (heavy metals, detergent and pesticide) was added separately into each of the conical flasks containing 50ml of the inoculated broth culture. For the plate cultures, contaminants were sprayed in standardized quantities of 135 μ l per spray, twice (135x2=270 μ l) to each of the agar plates inoculated with the bacteria.

Measurement of Luminescence

Bacterial bioluminescence is usually measured using an instrument called Illuminometer, which is often time consuming. An alternative and more convenient method is using the open source software Image to measure the intensity of light in MLU (Measured Light Units). The luminescence intensity (in light units) was determined in a series of photos taken over time. A digital camera was stationed inside a self-made lightproof box. Above the camera, openings were carved out in boards to hold either the flasks or Petri dishes so that the distance from the bottom of them to the camera lens was fixed. Pictures were taken with a constant setting and exposure time of 30 seconds. The pictures were then transferred to the Image Batch Measure Macro to obtain a mean value of light reading. The results were transferred to Microsoft Excel, analyzed and presented numerically as MLU. To determine whether the cells were affected by the contaminant treatment, their light output was compared with the light output of the control cells. The time taken between removing the flasks from the shaker and taking the pictures was maintained constant for all liquid samples. The final results of the Measured Light Units (MLU) were calculated by taking the average of three separate trials[8].

RESULTS AND DISCUSSION**Identification of the Bioluminescent Bacteria**

The 16s rRNA sequencing results confirmed that LUM01 was *Vibrio owensii* and LUM02 was *Vibrio hyugaensis*. (Fig.1)

Detection of Pollutants

The control maintained for broth and plate culture showed gradual increase in bioluminescence for about 90 min and then slowly decreased, whereas the addition of pollutants showed a sudden decrease in the luminescence properties of the bacteria (Fig.3 & 4). The luminescence of both the bacterial cultures was predominantly affected by chromium since the Measured Light Units (MLU) decreased about 86-84% within 90 min. The exposure of copper, lead and detergent on the cultures also decreased the bioluminescence below 15 MLU in 120 min (Table 1 & 2). The organic pesticide had very little effect on the bioluminescence property of both the cultures. It was noted that *Vibrio owensii* exhibited better luminescence when compared to *Vibrio hyugaensis* on the addition of pesticide (Fig.2).

The detection of pollutants by bioluminescent bacteria is non-specific. Hence this method can be used to detect un-anticipated toxins in the environment. Bioluminescent *Vibrio* species have proved to be excellent microbes for the discernment of environmental pollutants. *Vibrio campbellii* isolated from sea urchin has also been used as a biosensor for the detection of hexavalent chromium compounds in water [9]. Acute toxicity assessment on the basis of acute bioluminescence inhibition assay using the marine bacterium *Vibrio fischeri* is also being done[10]. The suitable ranges of environmental factors, including pH value, organic matter, turbidity, hardness, and dissolved oxygen of water samples were evaluated for the toxicity testing of bioluminescent bacteria. Bioluminescent bacteria tests are on average, enough sensitive to detect compounds that can be toxic to humans and to the whole environment. Bioluminescent assays are better choice when compared to the features of other assays due to the sensitivity, ease of use, rapidity, flexibility and low costs of the bioluminescent bacteria test systems [11].





Esther Mereen and Jemma Hermelin Jesy Diaz

CONCLUSION

Bioluminescence assay is a resourceful method for the rapid detection of toxic substances to analyze environmental pollutants. *Vibrio owensii* and *Vibrio hyugaensis* are proved to be potential microbes for sensing pollutants in the environment. Measurement of light intensity using Image software has also led to an appropriate methodology and time-saving detection of toxins.

ACKNOWLEDGEMENTS

The authors are grateful to the Principal of St. Mary's College (Autonomous) and the Head of the Department of Zoology for providing well equipped laboratory facilities to carry out the experiment.

REFERENCES

1. J. Malave-Orengo, E.N. Rubio-Marrero and C. Rios-Velazquez, "Isolation and characterization of bioluminescent bacteria from marine environments of Puerto Rico", *Technology and Education Topics in Applied Microbiology and Microbial Biotechnology*, 1(2) pp.103-108, 2010.
2. A. Nawaz and N. Ahmed, "Isolation and characterization of indigenous luminescent marine bacteria from Karachi coast", *Academic Research International*, 1(2) pp.74-83, 2011.
3. H. Urbanczyk, J.C. Ast, A.J. Kaeding, J.D. Oliver, and P.V. Dunlap, "Phylogenetic analysis of the incidence of lux gene horizontal transfer in Vibrionaceae", *Journal of Bacteriology*, 190(10) pp. 3494-3504, 2008.
4. E.A. Meighen, "Bacterial bioluminescence: organization, regulation, and application of the lux genes", *The FASEB Journal*, 7(11) pp. 1016-1022, 1993.
5. Yaohua Li, Xinyu He, Weinan Zhu, Haoran Li and Wei Wang, "Bacterial bioluminescence assay for bioanalysis and bioimaging", *Analytical and Bioanalytical Chemistry*, 414 pp. 75-83, 2021.
6. G.A. Tehrani, S. Mirzaahmadi, M. Bandehpour, F. Laloei, A. Eidi, T. Valinasab, and B. Kazemi, "Molecular cloning and expression of the luciferase coding genes of *Vibrio fischeri*", *African Journal of Biotechnology*, 10(20) pp. 4018-4023, 2011.
7. K.H. Nealon, "Isolation, identification and manipulation of luminous bacteria", *Methods in Enzymology*, 57 pp. 153-166, 1978.
8. Li Boynton, "Using bioluminescent bacteria to detect water contaminants", *Journal of the U.S. SJWP*, 4 pp. 29-41, 2009.
9. Aswin Thacharodi, C. Jeganathan and Dilipkumar Thacharodi, "Biomonitoring of heavy metal pollution by bioluminescent bacteria biosensors", *Indian Journal of Science and Technology*, 12(15) pp. 1-9, 2019.
10. Xuewen Yi, Zhanqi Gao, Lanhua Liu, Qian Zhu, Guanjiu Hu and Xiaohong Zhou, "Acute toxicity assessment of drinking water source with luminescent bacteria: Impact of environmental conditions and a case study in Luoma Lake, East China", *Frontiers of Environmental Science and Engineering*, 6 pp. 1-9, 2020.
11. Stefano Girotti, Elida Nora Ferri, Maria Grazia Fumo and Elisabetta Maiolini, "Monitoring of environmental pollutants by bioluminescent bacteria", *Analytica Chimica Acta*, 608 pp. 2-29, 2007.

Table 1: Intensity of luminescence (MLU) exhibited by *Vibrio owensii* on pollutants exposure

| Time after addition of Contaminants | Control | Copper | Lead | Chromium | Detergent | Pesticide |
|-------------------------------------|---------|---------|---------|----------|-----------|-----------|
| 0 min (Start) | 142.964 | 141.411 | 151.76 | 170.401 | 147.027 | 172.53 |
| 30 min | 149.996 | 129.695 | 144.538 | 64.019 | 123.202 | 134.352 |
| 60 min | 172.743 | 113.332 | 134.085 | 50.504 | 87.001 | 137.542 |
| 90 min | 174.722 | 64.906 | 130.666 | 26.781 | 65.161 | 128.959 |
| 120 min | 146.527 | 56.464 | 67.089 | 7.902 | 46.749 | 112.854 |
| 150 min | 145.065 | 20.077 | 57.765 | 6.527 | 45.887 | 90.668 |





Esther Mereen and Jemma Hermelin Jesy Diaz

| Plate culture | | | | | | |
|-------------------------------------|---------|--------|--------|----------|-----------|-----------|
| Time after addition of Contaminants | Control | Copper | Lead | Chromium | Detergent | Pesticide |
| 0 min (Start) | 50.565 | 95.375 | 76.487 | 67.998 | 82.712 | 84.374 |
| 30 min | 84.068 | 90.574 | 73.263 | 64.566 | 80.912 | 81.498 |
| 60 min | 87.204 | 89.73 | 41.805 | 25.62 | 55.628 | 76.494 |
| 90 min | 100.106 | 46.397 | 34.844 | 9.932 | 43.353 | 74.796 |
| 120 min | 77.131 | 11.707 | 8.369 | 8.946 | 26.826 | 28.793 |
| 150 min | 48.38 | 11.655 | 8.243 | 7.719 | 7.147 | 17.442 |

Table 2: Intensity of luminescence (MLU) exhibited by *Vibrio hyugaensis* on pollutants exposure

| Broth culture | | | | | | |
|-------------------------------------|---------|--------|---------|----------|-----------|-----------|
| Time after addition of Contaminants | Control | Copper | Lead | Chromium | Detergent | Pesticide |
| 0 min (Start) | 133.925 | 101.74 | 169.355 | 132.024 | 135.162 | 169.212 |
| 30 min | 132.117 | 48.322 | 57.183 | 49.118 | 87.02 | 148.995 |
| 60 min | 170.065 | 43.002 | 39.331 | 18.157 | 38.472 | 122.085 |
| 90 min | 169.94 | 36.316 | 23.093 | 15.036 | 36.964 | 70.661 |
| 120 min | 104.619 | 17.233 | 12.229 | 11.211 | 26.4 | 62.074 |
| 150 min | 101.621 | 8.081 | 8.988 | 8.384 | 8.071 | 16.184 |
| Plate culture | | | | | | |
| Time after addition of Contaminants | Control | Copper | Lead | Chromium | Detergent | Pesticide |
| 0 min (Start) | 58.541 | 69.777 | 53.244 | 69.385 | 71.684 | 57.084 |
| 30 min | 71.745 | 60.321 | 49.564 | 49.8 | 39.674 | 54.642 |
| 60 min | 73.498 | 59.345 | 47.303 | 47.534 | 32.576 | 48.864 |
| 90 min | 67.505 | 51.637 | 41.825 | 12.181 | 30.288 | 43.952 |
| 120 min | 62.483 | 8.545 | 11.349 | 11.771 | 23.873 | 9.86 |
| 150 min | 59.01 | 7.619 | 8.804 | 7.39 | 10.694 | 4.957 |

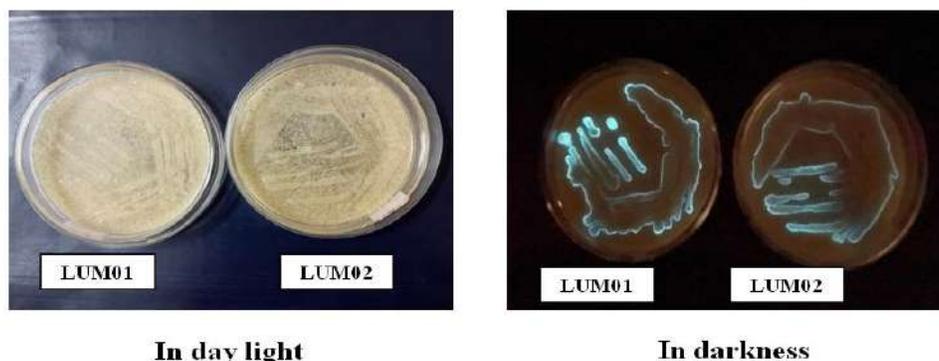


Fig.1: Bioluminescent *V. owensii* and *V. hyugaensis* cultures





Esther Mereen and Jemma Hermelin Jesy Diaz

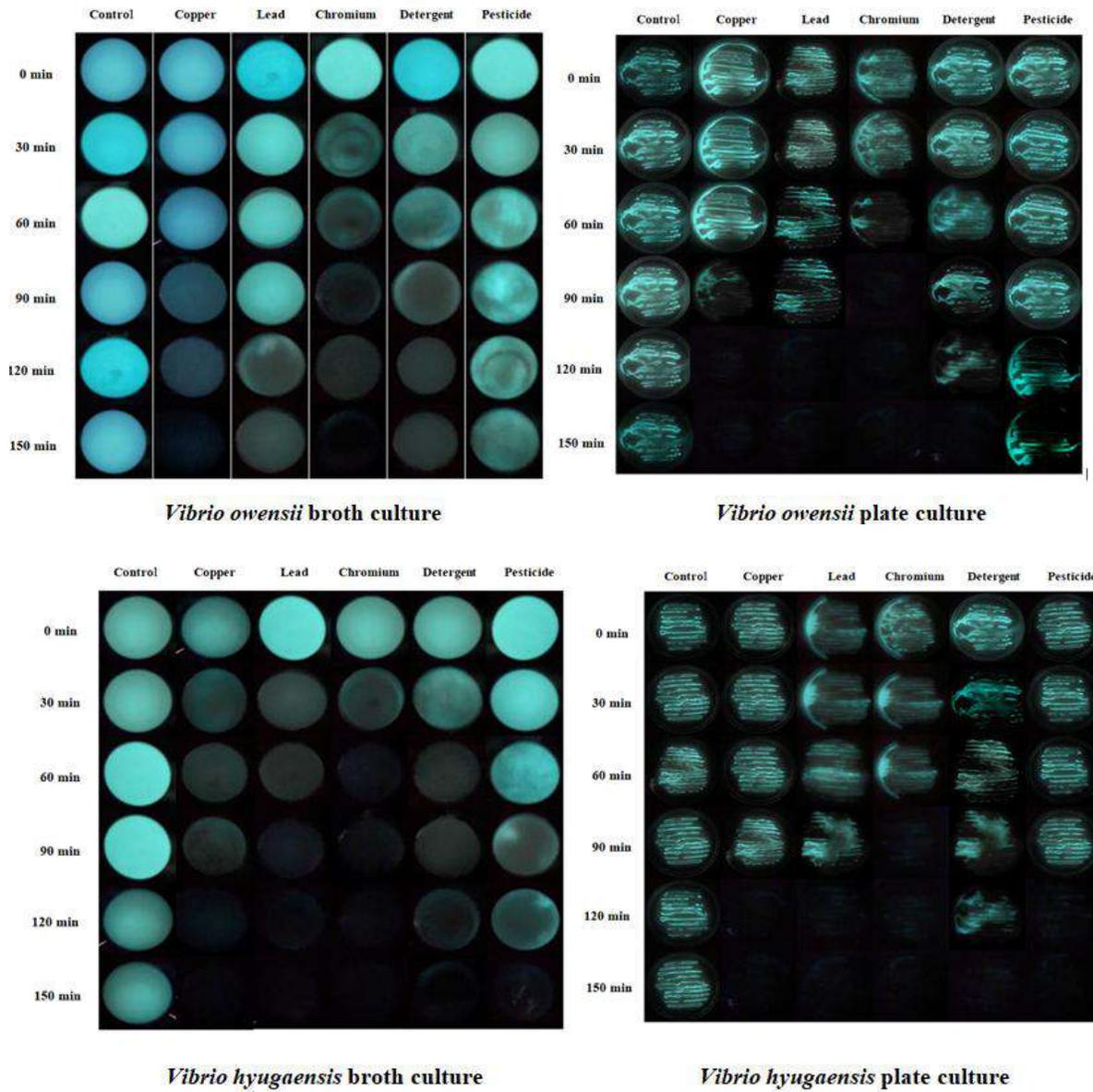


Fig. 2: Luminescence of *V. owensii* and *V. hyugaensis* on addition of pollutants





Esther Mereen and Jemma Hermelin Jesy Diaz

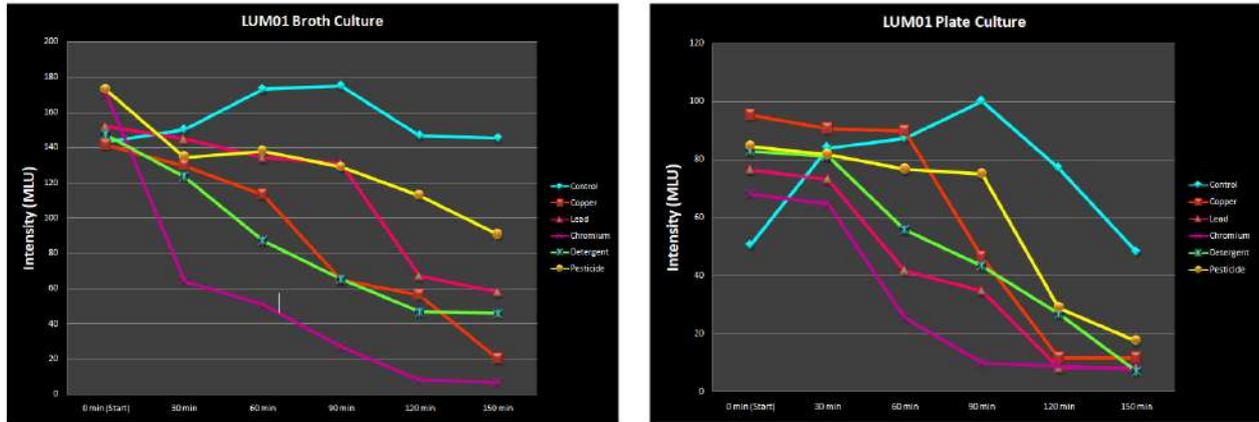


Fig. 3: Intensity (MLU) exhibited by *Vibrio owensii* on addition of pollutants

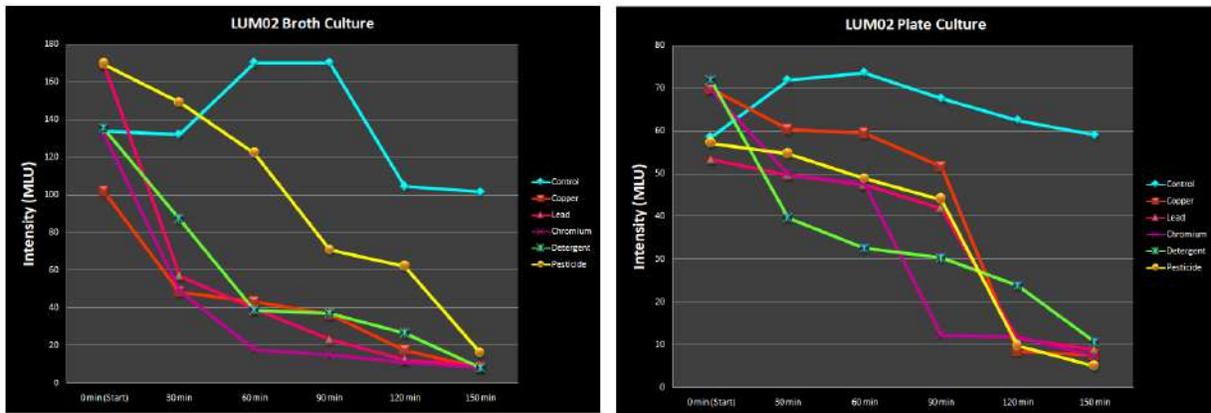


Fig. 4: Intensity (MLU) exhibited by *Vibrio hyugaensis* on addition of pollutants





REVIEW ARTICLE

An Overview and use of Different Pharmacoeconomic Modelling Methods used in Pharmacoeconomic Analyses a Review

Harshith N^{1*} and BR Jaidev Kumar²

¹Assistant Professor, Department of Health System Management Studies, JSSAHER, Mysuru, Karnataka, India.

²Lecturer, Department of Pharmacy Practice, JSS College of Pharmacy, Mysuru, Karnataka, India.

Received: 08 Apr 2022

Revised: 10 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Harshith N

Assistant Professor

Department of Health System

Management Studies, JSSAHER

Sri Shivarathreeshwara Nagara,

Mysuru - 570 015, Karnataka, India

Email: harshith.dhms@jssuni.edu.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In the ongoing environment of expanding medical care costs, pharmacoeconomics is turning out to be progressively significant, however information about pharmacoeconomic strategies is restricted among most clinicians. This article gives a prologue to, and outline of, normal strategies utilized in pharmacoeconomic demonstrating: choice analysis, Markov displaying, limiting and vulnerability investigations by means of Mont Carlo reenactment. Establishment of a proper Economic modeling is still a hectic task and especially in the field of Healthcare Assessment this is still in the early stages and as far as the review is compared the article here sheds light on the all possible methods possible for the adoption in pharmacoeconomic and their outcomes

Keywords: Pharmacoeconomics; Economic Modelling; Healthcare Assessment; Markov displaying

INTRODUCTION

pharmacoeconomic model joins pharmacological and additionally illness the board methods, proof based clinical results, patient endurance information as well as personal satisfaction (utility) information, epidemiological information, and expenses in an objective, quantifiable way. Proof based medication can be connected to the nearby climate utilizing pharmacoeconomic models. They require locally significant asset utilization and cost information so monetary results (like restorative endlessly cost viability) are current and important. Choice scientific models are valuable for intense affliction episodes since they portray a succession of chance occasions and choices over the



**Harshith and Jaidev Kumar**

course of time. Epidemiological models consolidate clinical preliminary information with observational information to anticipate the adequacy of chance administration systems like inoculation and antihypertensive prescription. To conjecture the adequacy of hazard the executives intercessions like immunization and antihypertensive treatment, epidemiological models join clinical preliminary information with observational information. Models are much of the time the main choice to accumulate exact data on the clinical, monetary, and humanistic aftereffects of ailment the executives regimens since they are quick, versatile, and by and large reasonable. They can, nonetheless, be jumbled and inclined to predisposition and confusion in the event that not took care of with alert. Both the examiner and the client should remember that lack of definition isn't equivalent to significance. Clinical preliminaries (or meta-investigations of clinical preliminaries) give the most elevated level of proof on a medication's viability, yet they seldom give understanding into its planned adequacy and cost-viability [1]. Clinical preliminaries are much of the time directed on exceptionally encircled populaces in firmly controlled concentrate on conditions, are in many cases short in length (as long as 5 years), and don't consider contending mortality and grimness from conditions not of interest, so there is much of the time a huge hole among adequacy and viability/cost-adequacy. Moreover, notwithstanding the way that cost-viability is a basic variable of pharmacological attainability, clinical preliminaries seldom inspect costs. Issues connecting with medical services costs might be all the more straightforwardly pertinent to medical care policymakers and agents than to clinicians, yet in the ongoing environment of taking off medical services costs, all wellbeing experts ought to be answerable for guaranteeing proper medical services spending [2].

Decision Analyses

Choice examination is a procedure for measuring and looking at different wellbeing medicines, like pharmacological treatment, as far as their normal wellbeing impacts or potentially costs, to direct clinical practice and wellbeing strategy. It's particularly gainful in cases where the equilibrium of expected advantages, dangers, and expenses related with different wellbeing measures is unclear. A choice examination tree, which makes sense of and evaluates the impacts of at least two opportunities for a choice to be taken, is a typical portrayal of choice investigation [3]. The following easiest coordinated diagram is choice trees, which are among the first and generally usually utilized. The supposition that will be that total probabilities are significant and generally used. They're only straight-forward coordinated diagrams with no recursion. While choice trees are by and large a proper technique for pursuing a decision, they might be carried out as PC models in an assortment of consistently utilized programming programmers. (TreeAgeTM, winDMTM) Straightforward choice trees exemplify the focal para-done by means of awareness examinations, which is many times the second worldview of choice investigation. All choice orders, specifically, can be isolated down into three essential classes: (i) the choice hub, a conventional portrayal of the moment when a chief should pick between contending procedures; (ii) the choice methodology, a particular system set or program of activities or occasions that follow a choice (in basic choice trees, this is joined); (iii) the choice technique, a particular technique set or program of activities or occasions that follow a choice (in straightforward choice trees, this is fused) [4]. Straightforward choice trees exemplify the focal para-done through responsiveness examinations, commonly second worldview of choice examination. In particular, all choices order. may be stalled into three extensively characterized parts: (I) the choice hub, the conventional portrayal existing apart from everything else in time when a chief settles on a decision between contending strategies; (ii) the choice procedure, a particular technique set or program of activities or occasions ensuing to a choice (in straightforward choice trees, this is incorporate-choice issue implies openness to gambles as a progression of chance hubs or potentially Boolean hubs occasions over the long run, continuous openings or circumstances addressing the subsequent explicit occasions where the particular timing of an occasion is viewed as resulting to pursuing a given vital decision) (iii) the result hubs, the terminal parts of the tree that address the worth of the results of the technique. There is no choice assuming there are no qualities relegated to the results. In medical care innovation evaluation, the result hub as a rule addresses future (LE), cost, QALYs or quality-changed future (QALE). There can be no choice assuming the results have no qualities joined to them. The result hub in a medical services innovation assessment normally demonstrates future (LE), cost, or QALYs (quality-changed future) (QALE). The normal worth of a choice tree has generally been figured by 'averaging out' or 'folding back' the tree's limbs. Basic trees can be assessed stochastically by sending



**Harshith and Jaidev Kumar**

single people down various branches. The way likelihood to the element's terminal hub duplicated by the worth of the terminal hub approaches the substance's normal worth. Every technique's worth is equivalent to the absolute of its singular worth. Whenever basic trees are utilized, one accepts that the populace being analyzed can be displayed in the total and that the total populace comes mirror similar extent of individuals in the populace being examined. Assuming a choice tree is being applied to an individual clinical decision, the as-sumption is that total probabilities are pertinent to the person. A limited time span, or time-hori-zon, portraying the timeframe over which the results of the choice are played out is additionally ordinarily accepted and is the period over which all results are amassed [5]

Markov Modelling

Markov models are to some extent cyclic coordinated networks developed by Andrei Markov. They're particularly successful when a decision issue implies long haul openness to perils or events, proceeding with openings, or conditions where the exact timing of an occasion is crucial or equivocal, or where determining the order of occasions is expected for face legitimacy. It is substantially more natural, for instance, to believe that an individual's disease risk changes after some time as they smoke more. In medical services, most of Markov models are semi-Markov state change models. In semi-Markov models, state advances might be allowed to change or be time-variation, and state advances should typically be addressed mathematically through Markov Chains, where state changes are steady across time and can be tackled scientifically [6]. Semi-Markov models have three crucial presumptions: state, time, and memory. Patients must be in one of a set number of wellbeing states known as Markov states. If you had any desire to research diabetes mellitus utilizing this strategy, you could display the wellbeing states 'well,' 'pre-diabetic,' 'diabetic without insulin,' 'diabetic with insulin,' or 'dead.' Simulated companions or people can't monitor their affliction or wellbeing accounts. All of this data should be joined into the model's system. Each conceivable wellbeing state and progress of interest should be demonstrated expressly. It isn't admissible to have at least two wellbeing states simultaneously. The amount and sorts of wellbeing states you can look not entirely set in stone by the significance of your concern and the data accessible to portray it. Every change of the two arrangements of ailment states portraying the infection should be depicted unequivocally assuming an individual has two sicknesses. The two cases should be expressly addressed assuming it is imagined that a patient treated for stroke with a thrombolytic specialist has an alternate impending gamble of mortality than one treated with angioplasty. In view of the unitary state necessity, suppositions in regards to which wellbeing states are of interest should be streamlined, generally the model's intricacy might become unmanageable. Markov models are basically discrete-time models, however constant time adaptations can be created also. This implies that time is partitioned into discrete spans, which are known as Markov cycles. The patient might change starting with one condition then onto the next toward the finish of each cycle. A to some degree cyclic coordinated chart can be utilized to portray this. The admissible advances toward the finish of a given Markov cycle are addressed by the curves or edges interfacing two states. Recursive circular segments represent a patient getting back to their present status, which is equivalent to staying solid. Individuals, either as people in a Monte Carlo reproduction or as parts of an accomplice in an associate recreation, can make each change in turn [7].

The most limited clinically critical time stretch is picked as the length of a Markov cycle. For instance, a model concentrating on the impacts of thrombolytic treatment for an intense stroke would pick a cycle time of a year, though a model inspecting the impacts of thrombolytic treatment for an intense stroke could pick a process duration of months [8]. Absence of memory is a fundamental Markova presumption and imperative. Just the dissemination of elements at timen + 1 is utilized to gauge the appropriation of substances in every future stage. There is no requirement for data to be held in memory. All intriguing events are addressed as changes starting with one state then onto the next. During a solitary cycle, the net probability of progressing starting with one state then onto the next.

Discounting

All health and cost measures are referred to the baseline time in pharmacoeconomic modeling, and future life/health and cost measures are discounted by convention. Discounting is done because the worth of life, health, and money



**Harshith and Jaidev Kumar**

in the future is lower than it is now (even after accounting for inflation). This reflects human nature's desire for instant gratification, or at the very least, as soon as feasible. Discount rates vary, although they are typically between 3% and 5% every year [9].

Uncertainty Analyses

Since pharmacoeconomic displaying depends on theory, it's important that vulnerability be shown in the outcomes. Without a doubt, the 95% certainty stretch that encompasses most assessments represents that showing vulnerability in clinical and applied research is so significant. Since models depend on numerous information inputs, they are touchy to vulnerability, and as the quantity of data sources and demonstrating stages develops, so does the vulnerability in yields. Moreover, as a rule, suspicions should be made, which adds to the degree of vulnerability. Monte Carlo reproduction is an approach to running rehashed reenactments of a model, each time utilizing tests from the model's bits of feedbacks' expressed vulnerability ranges (instead of point gauges). Likelihood disseminations are regularly used to communicate these vulnerability areas. The scope of potential qualities for a boundary, as well as the opportunity of each worth occurring, are portrayed by likelihood conveyances. 'Gamma,' 'uniform,' 'ordinary,' and 'three-sided' are instances of normal likelihood disseminations Input conveyances are likelihood appropriations that connect with information inputs for a model. Monte Carlo reenactment produces many results from which likelihood conveyances can be determined in light of the fact that it includes various recreations. These are normally alluded to as result circulations. In a Monte Carlo reproduction with a short number of emphases, the result dissemination isn't obviously characterized. The result appropriation, then again, turns out to be more characterized and steady as more emphases are led. Assembly is the term for this cycle. In Monte Carlo reenactment, an adequate number of emphases should be finished for a result dispersion to merge. Examining the uncertainty around decisions using these models and determining internal validity is done through sensitivity analyses, typically second order [10].

CONCLUSION

Pharmacoeconomics indeed plays a pivotal role in decision making process in expenditure of Healthcare Process and Pharmacoeconomic modeling aims in addressing the issues pertaining to effective estimation of the allocated resources and arrive at the crucial decision making process these methods gives an alternative ideas and the choice of the best method involved in the decision making process.

REFERENCES

1. Ademi Z, Kim H, Zomer E, Reid CM, Hollingsworth B, Liew D. Overview of pharmacoeconomic modelling methods. *British journal of clinical pharmacology*. 2013 Apr;75(4):944-50.
2. Stahl JE. Modelling methods for pharmacoeconomics and health technology assessment. *Pharmacoeconomics*. 2008 Feb;26(2):131-48.
3. Liew D, McNeil JJ, Peeters A, Lim SS, Vos T. Epidemiological modelling (including economic modelling) and its role in preventive drug therapy. *Medical journal of Australia*. 2002 Oct;177(7):364-7.
4. Liew D, Lim SS, Bertram M, McNeil JJ, Vos T. A model for undertaking effectiveness and cost-effectiveness analyses of primary preventive strategies in cardiovascular disease. *European Journal of Preventive Cardiology*. 2006 Aug 1;13(4):515-22.
5. Flay BR. Efficacy and effectiveness trials (and other phases of research) in the development of health promotion programs. *Preventive medicine*. 1986 Sep 1;15(5):451-74.
6. Russell LB, Gold MR, Siegel JE, Daniels N, Weinstein MC. The role of cost-effectiveness analysis in health and medicine. *Jama*. 1996 Oct 9;276(14):1172-7.
7. Robinson A, Thomson RG. The potential use of decision analysis to support shared decision making in the face of uncertainty: the example of atrial fibrillation and warfarin anticoagulation. *BMJ Quality & Safety*. 2000 Dec 1;9(4):238-44.





Harshith and Jaidev Kumar

8. Elwyn G, Edwards A, Eccles M, Rovner D. Decision analysis in patient care. *The Lancet*. 2001 Aug 18;358(9281):571-4.
9. Lilford RJ, Pauker SG, Braunholtz DA, Chard J. Decision analysis and the implementation of research findings. *Bmj*. 1998 Aug 8;317(7155):405-9.
10. Montgomery AA, Fahey T, Ben-Shlomo Y, Harding J. The influence of absolute cardiovascular risk, patient utilities, and costs on the decision to treat hypertension: a Markov decision analysis. *Journal of hypertension*. 2003 Sep 1;21(9):1753-9.





COVID-19 and Food Security in South Asia

Aditi Priya*

Assistant Professor, Manipal University Jaipur, India.

Received: 21 Mar 2022

Revised: 15 June 2022

Accepted: 04 July 2022

*Address for Correspondence

Aditi Priya

Assistant Professor, Manipal University,
Jaipur, India.

Email:



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The basic notion of security has remained a dynamic concept in International Relations. It has been considered as a contested concept as it continues to evolve both in terms of theory and practice. Security as a concept is not new in the domain of Social Sciences. In fact, it has been one of the major determinants of our international system. These phenomena compelled the world leaders to think about Security from a different perspective. According to the report, there are two types of threat: first that is mainly confined to a particular region culturally, economically and geographically. It includes threats to economic security, food security and health security. South Asian region is diverse in nature. That is why COVID 19 has a devastating impact on the food security of South Asia especially for the people working in the informal sector.

Keywords: phenomena, food security, Asian, COVID

INTRODUCTION

The basic notion of security has remained a dynamic concept in International Relations. It has been considered as a contested concept as it continues to evolve both in terms of theory and practice. Etymologically, the term security is derived from the Latin word *secures* which connotes 'liberty from any kind of threats' (Mesjasz, 2004). Security, in general, means safety from and protection against damage. According to Wolfers "security, in an objective sense, measures the absence of threats to acquired values, in a subjective sense, the absence of fear that such values will be attacked" (Wolfers, 1962). In international relations, Security has been understood something related to safety from and protection against military threat for ages. However, we can claim that in the present COVID 19, the meaning of security is not limited to its traditional concept only. Today, in the COVID 19 world, the non-traditional security threat holds much more importance where contagion is capable of the death of many people across borders. And no country whether developed or developing is immune to it.

The first section of the paper discusses the concept of security in international relations from both traditional and non-traditional aspects by elaborating on the similarities and differences of "threat". In the second section, the paper



**Aditi Priya**

analyses how the components of human security are directly affected by this pandemic. Further, I discuss one of the most essential components of Human Security, that is, Food Security which was severely affected during the pandemic. In the third section, the paper will detail the steps that need to be taken in order to ensure food security.

Security as a dynamic concept

Security is a core value of human existence. The Oxford Dictionary defines Security as “to be secure is to be untroubled by danger or fear.” (Concise Oxford Dictionary, 1990). Security as a concept is not new in the domain of Social Sciences. In fact, it has been one of the major determinants of our international system. In the study of international relations, security can be situated within three major frameworks, namely national security, international security, and human security. ‘National Security’ means the safety of the citizens of a nation from foreign attack. The UN Chronicle defines “National Security as the ability of a state to cater for the protection and defence of its citizenry” (UN Chronicle online). International Security which is also called as ‘Global Security’ means those measures taken by the nations and international organization which are required for the mutual survival. Barry Buzan defines international security or the global security as “more than a study of threats, but also a study of which threats that can be tolerated and which require immediate action” (Buzan, 2000). These two approaches, that is, national and international security are state-centric. The idea of Human Security, however, is different from the notions of national and global security. It gives primacy to the interests of the individuals or the community over that of the Nation States. That is why it is called “human-centric.”

Concept of Human Security

Human Security is relatively a new concept arising in the 20th century. During the Cold War period particularly, security was perceived largely in terms military power. After the Cold War, the nature of security has changed its meaning from a traditional notion to a non-traditional notion with the prevalence of trans-national terrorism, human rights violations, deadly diseases, poverty, hunger, natural disasters etc. These phenomena compelled the world leaders to think about Security from a different perspective.

In this respect, Human Security as a different aspect of Security became the subject of a policy and academic debate in early 1990s which concerned itself to the individual-centric issues. In common parlance, the term Human Security means anything which affects the security of individual and their existence can be treated under the concept of Human Security. The first systematic definition of Human Security came in 1994 by the United Nations Development Programme (UNDP) in its Human Development Report (HDR). The UNDP Report defines Human Security from two aspects. According to the report, “Human Security means, first, safety from such chronic threats as hunger disease and repression. And second, it means protection from sudden and hurtful disruptions in the patterns of daily life- whether in homes, in jobs or in communities” (UNDP, 1994). Thus, it describes Human Security as “freedom from fear” and “freedom from want.” Consequently, the HDR listed seven essential dimensions of Human Security: Economic Security, Food Security, Health Security, Environmental Security, Personal Security, Community Security, and Political Security.

According to the report, there are two types of threat: first that is mainly confined to a particular region culturally, economically and geographically. It includes threats to economic security, food security and health security. A second type of threat is universal in nature and scope and each region gets impacted by this irrespective of national boundaries. Threats caused by issues such as like drug trafficking, deadly diseases, international migration, environmental decay and so on fall into this second kind. Thus, UNDP considers Human Security within a wider scope and horizon which cannot be tackled merely through traditional solutions linked to war and peace negotiations. Therefore, in order to solve the problem of a wide range of threats, the cooperation and combined efforts of different stakeholders such as people, government, civil society, private institutions, and international organisation is required. Today the world is facing the most severe of all the non-security threats: the Coronavirus Pandemic. According to World Health Organisation, “a pandemic is the worldwide spread of a new disease” (WHO, 2010). Coronavirus was declared a pandemic by the WHO on 11th March, 2020. COVID 19 which emerged in the Chinese province of Wuhan, soon spread to other parts of the world and killed numbers of people. Apart from



**Aditi Priya**

economic challenges faced by nations that were severely affected, the spread of the virus also exposed the inherent weaknesses in the healthcare systems of the world. WHO in 2011 through its International Health Regulations Review had already alerted the world by their statement that “the world is ill-prepared to respond to a severe influenza pandemic or any other similarly global, sustained and threatening public health emergency” (Cohen, 2011). The statements made by the WHO proved to be right after nine years and the world is now facing the greatest challenge on humanity. Already 215 countries have been affected by this deadly virus and the South Asian region is not immune to it either. In the South Asian region, Nepal was the first country to report a confirmed case of COVID 19 on 23rd January 2020 when a person who had returned from China became positive for Coronavirus. By July, every South Asian country had at least one confirmed case of Coronavirus. The most infected people in the South Asian region are from India, Pakistan and Bangladesh. Although most of the countries took preventive measures and implemented lockdown in their respective regions yet it has impacted each and every component of human security. In the next section, the paper discusses about the impact of COVID upon food and health security of the South Asian Nations.

Implication of COVID 19 on the Food Security in South Asia

Food Security has emerged as an important aspect of Security Studies. Food is the basic necessity of life without which a person cannot lead a healthy life. That is why, it is considered a universal human right. People having without secure access to food cannot contribute towards the positive development of society and economy. As Wiggings and Slater remarks “Food Security is the cornerstone of human existence and without it other securities are undermined” (Wiggings and Slater, 2012). Food Security means “that all people at all times have physical & economic access to adequate amounts of nutritious, safe, and culturally appropriate foods, which are produced in an environmentally sustainable and socially just manner, and that people are able to make informed decisions about their food choices” (Staff, 2015). Here all people mean even the most vulnerable section should get adequate food in all times in order to live a healthy life.

Food Security as a concept of debate amongst the policy makers and academicians has evolved in the last few decades. The basic issue of debate has been what constitutes food security and how it can be ensured at the global, regional, and individual levels. Food Security as a concept has been defined variously by different thinkers. There have also been different approaches to tackle the problem of hunger and food insecurity. When seen in detail, food security is the combination of three elements: food availability, food access and food utilization. Food availability means availability of food in a consistent manner. Food access means acquiring adequate quantity of food consistently through purchase or other means. and thirdly, food utilization refers to the fact that the food that has been consumed should provide nutritional value.

However, ensuring all the above three elements of food security for the population of a region like South Asia is not an easy task. The South Asian region constitutes 1.891 billion people that make up for one-fourth of the world’s population. The size of the population varies from country to country, India being the largest populated country and Maldives one of the least populated countries. South Asian countries have been the worst affected regions in matters of food security. The World Bank describes that “a large majority of the poor and the food-insecure people live in this part of the world” (World Bank, 1990). According to *the State of Food Security and Nutrition in the World, 2019* “Southern Asia is still the sub-region where the prevalence of under-nourishment is highest (in Asia), at almost 15percent” (FAO, 2019). The major reasons for such a sorry state have been rising poverty, unemployment, industrialization, bad weather, higher food prices, and instable income amongst others. This has also been the reason for malnutrition in children leading to world’s stunted children.

South Asian countries have been vulnerable to climate change and global warming. COVID 19 pandemic exposed the vulnerabilities of food security in South Asia and made the situation worse. According to the UN World Food Programme, “COVID 19 is potentially catastrophic for millions who are already hanging by a thread. It is a hammer blow for millions more who can only eat if they can earn a wage. Lockdowns and global economic recession have already decimated their nest eggs. It only takes one more shock- line COVID 19- to push them over the edge. We



**Aditi Priya**

must collectively act now to mitigate the impact of this global catastrophe” (WFP, 2020). As noted by the WFP, similar is the case in South Asia. The food insecure people are rising in the post pandemic period or the new normal. The pandemic challenged all the elements of food security: food availability, accessibility of the food and food utilisation. Food availability has been severely impacted in south Asia due to lockdown, disruption of transportation, business closures and collapse of global markets due to COVID 19. It is also noted that “a range of informal and small and medium scale businesses constitute the great majority of the food system- providing production, processing, marketing, and food services, including street food vendors and restaurants. Their inability to operate will affect food access through major population centres.” (Howard and Simons, 2020).

The availability of the food has been severely impacted due to disrupted transportation system as the produce of the farmers either could not be sold or poorly paid. For instance, Rajasthan, in India is known for producing a good watermelon crop. As with every year, watermelon produce in the months of April was ready to be transported to other parts of India. Due to the lockdown and disruption in the transportation system, the farmers could not supply the fruit crop to the other parts of the country. This led to a huge loss for farmers leading to poverty and ultimately food insecurity.

Food security in some places was also impacted due to panic-buying by the affluent people. They started storing the food items viewing it unavailability soon. This panic-buying created a crisis for other customers making the food prices higher for those who could not store food items due to lack of money. Hoarding and other forms of inaccessibility were commonplace. Tiensen 2020 writes: Thus, “in some places nutritious food is becoming scarce. Among other concerns, food is being hoarded, leaving little on shelves for consumers” (Tiensen, 2020).

The accessibility of the food was also impacted due to unstable income of the people in South Asia, mostly those working in the unorganised sectors. The people working in the unorganised sector such as weavers, handloom workers, stall owners etc. lost their jobs due to lockdown. This was because factories were closed down. In order to contain the spread of the virus leaving the people unemployed, and hungry. According to a leading newspaper of Bangladesh Daily Star, “more than 10 million people who work in the informal sector have lost their livelihoods in Bangladesh due to the Coronavirus outbreak” (Daily Star, 2020).

COVID 19 situation has also impacted remittances. Remittances are that part of a migrant’s earnings which are sent back home in the form of gold or cash. In South Asia, remittances constitute a major part of the economy. It accounts for nearly 28% of Nepal’s GDP and 8% of Pakistan’s GDP. Even many households in South Asia depend directly upon remittances for fulfilling their basic needs. India is the largest remittances recipient country in South Asia. It received more than \$80 billion remittances in 2019. South Asia received \$140 remittances in 2019. However, it is predicted by the World Bank that “South Asia will lose 22.1% of remittances in 2020 due to COVID 19” (World Bank, 2020). Thus, it is going to severely impact food and nutritional security of those depending upon the remittances. Food utilisation has been impacted due to COVID 19. In South Asia, people are more concerned about two meals a day rather nutritional food. Due to pandemic, people lost their job and could not even secure two meals a day. The lockdown forced them to stay at home and therefore they could not meet their requirements.

What needs to be done?

Food Security has been an important aspect of human existence without which the overall development of human being is not possible. It is a universal human right and it should be secured for every individual irrespective of their status and class. That is why the Government should prioritise this and the problem should be tackled at all levels.

Following are some of the suggestions for ensuring food security in South Asia

First, the analysts and policymakers should engage themselves more upon the concept of food security as a component of non-traditional security. Food security has been considered as a concept more associated with the demand and supply chain of economics. Policy debate should consider individual as a referent object of Security. Here, it is necessary to mention that individual and their basic requirements should be prioritised.



**Aditi Priya**

Second, agriculture should be prioritised in the national budget. Also, sufficient loans with lower interest rates, agricultural subsidies, seeds distribution, and other aiding machinery need to be distributed among the farmers. Third, self-sufficiency which was the slogan of PM Lal Bahadur Shastri should be applied. This should be done to avoid dependency in future. When the movements of the goods and services were disrupted due to COVID-19, the vulnerability and dependence of South Asian nations got exposed.

Fourth, it is essential to stabilise the food system and keep the trade open locally, regionally, and globally. This way food security can be ensured. Also, it is important to make people aware about panic buying and wasting of food. Fifth, Sustainable economic growth is the need of hour. For these resources should be utilized in such a manner that in case of such pandemics in the future, people are not worried. Another option could be liberalizing the trade policy. Countries like USA have lifted themselves out of poverty due to the free trade policy. Garry Hufbauer writes that "in fact, free trade has increased American household income by lowering costs of products, increasing wages and making more-efficient American companies" (Hufbauer, 2008).

Sixth, Social security schemes including the food transfer programme should be launched keeping in mind the present scenario. It can cope up the vulnerabilities of even the weaker section of the society and of those working in the informal economy. Conditional cash transfer programme could also become beneficial. Seventh, Cooperation amongst the regional players such as SAARC is required. In the post COVID-19 world, South Asian leaders, academicians, civil society organisations, epistemic communities need to deepen cooperation at regional level to face future food insecurity arising from COVID-19.

CONCLUSION

South Asian region is diverse in nature. That is why COVID 19 has a devastating impact on the food security of South Asia especially for the people working in the informal sector. While making the policies on food security in the post pandemic period, the nutrition of the food in terms of utilization aspect should be taken into consideration which has been overlooked. Disruption in the global food supply chain can be avoided by lifting trade restrictions, travel restrictions and border closures. Global cooperation should also be strengthened to secure food supply. Above all, agriculture should be prioritised as it will reduce dependency of the nations and promote self-sufficiency.

REFERENCES

1. Buzan, B. (1991), *People, states, and fear: An Agenda for security Analysis in the Post Cold War Era*. Brighton: Weatsheaf.
2. Cohen, Jon (2011), Committees sharply critiques WHO's pandemic response Accessed at <https://www.sciencemag.org/news/2011/03/committee-sharply-critiques-whos-pandemic-response>
3. FAO (2019), *The state of Food Security and Nutrition in the World 2019, safeguarding against economic slowdowns and downturns*.
4. Howard J and Simons E (2020), *COVID 10 threatens global food security: what should the United States do?* Centre for Strategic and International Studies. Accessed at <https://www.csis.org/analysis/covid-19-threatens-global-food-security-what-should-united-states-do>
5. Hufbauer (2008), "Free Trade," *The National Interest*, 95: 15-18.
6. Mesjasz, Czeslaw (2004), "Security As An Analytical Concept", Paper presented on 9- 11 September 2004 at the 5th Pan-European conference on International Relations: The Hague, [Online :web].
7. Parvez S (2020), More than a crore with no job and hope, Daily Star.
8. Staff (2015), *Food Security News* Accessed at <https://www.resilience.org/stories/2015-01-09/what-is-food-security/#:~:text=Food%20Security%20means%20that%20all,decisions%20about%20their%20food%20choices>
9. *The Concise Oxford Dictionary* (Oxford: Clarendon Press, eighth edition 1990), p.1093.



**Aditi Priya**

10. UN Chronicle Online Accessed at <https://www.un.org/en/chronicle/article/national-security-versus-global-security>
11. UNDP (1994), Human Development Report 1994, New York: Oxford University Press. WFP (2020), COVID 19 will double number of people facing food crises unless swift action is taken. Accessed at <https://www.wfp.org/news/covid-19-will-double-number-people-facing-food-crises-unless-swift-action-taken>
12. WHO, 2010 accessed at https://www.who.int/csr/disease/swineflu/frequently_asked_questions/pandemic/en/
13. Wiggings S and Slater R (2012), Food Security in J P Burgess, The Routledge Handbook of new Security Studies, Abingdon, Oxon: Routledge.
14. Wolfers, Arnold: 'National Security as an Ambiguous Symbol', in idem: *Discord and Collaboration. Essays on International Politics* (Baltimore: John Hopkins University Press, 1962), pp. 147-165.
15. World Bank (1990), World Development Report.
16. World Bank (2020), Food Security and COVID 19 Accessed at <https://www.worldbank.org/en/topic/agriculture/brief/food-security-and-covid-19#:~:text=The%20U.N.%20World%20Food%20Programme,of%20income%20and%20remittance%20losses>
17. Tiensin T (2020), Ensuring Food Security in the Era of COVID 19, Project Syndicate Accessed at <https://www.project-syndicate.org/commentary/covid19-threatens-to-unleash-global-food-insecurity-by-thanawat-tiensin-et-al-2020-03?barrier=accesspaylog>





Gaussian Quaternion Signal Minimizes the Uncertainty

Ravikumar K¹ and Diana Vinster Nadeen. A^{2*}

¹Engineering Mathematics Section, Faculty of Engineering and Technology, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

²Research Scholar, Department of Mathematics, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Received: 25 Apr 2022

Revised: 05 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Diana Vinster Nadeen. A

Research Scholar,

Department of Mathematics,

Annamalai University,

Annamalai Nagar, Tamil Nadu, India

Email: vinster.nad@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The influence of uncertainty principle is always considered as limitations and hurdles in all areas of computation. In the new technique of acquiring and reconstructing a signal, the uncertainty principle acts as an advantage for retrieving information. This can be attained using Gaussian Quaternion signal as it minimizes uncertainty. Here we are going to discuss why and how Gaussian Quaternion signal, Gaussian filters and Gaussian Blurs are used in signal and image processing.

Keywords: Gaussian Quaternion Signal, Uncertainty Principle, Gaussian Filters, Gaussian Blurs

INTRODUCTION

When speaking of uncertainty, there will arise a situation where we will be unable to determine the quantity's value with random certainty, in spite of initial constraints. We can also state that the position and its momentum are inversely proportional to each other, that is from initial conditions the more the position of particle is determined, the less its momentum can be predicted and its inverse holds. The uncertainty principle is innately possessed in all the systems which have its pattern to be in a form of a wave. It is usually understood as a relation between the simultaneous distribution of a function and its Fourier Transform. These wave functions are represented by a series of sinusoidal functions. It is here we need Fourier Transform, mainly in signal and image processing. When the domain becomes a spatial domain hyper complex numbers come in to process. These hyper complex numbers are called Quaternion.

When quaternion is used in Fourier Transform, it is helpful in signal processing. As Quaternion Fourier Transform (QFT) has an important character in representing the signals. It transforms a real 2D signal to quaternion-valued





Ravikumar and Diana Vinster Nadeen

frequency domain signal. While considering image processing, an enhanced image can be drawn through filters. In general there are two main approaches for filtering an image. The convolution of an image and kernel in the spatial domain is the first approach and the second one is the multiplication of an image’s Fourier Transform with a filter in the frequency domain [1]. Real world images are generated by capturing a signal and reconstructing an image based on a specified model. Unfortunately, image uncertainty is an often neglected aspect in image processing task as it is important information about the trustworthiness of the individual image pixels [2].

This uncertainty can be minimized by Gaussian Quaternion signal. This paper is going to discuss in detail about Gaussian. In section 1, Quaternion Fourier Transform is on an over view. In section 2, all uncertainty principle has been discussed. In section 3 and 4, we are going to converse about the usage of Gaussian in signal processing and image processing respectively. In Section 5, we have the conclusion of the paper by explaining the reduction of uncertainty.

Quaternion Fourier Transform

The knowledge of quaternion algebra is very essential for the computation of Quaternion Fourier Transform (QFT). $\mathbb{H} = \{c = c_0 + ic_1 + jc_2 + kc_3; c_0, c_1, c_2, c_3 \in \mathbb{R}\}$

$$\text{where } c_0 \text{ is } Re(c) \text{ and } c_1, c_2, c_3 \text{ is } Im(c). \quad (1.1)$$

$$\text{Where } i^2 = j^2 = k^2 = -1, ij = -ji = k, jk = -kj = i, ki = -ik = j. \quad (1.2)$$

From the above expression it is clear that commutative property is not true for Quaternion.

$$\bar{c} = c_0 - ic_1 - jc_2 - kc_3 \quad (1.3)$$

Where (1.3) is a Quaternion Conjugate. The multiplications of two Quaternion number is as follows:

$$\text{Let } c = c_0 + c, \quad (1.4)$$

$$\text{where } c = ic_1 + jc_2 + kc_3 \text{ and similarly let } b = b_0 + b, \quad (1.5)$$

$$cb = c_0b_0 + c.b + c_0b + b_0c + c \times b \quad (1.6)$$

Where $c.b = -(c_1b_1 + c_2b_2 + c_3b_3)$ - Scalar product(1.7)

$$c \times b = i(c_2b_3 - c_3b_2) + j(c_3b_1 - c_1b_3) + k(c_1b_2 - c_2b_1) \quad (1.8)$$

- Anti-symmetric cross type product.

The multiplication of quaternion and its conjugate is

$$c\bar{c} = c_0c_0 - c.c + c_0(-c) + c_0c + c \times (-c), \quad (1.9)$$

$$|c| = \sqrt{c\bar{c}} \text{ - Modulus,} \quad (1.10)$$

$$c^{-1} = \frac{\bar{c}}{|c|^2} \text{ - Inverse,} \quad (1.11)$$

Thus we had discussed briefly in Quaternion Algebra. This will be very much helpful in the evaluation of complex valued functions. When a function corresponds to time gets resolved in to its ,basic parts corresponding to spatial frequency then it is called Fourier transform. This can be put forth to algebra of Quaternion’s and this extension is termed as Quaternion Fourier Transform (QFT). There are three main types in QFT which arise due to its non-commutative property, the right-sided QFT, left-sided QFT and two-sided QFT. [3]

Definition

The Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by [4]

$$\widehat{f}_c(\xi_1, \xi_2) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-i\xi_1x_1} f(x_1, x_2) e^{-j\xi_2x_2} dx_1 dx_2 \quad (1.12)$$

Definition

The Inverse Quaternion Fourier Transform \widehat{f}_c^{-1} of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ and $\widehat{f}_c \in L^1(\mathbb{R}^2, \mathbb{H})$ is defined as follows

$$f(x_1, x_2) = \widehat{f}_c^{-1} \widehat{f}_c = \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{i\xi_1x_1} \widehat{f}_c(\xi_1, \xi_2) e^{j\xi_2x_2} d\xi_1 d\xi_2 \quad (1.13)$$





Ravikumar and Diana Vinster Nadeen

Definition

The left-sided Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by [5]

$$\widehat{f}_L(\xi_1, \xi_2) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-\mu(\xi_1 x_1 + \xi_2 x_2)} f(x_1, x_2) dx_1 dx_2 \tag{1.14}$$

Definition

The right-sided Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by [6]

$$\widehat{f}_R(\xi_1, \xi_2) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(x_1, x_2) e^{-\mu(\xi_1 x_1 + \xi_2 x_2)} dx_1 dx_2 \tag{1.15}$$

We use the integral representation to express the convolutions.

Definition

The convolution of $f \in L^2(\mathbb{R}^2, \mathbb{H})$ and $g \in L^2(\mathbb{R}^2, \mathbb{H})$, denoted by $f * g$, is defined by

$$(f * g)(x) = \int_{\mathbb{R}^2} f(y)g(x - y)dy.$$

Comparison of Convolution theorem of the QFT and Classical Fourier Transform for $f, g \in L^2(\mathbb{R}^2, \mathbb{H})$. [7]

The following theorem is used for solving the heat equation in Quaternion algebra

Theorem

If $f \in L^2(\mathbb{R}^2, \mathbb{H})$ and $g \in L^2(\mathbb{R}^2, \mathbb{H})$ then $\widehat{f}_c g \in L^2(\mathbb{R}^2, \mathbb{R})$ then $\widehat{f}_c^{-1}[\widehat{f}_c f \widehat{f}_c g](x) = (f_0 * g)(x) + (if_1 * g)(x) + (jf_2 * g)(-x_1, x_2) + (kf_3 * g)(-x_1, x_2)$.

Corollary

If $f \in L^2(\mathbb{R}^2, \mathbb{H})$ and $g \in L^2(\mathbb{R}^2, \mathbb{H})$ and $\widehat{f}_c g \in L^2(\mathbb{R}^2, \mathbb{R})$ where $f = f_0 + if_1, g = g_0 + ig_1 + jg_2 + kg_3$ then the above theorem reduce to $(f * g)(x)$.

Theorem (Inversion of RQFT)

If $f, \widehat{f}_R \in L^1(\mathbb{R}^2, \mathbb{H})$ and $g(x_1, x_2) = \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \widehat{f}_R(\xi_1, \xi_2) e^{i\xi_1 x_1} e^{j\xi_2 x_2} d\xi_1 d\xi_2$ then $f(x_1, x_2) = g(x_1, x_2)$ for almost every $(x_1, x_2) \in \mathbb{R}^2$.

Corollary (Uniqueness of RQFT)

If $f, g \in L^1(\mathbb{R}^2, \mathbb{H})$ and $\widehat{f}_R f(\xi_1, \xi_2) = \widehat{f}_R g(\xi_1, \xi_2)$ for almost every $(\xi_1, \xi_2) \in \mathbb{R}^2$, then $f(x_1, x_2) = g(x_1, x_2)$ for almost every $(x_1, x_2) \in \mathbb{R}^2$.

Definition

The two-sided Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by

$$\widehat{f}_c(\xi_1, \xi_2) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-\mu(\xi_1 x_1)} f(x_1, x_2) e^{-\theta \xi_2 x_2} dx_1 dx_2 \tag{1.16}$$

Definition

The Inverse left-sided Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by

$$f(x_1, x_2) = \widehat{f}_c^{-1} \widehat{f}_c = \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{\mu(\xi_1 x_1 + \xi_2 x_2)} \widehat{f}_L(\xi_1, \xi_2) d\xi_1 d\xi_2 \tag{1.17}$$

The reconstruction of the original signal f can be done by the inverse right-sided quaternion Fourier Transform under suitable conditions.

Definition

The Inverse right-sided Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by

$$f(x_1, x_2) = \widehat{f}_c^{-1} \widehat{f}_c = \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \widehat{f}_R(\xi_1, \xi_2) e^{\mu(\xi_1 x_1 + \xi_2 x_2)} d\xi_1 d\xi_2 \tag{1.18}$$





Ravikumar and Diana Vinster Nadeen

Definition

The Inverse two-sided Quaternion Fourier Transform of $f \in L^1(\mathbb{R}^2, \mathbb{H})$ is the Transform $\widehat{f}_c: \mathbb{R}^2 \rightarrow \mathbb{H}$ defined by

$$\widehat{f}_c(\xi_1, \xi_2) = \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-\mu \xi_1 x_1} f_{L-R}(x_1, x_2) e^{-\theta \xi_2 x_2} dx_1 dx_2 \tag{1.19}$$

Lemma (QFT Parseval)

Let $f, g \in L^1(\mathbb{R}^2, \mathbb{H}) \cap L^2(\mathbb{R}^2, \mathbb{H})$. The relation between f, g and their QFT is given by

$$\langle f, g \rangle = \langle \widehat{f}_c(f), \widehat{f}_c(g) \rangle \tag{1.20}$$

Inparticular, with $f=g$, we get the QFT version of the Plancherel formula; that is, [8]

$$\|f\|_{L^2(\mathbb{R}^2; \mathbb{H})}^2 = \frac{1}{(2\pi)^2} \|\widehat{f}_c(f)\|_{L^2(\mathbb{R}^2; \mathbb{H})}^2 \tag{1.21}$$

From this we can understand that the complete signal computed in the spatialdomain is equal to the complete signal computed in the quaternion domain. The Fourier Transforms which are applicable to colour images can be defined using Quaternion. It is framed in such a way to figure out the Fourier transform which treats colour image as a vector field. In image processing the blurred image is formed by forwarding the solution of the heat or diffusion equation where as sharpened image is produced by back warding the same by considering the given image as initial value.

Uncertainty

First we need to know the cause of uncertainty. All kind of measurements irrespective of precision and accuracy has uncertainty to some extent. This is due to 2 aspects, the limitations of the measuring instrument and the talent of the experimenter in computing the measurement. The former is called systematic error and the later is called random error. According to Werner Heisenberg a German Physicist “the position and the velocity of an object cannot be measured exactly, at the same time even in theory”. Here comes the uncertainty.

Uncertainty in position and velocity is greater than or equal to $\frac{h}{4\pi}$, where h is a Planck’s constant = $6.6 \times 10^{-34} \frac{\text{Joule}}{\text{second}}$, [9] for the atoms and subatomic particle whose mass is extremely small, the product of the uncertainties become significant. Every particle exhibits a wave like behaviour and has a wave associated with it.

We also have to get a good understanding about uncertainty and noise. A noise is a disturbance which occurs in an experiment voluntarily or involuntarily, where as uncertainty is an inability to distinguish the noise. This uncertainty is the fundamental property of quantum system. We are going to discuss on the uncertainty in image processing and signal processing.

Uncertainty in image processing was given in two common forms, Gabor form of uncertainty principle and Shannon entropy. Gabor uncertainty principle is a modified form of Heisenberg uncertainty principle. According to Gabor, “the exact time and frequency of signal can never be known simultaneously” and it is given by the product of standard deviation of time and standard deviation of frequency.

$$\sigma_t \sigma_f \geq \frac{1}{4\pi} \approx 0.08 \text{ cycles} \tag{1.22}$$

Whereas, the same idea was proposed by Heisenberg using position and momentum. According to him,

$$\sigma_x \sigma_p \geq \frac{h}{4\pi} \approx 5.3 \times 10^{-35} m^2 kg S^{-1} \tag{1.23}$$

Where, the standard deviation of position is σ_x , σ_p is the standard deviation of momentum and h is a Planck constant. The next uncertainty is entropic uncertainty. In Fourier analysis the entropic uncertainty otherwise called as Hirschman uncertainty is an addition of the sequential and spectral Shannon entropies. [10]. He also considered a function to be f and its Fourier transform to be g , where





Ravikumar and Diana Vinster Nadeen

$$g(y) \approx \int_{-\infty}^{\infty} e^{-2\pi ixy} f(x)dx \text{ and } f(x) \approx \int_{-\infty}^{\infty} e^{2\pi ixy} g(y)dy, \text{ also } \approx \text{represents that they converge in } L^2. \tag{1.24}$$

Thus according to Hirschman for any such functions

$$\mathcal{H}|f|^2 + \mathcal{H}|g|^2 = - \int_{-\infty}^{\infty} |f(x)|^2 \log|f(x)|^2 dx - \int_{-\infty}^{\infty} |g(y)|^2 \log|g(y)|^2 dy \geq 0 \geq \log \frac{e}{2}. \tag{1.25}$$

This entropy identity has the proof for the two-sided quaternion Fourier transform.

Theorem

For $f, g \in \mathcal{S}(\mathbb{R}^2, \mathbb{H})$ and $\|f\|_2 = 1$, we have $\mathcal{H}|f|^2 + \mathcal{H}|g|^2 \geq 2 - 2\log 2$. (1.26)

Where $\mathcal{H}|f|^2 = - \int_{-\infty}^{\infty} |f(x)|^2 \log|f(x)|^2 dx, \mathcal{H}|g|^2 = \int_{-\infty}^{\infty} |g(y)|^2 \log|g(y)|^2 dy$. [10]

Also let $\phi(x_1)$ be a signal chosen arbitrarily with energy and $\phi'(x_1)$ be its derivative, then if $\int_{-\infty}^{\infty} x|\phi(x_1)|^2 dx = 0, -\infty \leq \phi(x_1) \leq \infty$ (1.27)

Then

$$\int_{-\infty}^{\infty} x^2 |\phi(x_1)|^2 dx \int_{-\infty}^{\infty} |\phi'(x_1)|^2 dx \geq \frac{E^2}{4}, \tag{1.28}$$

When $\phi(x_1) = e^{-\alpha x_1^2}, \alpha > 0$.

This has the form $(\frac{\partial^2}{\partial x_1^2} - kx_1^2)\phi(x_1) = \mu\phi(x_1)$, (1.29)

where $k > 0$ is a scaling constant, $\frac{\partial}{\partial x_1}$ is the differential operator and μ is minimized for $\phi(x_1)$ Gaussian. Also μ represent the sum of uncertainties in position and derivative. We can understand the uncertainties in image processing from the description below [2]. Similarly the uncertainty in signal processing is explained using time σ_t and bandwidth σ_ω in the place of position and momentum of image processing.

Gaussian in Image Processing

The uncertainty in image processing can be minimized by Gaussian function. An image can be blurred up using Gaussian function and this process of blurring the image is termed up to be Gaussian blur or Gaussian smoothing. The name of Gaussian function comes from Carl Friedrich Gauss. [11]. While applying Gaussian Blur the bright spots are eliminated by reducing the bright pixels which are extremely high around the edges. More noise (random variation) in shades and brightness will be found in black and white or colour image. These variations will result in high standard deviation in pixels. The reason behind this is that the photograph is two-dimensional. Therefore two mathematical functions are used. These two functions create a third function in Gaussian Blur known as a convolution (1.1.5). This convolution makes the distribution normal for those pixel values and they get smoothed out of the randomness. Amount of smoothing depends on the size of the blur radius. Thus the image is blurred. We have to be cautious while applying a Gaussian blur because greater the blurring intensity will lead to decrease in the sharpness.

Definition

Let $g(x)$ be a Gaussian function. Mathematically it is of the form

$$g(x) = ae^{-(x-b)^2/2c^2} \tag{1.30}$$

Where a, b , and c are arbitrary real constants. [12]

Definition

Let $g(x_1, x_2)$ be a Gaussian function for calculating the transformation in each pixel of an image $I(i,j)$ be

$$g(x_1, x_2) = \frac{1}{2\pi\sigma^2} \tag{1.31}$$

Where x and y are the vertical and horizontal dimensions of the Gaussian kernel that convolutes with the image $I(i,j)$ and σ is the standard deviation of the Gaussian distribution.





Ravikumar and Diana Vinster Nadeen

Definition

Convolution of the image $I(i, j)$ by a kernel $H(x_1, x_2)$ results to a new image $I'(i', j')$ and is defined as

$$I'(i', j') = \sum_{(x_1, x_2) \in R_H} I(i' - x_1, j' - x_2) \times H(x_1, x_2) \tag{1.32}$$

To know about convolution, we have to understand an important concept called kernel. In image operation two functions are merged to yield a third one and this is how the image is manipulated. A small portion of convolution is allowed to glide over the same and it is called Kernels, also the important aim of these kernels are to get better and valuable information from the convolution with limited measures.

Definition

The Gaussian Kernel is defined in one-dimension, two-dimension and n-dimension as

$$G_{1d}(x; \sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}} \tag{1.33}$$

$$G_{2d}(x_1, x_2; \sigma) = \frac{1}{\sqrt{2\pi}\sigma^2} e^{-\frac{x_1^2 + x_2^2}{2\sigma^2}} \tag{1.34}$$

$$G_{nd}(\vec{x}; \sigma) = \frac{1}{(\sqrt{2\pi}\sigma)^N} e^{-\frac{|\vec{x}|^2}{2\sigma^2}} \tag{1.35}$$

Respectively, where σ is the width or standard deviation in Gaussian Density Function. [13]

Theorem (Convolution)

The Convolution theorem give us the association between the spatial domain and the frequency domain. It is represented as:

$$f(x_1, x_2) * h(x_1, x_2) \leftrightarrow F(u, v)H(u, v) \tag{1.36}$$

$$f(x_1, x_2)h(x_1, x_2) \leftrightarrow F(u, v) * H(u, v) \tag{1.37}$$

$$h(x_1, x_2) \leftrightarrow H(u, v) \tag{1.38}$$

From this we understand that the convolution in spatial domain is equal to filtering in frequency domain and vice versa.

We shall formulate the steps mathematically which are used in filtering

We have to begin with increasing the contrast or brightness of an image which is in the spatial domain (pre – processing).

In order to increase the contrast or the brightness of an image we need to add a constant that is positive to each and every pixel of an image and to increase the contract we have to alter the slope of the transfer function. The equation of pixel is given by the following:

$$\text{for all } p \in \Omega, |N_p|f_p - \sum_{q \in N_p \cap \Omega} f_q = \sum_{q \in N_p \cap \partial\Omega} f_q^* + \sum_{q \in N_p} v_{pq}$$

$$\text{for all } \langle p, q \rangle, v_{pq} = g_p - g_q$$

- f^* = source image
- g = target image
- p = pixel
- Ω = pixels under the mask
- $\partial\Omega$ = pixels who have at least one neighbor under the mask
- N_p = neighborhood of pixel p
- f_p = new value of pixel p (the value you are solving for)
- f^*_p = value of pixel p in in the target image
- v_{pq} = gradient of the pixel to a neighbor in the source image g

(1.39)





Ravikumar and Diana Vinster Nadeen

- Discrete Fourier transform of this image is taken

Consider a *Discrete Fourier Transform* (DFT), for a square image of size $N \times N$, the two-dimensional [14]

$$F(k, l) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} f(i, j) e^{-i2\pi(\frac{ki}{N} + \frac{lj}{N})} \quad (1.40)$$

Where $f(a, b)$ - the image in the spatial domain

$e^{-i2\pi(\frac{ki}{N} + \frac{lj}{N})}$ - The basis function equivalent to each point $F(k, l)$ in the Fourier space.

- Then we will bring the discrete Fourier transform in centre from corners. That is letting $F(0,0)$ - the DC-component of the image (average brightness)
- Then we will have the product of the Fourier transform and the filter function (apply filtering)

$$\text{Consider a Gaussian function } G_{2d}(x_1, x_2; \sigma) = \frac{1}{\sqrt{2\pi}\sigma^2} e^{-\frac{x_1^2 + x_2^2}{2\sigma^2}} \quad (1.41)$$

$$T(G(x_1, x_2)) = e^{2\pi i(x_1 + x_2)\rho} e^{-2\pi^2\sigma^2\rho^2} \quad (1.42)$$

This is the Fourier transform of a Gaussian, we also have to know that the Fourier transform of a Gaussian is also another Gaussian. There is a phase term, corresponding to the location of the core of the Gaussian, and then the negative squared term in an exponential. Also notice that the standard deviation has moved from the denominator to the numerator. This means that, as a Gaussian in real space gets broader, the corresponding Gaussian in reciprocal space gets narrower, and vice versa. That is, as the Gaussian in real space gets broader, contributions from points within that Gaussian start to interfere with each other at lower and lower resolutions. Convolution with a Gaussian will shift the origin of the function to the position of the peak of the Gaussian, and the function will be smeared out, as illustrated above.

- Then we will once more move the DFT from core to the corners
- Finally we will take the inverse of discrete Fourier transform, which will bring the resulting frequency domain to spatial domain

The inverse Fourier transform is given by:

$$f(a, b) = \frac{1}{N^2} \sum_{k=0}^{N-1} \sum_{l=0}^{N-1} F(k, l) e^{i2\pi(\frac{ka}{N} + \frac{lb}{N})} \quad (1.43)$$

We can get the above result by double sum

$$F(k, l) = \frac{1}{N} \sum_{b=0}^{N-1} P(k, b) e^{-i2\pi\frac{lb}{N}} \quad (1.44)$$

Where

$$P(k, b) = \frac{1}{N} \sum_{a=0}^{N-1} f(a, b) e^{-i2\pi\frac{ka}{N}} \quad (1.45)$$

- Using these two formulations, the spatial domain image is first transformed into an intermediate image and then intermediate image is then transformed into the final image, again using N one-dimensional Fourier Transforms. Expressing the two-dimensional Fourier Transform in terms of a series of $2N$ one-dimensional transforms decreases the number of vital calculations.
- And this step of post processing is optional, just like pre-processing, in which we just increase the appearance of image.

This is how the uncertainty is reduced by Gaussian.





Ravikumar and Diana Vinster Nadeen

Gaussian in Signal Processing

In real situation a signal can be understood as a measure which is measured using time around space or any other higher dimensions. A signal can be one, two and any higher dimensional mathematical function. Human voice is a one dimensional signal, it has the measure of time. A digital image is a two dimensional signal and television signal is a multi-dimensional signal. While applying a Gaussian filter to a signal, the noise is reduced and we get a strong signal. Any how this Gaussian is less effective in signal processing and it is rarely used. A vital trait of Gaussian filters is that, "the Fourier transform of a Gaussian is also a Gaussian", so the filter has the similar character in the time and frequency domains. Narrow bandwidths, sharp cut-offs, and low overshoots are the features of the filter. An impulse responds otherwise called as impulse response function is the output of an input signal in a dynamic field. [15]. Filters with this type of impulse response act as low pass filters. A 1-D Gaussian or Normal density function is defined as

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (1.46)$$

CONCLUSION

In this paper we have discussed about the Gaussian in signal and image processing. By the application of Gaussian blur we can reframe the size of an image especially in using the low pass filter because high frequency image cannot appear in the low spatial resolution. This is done by reducing the noise or smoothening the image. Similarly in signals it can be used to reduce the noise in it. Here we have attempted to represent the steps mathematically using Fourier transforms.

REFERENCES

1. Vikas R. Dubey, Quaternion Fourier Transform for Colour Image, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol.5 (3), 2014, 4411-4416.
2. Roland Wilson and Goesta H. Granlund, The Uncertainty Principle in Image Processing, IEEE Transactions on Pattern Analysis and Machine Intelligence, June 1984, pp. 758-767, vol. 6.
3. MawardiBahri, Eckhard Hitzer, Akihisa Hayashi, RyuichiAshino, An Uncertainty Principle for Quaternion Fourier Transform, Computers and Mathematics withapplications 56(2008)2398-2410.
4. Eckhard Hitzer, Quaternion Fourier Transform on Quaternion Fields and Generalizations, arXiv:1306.1023v1 [Math.RA].
5. MawardiBahri, A modified Uncertainty Principle for Two-sided Quaternion Fourier Transform, Adv.Appl.Clifford Algebras26(2016), 513-527.
6. Dong Cheng and Kit Ian Kou, Properties of Quaternion Fourier Transforms, 2000 Mathematics Subject Classification: 42A38, 42B10, 43A32, 43A50.
7. Mawardi Bahri,¹ Ryuichi Ashino,² and Rémi Vaillancourt³, Convolution Theorems for Quaternion Fourier Transform: Properties and Applications, Volume 2013 | Article ID 162769.
8. MawardiBahri and RyuichiAshino, A simplified Proof of Uncertainty Principle for Quaternion Linear Canonical Transform, Abstract and Applied Analysis, Volume 2016, Article ID 5874930.
9. V.E. Kuzmichev, V.V. Kuzmichev, Uncertainty principle in quantum mechanics with newton's gravity, Eur.Phys.J.C (2020) 80:248.
10. Pan Lian, uncertainty principle for the quaternion Fourier transforms, J. Math. Anal. Appl.(2018).
11. Estevão S. Gedraite; Murielle Hadad, Investigation on the effect of a Gaussian Blur in image filtering and segmentation, Proceedings ELMAR-2011.





Ravikumar and Diana Vinster Nadeen

12. HongweiGuo,A Simple Algorithm for Fitting a Gaussian Function, IEEE Signal Processing Magazine, Volume: 28 Issue: 5.
13. Hohohong, Gaussian blur and image convolution filtering, 2020-04-19, blog.csdn.net/zan1763921822/article/details/104520962.
14. MawardiBahri and Surahman, Discrete Quaternion Fourier Transform and Properties, Int. Journal of Math. Analysis, Vol. 7, 2013, no. 25, 1207 - 1215 HIKARI Ltd.
15. Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing, Chapter 2: Statistics, Probability and Noise.

Table 1: Basic Properties of Quaternion Convolution

| Basic property | Quaternion convolution |
|---------------------|---|
| Linearity | $(\kappa_1 f + \kappa_2 g) * h = \kappa_1 (f * h) + \kappa_2 (f * h), \quad \kappa_1, \kappa_2 \in \mathbb{H},$ $h * (\kappa_1 f + \kappa_2 g) = \kappa_1 (h * f) + \kappa_2 (h * g), \quad \kappa_1, \kappa_2 \in \mathbb{R}$ |
| Shifting | $(\tau_a f * g) = \tau_a (f * g),$ $(f * \tau_a g) = \tau_a (f * g)$ |
| Conjugation | $\overline{(f * g)} = (\overline{g} * \overline{f})$ |
| Associativity | $(f * g) * h = f * (g * h)$ |
| Distributivity | $f * (g + h) = (f * g) + (f * h)$ |
| Vector differential | $\mathbf{a} \cdot \nabla (f * g) = (\mathbf{a} \cdot \nabla f) * g = f * (\mathbf{a} \cdot \nabla g)$ |
| Impulse convolution | $f * \delta = f$ |

Table 2: Assumptions on Quaternion Functions

| Assumptions on quaternion functions | QFT of convolution |
|--|-------------------------|
| $\mathcal{F}_q\{f\}, \mathcal{F}_q\{g\} \in L^2(\mathbb{R}^2; \mathbb{H})$ | QFT \neq classical FT |
| $\mathcal{F}_q\{f\} \in L^2(\mathbb{R}^2; \mathbb{R})$ and $\mathcal{F}_q\{g\} \in L^2(\mathbb{R}^2; \mathbb{H})$ | QFT \neq classical FT |
| $\mathcal{F}_q\{f\} \in L^2(\mathbb{R}^2; \mathbb{H})$ and $\mathcal{F}_q\{g\} \in L^2(\mathbb{R}^2; \mathbb{R})$ | QFT \neq classical FT |
| $f = f_0 + \mathbf{i}f_1$ and $\mathcal{F}_q\{f\}, \mathcal{F}_q\{g\} \in L^2(\mathbb{R}^2; \mathbb{R})$ | QFT = classical FT |
| $f = \mathbf{j}f_2 + \mathbf{k}f_3$ and $\mathcal{F}_q\{f\}, \mathcal{F}_q\{g\} \in L^2(\mathbb{R}^2; \mathbb{R})$ | QFT = classical FT |





Ravikumar and Diana Vinsten Nadeen

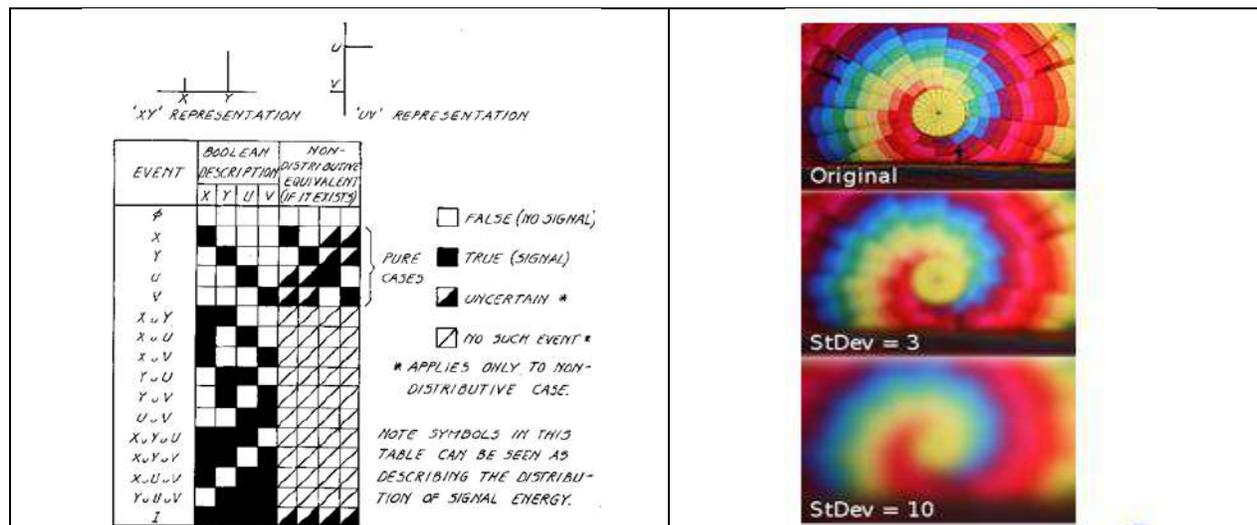


Figure 1: Uncertain Signal Energy

Figure 2: Applying Gaussian Blur

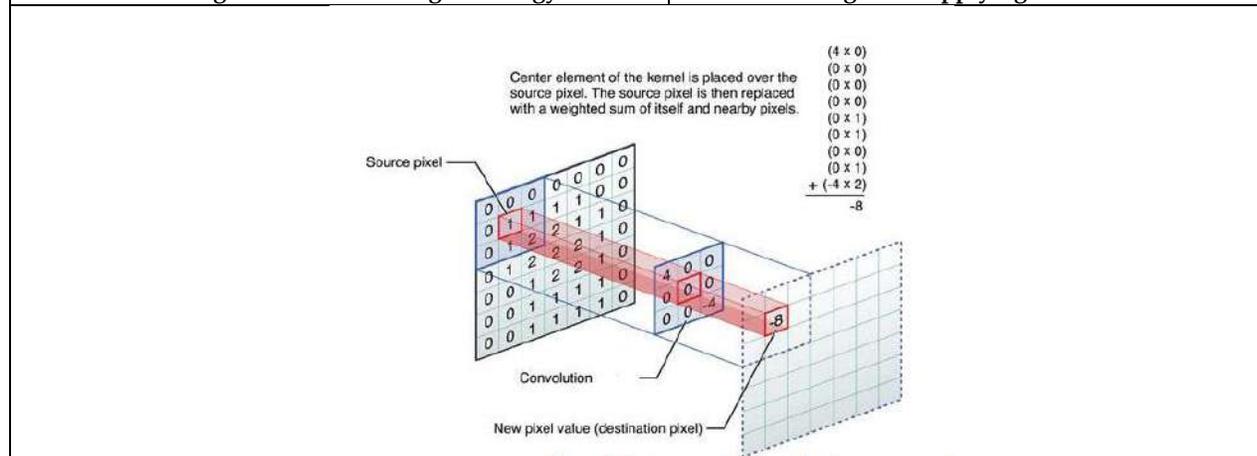


Figure 3: Replacement of Source Pixel

AUTHOR PROFILE

K. Ravikumar, completed his Bachelor’s degree in Mathematics during the year 1987. He finished his master degree in Mathematics in the year 1989 and Master of Philosophy degree in Mathematics in 1990. All the above degrees were obtained from Bharathidasan University, Tamil Nadu, India. He was awarded Ph.D. in Mathematics from Annamalai University, India in 2012. Additionally he got his M.S degree in Software System from BITS, Pilani in 2002. He is currently working as Assistant Professor in Engineering Mathematics, Faculty of Engineering and Technology at Annamalai University. His research interests include Wavelet theory and its Applications.

A. Diana VinstenNadeen, obtained her Bachelor’s degree in Mathematics in the year 2008. She obtained her Master degree in Mathematics in the year 2011 and Master of Philosophy degree in Mathematics in 2012. All the degrees were obtained from St. Joseph’s College of Arts and Science, Affiliated to Thiruvalluvar University, Tamil Nadu, India. In addition she have Bachelor’s Degree in Education in the year 2009. In 2012 she joined and working as Lecturer in Department of Mathematics at Achariya Arts and Science College, Pondicherry, Tamil Nadu, India. She is currently pursuing her Ph.D. in Mathematics at Annamalai University. Her research interest is in the area of Wavelet theory and its Applications.





Development and Psychometric Analysis of Health Questionnaire for Bharatnatyam and Kathak Dancers

Mistry gopi S^{1*} and Sweety Shah²

¹Ph.D Scholar, Gujarat University, Navrangpura, Ahmedabad, Gujarat- 380009, India.

²Ph.D Guide, Gujarat University, Navrangpura, Ahmedabad, Gujarat- 380009, India.

Received: 24 May 2022

Revised: 23 Jun 2022

Accepted: 08 July 2022

*Address for Correspondence

Mistry Gopi S

Ph.D Scholar,

Gujarat University,

Navrangpura, Ahmedabad,

Gujarat- 380009, India.

Email: gtgopi2007@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Bharatnatyam and Kathak dancing activities consist of complex movement and postures which can affect the musculoskeletal as well as psychological status. Paucity of literatures discussed evaluation of the same. So arises the need to develop and psychometrically evaluate Questionnaire for the same so that in future it can be used as a valid and reliable instrument to identify health status of Dancers. 10 Experts for calculation of Content Validity Ratio(CVR), Content Validity Index(CVI), Modified Kappa(k) and 15 dancers for face validity and Internal consistency reliability were selected. Study was conducted in three phases. First, the framework was designed from the Literature review, 22 personal interviews and three focus group discussion (FGD) and generation of items were done. This resulted in preliminary version of the questionnaire with 4 domains comprising of 48 items. Second, item reduction and psychometric evaluation. Third phase, development of final questionnaire. Analysis was done using mixed-method approach, quantitative-qualitative analysis was done for primarily developed questionnaire. After qualitative analysis few items were deleted, added, modified and change in order of words and sentences were done. Quantitative analysis [CVR,CVI and modified kappa statistics(k)] done to find out content validity. 2 items were eliminated as their CVR was <0.60. 26 Item's CVI was between 0.70 to 0.79, so minor revision done. Modified kappa(k) of 19 items has excellent; 7 items have good and 2 items have poor validity. The Item Impact Score(IIT) of item was >1.5 shows excellent face validity. The Cronbach's alpha was 0.97 shows excellent reliability. The final questionnaire contains 18 Likert MCQs, 9 'yes' and 'No' options, 18 one-word answer based questions categorised in to 4 thematic domains. This study concludes that the questionnaire has good psychometric values. It can be one of the best tools for health evaluation of Bharatnatyam and Kathak dancers.





Keywords: Bharatnatyam dancers, Kathak Dancers, Musculoskeletal status, psychological status, Health Questionnaire.

INTRODUCTION

All Indian classical dances are rooted in Natyashastras (Indian treatise on performing arts) in varying proportions and, therefore, share common features such as mudras (gestures made with hands or fingers), body positions, and inclusion of dramatic or expressive acting, or abhinaya [1]. They are categorized into seven major kinds, namely Bharatnatyam, Kathak, Manipuri, Kathakali, Odissi, Kuchupudi, and Mohiniattam. Bharatanatyam is one of the most sublime and ancient of Indian classical dances; it originated in Tanjore, a town of Tamil Nadu in Southern India¹. Bharatnatyam and Kathak are the most popular type of classical dances. This dance form lays its foundation on the aesthetic beauty of angles and lines formed by various positions of different body parts. Bharatnatyam dancing is a traditional form of Indian classical dance which involves different body postures with continuous rhythmic body movements and therefore it may have some impact on body composition [2]. It consists of various steps, skips, jumps, turns and movements which are performed in all directions and on various plains and are used in accordance with the shape and abilities of the person. Another dance form, Kathak, is a partially narrative form characterized by fast foot work (tatkar), spins (chakkar), and innovative use of bhav (expression) in abhinaya [3]. This dance form includes variations of sitting, walking, leaping, and elevations that reinforce some of the basic therapeutic movements of the dance. Dance therapy is based on the idea that body and mind are co-relational, that the physical state of the body can affect the emotional and mental wellbeing both positively and negatively [4]. It provides an active, non-competitive form of exercise that has potential influence on physical as well as mental and emotional health [3].

Though practiced over centuries, Indian classical dance has undergone enormous change along with passage of time. Today it stands facing new challenges in order to meet the demands of the present world. Injuries have become a great threat to the classical dancers. Traditionally, dancers are considered to be both artists and athletes. The use of improper dance technique, attributable to poor application or lack of knowledge of the correct approach, has been suggested as a risk factor for injury. For those injuries related to technique, any "cure" is only temporary until the fault is corrected.

Despite wide practice of several traditional Indian dance forms, extensive length of training, and performance life, Indian classical dancers' health problems are rarely explored. Limited studies have been conducted till date which analyse the musculoskeletal as well as psychological health as a whole. While reviewing available literature, it was found that only few instruments were available which measures the musculoskeletal and psychological health of classical dancers. To conduct such kind of research, society is in need of valid and reliable instrument which covers both Musculoskeletal and Psychological health of Bharatnatyam and Kathak dancers. So arises the need of this study. When a new questionnaire is designed, measurement and report of its content as well as face validity and reliability development have fundamental importance. It provides information on the representativeness and clarity of items and help improve a questionnaire through achieving recommendations from an expert panel.

MATERIALS AND METHOD

The study was approved by Institutional Research and Ethics committee. This exploratory mixed method research (qualitative quantitative) study was carried out to design and validate the questionnaire evaluating musculoskeletal and psychological status in classical dancers.





Mistry gopi and Sweety Shah

Stage 1: Questionnaire Design

Process of questionnaire design follows 3 steps including Step 1: content domain determination, Step 2 : item generation and Step 3: questionnaire construction. A conventional qualitative content analysis was designed. During first step, the basic framework was designed from the literature review as well as 22 personal in depth interviews with Classical Dancers, Dance Gurus and Senior Physiotherapists and three focus group discussion (FGD) to explore the experiences of dancers. Following the guidelines of Tilden et al. (1990) the data from interview was used as a resource to generate questionnaire items⁵. For item generation, Ridenour and Newman's deductive- inductive technique was applied⁶. In third step, questionnaire was constructed by refining and organizing items in a suitable format and sequence so that the finalized items are in a usable form⁷. Before coding, the whole text was read repeatedly so that the researcher would completely get familiar with the data, achieve immersion, and obtain a sense of the whole. At last available texts were reviewed and the items pool was completed.

Stage2: Judgment

This step included confirmation by a panel of experts, indicating that questionnaire items and the entire questionnaire have content validity. For this purpose, a panel with 10 experts including content experts and lay experts having mean research or work experience of 15±7 years were appointed. The panel experts were 2 Orthopaedic surgeons, 2 Psychiatrists, 2 statisticians, 2 senior physiotherapists and 2 classical dance gurus. First of all telephonic conversation were done with all experts for taking their permission as a part of Expert panel member. An official Invitation letter including primary questionnaire and all related instructions regarding qualitative and quantitative analysis of content validation process was explained clearly. Experts were requested to provide their viewpoints on the relevance, clarity and essentiality of the items [7,8]. In first round of judgement, few items were modified whereas some were eliminated based on the opinion of content experts about grammar, appropriate and correct words, correct and proper order of words and appropriate scoring [9]. For quantification purpose Content Validity Ratio (CVR) was used, where the experts were requested to score each item from 1 to 3, with a 3-degree range of "not necessary, useful but not essential, essential", and specify whether an item is necessary in a set of items or not. Values of CVR vary between 1 and -1. For this study 10 experts were included, therefore item with CVR value bigger than 0.60 was accepted¹⁰. Another widely reported approach for content validity for questionnaire development study is the content validity index (CVI) [7,11,12]. The expert panel members (n=10) were requested for to rate questionnaire items in terms of relevance and clarity on a 4-point ordinal scale [11]. A table like the one shown below (Table 1) was added to the cover letter to guide experts for scoring method. For relevance, CVI was calculated both for item level.

I-CVI (Item CVI)= No. of experts giving rating of 3 or 4 to relevancy or Clarity of item/ Total no. of experts. The values are between 0 and 1, If I-CVI is >0.79 then item is appropriate; If it is between 0.70 to 0.79 then item need minor revision and if it is < 0.70 then item should be eliminated. Minimum 80% agreement among experts was considered for the items to be appropriate for selection in the questionnaire. Kappa statistic was undertaken to provide adjustment for chance agreement by this formula [7,11,13]

$$K^{\circ} = I-CVI - P_c / 1 - P_c \text{ and } P_c = [N! / (A!(N-A)!)] * 0.5^N$$

In this formula, N is the number of evaluators, and A is the number of agreements in terms of relevance. I-CVI is the Item CVI and P_c is the probability of chance agreement Modified Kappa statistic of higher than 0.75, between 0.60 and 0.749, between 0.40 and 0.599 and <0.40 is considered excellent, good, fair, and poor, respectively.

Determining face validity of a questionnaire

Face validity is related to the appearance and apparent attractiveness of a questionnaire, which may affect the questionnaire acceptability by respondents [14]. As a part of qualitative analysis to determine face validity, 15 classical dancers (lay experts) were requested to judge on the importance, simplicity and understandability of items [15]. They were also asked about the level of difficulty and ambiguity of items. Items were edited according to the recommendations of this group. As a part of quantitative analysis, they were asked to grade importance of all items



**Mistry gopi and Sweety Shah**

on a 5-point Likert scale i.e. very important, important, relatively important, slightly important, and unimportant in the sequence of 5,4,3,2 and 1 respectively. Impact scores of the items were measured using formula: percentage of participants who give each item scores as 4 or 5 × mean of importance score for each item. An impact score ≥ 1.5 was considered appropriate [16,17]. The items were revised to make them more meaningful and understandable as per the suggestions from respondents. Final questionnaire was constructed at the end of this designing and validation process. The final version of questionnaire included 4 sections and 27 questions.

Assessment of reliability

To determine the internal consistency, Cronbach's alpha was calculated for the total questionnaire and its dimensions. Cronbach's alpha was 0.97 which was considered as an excellent internal consistency.

RESULTS**Item generation**

After the qualitative analysis of the individual interviews and two group discussions, 36 items were obtained using the quotations of the participants. 18 items were added through literature review and eventually, the pool of items was formed with 54 items.

Content validity

Out of that 54 items, in the second stage the panel of 10 content experts were requested to judge the content of 29 questionnaire qualitatively and quantitatively using prescribed format. In the first round of judgment, 2 items having CVR lower than 0.60 were eliminated. The remaining items were modified according to the recommendations of panel members. In the second round, the proportion of agreement among panel members on the relevance and clarity of remaining items of the first round of judgment was calculated. In this round, among the 26 questionnaire items with a CVI between 0.70 and 0.79 were modified (according to the recommendation of panel members and research group forums). According to experts' suggestions, an item about sleep was added in section D of the questionnaire. After modification, the questionnaire containing 27 items was sent to the panel members for the third time to judge on the relevance, clarity and comprehensiveness. The probability of chance agreement was first calculated for each item and then kappa (K) was computed by using the numerical values of Pc and I-CVI. All 27 items had K values >0.74 and were accepted for face validation

Item selection and face validity

Regarding qualitative face validity, the wording of three items was changed according to the opinion of the research team and again evaluated by 15 dancers of the target group. Moreover, all the items had impact scores of >1.5 (i.e., from 1.8 to 5).

IIS score of each question was more than 1.5. So, they were remained. Cronbach's alpha was 0.97. Which was considered as an excellent internal consistency.

DISCUSSION

The overall purpose of this research was to develop a conceptually sound and psychometrically robust measure to evaluate the musculoskeletal and psychological health status of classical dancers. To our knowledge, this is the first of its kind of questionnaire developed specifically for the classical dancers as a target population, and several points are worthy of note. First, we sought to ensure that the health questionnaire demonstrated good content validity, through the input of Panel experts, Lay experts and various health care professionals in the development of the items. Second, we sought to ensure that the items in health questionnaire were developmentally appropriate. Finally, the questionnaire was found to demonstrate good content validity as well as face validity and Reliability. The





Mistry gopi and Sweety Shah

strength of the present study was the questionnaire was developed based on experiences of the subject as well as lay experts. Other strength was precise implementation of the steps for face and content validity. Furthermore, unlike most studies which use only qualitative analysis for validation, present study includes quantitative analysis also which is a valid and precise methodology for psychometric analysis of newly developed questionnaire. Some limitations of this studies should be noted. Experts' feedback is subjective; thus, the study is subjected to bias that may exist among the experts. If content domain is not well identified, this type of study does not necessarily identify content that might have been omitted from the instrument. However, experts are asked to suggest other items for the instrument, which may help minimize this limitation. The further analyses of psychometrics should be directed towards reliability evaluation (through test-retest), construct validity (through factor analysis) and criterion related validity.

CONCLUSION

The study concludes that health questionnaire for Bharatnatyam and Kathak dancers is a valid and reliable tool to measure musculoskeletal and Psychological health status of dancers.

REFERENCES

1. Nair SP, Kotian S, Hiller C, Mullerpatan R. Survey of musculoskeletal disorders among Indian dancers in Mumbai and Mangalore. *Journal of Dance Medicine & Science*. 2018 Jun 15;22(2):67-74.
2. Mukherjee S, Banerjee N, Chatterjee S, Chatterjee S, Chatterjee A, Santra T, Saha B. Effect of Bharatnatyam Dancing on Body Composition of Bengalee Female Children. *American Journal of Sports Science and Medicine*. 2014;2(1):56-9.
3. Chatterjee A. The therapeutic value of Indian classical, folk and innovative dance forms. *Rupkatha J Interdiscip Stud Humanit*. 2013 Jan 1;5:75-83.
4. Quin, E., Redding, E. and Frazer, L. "The effects of an eight-week creative dance program me on the physiological and psychological status of 11-14 year old adolescents: An experimental study." *Dance Science Research Report*. England: Hampshire Dance and Laban, 2007.
5. Tilden VP, Nelson CA, May BA. Use of qualitative methods to enhance content validity. *Nursing Research*. 1990.
6. Benz CR, Ridenour CS, Newman I. *Mixed methods research: Exploring the interactive continuum*. SIU Press; 2008.
7. Lynn MR. Determination and quantification of content validity. *Nursing research*. 1986.
8. Yaghmaie F. Content validity and its estimation. *Journal of Medical Education*. 2003;3(1).
9. Safikhani S, Sundaram M, Bao Y, Mulani P, Revicki DA. Qualitative assessment of the content validity of the Dermatology Life Quality Index in patients with moderate to severe psoriasis. *Journal of Dermatological Treatment*. 2013;24(1):50-59.
10. Lawshe CH. A quantitative approach to content validity 1. *Personnel psychology*. 1975;28(4):563- 575
11. Davis LL. Instrument review: Getting the most from a panel of experts. *Applied nursing research*. 1992;5(4):194-197.
12. Grant JS, Davis LL. Selection and use of content experts for instrument development. *Research in nursing & health*. 1997;20(3):269-274
13. Waltz CF, Strickland OL, Lenz ER. *Measurement in nursing and health research*. Springer publishing company; 2010.
14. Nunnally JC. *Psychometric theory* 3E. Tata McGraw-Hill Education; 1994
15. Grant JS, Davis LL. Selection and use of content experts for instrument development. *Research in nursing & health*. 1997;20(3):269-274.
16. Polit DF, Beck CT. *Resource manual for nursing research: generating and assessing evidence for nursing practice*. Wolters Kluwer Health: Lippincott Williams &Wilkins; 2012.





Mistry gopi and Sweety Shah

17. Juniper EF, Guyatt GH, Streiner DL, King DR. Clinical impact versus factor analysis for quality of life questionnaire construction. *J Clin Epidemiol.* 1997;50(3):233–8.

Table 1. The table added to the cover letter to guide experts for scoring method

| Relevancy | Clarity |
|--------------------------------------|-----------------------------------|
| 1 – Not relevant | 1 – Not clear |
| 2 – Item needs some revision | 2 – Item needs some revision |
| 3 – Relevant but need minor revision | 3 – Clear but need minor revision |
| 4 – Very relevant | 4 – Very clear |

Table: 2 Calculation of Content Validity Ration(CVR) for a sample of instrument items

| Items | Ne | CVR | Interpretation |
|-------|----|------|----------------|
| Q-B1 | 10 | 1 | Remained |
| Q-B2 | 10 | 1 | Remained |
| Q-B3 | 9 | 0.8 | Remained |
| Q-B4 | 9 | 0.8 | Remained |
| Q-B5 | 8 | 0.6 | Remained |
| Q-B6 | 9 | 0.8 | Remained |
| Q-B7 | 9 | 0.8 | Remained |
| Q-B8 | 8 | 0.6 | Remained |
| Q-C1 | 9 | 0.8 | Remained |
| Q-C2 | 9 | 0.8 | Remained |
| Q-C3 | 9 | 0.8 | Remained |
| Q-C4 | 10 | 1 | Remained |
| Q-C5 | 9 | 0.8 | Remained |
| Q-C6 | 6 | 0.2 | Eliminated |
| Q-C7 | 10 | 1 | Remained |
| Q-C8 | 10 | 1 | Remained |
| Q-C9 | 9 | 0.8 | Remained |
| Q-D1 | 8 | 0.6 | Remained |
| Q-D2 | 8 | 0.6 | Remained |
| Q-D3 | 8 | 0.6 | Remained |
| Q-D4 | 8 | 0.6 | Remained |
| Q-D5 | 4 | -0.2 | Eliminated |
| Q-D6 | 10 | 1 | Remained |
| Q-D7 | 10 | 1 | Remained |
| Q-D8 | 9 | 0.8 | Remained |
| Q-D9 | 8 | 0.6 | Remained |
| Q-D10 | 10 | 1 | Remained |
| Q-D11 | 9 | 0.8 | Remained |

Table 3: Calculation of Content Validity Index (Item – CVI)

| Items | Relevant (Rating 3 or 4) | Non Relevant (Rating 1 or 2) | Item- CVI | Interpretation |
|-------|-----------------------------|---------------------------------|-----------|-------------------|
| Q-B1 | 10 | 0 | 1 | Appropriate |
| Q-B2 | 7 | 3 | 0.7 | Need for Revision |





Mistry gopi and Sweety Shah

| | | | | |
|-------|----|---|-----|---------------------|
| Q-B3 | 8 | 2 | 0.8 | Need minor Revision |
| Q-B4 | 10 | 0 | 1 | Appropriate |
| Q-B5 | 8 | 2 | 0.8 | Need minor Revision |
| Q-B6 | 7 | 3 | 0.7 | Need for Revision |
| Q-B7 | 9 | 1 | 0.9 | Need minor Revision |
| Q-B8 | 5 | 5 | 0.5 | Eliminated |
| Q-C1 | 8 | 2 | 0.8 | Need Minor Revision |
| Q-C2 | 9 | 1 | 0.9 | Need minor Revision |
| Q-C3 | 8 | 2 | 0.8 | Need minor revision |
| Q-C4 | 9 | 1 | 0.9 | Need minor revision |
| Q-C5 | 7 | 3 | 0.7 | Need for revision |
| Q-C6 | 6 | 4 | 0.6 | Eliminated |
| Q-C7 | 7 | 3 | 0.7 | Need for revision |
| Q-C8 | 8 | 2 | 0.8 | Need minor revision |
| Q-C9 | 8 | 2 | 0.8 | Need minor revision |
| Q-D1 | 7 | 3 | 0.7 | Need for revision |
| Q-D2 | 7 | 3 | 0.7 | Need for revision |
| Q-D3 | 8 | 2 | 0.8 | Need minor revision |
| Q-D4 | 10 | 0 | 1 | Appropriate |
| Q-D5 | 8 | 2 | 0.8 | Need minor revision |
| Q-D6 | 9 | 1 | 0.9 | Need minor revision |
| Q-D7 | 9 | 1 | 0.9 | Need minor revision |
| Q-D8 | 9 | 1 | 0.9 | Need minor revision |
| Q-D9 | 7 | 3 | 0.7 | Need for revision |
| Q-D10 | 9 | 1 | 0.9 | Need minor revision |
| Q-D11 | 9 | 1 | 0.9 | Need minor revision |

Table 4: Calculation of Probability of Chance(Pc) and Modified Kappa(k)

| Items | I-CVI | Pc | k | Interpretation |
|-------|-------|------|------|----------------|
| Q-B1 | 1 | 0.00 | 1.00 | Excellent |
| Q-B2 | 0.7 | 0.12 | 0.66 | Good |
| Q-B3 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-B4 | 1 | 0.00 | 1.00 | Excellent |
| Q-B5 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-B6 | 0.7 | 0.12 | 0.66 | Good |
| Q-B7 | 0.9 | 0.01 | 0.90 | Excellent |
| Q-B8 | 0.5 | 0.25 | 0.34 | Poor |
| Q-C1 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-C2 | 0.9 | 0.01 | 0.90 | Excellent |
| Q-C3 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-C4 | 0.9 | 0.01 | 0.90 | Excellent |
| Q-C5 | 0.7 | 0.12 | 0.66 | Good |
| Q-C6 | 0.6 | 0.21 | 0.15 | Poor |
| Q-C7 | 0.7 | 0.12 | 0.66 | Good |
| Q-C8 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-C9 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-D1 | 0.7 | 0.12 | 0.66 | Good |





Mistry gopi and Sweety Shah

| | | | | |
|-------|-----|------|------|------------|
| Q-D2 | 0.7 | 0.12 | 0.66 | Good |
| Q-D3 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-D4 | 1 | 0.00 | 1.00 | Excellent |
| Q-D5 | 0.8 | 0.04 | 0.79 | Excellent |
| Q-D6 | 0.9 | 0.00 | 1.00 | Excellent |
| Q-D7 | 0.9 | 0.00 | 1.00 | Excellent |
| Q-D8 | 0.9 | 0.00 | 1.00 | Excellent |
| Q-D9 | 0.7 | 0.12 | 0.66 | Good |
| Q-D10 | 0.9 | 0.00 | 1.00 | Excellent |
| Q-D11 | 0.9 | 0.00 | 1.00 | Excellent. |





Phosphatase and Tensin Homolog (PTEN) as a Negative Regulator of PI3K and AKT Pathway

Mukta Raghav¹, Varruchi Sharma², Sushil Kumar Upadhyay¹, Poonam Bansal¹, Vasu Punj³ and Anil K. Sharma^{1*}

¹Department of Biotechnology, Maharishi Markandeshwar (Deemed to be University), Mullana (Ambala), Haryana, India

²Department of Biotechnology & Bioinformatics, Sri Guru Gobind Singh College Sector-26, Chandigarh (UT), India.

³Department of Medicine, Keck School of Medicine, NRT G511, Health Sciences Campus, University of Southern California, Los Angeles, US.

Received: 17 May 2022

Revised: 04 June 2022

Accepted: 06 July 2022

*Address for Correspondence

Anil K. Sharma,

Department of Biotechnology,

Maharishi Markandeshwar (Deemed to be University),

Mullana (Ambala),

Haryana, India.

Email: anibiotech18@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

PTEN and various other components of m TOR pathway regulate both in positive and negative ways, having a deeper impact on survival and growth of the cell. PTEN by dephosphorylating PIP3 regulates PI3K signaling. PTEN exercises enzymatic activity in the form of a phosphatidylinositol-3,4,5-trisphosphate (PIP3) phosphatase. Therefore, the divergent activity of PI3K leads to concerted action to increase the availability of PIP3 in malignant cells, depending either on other phosphoinositide enzymes or intrinsic regulation of PTEN by other molecules. In the current report, we have made an effort to explore regulatory role of PTEN and PI3K/AKT/m TOR activity in life threatening diseases like cancer and other related complexities associated with these diseases. Best probable novel activities of PTEN especially in context with regulatory processes have also been emphasized, making PTEN and PI3K/AKT/m TOR signalling as predominant and profound therapeutic intervention for oncogenes and oncogenesis.

Keywords: PTEN, m TOR, PIP3, PI3K pathway, AKT pathway, Oncogene suppressor.





Mukta Raghav et al.,

INTRODUCTION

PTEN is the most important negative regulator of the PI3K signaling pathway. In human cancers, the phosphoinositide 3-kinase (PI3K)/AKT/mammalian target of Rapamycin (*m TOR*) is presumably the most common pathway which is upregulated [1,2]. PTEN is deeply involved in various mechanisms like cell growth, proliferation, survival, metabolism and also in regulation of immune responses (Fig. 1) [3]. PI3K is organised into three classes depending upon its specificity and structure [4]. Specifically, Class I PI3K's are signal transducers of tyrosine kinases, small GTPases, G protein-coupled receptors (GPCRs) while regulation of membrane trafficking is mainly influenced by indirect signalling of class II and class III PI3Ks [5]. Auto-phosphorylation on tyrosine residues may occur due to the activation of GPCRs, chemokine receptor (CKRs) and receptor tyrosine kinases (RTKs) through specific ligands [3]. Production of PIP3 (second messenger) from the substrate PIP2 takes place due to the activation of three classes of PI3Ks [6].

Recruitment of signalling proteins takes place with protein serine/threonine kinase-3 phosphoinositide-dependent kinase 1(PDK1) and AKT [3,6]. PDK1 and *m TOR* complexes along with other kinases may get activated by the serine-threonine kinase followed by phosphorylation [7,8]. Leucine-rich repeat protein phosphatase (PHLPP) and phosphatase domain from de-phosphorylation directly inactivates AKT [7]. Negative regulation of the PI3K/AKT/*m TOR* pathway represents the important role of PTEN as a tumor suppressor (Fig. 1). PTEN protein consists of 179 residues in the N terminal domain and have phosphatase domain, which results in most of the mutations. N-terminal domain of PTEN is connected to C-terminal domain, by a flexible loop consisting of 166 residues and some basic sub domains of the protein which is common to other signalling molecules [9]. Protein-protein interaction is due to PDZ motif and the tail region molecule present in the C-terminal domain of two PEST sequences (degradation signals) [10].

PTEN promoter binds to the p53 transcription factor and trans activates the PTEN gene expression [11]. Activation of PI3K/PTEN pathway is connected with Ras by regulating the same targets such as PI3K, BAD, TSC2 [12-14]. Ras upon activation works on loss of PTEN expression with C-Jun mediated functions [15]. Illustration of many interconnections between PTEN and other tumor suppressor and oncogenic signalling networks have been explored by the ability of PTEN signalling to integrate with p53 and Ras. Interactions shown as arrows in the figure 1 refer to activation, while hammerheads, referred to inhibition. Expression of these tumour suppressor genes are regulated by genetic, epigenetic, and transcriptional changes, which may result in DNA repair and cell division regulation. Down regulation of the function can contribute to genomic instability.

REGULATION OF PTEN

Localization of PTEN

On PTEN, several non-canonical nuclear localization domains have been found [16]. For the N terminus of PTEN, cytoplasmic localization signal has been identified that moves the residue from 19-25 [17]. Nuclear localization of PTEN is increased as a result of mutation in residues from 19-25 through some unknown mechanism. Shuttling of PTEN between cytosol and nucleus is controlled by ubiquitination [18,19]. To move into the nucleus, monoubiquitination of lysine 289 (k289) is necessary for PTEN. Multiple mutations of the PTEN gene in Cowden syndrome is attributed to the mutation in K289E site [18,20]. Nuclear transportation of PTEN is facilitated by second ubiquitination site K13. Calcium mediated interactions are regulated by localization of PTEN along with the major volt protein (MVP) [21]. PTEN is more stable in the nucleus and is capable of restrained AKT and activating cell death. PTEN docks the PDZ domain and two pest sequence in the C terminal region as per reviewed by structural analysis [22]. PTEN sub cellular localization is thought to be regulated by PDZ domain whereas protein stability is regulated by two pest sequences [23].



**Mukta Raghav et al.,****Transcriptional Regulation of PTEN**

Regulation of PTEN on chromosome 10 is conferred by many transcription factors positively and negatively that act at definite times and in different types of cells [24] (Fig. 2). Early growth response protein 1, peroxisome proliferator-activated receptor γ and tumor protein 53 are positive regulators of PTEN gene expression. Direct binding of these transcription factors to PTEN promoter region has been reported previously [11,25,26]. Anti-proliferative actions are mediated by the human sprout homolog 2 (SPRY2), altering the PTEN content and activity as well [26]. On the other hand, diverse negative regulators of PTEN have been reported. Indeed, the transcription of PTEN through c-Jun is reported to be suppressed by the Ras/Raf/MEK/ERK pathway [27]. Besides, PTEN expression is negatively regulated by nuclear factor B (NF- κ B) through sequestration of the transcriptional co-activator CBP/p300 [28]. PTEN expression in several cancer models is suppressed by transcription factors, such as mitogen-activated protein kinase kinase-4 (MKK4), transforming growth factor beta (TGF- β), and the polycomb group (PcG) protein BMI1 [29-31].

PTEN expression is known to be suppressed by a mechanism proposed as epigenetic silencing by gene promoter methylation and histone modification. In several cancers, such as gastric, colorectal, melanoma, and breast cancer, the above mechanism of PTEN regulation has been involved [32,33]. Silencing of PTEN transcription in general is due to the presence of hypermethylated CpG islands in the PTEN promoter as has been shown by several studies [33]. Nonetheless, when interpreting epigenetic silencing of PTEN, careful consideration must be taken because of the existence of a promoter PTEN-pseudo gene, which is shown to be methylated [34]. With the PTEN mRNA sequence, PTENP1 pseudo gene shares 97.8% sequence identity, and 91% identity with a 921-base pair region of the PTEN CpG Island. Furthermore, a gene called as KLLN, which is transcribed from the negative DNA strand in the opposite direction, the PTEN shares a CpG island promoter [35].

The above methods that detect methylation but are not able to distinguish between PTEN and the pseudo gene arrangements may lead to false positives [34]. By using allelic bisulphite sequencing, the methylation status of regions with particularly high homology to pseudogenes can only be determined to allow the identification of pseudo gene-specific alleles in this scenario [35]. In PTEN transcription, finally it had been shown that NOTCH signalling acts either as a negative or as a positive regulator. NOTCH signalling results in PTEN down regulation by activating the transcription factor hairy and enhancer of split1 (HES1) [36], or up-regulation by constraining the recombining binding protein suppressor of hairless (RBPJ, also known as CBF-1) by acting through PTEN down-regulators [37].

Post-Transcriptional Regulation

Micro RNAs are small and evolutionarily conserved non-coding single-stranded RNAs that negatively regulate gene expression by binding to the 3'-untranslated region (3'-UTR) of the target mRNAs in mammalian cells, which result in mRNA degradation or translational repression [38]. The miRNAs play critical roles in the coordination of fundamental processes, including differentiation, proliferation, angiogenesis, death, and metabolism and consequently thought to regulate the expression of almost all genes [39]. The miRNAs play an important role in the pathogenesis, from beginning to metastasis, of many cancers by regulating proto-oncogenes or tumor-suppressor genes demonstrated by growing evidences [40]. Many types of tumor miRNAs that act as tumor suppressors (e.g., miR-145, miR-124, and miR-142-3p) [41-43] or oncogenes (e.g., miR-21, miR-218, and miR-24) [45,45] have been identified as well.

Given the importance of PTEN as a tumour suppressor [46], it is not surprising that a plenty of miRNAs have been classified to modulate PTEN expression at the post-transcriptional level including miRNA-21 [47], miRNA-22 [48], and miRNA-214 [49], as well as PTEN with a polycistronic structure, such as mir-17-92 [50-52], mir-106b-25 [48], mir-367-302b [48], and mir-221-222 [47]. In human cancers, miR-21 is one of the most frequently observed abnormal miRNAs. Growth and metastasis of specific cancers, including non-small cell lung cancer [53], colorectal carcinoma [54], ovarian cancer [55], as well as triple-negative breast cancers have been reported to directly target PTEN proteins by up regulation of miR-21 [56]. Moreover, a study by Iliopoulos et al. [57] had shown that microRNA -21, in sync with microRNA-181b-1 inhibit PTEN and cylindromatosis (CYLD) tumor suppressor



**Mukta Raghav et al.,**

functions, leading to increased NF- κ B activity, thus underlying the epigenetic switch that links inflammation to cancer. Activation of cell survival and cisplatin resistance begin by miR-214 by direct binding to the 3'-UTR of PTEN resulting in contraction of PTEN expression and to induce AK signalling pathway [58]. In certain human cancers including breast, melanoma, and hepatocellular cancer, deregulation of miR-214 has also been shown by Penna et al. [59]. Moreover, miR-93 and miR-130a may also be correlated with cisplatin resistance by directly targeting PTEN in ovarian cancer cells [60]. In continuation with this result, blocking of MiR-130a led to reverse the cisplatin resistance by up regulating the expression of PTEN and deregulating P-glycoprotein (P-gp) in A2780 cell lines [61].

Similar findings have also been published for other miRNAs. Cell proliferation and 1,3-bis(2-chloroethyl)-1-nitrosourea (BCNU) resistance in human glioblastoma, activated by miR-22, further targets PI3K/Akt signalling axis [62]. The PI3K inhibitor, wortmannin was designed to constrict the miR-221-mediated BCNU resistance and to promote cell apoptosis or the over expression of PTEN lacking 3-UTR more specifically. The importance of PTEN regulation by miRNAs holds a crucial role in cancer development. In ovarian cancers, deregulation of miR-214, miP-199a, miR-200a, and miR-100 was shown to be persistent [63]. The expression of PTEN in a murine glioma model was negatively regulated by MiR-26a increasing the formation of new tumor [64]. Through modulation of metastasis-related genes and PTEN inhibition MiR-26a, may increase lung cancer metastasis [65]. The miR-429 stimulates the formation of tumors of human non-small cell lung cancer cells by directly targeting the 3'-UTR of multiple tumor suppressor genes including PTEN, RASSF8, and TIMP2 [66]. The miR-29b [67] and miR-301 targeted the PTEN in breast cancer [68]. PTEN is suppressed and directly targeted by miR-301a, resulting in increase in breast cancer invasion and metastasis maintaining constitutively activated Wnt/ β -catenin signalling. This may further lead to the enhancement of breast cancer invasion and metastasis [69].

Prostate cancer development and progression is also associated with high-frequency miRNA dysfunction. Cells through direct suppression of PTEN expression MiR-153 promotes proliferation of human prostate cancer cells [70]. PTEN expression post-transcriptionally was found to be regulated by a combination of four miRNAs (miR-19b, miR-23b, miR-26a, and miR-92a), and through PIK3CA to affect the downstream PI3K/Akt pathway (p110 α), PIK3CD (p110 δ), PIK3R1 (p85), AKT, and cyclin D1, propagating the prostate cancer cells [71]. In colorectal cancer, the control of PTEN by miRNAs has also been investigated previously [72]. The miR-92a was described to promote cell metastasis of colorectal cancer via PTEN-mediated PI3K/AKT pathway. Besides, expanded miR-494 was associated with tumor aggressiveness and tumor metastasis and was found to directly target the 3'-UTR of PTEN [73]. Colorectal cancer was shown to be aggravated by miR-103 through suppression of the tumor suppressor genes PTEN and DICER [74]. In colorectal cancer, miR-3 was found to be over expressed which also induced cell proliferation migration and invasion [75]. Besides the expression of PTEN was decreased in hepatocellular cancer while inverse correlation was observed in the expression of miR-32 [76].

Emerging data featured the consequences of newer types of RNA-RNA interactions that control the arrangement of gene expression. It is important to note that a single mi RNA can control an entire post-transcriptional program and influences dozens of targets genes and by that one single mi RNA can regulate multiple mRNAs of the same or different pathways [77]. On the contrary, a single mi RNA can be regulated by few miRNAs. mRNAs, non-coding RNAs, pseudo gene transcripts, and circular RNAs are RNA transcripts competing for the same pool of miRNAs by regulating each other and acting as "competing endogenous RNAs" (ce RNAs) [78]. Mi RNA also called as microRNA recognition elements (MREs) recognized the sequences shared by these ce RNAs [79]. Direct competition for mi RNA binding could sponge the mi RNA by ce RNAs and it increases the levels of endogenous miRNA targets as a consequence [80]. The ce RNAs also called "oncocers" take crucial roles in oncogenic pathways of many types of cancers [81].

Poliseno et al. showed that quenching mi RNA in humans have regulatory functions by an endogenous non-coding transcript [82]. PTEN pseudo gene (PTENpg1) action was found to post-transcriptionally regulate the PTEN expression (PTENpg1, also known as PTENp1, PTEN 2 and PTEN Ψ 1) [82]. Three different long non-coding RNA (lnc RNA) molecules, one sense PTENp1 and two functional antisense RNAs (as RNAs) is forms, α and β [83] are





Mukta Raghav et al.,

encoded by the PTENp1 locus. PTEN mi RNA shares extensive sequence homology with PTENp1 sense, which is a lncRNA, mainly in the ORF region and within the first third of its 3'-UTR, an area augmented and known for miRNA target sites. Therefore, PTENp1 functions like miRNA sponge segregate and thus activate PTEN expression and increasing its tumor-suppressor activity. Few miRNA families that target PTEN mRNA, such as miR-17, miR-19, miR-21, miR-26, and miR-214, were found to segregate by PTENp1 among others in detail [82]. PTENp1 antisense transcripts regulate PTEN expression both at the transcriptional and translational levels which could provide an inclusive level of complications in this crosstalk between miRNAs and RNAs. RNA- α acts in trans as PTENp1, and inhibits PTEN transcription by recruiting epigenetic repressor complexes and localizes to the PTEN promoter. PTENp1 sense which is partially complementary to the β is form, through an RNA-RNA pairing interaction interacts with PTENp1 sense and positively regulates PTEN expression and thus promotes stabilization of PTENp1 sense by binding to its 5' end [83]. Not only the PTENp1 but the other members of miRNA also act as decoy regulating PTEN expression. For PTEN-interacting miRNAs, other protein-coding genes, such as vesicle-associated membrane protein-associated protein A (VAPA), CCR4-NOT transcription complex, subunit 6-like (CNOT6L), or Versican (VCAN), have a similar role and act as competing RNAs [84]. Additionally ZEB2 was characterized as a bona fide PTEN ceRNA [85]. In melanoma, ZEB2 acts a tumor suppressor by regulating PTEN expression through its miRNA. The miRNA released as a result could down regulate PTEN collaborating with BRAF to promote melanoma genesis. Direct targeting of miRNAs may prove to be a potential strategy of certain cancer treatments in the near future.

VARIOUS ACTION OF PTEN ON CELL METABOLISM

Cancer cells adapt their metabolism to assist abnormal cell proliferation survival, and long-term maintenance. Increased glucose uptake and fermentation of glucose to lactate are the well accepted features of modified metabolism. In the presence of completely functioning mitochondria, which is the most important metabolic hallmark of cancer cells known as the Warburg effect selecting the glycolysis pathway even in the presence of normal or high oxygen tension. Despite an inefficient means of generating ATP through aerobic glycolysis in comparison to mitochondrial respiration, cancer cells adapt the metabolic reprogramming for energy compensation [86]. Certainly through aerobic glycolysis the rate of glucose metabolism is high as the production of lactate from glucose occurs 10–100 times faster, when compared with the complete oxidation of glucose in the mitochondria [87]. The amount of ATP produced over any given time period in cancer cells is proportionate when one of the form of glucose metabolism is used [88]. In this matter, the majority of the clinically relevant oncogenes of glycolysis pathway are over expressed done by microarray analysis. In many tumor types, it had been observed that changes occur in key enzymes involved in glucose utilization. Glucose transporters contribute to the avid uptake of glucose and also in the up regulation of plasma membrane [88] due to the continuous growth of the tumor. Increased expression and activity levels of hexokinase (HK) is forms, PFK1, PFK2, aldolase (ADO), phosphoglycerate kinase (PGK), enolase (ENO), and pyruvate kinase (PK) [89] as shown by some tumors may result in increased pyruvate production from glucose breakdown [90]. Blockage of glycolysis in cancer cells has been treated as a distinct therapeutic strategy for cancer patients. Drugs targeting the regulating enzymes in tumor glycolysis could have newer promising applications in future.

Regulation of Glucose Metabolism

Ras -dependent, Myc or PI3K, are multiple oncogenic pathways which favour glycolysis over oxidative phosphorylation, while p53, Von Hippel-Lindau (VHL), or liver kinase B1 (LKB1) as tumor suppressors tend to neutralize the “Warburg effect” [91]. Mouse embryonic fibroblast (MEF) cells displayed metabolic changes resulting in increased PTEN expression in *in-vivo* models which is persistent with an “anti-Warburg effect”. Proliferator-activated receptor gamma coactivator 1-alpha (PGC1 α), a transcriptional coactivator which regulates mitochondrial biogenesis and energy metabolism [92] clearly showed higher levels of peroxisome in PTEN tg MEFs. Increased oxygen consumption and energy expenditure were observed in these mice [93]. An augmented number of mitochondria, together with ATP production and oxygen consumption and lower levels of lactate secretion were shown by MEFs in addition. All these factors expressed that PTEN leads to decline the glycolytic rate and favours oxidative phosphorylation. Thus, in brief, PTEN tg mice exhibited an unexpected cancer-resistant and very unique





Mukta Raghav et al.,

metabolic state by PTEN tg mice as a result of the ability of PTEN to regulate metabolism at various levels both in the nucleus and cytosol. By preventing the expression of Glut1 on plasma membrane, glucose consumption is limited by PTEN in cancer cells. The localization of Glut1 in the plasma membrane regulated through AKT activation is blocked by PTEN at a molecular level [88]. The combined loss of PTEN and p53 may lead to increase in HK2, a glycolysis regulator. Activation of the AKT-mTORC1 and HK2 protein synthesis results in the process of PTEN deletion. Tumor growth in prostate cancer models with PTEN/p53-deficiency is driven by aerobic glycolysis dependent on HK2 [88]. The regulation of PTEN/AKT/HK2 could be targeted to overcome cancer resistance to cisplatin treatment [94]. In addition, PTEN decreases the levels of pyruvate kinase muscle isozyme (PKM)2 which activates the last step of glycolysis (Fig. 3) and its expression is associated to the “Warburg effect” of cancer cells [95]. Lower levels of PKM2 are found in PTEN transgenic cells and the transcription of PKM2 is induced by m TOR [92]. An elevated glycolytic rate and cell proliferation in prostate canceris induced when PTEN counteracts the glyoxalase dependent PI3K/AKT/m TOR/p-PKM2(Y105)-axis [96].

Loss of PTEN, on anaphase-promoting complex (APC) and its coactivator, Cdh1-mediated ubiquitination occur via suppressive effects, which could stabilize family member 6-phosphofructo-1-kinase/fructose-2,6-biphosphatase is form 3 (PFKFB3) [97] which is important for the first fundamental step of glycolysis and whose activity is reportedly involved in cancer [98].

Regulation of Glutamine Metabolism

Glutaminyls, along with glycolysis, are attributed for energy production and anabolism in cancer cells. PTEN loss brings a hyperglycolytic phenotype which would distribute T-cell acute lymphoblastic leukemia (T-ALL) cells resistant to Notch signaling pathway inhibition [99], given to the abnormal activation of Notch in over 60% of T-ALL cases shown previously. The same T-cells are less sensitive to blockage of glutaminolysis due to increased glucose-derived carbon input to the Krebs cycle. In metabolic reprogramming, particularly PTEN can affect glutaminolysis, determined by Notch. In the glutaminolytic pathway Glutaminases (GLS1 and GLS2), produce glutamate from glutamine and switch on step one. PTEN reduced the glutamine consumption because of concomitant degradation of GLS1 which is pro-oncogenic [100,101], while GLS2 is anti-oncogenic [102]. The on co suppressor p53 stimulates GLS2 while the oncogene Myc up-regulates only GLS1 [103]. In accordance with these inputs in cancer metabolism, PTEN supports the tumor-suppressive activity and also inhibits the glutaminase GLS1. Remarkably, studies on the effects of suppression of PTEN expression by a specific miRNA, such as miR-181a, increased lactate production and AKT phosphorylation, causing cell proliferation [104]. Specifically, in colon cancer PTEN is a crucial determinant of metabolic reprogramming, *via*, miR-181a although no significant changes in the critical components of mTORC2 have been observed.

Regulation of Krebs Cycle and Oxidative Phosphorylation

Most of cell energy requirements are met through the Krebs cycle that occupies a central position in metabolism by the complete oxidation of acetyl-CoA, a fundamental product in the catabolism of carbohydrates, fatty acids and amino acids, to CO₂. Krebs cycle and oxidative phosphorylation are greatly affected by the constitutive PTEN loss in non-transformed thyrocytes of a PTEN-deficient mouse model, with defective mitochondria and compensatory metabolic switch to glycolysis [105]. Moreover, deterioration of the Krebs cycle is associated to pathological conditions including cancer, whereas the shift of cancer cells from oxidative phosphorylation to anaerobic glycolysis is favoured by the genetic and epigenetic alterations of Krebs cycle enzymes. Increased energy expenditure, reduced body fat accumulation are typical characteristics of a healthy metabolism because of elevation of PTEN. Increased mitochondrial oxidative phosphorylation, and reduced glucose and glutamine up take have been shown by the cells derived from transgenic mouse that are resistant to oncogenic transformation. PTEN plays an important role for the control of tumorigenesis related to dysregulated cell metabolism demonstrated by above results.

In *in-vivo* models, PTEN particularly plays a crucial role in insulin-mediated oxidative stress and genomic damage in a human hepatocyte cell line. A causative role of PTEN in hepatic and extra hepatic carcinogenesis was observed in obese subjects [106]. Increased reactive oxygen species (ROS), stress-proteins, and genomic damage in the liver of





Mukta Raghav *et al.*,

PTEN haplo-deficient mice maintained with a high fat diet have also been reported [106]. Notably, oxidative phosphorylation is augmented together with the ROS amount in PTEN transgenic mice [92]. This increase in ROS levels is not sufficient to imply relevant effects on DNA, as PTEN over expression is associated with cancer protection. Moreover, it needs to be proven that through the Forkhead box O (FOXO)3 transcription factors, PTEN induces the transcription of genes mediating antioxidant activity [107].

CONCLUSION

PTEN as a negative regulator has been established to be quite imperative in its role in PI3K/AKT/mTOR cancer pathway. Moreover, PI3K-AKT signalling nonlinear pathway has various regulatory components/levels, though the process of elucidation is still going on. After detailed investigations and studies carried out in the past, it has been proven that PTEN remains the main negative regulator of the PI3K-AKT pathway. The emergence and roles of PTEN as both (negative regulator of tumor and a suppressor of metabolic pathways) recorded herein showed the biological efficiency of PTEN and its downstream key proteins. Authors also explored the regulations of PTEN transcriptionally, post-transcriptionally and sub cellular localization as well. The alterations in PTEN protein proportion, localization, and enzymatic activities by different biomolecular pathways (PI3K/PKT pathway) give rise spectrum of functional PTEN levels and its role in the suppression of life-threatening disease, metabolic disorders, oncogenesis, sporadic cancers and associated complications.

CONFLICT OF INTEREST

There exists no conflict of interest amongst authors regarding publication of this manuscript.

ACKNOWLEDGEMENTS

Authors greatly acknowledge Maharishi Markandeshwar (Deemed to be University), Mullana–Ambala (Haryana), India for providing the requisite platform for this collaborative research work.

REFERENCES

1. Lawrence MS, Stojanov P, Mermel CH, Robinson JT, Garraway LA, Golub TR, Meyerson M, Gabriel SB, Lander ES, Getz G. Discovery and saturation analysis of cancer genes across 21 tumour types. *Nature*. 2014;505(7484):495-501.
2. Ruchi Sharma V, Kumar Gupta G, K Sharma A, Batra N, K Sharma D, Joshi A, K Sharma A. PI3K/Akt/mTOR intracellular pathway and breast cancer: factors, mechanism and regulation. *Current Pharmaceutical Design*. 2017;1;23(11):1633-1638.
3. Hoxhaj G, Manning BD. The PI3K–AKT network at the interface of oncogenic signalling and cancer metabolism. *Nature Reviews Cancer*. 2020;20(2):74-88.
4. Gozzelino L, De Santis MC, Gulluni F, Hirsch E, Martini M. PI (3, 4) P2 signaling in cancer and metabolism. *Frontiers in Oncology*. 2020;10:360.
5. Bilanges B, Posor Y, Vanhaesebroeck B. PI3K isoforms in cell signalling and vesicle trafficking. *Nature Reviews Molecular Cell Biology*. 2019;20(9):515-534.
6. Fruman DA, Chiu H, Hopkins BD, Bagrodia S, Cantley LC, Abraham RT. The PI3K pathway in human disease. *Cell*. 2017;170(4):605-635.
7. Kalil K, Dent EW. Branch management: mechanisms of axon branching in the developing vertebrate CNS. *Nature Reviews Neuroscience*. 2014;15(1):7-18.
8. Sharma V, Sharma AK, Punj V, Priya P. Recent nanotechnological interventions targeting PI3K/Akt/mTOR pathway: a focus on breast cancer. *Seminars in Cancer Biology* 2019;59:133-146.



**Mukta Raghav et al.,**

9. Sansal I, Sellers WR. The biology and clinical relevance of the PTEN tumor suppressor pathway. *Journal of Clinical Oncology*. 2004;22(14):2954-2963.
10. Shaw RJ, Cantley LC. Ras, PI (3) K and mTOR signalling controls tumour cell growth. *Nature*. 2006;441(7092):424-430.
11. Stambolic V, MacPherson D, Sas D, Lin Y, Snow B, Jang Y, Benchimol S, Mak TW. Regulation of PTEN transcription by p53. *Molecular Cell*. 2001;8(2):317-325.
12. Singh M, Kumar V, Sehrawat N, Yadav M, Chaudhary M, Upadhyay SK, Kumar S, Sharma V, Kumar S, Dilbaghi N, Sharma AK. Current paradigms in epigenetic anticancer therapeutics and future challenges. *Seminars in Cancer Biology*. 2021; <https://doi.org/10.1016/j.semcancer.2021.03.013>.
13. Ma L, Chen Z, Erdjument-Bromage H, Tempst P, Pandolfi PP. Phosphorylation and functional inactivation of TSC2 by Erk: implications for tuberous sclerosis and cancer pathogenesis. *Cell*. 2005;121(2):179-193.
14. Gupta S, Ramjaun AR, Haiko P, Wang Y, Warne PH, Nicke B, Nye E, Stamp G, Alitalo K, Downward J. Binding of ras to phosphoinositide 3-kinase p110 α is required for ras-driven tumorigenesis in mice. *Cell*. 2007;129(5):957-968.
15. Vasudevan KM, Burikhanov R, Goswami A, Rangnekar VM. Suppression of PTEN expression is essential for antiapoptosis and cellular transformation by oncogenic Ras. *Cancer Research*. 2007;67(21):10343-10350.
16. Chung JH, Eng C. Nuclear-cytoplasmic partitioning of phosphatase and tensin homologue deleted on chromosome 10 (PTEN) differentially regulates the cell cycle and apoptosis. *Cancer Research*. 2005;65(18):8096-8100.
17. Denning G, Jean-Joseph B, Prince C, Durden DL, Vogt PK. A short N-terminal sequence of PTEN controls cytoplasmic localization and is required for suppression of cell growth. *Oncogene*. 2007;26(27):3930-3940.
18. Tuli HS, Mittal S, Aggarwal D, Parashar G, Parashar NC, Upadhyay SK, Barwal TS, Jain A, Kaur G, Salva R, Sak K, Kumar M, Varol M, Iqbal A, Sharma AK. Path of silibinin from diet to medicine: A dietary polyphenolic flavonoid having potential anti-cancer therapeutic significance. *Seminars in Cancer Biology*. 2021;73:196-218.
19. Drinjakovic J, Jung H, Campbell DS, Strohlic L, Dwivedy A, Holt CE. E3 ligase Nedd4 promotes axon branching by downregulating PTEN. *Neuron*. 2010;65(3):341-357.
20. Fouladkou F, Landry T, Kawabe H, Neeb A, Lu C, Brose N, Stambolic V, Rotin D. The ubiquitin ligase Nedd4-1 is dispensable for the regulation of PTEN stability and localization. *Proceedings of the National Academy of Sciences*. 2008;105(25):8585-8590.
21. Chung JH, Ostrowski MC, Romigh T, Minaguchi T, Waite KA, Eng C. The ERK1/2 pathway modulates nuclear PTEN-mediated cell cycle arrest by cyclin D1 transcriptional regulation. *Human Molecular Genetics*. 2006;15(17):2553-2559.
22. Furnari FB, Huang HS, Cavenee WK. The phosphoinositol phosphatase activity of PTEN mediates a serum-sensitive G1 growth arrest in glioma cells. *Cancer Research*. 1998;58(22):5002-5008.
23. Jiang X, Chen S, Asara JM, Balk SP. Phosphoinositide 3-kinase pathway activation in phosphate and tensin homolog (PTEN)-deficient prostate cancer cells is independent of receptor tyrosine kinases and mediated by the p110 β and p110 δ catalytic subunits. *Journal of Biological Chemistry*. 2010;285(20):14980-14989.
24. Shi Y, Paluch BE, Wang X, Jiang X. PTEN at a glance. *Journal of Cell Science*. 2012;125(20):4687-4692.
25. Virolle T, Adamson ED, Baron V, Birle D, Mercola D, Mustelin T, de Belle I. The Egr-1 transcription factor directly activates PTEN during irradiation-induced signalling. *Nature Cell Biology*. 2001;3(12):1124-1128.
26. Edwin F, Singh R, Endersby R, Baker SJ, Patel TB. The tumor suppressor PTEN is necessary for human Sprouty 2-mediated inhibition of cell proliferation. *Journal of Biological Chemistry*. 2006;281(8):4816-4822.
27. Sharma V, Sankhyan A, Varshney A, Choudhary R, Sharma AK. Current paradigms to explore the gut microbiota linkage to neurological disorders. *Neurology*. 2020;8(1):68-79.
28. Vasudevan KM, Gurumurthy S, Rangnekar VM. Suppression of PTEN expression by NF- κ B prevents apoptosis. *Molecular and Cellular Biology*. 2004;24(3):1007-21.
29. Gericke A, Munson M, Ross AH. Regulation of the PTEN phosphatase. *Gene*. 2006;374:1-9.
30. Aggarwal D, Upadhyay SK, Singh R, Tuli HS. Recent patents on therapeutic activities of xanthohumol: A prenylated chalconoid from hops (*Humulus lupulus* L.). *Pharmaceutical Patent Analyst*. 2021;10(1):37-49.



**Mukta Raghav et al.,**

31. Meng X, Wang Y, Zheng X, Liu C, Su B, Nie H, Zhao B, Zhao X, Yang H. shRNA-mediated knockdown of Bmi-1 inhibit lung adenocarcinoma cell migration and metastasis. *Lung Cancer*. 2012;77(1):24-30.
32. Goel A, Arnold CN, Niedzwiecki D, Carethers JM, Dowell JM, Wasserman L, Compton C, Mayer RJ, Bertagnolli MM, Boland CR. Frequent inactivation of PTEN by promoter hypermethylation in microsatellite instability-high sporadic colorectal cancers. *Cancer Research*. 2004;64(9):3014-3021.
33. Kim DS, Lee SM, Yoon GS, Choi JE, Park JY. Infrequent hypermethylation of the PTEN gene in Korean non-small-cell lung cancers. *Cancer Science*. 2010;101(2):568-572.
34. Zysman MA, Chapman WB, Bapat B. Considerations when analyzing the methylation status of PTEN tumor suppressor gene. *The American Journal of Pathology*. 2002;160(3):795-800.
35. Hesson LB, Packham D, Pontzer E, Funchain P, Eng C, Ward RL. A reinvestigation of somatic hypermethylation at the PTEN CpG island in cancer cell lines. *Biological Procedures Online*. 2012;14(1):1-8.
36. Palomero T, Sulis ML, Cortina M, Real PJ, Barnes K, Ciofani M, Caparros E, Buteau J, Brown K, Perkins SL, Bhagat G. Mutational loss of PTEN induces resistance to NOTCH1 inhibition in T-cell leukemia. *Nature Medicine*. 2007;13(10):1203-1210.
37. Chappell WH, Green TD, Spengeman JD, McCubrey JA, Akula SM, Bertrand FE. Increased protein expression of the PTEN tumor suppressor in the presence of constitutively active Notch-1. *Cell Cycle*. 2005;4(10):1389-1395.
38. Bartel DP. MicroRNAs: genomics, biogenesis, mechanism, and function. *Cell*. 2004;116(2):281-297.
39. Ambros V. The functions of animal microRNAs. *Nature*. 2004;431(7006):350-5.
40. Wilmott JS, Zhang XD, Hersey P, Scolyer RA. The emerging important role of microRNAs in the pathogenesis, diagnosis and treatment of human cancers. *Pathology*. 2011;43(6):657-671.
41. Hunt S, Jones AV, Hinsley EE, Whawell SA, Lambert DW. MicroRNA-124 suppresses oral squamous cell carcinoma motility by targeting ITGB1. *FEBS Letters*. 2011;585(1):187-192.
42. Dan S, Upadhyay SK, Girdhar M, Mandal M, Sakshi. Oral carcinoma and therapeutic approaches of nanotechnology: From fundamental concept, incidence, molecular mechanism to emerging treatment techniques. *Biointerface Research in Applied Chemistry*. 2021;12(3):3900-3937.
43. Wang Z, Zhang X, Yang Z, Du H, Wu Z, Gong J, Yan J, Zheng Q. MiR-145 regulates PAK4 via the MAPK pathway and exhibits an antitumor effect in human colon cells. *Biochemical and Biophysical Research Communications*. 2012;427(3):444-449.
44. Liu C, Yu J, Yu S, Lavker RM, Cai L, Liu W, Yang K, He X, Chen S. MicroRNA-21 acts as an oncomir through multiple targets in human hepatocellular carcinoma. *Journal of Hepatology*. 2010;53(1):98-107.
45. Yang L, Li Q, Wang Q, Jiang Z, Zhang L. Silencing of miRNA-218 promotes migration and invasion of breast cancer via Slit2-Robo1 pathway. *Biomedicine and Pharmacotherapy*. 2012;66(7):535-540.
46. Meng F, Henson R, Wehbe-Janek H, Ghoshal K, Jacob ST, Patel T. MicroRNA-21 regulates expression of the PTEN tumor suppressor gene in human hepatocellular cancer. *Gastroenterology*. 2007;133(2):647-658.
47. Wang B, Majumder S, Nuovo G, Kutay H, Volinia S, Patel T, Schmittgen TD, Croce C, Ghoshal K, Jacob ST. Role of microRNA-155 at early stages of hepatocarcinogenesis induced by choline-deficient and amino acid-defined diet in C57BL/6 mice. *Hepatology*. 2009;50(4):1152-1161.
48. Poliseno L, Salmena L, Riccardi L, Fornari A, Song MS, Hobbs RM, Sportoletti P, Varmeh S, Egia A, Fedele G, Rameh L. Identification of the miR-106b~25 microRNA cluster as a proto-oncogenic PTEN-targeting intron that cooperates with its host gene MCM7 in transformation. *Science Signaling*. 2010;3(117):29.
49. Jindra PT, Bagley J, Godwin JG, Iacomini J. Costimulation-dependent expression of microRNA-214 increases the ability of T cells to proliferate by targeting Pten. *The Journal of Immunology*. 2010;185(2):990-997.
50. Xiao C, Srinivasan L, Calado DP, Patterson HC, Zhang B, Wang J, Henderson JM, Kutok JL, Rajewsky K. Lymphoproliferative disease and autoimmunity in mice with increased miR-17-92 expression in lymphocytes. *Nature Immunology*. 2008;9(4):405-414.
51. Upadhyay SK, Dan S, Pant M, Shaloo. Synergistic approach of graphene oxide-silver-titanium nanocomposite film in oral and dental studies: A new paradigm of infection control in dentistry. *Biointerface Research in Applied Chemistry*. 2021;11(2):9680-9703.
52. Olive V, Bennett MJ, Walker JC, Ma C, Jiang I, Cordon-Cardo C, Li QJ, Lowe SW, Hannon GJ, He L. miR-19 is a key oncogenic component of mir-17-92. *Genes and Development*. 2009;23(24):2839-2849.



**Mukta Raghav et al.,**

53. Liu ZL, Wang H, Liu J, Wang ZX. MicroRNA-21 (miR-21) expression promotes growth, metastasis, and chemoradioresistance in non-small cell lung cancer cells by targeting PTEN. *Molecular and Cellular Biochemistry*. 2013;372(1):35-45.
54. Xiong Y, Zhang YY, Wu YY, Wang XD, Wan LH, Zhou LM. Correlation of over-expressions of miR-21 and Notch-1 in human colorectal cancer with clinical stages. *Life Sciences*. 2014;106(1-2):19-24.
55. Lou Y, Yang X, Wang F, Cui Z, Huang Y. MicroRNA-21 promotes the cell proliferation, invasion and migration abilities in ovarian epithelial carcinomas through inhibiting the expression of PTEN protein. *International Journal of Molecular Medicine*. 2010;26(6):819-827.
56. Dong G, Liang X, Wang D, Gao H, Wang L, Wang L, Liu J, Du Z. High expression of miR-21 in triple-negative breast cancers was correlated with a poor prognosis and promoted tumor cell in vitro proliferation. *Medical Oncology*. 2014;31(7):1-10.
57. Iliopoulos D, Jaeger SA, Hirsch HA, Bulyk ML, Struhl K. STAT3 activation of miR-21 and miR-181b-1 via PTEN and CYLD are part of the epigenetic switch linking inflammation to cancer. *Molecular Cell*. 2010;39(4):493-506.
58. Yang H, Kong W, He L, Zhao JJ, O'Donnell JD, Wang J, Wenham RM, Coppola D, Kruk PA, Nicosia SV, Cheng JQ. MicroRNA expression profiling in human ovarian cancer: miR-214 induces cell survival and cisplatin resistance by targeting PTEN. *Cancer Research*. 2008;68(2):425-433.
59. Penna E, Orso F, Taverna D. miR-214 as a key hub that controls cancer networks: small player, multiple functions. *Journal of Investigative Dermatology*. 2015;135(4):960-969.
60. Fu X, Tian J, Zhang L, Chen Y, Hao Q. Involvement of microRNA-93, a new regulator of PTEN/Akt signaling pathway, in regulation of chemotherapeutic drug cisplatin chemosensitivity in ovarian cancer cells. *FEBS letters*. 2012;586(9):1279-1286.
61. Li NW, Wang HJ, Yang LY, Jia XB, Chen C, Wang X. Regulatory effects and associated mechanisms of miR-130a molecules on cisplatin resistance in ovarian cancer A2780 cell lines. *Journal of Sichuan University Medical Science Edition*. 2013;44(6):865-870.
62. Xie Q, Yan Y, Huang Z, Zhong X, Huang L. MicroRNA-221 targeting PI3-K/Akt signaling axis induces cell proliferation and BCNU resistance in human glioblastoma. *Neuropathology*. 2014;34(5):455-464.
63. Yang H, Kong W, He L, Zhao JJ, O'Donnell JD, Wang J, Wenham RM, Coppola D, Kruk PA, Nicosia SV, Cheng JQ. MicroRNA expression profiling in human ovarian cancer: miR-214 induces cell survival and cisplatin resistance by targeting PTEN. *Cancer Research*. 2008;68(2):425-433.
64. Huse JT, Brennan C, Hambarzumyan D, Wee B, Pena J, Rouhanifard SH, Sohn-Lee C, Le Sage C, Agami R, Tuschl T, Holland EC. The PTEN-regulating microRNA miR-26a is amplified in high-grade glioma and facilitates gliomagenesis in vivo. *Genes and Development*. 2009;23(11):1327-1337.
65. Liu B, Wu X, Liu B, Wang C, Liu Y, Zhou Q, Xu K. MiR-26a enhances metastasis potential of lung cancer cells via AKT pathway by targeting PTEN. *Biochimica et Biophysica Acta (BBA)-Molecular Basis of Disease*. 2012;1822(11):1692-1704.
66. Lang Y, Xu S, Ma J, Wu J, Jin S, Cao S, Yu Y. MicroRNA-429 induces tumorigenesis of human non-small cell lung cancer cells and targets multiple tumor suppressor genes. *Biochemical and Biophysical Research Communications*. 2014;450(1):154-159.
67. Wang C, Bian Z, Wei D, Zhang JG. miR-29b regulates migration of human breast cancer cells. *Molecular and Cellular Biochemistry*. 2011;352(1):197-207.
68. Shi W, Gerster K, Alajez NM, Tsang J, Waldron L, Pintilie M, Hui AB, Sykes J, P'ng C, Miller N, McCreedy D. MicroRNA-301 mediates proliferation and invasion in human breast cancer. *Cancer Research*. 2011;71(8):2926-2937.
69. Ma F, Zhang J, Zhong L, Wang L, Liu Y, Wang Y, Peng L, Guo B. Upregulated microRNA-301a in breast cancer promotes tumor metastasis by targeting PTEN and activating Wnt/ β -catenin signaling. *Gene*. 2014;535(2):191-197.
70. Wu Z, He B, He J, Mao X. Upregulation of miR-153 promotes cell proliferation via downregulation of the PTEN tumor suppressor gene in human prostate cancer. *The Prostate*. 2013;73(6):596-604.
71. Tian L, Fang YX, Xue JL, Chen JZ. Four microRNAs promote prostate cell proliferation with regulation of PTEN and its downstream signals in vitro. *PloSone*. 2013;8(9):e75885.





Mukta Raghav et al.,

72. Ke TW, Wei PL, Yeh KT, Chen WT, Cheng YW. MiR-92a promotes cell metastasis of colorectal cancer through PTEN-mediated PI3K/AKT pathway. *Annals of surgical Oncology*. 2015;22(8):2649-2655.
73. Sun HB, Chen X, Ji H, Wu T, Lu HW, Zhang Y, Li H, Li YM. miR-494 is an independent prognostic factor and promotes cell migration and invasion in colorectal cancer by directly targeting PTEN. *International Journal of Oncology*. 2014;45(6):2486-2494.
74. Geng L, Sun B, Gao B, Wang Z, Quan C, Wei F, Fang XD. MicroRNA-103 promotes colorectal cancer by targeting tumor suppressor DICER and PTEN. *International Journal of Molecular Sciences*. 2014;15(5):8458-8472.
75. Wu W, Yang J, Feng X, Wang H, Ye S, Yang P, Tan W, Wei G, Zhou Y. MicroRNA-32 (miR-32) regulates phosphatase and tensin homologue (PTEN) expression and promotes growth, migration, and invasion in colorectal carcinoma cells. *Molecular cancer*. 2013;12(1):1-1.
76. Yan SY, Chen MM, Li GM, Wang YQ, Fan JG. MiR-32 induces cell proliferation, migration, and invasion in hepatocellular carcinoma by targeting PTEN. *Tumor Biology*. 2015;36(6):4747-4755.
77. Croce CM. Causes and consequences of microRNA dysregulation in cancer. *Nature Reviews Genetics*. 2009;10(10):704-714.
78. Cheng DL, Xiang YY, Ji LJ, Lu XJ. Competing endogenous RNA interplay in cancer: Mechanism, methodology, and perspectives. *Tumor Biology*. 2015;36(2):479-488.
79. Kartha RV, Subramanian S. Competing endogenous RNAs (ceRNAs): New entrants to the intricacies of gene regulation. *Frontiers in Genetics*. 2014;5:8.
80. de Giorgio A, Krell J, Harding V, Stebbing J, Castellano L. Emerging roles of competing endogenous RNAs in cancer: insights from the regulation of PTEN. *Molecular and Cellular Biology*. 2013;33(20):3976-3982.
81. Ergun S, Oztuzcu S. Oncocers: ceRNA-mediated cross-talk by sponging miRNAs in oncogenic pathways. *Tumor Biology*. 2015;36(5):3129-3136.
82. Polisenio L, Salmena L, Zhang J, Carver B, Haveman WJ, Pandolfi PP. A coding-independent function of gene and pseudogene mRNAs regulates tumour biology. *Nature*. 2010;465(7301):1033-1038.
83. Khadwal, S., Singh, R., Singh, K., Sharma, V., & Sharma, A. K. Probing into the edible vaccines: Newer paradigms, scope and relevance. *Plant Archives*. 2020;20(2):5483-5495.
84. Tay Y, Kats L, Salmena L, Weiss D, Tan SM, Ala U, Karreth F, Polisenio L, Provero P, Di Cunto F, Lieberman J. Coding-independent regulation of the tumor suppressor PTEN by competing endogenous mRNAs. *Cell*. 2011;147(2):344-357.
85. Karreth FA, Tay Y, Perna D, Ala U, Tan SM, Rust AG, DeNicola G, Webster KA, Weiss D, Perez-Mancera PA, Krauthammer M. In vivo identification of tumor-suppressive PTEN ceRNAs in an oncogenic BRAF-induced mouse model of melanoma. *Cell*. 2011;147(2):382-395.
86. Alimonti A, Carracedo A, Clohessy JG, Trotman LC, Nardella C, Egia A, Salmena L, Sampieri K, Haveman WJ, Brogi E, Richardson AL. Subtle variations in Pten dose determine cancer susceptibility. *Nature Genetics*. 2010;42(5):454-458.
87. Rajpoot M, Bhattacharya R, Sharma S, Gupta S, Sharma V, Sharma AK. Melamine contamination and associated health risks: Gut microbiota does make a difference. *Biotechnology and Applied Biochemistry*. 2021;68(6):1271-1280.
88. Phadngam S, Castiglioni A, Ferraresi A, Morani F, Follo C, Isidoro C. PTEN dephosphorylates AKT to prevent the expression of GLUT1 on plasmamembrane and to limit glucose consumption in cancer cells. *Oncotarget*. 2016;7(51):84999.
89. Marín-Hernández A, Gallardo-Pérez JC, Rodríguez-Enríquez S, Encalada R, Moreno-Sánchez R, Saavedra E. Modeling cancer glycolysis. *Biochimica et Biophysica Acta (BBA)-Bioenergetics*. 2011;1807(6):755-767.
90. Ram G, Sharma VR, Sheikh I, Sankhyan A, Aggarwal D, Sharma A. Anti-cancer potential of natural products: recent trends, scope and relevance. *Letters in Applied NanoBioScience*. 2020;9(1):902-907.
91. Tramontano D, De Amicis F. Is the secret for a successful aging to keep track of cancer pathways. *Journal of Cellular Physiology*. 2018;233(11):8467-8476.
92. Garcia-Cao I, Song MS, Hobbs RM, Laurent G, Giorgi C, De Boer VC, Anastasiou D, Ito K, Sasaki AT, Rameh L, Carracedo A. Systemic elevation of PTEN induces a tumor-suppressive metabolic state. *Cell*. 2012;149(1):49-62.



**Mukta Raghav et al.,**

93. Raghav M, Sharma V, Chaudhary M, Tuli HS, Saini AK, Sharma AK. Essence of PTEN: a Broad-Spectrum Therapeutic Target in Cancer. *Biointerface Research in Applied Chemistry*. 2021;11(2):9587-9603.
94. He R, Liu H. TRIM59 knockdown blocks cisplatin resistance in A549/DDP cells through regulating PTEN/AKT/HK2. *Gene*. 2020;747:144553.
95. Talesa VN, Ferri I, Bellezza G, Love HD, Sidoni A, Antognelli C. Glyoxalase 2 is involved in human prostate cancer progression as part of a mechanism driven by PTEN/PI3K/AKT/mTOR signaling with involvement of PKM2 and ER α . *The Prostate*. 2017;77(2):196-210.
96. Sharma V, Panwar A, Sharma AK. Molecular dynamic simulation study on chromones and flavonoids for the in silico designing of a potential ligand inhibiting mTOR pathway in breast cancer. *Current Pharmacology Reports*. 2020;6(6):373-379.
97. Klarer AC, O'Neal J, Imbert-Fernandez Y, Clem A, Ellis SR, Clark J, Clem B, Chesney J, Telang S. Inhibition of 6-phosphofructo-2-kinase (PFKFB3) induces autophagy as a survival mechanism. *Cancer and Metabolism*. 2014;2(1):1-4.
98. Unterlass JE, Curtin NJ. Warburg and Krebs and related effects in cancer. *Expert Reviews in Molecular Medicine*. 2019;21.
99. Herranz D, Ambesi-Impiomato A, Sudderth J, Sánchez-Martín M, Belver L, Tosello V, Xu L, Wendorff AA, Castillo M, Haydu JE, Márquez J. Metabolic reprogramming induces resistance to anti-NOTCH1 therapies in T cell acute lymphoblastic leukemia. *Nature Medicine*. 2015;21(10):1182-1189.
100. Qu X, Sun J, Zhang Y, Li J, Hu J, Li K, Gao L, Shen L. c-Myc-driven glycolysis via TXNIP suppression is dependent on glutaminase-MondoA axis in prostate cancer. *Biochemical and Biophysical Research Communications*. 2018;504(2):415-421.
101. Ortega-Molina A, Serrano M. PTEN in cancer, metabolism, and aging. *Trends in Endocrinology & Metabolism*. 2013;24(4):184-9.
102. Hu W, Zhang C, Wu R, Sun Y, Levine A, Feng Z. Glutaminase 2, a novel p53 target gene regulating energy metabolism and antioxidant function. *Proceedings of the National Academy of Sciences*. 2010;107(16):7455-7460.
103. Suzuki S, Tanaka T, Poyurovsky MV, Nagano H, Mayama T, Ohkubo S, Lokshin M, Hosokawa H, Nakayama T, Suzuki Y, Sugano S. Phosphate-activated glutaminase (GLS2), a p53-inducible regulator of glutamine metabolism and reactive oxygen species. *Proceedings of the National Academy of Sciences*. 2010;107(16):7461-7466.
104. Wei Z, Cui L, Mei Z, Liu M, Zhang D. miR-181a mediates metabolic shift in colon cancer cells via the PTEN/AKT pathway. *FEBS Letters*. 2014;588(9):1773-1779.
105. Arciuch VG, Russo MA, Kang KS, Di Cristofano A. Inhibition of AMPK and Krebs cycle gene expression drives metabolic remodeling of Pten-deficient preneoplastic thyroid cells. *Cancer Research*. 2013;73(17):5459-5472.
106. Sharma, VR. Bioinformatics and its applications in environmental science and health and its applications in other disciplines. 2021;4:1:88-93.
107. Wang KC, Liu YC, El-Shazly M, Shih SP, Du YC, Hsu YM, Lin HY, Chen YC, Wu YC, Yang SC, Lu MC. The antioxidant from ethanolic extract of *Rosa cymosa* fruits activates phosphatase and tensin homolog in vitro and in vivo: A new insight on its antileukemic effect. *International Journal of Molecular Sciences*. 2019;20(8):1935.





Mukta Raghav et al.,

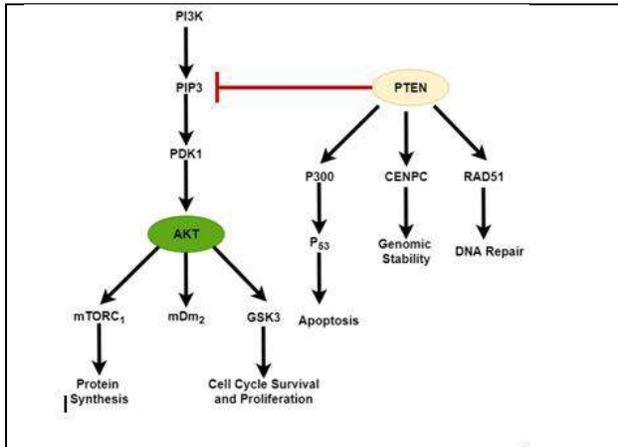


Fig. 1. PI3K/AKT/mTOR signalling and its interaction with PTEN.

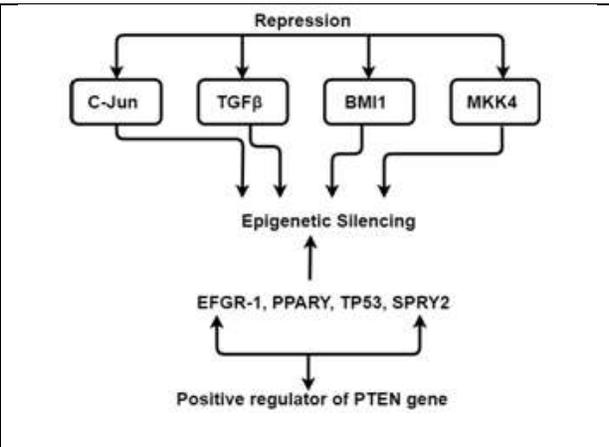


Fig. 2. Regulation of PTEN at transcription and post transcription level.

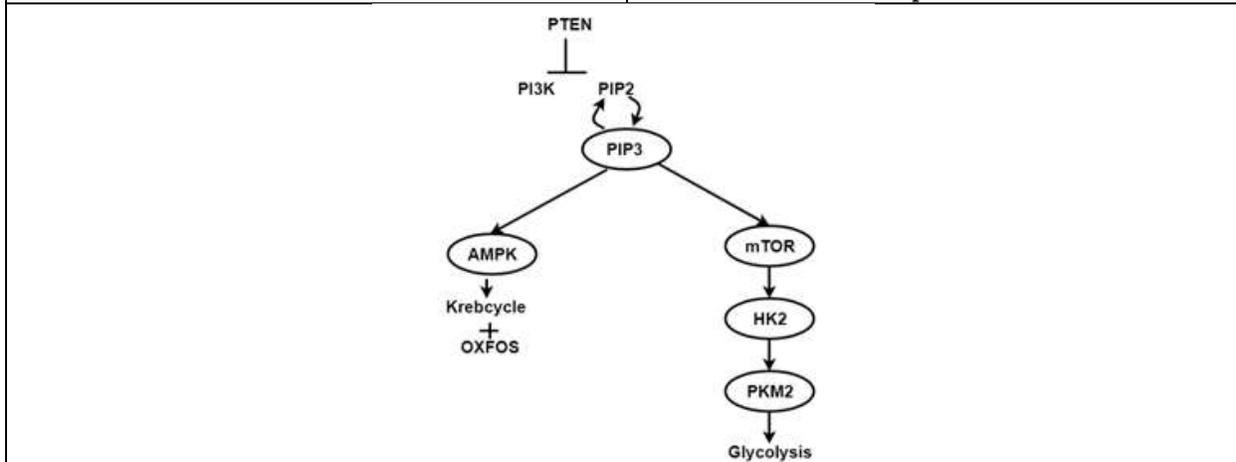


Fig. 3. Tumor suppressive Metabolic State.





Clinical Data Analysis of Acquired Aplastic Anemia Treated by Immunosuppressive Therapy

Joshna C^{1*}, Shamina S² and Santhana Megala S³

¹Student, Department of Biochemistry, Rathnavel Subramaniam College of Arts and Science, Coimbatore, Tamil Nadu, India.

²Head and Associate Professor, Department of Biochemistry, Rathnavel Subramaniam College of Arts and Science, Coimbatore, Tamil Nadu, India

³Assistant Professor, School of Computer Studies, Rathnavel Subramaniam College of Arts and Science, Coimbatore, Tamil Nadu, India.

Received: 02 May 2022

Revised: 01 June 2022

Accepted: 05 July 2022

*Address for Correspondence

Joshna C

Student, Department of Biochemistry,
Rathnavel Subramaniam College of Arts and Science,
Coimbatore, Tamil Nadu, India.

Email: joshna1419@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Aplastic anemia is a rare disorder which suppresses bone marrow function results in pancytopenia. Acquired aplastic anemia is a rare disorder satisfactorily treated in 90% of cases. Survival progress over last 30 years was due to improvement of immunosuppressive treatment and hematopoietic stem cell transplantation. Acquired aplastic anemia (AA) is a disorder characterized by a profound deficit of hematopoietic and progenitor cells, bone marrow hypocellularity, and peripheral blood pancytopenia. Patients were treated by immunosuppressive therapy method and diagnosed by biopsy or bone marrow aspiration methods. This dissertation about immunosuppressive therapy seems to be effective first-line treatment for patients with AA during several clinical trials. In this study nearly 365 patients data has been collected and extracted based on anemic and non – anemic category. In which 150 patients data were anemic category in particularly chosen 76 patients data based on their age groups from 17 – 30. The statistical analysis method shows that 93% of cases had a better survival rate.

Keywords: Pancytopenia, Immunosuppressive therapy, Acquired aplastic anemia.

INTRODUCTION

Aplastic anemia is a life threatening condition. In this condition occurs when our body unable to producing enough amount of new blood cells. Sometimes it stops only one type, but most often to become low on all three cells such as



**Joshna et al.,**

RBC, WBC and Platelets. Figure 1, represents the aplastic anemic bone marrow. It was a most common condition in late teens and early 20's people. It is a complicated deficiency and the development of disease is mild and it severe during the final stage. It is most common deficiency in developing countries. This deficiency classified based on the life style changes and genetically changes. There are Acquired aplastic anemia and inherited aplastic anemia. In this deficiency have common anemia symptoms in its primary stage. Severe aplastic anemia (SAA) is characterized by marked pancytopenia with serious clinical sequel, and disproportionately affects children and young adults. Its aetiology is broadly characterized as either 'constitutional' or 'acquired'. Acquired or immune AA is the most common and due to cytotoxic T-cell destruction of hematopoietic cells [1].

Treatment for immune AA is either hematopoietic stem cell transplant (HSCT) [2] or immunosuppressive therapy (IST). In children and adults aged <40 years without a fully matched human leukocyte antigen (HLA) sibling donor, IST remains the standard-of-care. Hematological responses to IST in children are favorable, [3-5] with an overall response rate (ORR) of 70% and complete response (CR) rate of 23–60%. Overall survival (OS) rates are also high at 80–93%; however, long-term complications such as relapse and clonal evolution result in a long-term event-free survival (EFS) of only 56–62%.

ACQUIRED APLASTIC ANEMIA - OVERVIEW

Acquired aplastic anemia is a disorder characterized by a profound deficit of hematopoietic stem and progenitor cells, bone marrow hypocellularity, and peripheral blood pancytopenia. It is paradigm of bone marrow (BM) failure syndrome [7]. Figure 2, represents characterizes acute onset, rapid progression and high mortality, patients often died of severe bleeding or infection [8]. According to the clinical guidelines and characteristic practice, allogeneic hematopoietic stem cell transplantation (allo-HSCT) and immune suppression therapy (IST) are the first treatment options for SAA [13]. The estimated affecting rate of this disease in Asia is 2-3 higher than west it means estimated rate of AA is 2 per million people per year [14]. The immunosuppressive therapy used as a first-line treatment for 70% of patients with SAA and it shows the survival rate > 80% [14].

LITERATURE REVIEW

In this section, we present the most relevant past and ongoing research in aplastic anemia using various kinds of methods for this deficiency. After conducting systematic search and relating the inclusion criteria, different studies were included. In [1] using co transplantation of haplo-HSCs and UC- MSC, engraftment for people with Sever aplastic anemia (SAA), but also investigated the factors related to Graft versus host disease (GVHD). The final outcome of this research is all the patients achieved 70-100% donor chimerism within 1 month after haplo-HSCT. And also engraftment method helps to achieve median range of neutrophils and platelets were 11 and 13 days. In this method decrease the failure rate of transplantation. In other hand it has some complications like all the patients suffered from nausea, vomiting, and various degrees and anepithymia these are occurred during HSCT period.

In [2], using immunosuppressive therapy with Eltrombopag for Sever aplastic anemia patients (SAA). In this research shows there were no significant difference in after sex, or in the ARC, ANC or platelets. And also it gives the estimated survival rate at median followed –up was 1432.5 days in the EPAG group and 2409 days in the IST group so the survival rate is 82% and 58%. In this method of treatment also have complications because of the no clear relationship between exposure and hematological response at the tested dose in each group. In [3] this study using immunosuppressive therapy alone for patients with acquired aplastic anemia. Here the researcher using allo-HSCT used as a first –line treatment for AA patients in this method shows longer survival rate than the first – line IST, in this methods evaluate the donor availability, patients age, expected quality of life, risk of disease relapse or clonal evolution after IST method. Nowadays MRT-HSCT is recommended treatment for young and adult patients who have an MRD. This paper shows the survival rate 75- 80% and long-term curable. The complications of this the method caused severe infection in who received first-line IST compared to first-line allo-HSCT. And it also shows graft failure in this method.





In [4], this paper used transfusion method for severe aplastic anemia (SAA). Here the 80% patients are largely agreed that transfusion independence would result in fewer burdens on time and cost effective method. This method was shown least survival rate like 26.77%, also has some complications such as bleeding nose, infection, and increased development of genetically disease. In [5], this author used questionnaire method for self-evaluation the patients who have aplastic anemia and Paroxysmal Nocturnal Hemoglobinuria This was useful method for self-assessment of each person who are having AA and move on into further treatments for this deficiency. In [6], here the researcher using Southern blot and quantitative PCR method for aplastic anemia and idiopathic pulmonary fibrosis with short telomeres. In this method have more complications such as inherited BRCA 1 &2, so this method has least number of survival rates in patients.

In [7], using MSC transplantation method for acquired aplastic anemia patients. The results of this paper has high amount of survival rate and 30% of relapse rate over the process. And also together with the in vivo transplantation analysis for MSC as a pivotal microenvironment components, which could help understand the pathogenesis of AA. In [8], using syngeneic stem cell transplantation method for patients with Severe Aplastic anemia in analysis of all syngeneic transplants performed in SAA in the EMBT registry it shows the results showed that engraftment was similar in the patient with or without conditioning but it was more rapid with PBSC compared to BM. In [9], using allogeneic stem cell transplantation and biopsy method for the patients with hepatitis hypo cellular myelodysplastic syndrome and aplastic anemia. The diagnosis of HAAA should be considered whenever cytopenia could not completely corrected while apparent improvement of HLH and hepatitis related complications were improved after immunosuppressive therapy. The severe or transfusion depended aplastic anemia are diagnosed by ATG or HSC t methods. These diagnostic methods are helps to identify the aplastic anemic conditions as soon as possible. But this type of diagnosis methods may be having any mistaken results.

In [10], here the researcher using flow cytometry, NK cell cytotoxicity assay, cell apoptosis, quantities real time PCR, Blood count and BM biopsy, ELISA methods for the patients with severe aplastic anemia. NK cells might play an immunoregulative role in SAA. In this method might bring a novel aspect to SAA therapy. In this methods also contributed to the path physiology of SAA. But in this methods producing of T- cell in chronic virus infections and GVHD. In [11], this paper using different diagnostic methods for hypo cellular myelodysplastic syndrome and aplastic anemia patients. The logical regressing, decision tree and other methods are used compared a support vector machine. In these methods are helps to identify and diagnose two different diseases. But still these methods are misjudging hypo-MDS and AA. In [12], using allogeneic Hematopoietic Stem cell Transplantation for severe aplastic anemia (SAA) patients. In conclusion these results indicate that IST is less effective in SAA progressing from non-SAA but allo- HSCT can improve outcome.

In [13], using immunosuppressive therapy for aplastic anemic patients. This method shows 68.1% cases has transfusion independence and 31% of the people most common causes of death were infection and intracranial hemorrhage within 2 months. In [14], using allogeneic Hematopoietic stem cell transplantation for the patients with severe aplastic anemia (SAA). Fourteen days later HSCT, the syndrome developed into "Spleen- Kidney Yang Deficiency" and stasis score decreased. On +90 days, majority patients were diagnosed with "Kidney yang deficiency" or "spleen – kidney yang deficiency" and 88.9% were diagnosed without stasis.

MATERIALS AND METHODS

DATA COLLECTION

Basic patient's materials were identified from the medical records of the hospital. Data were obtained on a pre-designed case record form (CRF) from the achieved patients files. Data on patients' blood counts, marrow transplantation details, IST therapy, complications, and concomitant medications were extracted from the achieved patient's files. The outcomes of interest were hematological response rate (partial and complete), mortality, incidence of complications/ adverse effects, and their clinical outcomes. The hematological response rate was recorded as complete response (CR) or partial response (PR) as per the criteria given in British Committee for Standard in





Hematology (2009) guidelines for the diagnosis and management of aplastic anemia. The study outcome was analyzed for the whole study populations as well as separately for the different age groups.

STATISTICAL ANALYSIS

Data was collected in Microsoft® Excel® spreadsheet and statistical analysis was done on it. The baseline characteristics have been summarized using descriptive statistics [number of patients (n), mean standard deviation (SD), median]. Response to IST, mortality, and adverse events has been summarized using frequency counts (n) and percentages (%).

RESULT AND INFERENCE OF EXPERIMENTAL RESULTS

RESULT

The survey result states that while analyzing various averages PCV, RBC, MCV, MCHC, PLT, RDW, HGB and MCH. We can determine the patient's data from age 17 to 30 yrs. and also determine whether the patients are anemic or non-anemic.

PATIENTS CHARACTERISTICS

13 patients were included in these study. All the patients belong to acquired aplastic anemia disease. Mostly the data were collected from female patients only and their age from 17 – 30 yrs. summary demographic and baseline data is provided in table 1. In table 2 we can determine whether the patients having acquired aplastic anemia are being treated with IST and the outcome of the IST and allo-HSCT are determined. The treatment related mortality, relapse and survival rate are being determined. The characteristics of AA patient donor in IST and Allo-HSCT are shown in table 2. VSAA very severe aplastic anemia, SAA severe aplastic anemia, NSAA non-severe aplastic anemia, ANC absolute neutrophil count. From the figure .1 PCV average bar diagram we can determine 13 patients data in which 21, 24, 25 and 30 age group patients having below average value. i.e. (28.3%, 32.9%, 26.9% and 31.2%).

From the figure .2 RBC average bar diagram we can determine 13 patients data in which 18, 21, 22, 24, 26 and 27 age group patients having below average value. i.e. (3.765 (cells / mL), 3.913 (cells / mL), 4.091 (cells / mL), 4.016 (cells / mL), 4.145 (cells / mL) and 4.183 (cells / mL)). From the figure .3 MCV average bar diagram we can determine 13 patients data in which 21, 22, 24, 25, 26, 27, 28, 29 and 30 age group patients having below average value. i.e. (28.3fl, 44.4fl, 32.9fl, 26.9fl, 38.5fl, 44.5fl, 41.4fl, 36.7fl and 31.2fl). From the figure .4 MCH average bar diagram we can determine 13 patients data in which 20, 26 and 29 age group patients having below average value. i.e. (25.3 pg/ cells, 26.5 pg/ cells and 26.7 pg/ cells). From the figure .5 MCHC average bar diagram we can determine 13 patients data in which 17, 19, 20, 21, 22, 24, 26, 29 and 30 age group patients having below average value. i.e. (29.3 g/dL, 31.0 g/dL, 29.2 g/dL, 30.0 g/dL, 30.2 g/dL, 31.0 g/dL, 30.4 g/dL, 30.8 and 28.8 g/dL)

From the figure .6 RDW average bar diagram we can determine 13 patients data in which 17, 18, 19, 20, 21, 24, 25 and 30 age group patients having below average value. i.e. (16.2%, 15.2%, 17.9%, 15.6%, 24.6%, 16.8%, 15.6% and 25%). From the figure .7 TLC average bar diagram we can determine 13 patients' data in which 29 age group patients having below average value. i.e. (13.41 cmm). From the figure .8 PLT average bar diagram we can determine 13 patients data in which 21, 24 and 26 age group patients having below average value. i.e. (92 platelets/ mL, 132 platelets/ mL and 589 platelets/ mL). From the figure .9 HGB average bar diagram we can determine 13 patients data in which 21, 24, 25, 29 and 30 age group patients having below average value. i.e. (6.1g/dL, 10.2 g/dL, 9.3 g/dL, 11.3 g/dL and 9.0 g/dL). By analyzing the above graphs we could determine the patients from age 17 -30 yrs having aplastic anemia. By isolating the data and these patients are treated with immunosuppressive therapy before they would go for transplantation. We would also determine whether the survival rate increased or decreased. SAA, severe aplastic anemia; allo-HSCT, allogeneic hematopoietic stem cell transplantation; BM, bone marrow; PB, peripheral blood; MNC, mononuclear cell.



**Joshna et al.,****OUTCOME IST**

While analyzing the data of 13 patients were they have been treated with immunosuppressive drug for the disease acquired aplastic anemia. We come to know that this treatment has high positive outcomes. Immunosuppressive therapy makes characteristic changes in the patient's age group 17 – 30 years.

OUTCOME OF Allo– HSCT

The donor median age is ranging around 17 – 30 years and the donor recipient sex match is around 10:3 ratio. The blood types of donor to recipient is around matched and mismatched (2, 11). The grafting percentage is around Bone marrow (BM) and peripheral blood (PB) are 3 and 10. The HLA match is based on 8/10, 9/10 and 10/10 is 4, 2 and 7. the graft failure is 0.72%, secondary graft failure 2.90 % and delayed PLT recovery percentage is 10.87%.

TREATMENT RELATED MORTALITY, RELAPSE

The following details represents the data for the acquired aplastic anemia and their chances of treatment. The median platelet recovery is around 14 days and the median neutrophil recovery is around 11 days. The hemoglobin total number is approximately around 11.56% and RBC around 4.26%. The platelet count is around 236.2308% and the total number of severity of acquired aplastic anemia is 62.6%. It is being analyzed from table 1 and 2.

INFERENCE FROM THE EXPERIMENTAL RESULT

While analyzing the data and the current therapeutically algorithm of IST and allo- HSCT is the treatment for severe acquired aplastic anemia. Today there are still many challenges in the management of patients with severe acquired aplastic anemia (SAA) and the aim of this is to achieve precision therapy. While analyzing the patient's data we can understand that immunosuppressive drug therapy is more effective than the transplantation process. However at present we do not know the result of IST is for Sever aplastic anemia that has processed from non- anemic conditions. For sever acquired plastic anemia patients there no longer parameter used to determine the first line-treatment. Many patients with SAA experience have poor quality of life. These include fatigue, poor global health status, hemorrhage, and dyspnea. Impairment in these poor quality of life measures has been attributing, at least in part, to downstream effect of pancytopenia in these patients. If the acquired aplastic anemia is being treated with IST before they going for allo- HSCT at that chances of survival rate will be up to 90%.

CONCLUSION

In conclusion the encouraging results observed from the data has high effect on immunosuppressive therapy. The allo- HSCT can improve clinical outcome for patient with sever acquired aplastic anemia that progressed from non – anemic conditions. The allo- HSCT may be the first therapy for patients who can tolerate aggressive treatment. We wish to mention that our study is limited by its retrospective nature. Further well-designed, prospective, controlled multicenter co- operative studies are needed to validate our results to confirm the superiority of this approach.

REFERENCES

1. Lixin Xu1†, Zhouyang Liu1†, Yamei Wu1, Xueliang Yang1, Yongbin Cao1, Xiaohong Li1, Bei Yan1, Songwei Li1 "Clinical evaluation of haploidentical hematopoietic combined with human umbilical cord-derived mesenchymal stem cells in severe aplastic anemia" *European Journal of Medical Research-SPRINGER*, 2018.
2. Emma M. Groarke,1 Bhavisha A. Patel,1 Fernanda Gutierrez-Rodrigues,1 Olga Rios,1 Jennifer Lotter,1 Daniela Baldoni,2 Annie St. Pierre,2 Ruba Shalhoub,3 Colin O. Wu,3 Danielle M. Townsley,1 and Neal S. Young1 "Eltrombopag added to immunosuppression for children with treatment-naïve severe aplastic anaemia" *pubmed.gov –ACM*, 2021.
3. Yangmin Zhu, Qingyan Gao, Jing Hu, Xu Liu, Dongrui Guan and Fengkui Zhang* "Allo-HSCT compared with immunosuppressive therapy for acquired aplastic anemia: a system review and metaanalysis" *BMC Immunology-SPRINGER*, 2020.





Joshna et al.,

4. A. Simon Pickard¹, Lynn Huynh^{2*}, Jasmina I. Ivanova³, Todor Totev², Sophia Graham⁴, Axel C. Mühlbacher⁵, Anuja Roy⁶ and Mei Sheng Duh², "Value of transfusion independence in severe aplastic anemia from patients' perspectives – a discrete choice experiment" *Journal of Patient Reported Outcomes – SPRINGER*, 2018.
5. Kimmo Weisshaar¹, Hannah Ewald^{2,3}, Jörg Halter¹, Sabine Gerull¹, Sandra Schönfeld¹, Yuliya Senft¹, Maria Martinez⁴, Anne Leuppi-Taegtmeier⁵, Nina Khanna⁶, Birgit Maier⁷, Antonio Risitano^{8,9}, Regis Peffault de Latour^{9,10}, Andre Tichelli¹, Jakob Passweg¹ and Beatrice Drexler^{1*} "Development of a patient-reported outcome questionnaire for aplastic anemia and paroxysmal nocturnal hemoglobinuria (PRO-AA/PNH)" *Orphanet Journal of Rare Diseases- SPRINGER*, 2020.
6. Elena G. Arias-Salgado^{1,2}, Eva Galvez³, Lurdes Planas-Cerezales⁴, Laura Pintado-Berninches^{1,2}, Elena Vallespin⁵, Pilar Martinez⁵, Jaime Carrillo¹, Laura Iarriccio^{1,2}, Anna Ruiz-Llobet^{6,7}, Albert Catalá^{6,7}, Isabel Badell-Serra⁸, Luis I. Gonzalez-Granado⁹, Andrea Martín-Nalda¹⁰, Mónica Martínez-Gallo¹⁰, Ana Galera-Miñarro¹¹, Carmen Rodríguez-Vigil¹², Mariana Bastos-Oreiro¹³, Guiomar Perez de Nanclares¹⁴, Virginia Leiro-Fernández¹⁵, Maria-Luz Uria¹⁰, Cristina Diaz-Heredia¹⁰, Claudia Valenzuela¹⁶, Sara Martín⁴, Belén López-Muñiz¹⁷, Pablo Lapunzina^{5,18}, Julian Sevilla^{3,18}, María Molina-Molina^{4,19}, Rosario Perona^{1,18†} and Leandro Sastre^{1,18*†}, "Genetic analyses of aplastic anemia and idiopathic pulmonary fibrosis patients with short telomeres, possible implication of DNA-repair genes" *Orphanet Journal of Rare Diseases-ELSEVIER*, 2019.
7. Jiali Huo¹, Leisheng Zhang^{1,2*}, Xiang Ren¹, Chengwen Li¹, Xingxin Li¹, Peiyuan Dong¹, Xuan Zheng¹, Jinbo Huang¹, Yingqi Shao¹, Meili Ge¹, Jing Zhang¹, Min Wang¹, Neng Nie¹, Peng Jin¹ and Yizhou Zheng^{1*} "Multifaceted characterization of the signatures and efficacy of mesenchymal stem/stromal cells in acquired aplastic anemia" *Stem Cell Research & Therapy-ELSEVIER*, 2020.
8. A Wei¹, H H Ma¹, L P Zhang¹, R H Wu¹, R Zhang¹, T Y Wang¹, "Analysis of five cases of hepatitis associated aplastic anemia presenting with hemophagocytic lymphohistiocytosis (HLH) at onset" *pubmed.gov –ACM*, 2020.
9. Jean El-Cheikha, □, Ali Atouia, Nour Moukalleda, Nohra Ghaouia, Haidar El Darsaa, Souha S. Kanjb, Ali Bazarbachi, "Successful treatment of severe aplastic anemia with syngeneic stem cell transplantation in the setting of active disseminated mucormycosis" *Medical Mycology Case Report –ELSEVIER*, 2019.
10. Tong Chen Tian Zhang Chunyan Liu Chao Meng Wang Shaoxue Ding Zong Hong Shao, "NK cells suppress CD8+T cell immunity via NKG2D in severe aplastic anemia" *cellular immunology- ELSEVIER*, 2019.
11. Jianhui Wu^{1,2}, Lu Zhang¹, Sufeng Yin^{1,2}, Haidong Wang¹, Guoli Wang^{1,2} and Juxiang Yuan, "Differential Diagnosis Model of Hypocellular Myelodysplastic Syndrome and Aplastic Anemia Based on the Medical Big Data Platform" *hindawi –ACM*, 2018.
12. Limin Liu^{1†}, Xin Zhao^{2†}, Miao Miao^{1†}, Yanming Zhang³, Wenjing Jiao⁴, Meiqing Lei⁵, Huifen Zhou¹, Qingyuan Wang¹, Yifeng Cai⁶, Liyun Zhao⁷, Xiaohui Shangguan⁸, Zefa Liu⁹, Jinge Xu¹⁰, Fengkui Zhang^{2*} and Depei Wu^{1*} "Inefficacy of Immunosuppressive Therapy for Severe Aplastic Anemia Progressing From Non-SAA: Improved Outcome After Allogeneic Hematopoietic Stem Cell Transplantation" *Frontiers in oncology-ACM*, 2021.
13. Sandip Shah¹ & Preetam Jain¹ & Kamlesh Shah¹ & Kinnari Patel¹ & Sonia Parikh¹ & Apurva Patel¹ & Harsha Panchal¹ & Asha Anand¹, "Immunosuppressive therapy for aplastic anemia: a single-center experience from western India" *Annals of Hematology-SPRINGER*, 2019.
14. Hu H, Chen T, Liu W, Shen Y, Li Q, Zhou Y, Ye B, Wu D, "Differentiation of Yin, Yang and Stasis Syndromes in Severe Aplastic Anemia Patients Undergoing Allogeneic Hematopoietic Stem Cell Transplantation and Their Correlation with Iron Metabolism, cAMP/cGMP, 17-OH-CS and Thyroxine" *dovepress-ACM*, 2021.
15. Anemia dataset – Kaggle.
16. Transplantation – Kaggle.





Joshna et al.,

Table 1:demographic and baseline characteristics

| Parameter | Value |
|--------------------------------|--------------------------|
| Total number of subjects | 13 |
| Severity of AA [n (%)] SAA | 62.6% Adults (n = 13) |
| Age [years (median)] | 24 |
| Sex (female) | 13 |
| Hemoglobin [gm/dl (Mean ± SD)] | 11.56154 ± 2.349659 |
| RBC [per µL (Mean ± SD)] | 4.267607 ± 0.357162 |
| Platelets [per µL (Mean ± SD)] | 236.2308 ± 131.7448 |

Table 2 Characteristic of SAA patient and donors in Allo – HSCT

| Variable | N=13 |
|--|--------------------|
| Donor median age, years (range) | 24 (17- 30) |
| Donor–recipient sex match, no. (N) | |
| Female–female | 10 |
| Female–male | 3 |
| Blood types of donor to recipient, no. (N) | |
| Matched | 2 |
| Mismatched | 11 |
| Source of graft, no. (N) | |
| BM | 3 |
| PB | 10 |
| BM +PB | 0 |
| HLA-matched, no. (N) | |
| 8/104 | |
| 9/102 | |
| 10/107 | |
| Median MNC, ×108 /kg (range) | 10.76 (2.33–33.40) |
| Median CD34+ cells, ×106 /kg (range) | 4.07 (0.68–12.39) |
| Median neutrophil recovery, days (range) | 11 (8–37) |
| Median platelet recovery, days (range) | 4 (8–330) |
| Primary graft failure, no. (%) | 1 (0.72) |
| Secondary graft failure, no. (%) | 4 (2.90) |
| Graft failure of platelets, no. (%) | 5 (3.62) |
| Delayed platelet recovery, no. (%) | 15 (10.87) |





Joshna et al.,



Figure 1. Aplastic anemic bone marrow

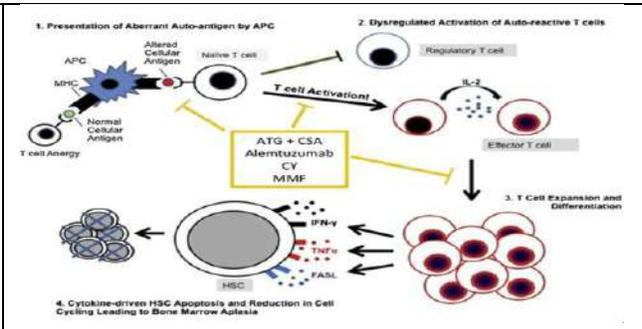


Figure 2. Pathogenesis of Acquired aplastic anemia

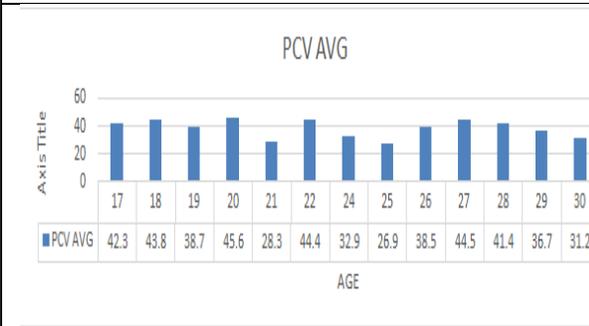


Figure 3. Packed Cell Volume Average (PCV)

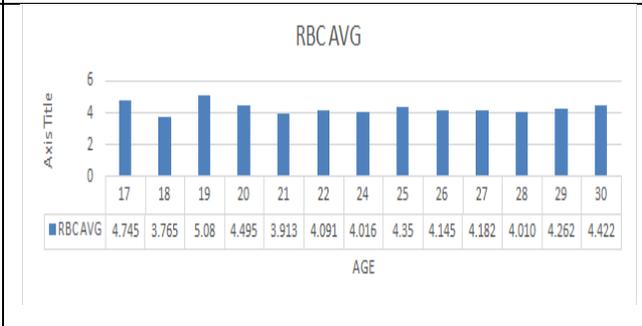


Figure 4. Red Blood Cells Average (RBC)

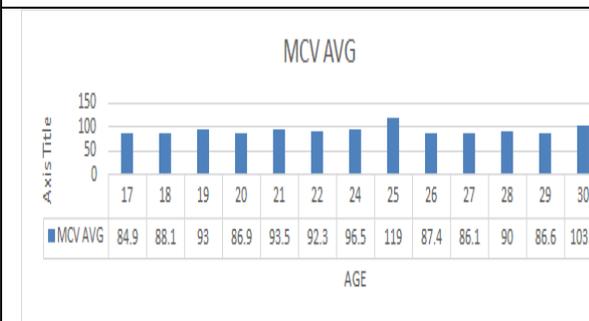


Figure 5. Mean corpuscular volume Average (MCV)

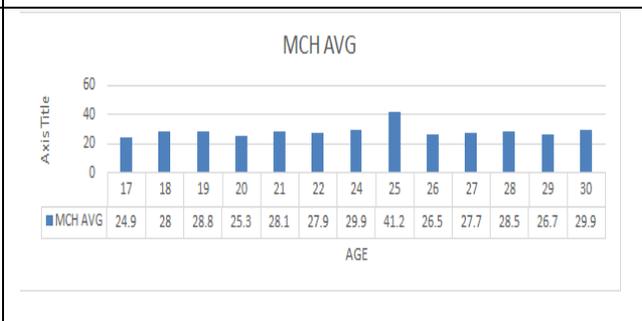


Figure 6. Mean corpuscular hemoglobin average(MCH)

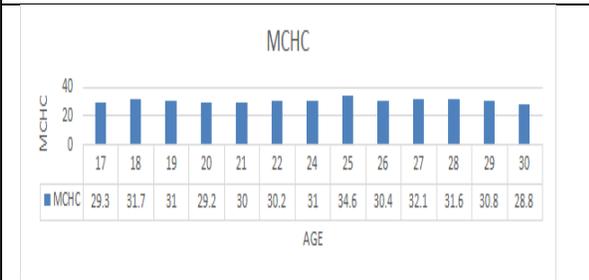


Figure 7. Mean corpuscular hemoglobin average concentration(MCHC)

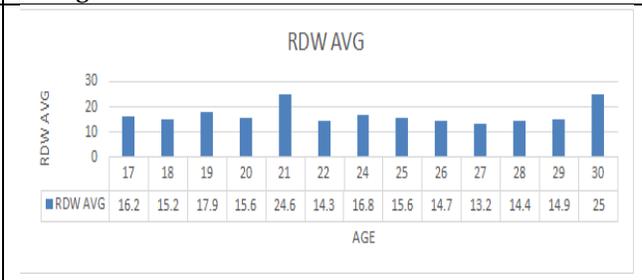


Figure 8. Red cell distribution width average (RDW)





Joshna et al.,

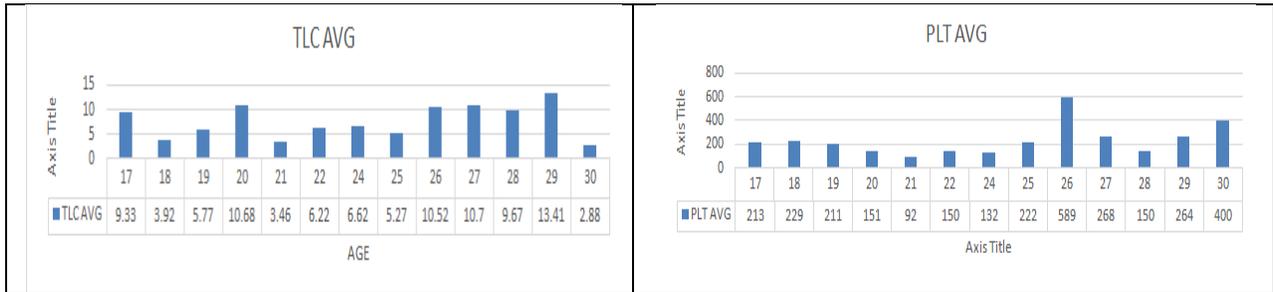


Figure 9.– Total Leukocyte Count Average (TLC)

Figure 10. Platelet count Average (PLT)

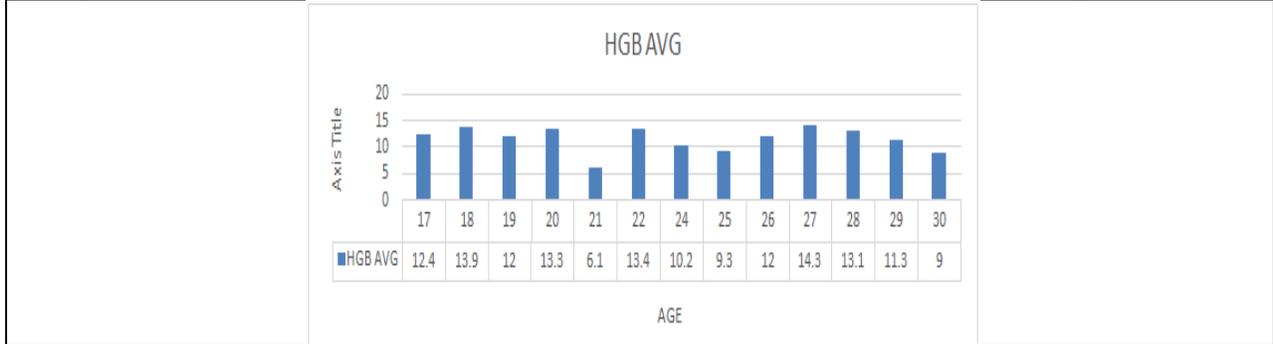


Figure 11. Hemoglobin Average (HGB)





Effect of Vitexin on Inflammatory Genes of Rheumatoid Arthritis

R.Gayathri Devi^{1*} and S.Bhagavathy²

¹Research Scholar, PG and Research Department of Biochemistry, Mohamed Sathak College of Arts and Science, (University of Madras), Sholinganallur, Chennai, Tamil Nadu, India.

²Assistant Professor, PG and Research Department of Biochemistry, Mohamed Sathak College of Arts and Science Sholinganallur, (University of Madras), Chennai, Tamil Nadu, India.

Received: 03 May 2022

Revised: 13 June 2022

Accepted: 02 July 2022

*Address for Correspondence

R.Gayathri Devi,

Research Scholar,

PG and Research Department of Biochemistry,

Mohamed Sathak College of Arts and Science, (University of Madras),

Sholinganallur, Chennai, Tamil Nadu, India.

Email: gaya3dev20msc@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Rheumatoid arthritis is a chronic inflammatory disease that needs global attention. *Vitex negundo* commonly called *Nochi* has been widely used in traditional arthritis ailments. The replacement of adequate steroid drugs with plant-based biochemical leads may reduce the treatment-based side effects and consequences. The current study involves *in vitro* pharmacologically beneficial effect of Vitexin, a bioactive compound of *Vitex negundo* on highly differentiating THP-1 cell lines. Cell cytotoxicity assay was performed to assess the toxicity of the compound, Vitexin. Followed by RT-PCR gene expression studies of Vitexin before and after treatment on LPS induced THP-1 cell lines in varying concentrations. Vitexin treated cell lines showed significant ($p < 0.05$) effect on down regulation of inflammatory key target genes such as Tumor necrosis factor α (TNF α), Interleukins (IL-1 β , and IL-6). The effects are compared with the standard drug Prednisone treatment. Amplification blots are recorded and the corresponding CT values and their reports are expressed statistically. The results show that the bioactive compound, Vitexin has a significant inhibitory role in expression of inflammatory genes in THP-1 cell lines stimulated by Lipopolysaccharides. The current study suggests that Vitexin may act as a potent anti-inflammatory agent for rheumatoid arthritis treatment and further *in vivo* studies are needed.

Keywords: Rheumatoid arthritis, TNF α , IL-1 β , IL-6, Vitexin, THP-1 cell lines, LPS





Gayathri Devi and Bhagavathy

INTRODUCTION

Plants are the rich source of pharmacologically beneficial molecules and metabolites such as flavonoids, alkaloids, tannins, coumarins, phenols, glycosides that play a dynamic role in engaging in various activities like anti-inflammation, anti-ageing, anti-cancerous, antibacterial and antiviral [1]. Traditional folkloric herbal medicines and procedures are gaining immense importance [2] in replacing chemical-based Disease Modifying Anti-Inflammatory Drugs (DMARDS) and Non-Steroidal Anti-Inflammatory Drugs (NSAIDS) especially in developing countries like India due to their promising cost and drastic prolonged side effects [3]. One such well known medicinally significant annual shrub is *Vitex negundo*, used as an important natural constituent in Ayurvedic anti-inflammatory medicines and procedures for centuries [4]. From earlier studies it is known that *Vitex negundo* is reported to contain an ample number of naturally effective phytochemical candidates of choice [5]. The present study deals with the scientific validation of the anti-rheumatic potential of an herbal lead, Vitexin from *Vitex negundo* [6]. Vitexin is a Flavonoid C-glycoside and flavonoids are generally polyphenolic compounds with a wide array of pharmacological actions [7]. Vitexin has been reported as a promising pharmacokinetic property in various oxidative stress-related models [8]. Vitexin acts as a good radical scavenger and a potent antioxidant candidate. Since it is a small polar molecule, it is easy to dissolve and may become a better lead of choice [9] (Figure 1).

A commonly increasing chronic autoimmune inflammatory disease which ranked 42nd highest contributor of over 150 types of rheumatic and musculoskeletal disorders categorized that needs global attention is Rheumatoid arthritis [10]. RA is a bone deformity disease in which the inflammation originates at the synovium [11]. At the site of inflammation, high traces of expression of pro-inflammatory cytokines are reported. Cytokines further sequester the proliferation of macrophages and immune cells at the synovium, leading to irreversible bone damage [12]. Tumor necrosis factor α (TNF α), IL-1 β , and IL-6, are the most prominent pro-inflammatory cytokines produced by activated macrophages at the site of inflammation and stimulate the synovial fibroblasts (SFs) called fibroblast-like Synoviocytes (FLS) [13], [14]. Inflammatory processes may lead to collagen degradation mostly due to the up-regulation of matrix metallo-proteinases (MMPs) by the above-mentioned Tumor necrosis factor α (TNF α), IL-1 β , and IL-6 followed by NF κ B and human IK β Kinase proteins [15]. Vitexin may act as a potent anti-inflammatory agent which has been traditionally used for various inflammatory diseases [16]. This study involves research on validating the efficacy of Vitexin on inflammatory targets at the site of synovium in rheumatoid arthritic condition by assessing the cytotoxicity of Vitexin on differentiating human monocytic THP-1 cell lines and the determination of mechanism of action of Vitexin on pro-inflammatory genes and their corresponding downregulations using LPS stimulated human monocytic THP-1 cell lines [17].

MATERIALS AND METHODS

Chemicals

Vitexin and Prednisone were purchased from sigma. Fetal bovine serum from Genetix Biotech, India. RPMI-1640 from Genetix Biotech, India. MEM medium from Genetix Biotech, India. DMSO from SRL chemicals. MTT, (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) were purchased from Sigma

Cell culture

THP-1 cell line was purchased from NCCS Pune. The cell lines were grown in a RPMI-1640 medium supplemented with 10% fetal bovine serum and 100 U/ml penicillin and 100 μ g/ml streptomycin. When a cell density in a culture flask reached 70-80% confluence, they were collected by centrifugation, counted and seeded in 6-well plates in the density of 200000 cells per well in 2 ml complete medium. THP 1 cells were treated with Vitexin for inflammatory stimulus and the corresponding changes in mRNA and inflammatory protein levels were assessed.





Cell proliferation (MTT) assay

Cell proliferation (MTT) assay was performed following the method described by Carmichael *et al.*, (1987) and percentage of cell viability was determined by spectrophotometric determination of accumulated formazan derivative in treated cells at 570 nm in comparison with the untreated ones [18]. For the MTT assay, the cells were grown in tissue culture flasks containing RPMI-1640 medium supplemented with 10% FCS, 100 U/ml penicillin, and 100 µg/ml streptomycin and grown at 37°C under a humidified atmosphere of 95% air and 5% CO₂. Cells were regularly passaged and maintained before including for the experiment. When a cell density in a culture flask reached 70-80% confluence, they were collected by centrifugation, counted and seeded in 96-well plates in the density of 10000 cells per well in 100 µL. Test item was prepared as 200 mg/ml stocks by adding 100% DMSO. The working stock of 2X (2, 6, 20, 60, 200, 600 and 2000 µg/ml) concentration was prepared in complete medium supplemented with 10% FBS and antibiotics. 100 µL volume of 2X stock was transferred to respective wells to maintain the final concentration range of 1, 3, 10, 30, 100, 300 and 1000 µg/ml and the plate was further incubated for 48 hours at 37°C, 5% CO₂ in the incubator.

MTT solution was prepared at 5 mg/ml in PBS and after 48 hours incubation 50 µl of MTT solution was pipetted into each well to achieve 1mg/mL as final concentration. The plate was further incubated for 3 hours in incubator and the medium was carefully decanted by pipetting. The formazan crystals were air dried in dark place for 30 min at room temperature and dissolved in 100 µL DMSO. The plates were mildly mixed at room temperature for 10 min and the OD was measured using Synergy HT microplate reader at 570 nm. From the optical densities the percentage growths were calculated using the following formula:

$$\text{Percentage growth} = 100 \times [(T - T_0) / (C - T_0)]$$

Where, T is optical density of test, C is the optical density of untreated control, T₀ is the optical density at time zero (at the time of compound addition). From the percentage growth a dose response curve was generated and GI₅₀ values were interpolated from the growth curves.

Vitexin Treatment

2×10⁵ cells/well of human THP-1 plated in 1.6 ml volume on 6-well tissue culture plate and incubated for 30 min before compound treatment at 37°C under a humidified atmosphere of 95% air and 5% CO₂. The test compounds were prepared 20 mg/ml stock from this working stock are prepared as 5X concentration (250, 500 and 1000 µg/ml) in complete RPMI-1640 medium. 400 µl of Vitexin and Prednisone were transferred to respective wells to achieve the final concentration of 50, 100 and 200 µg/ml and the plates was gently rocked for few seconds. 400µl of complete medium was added to the well served as untreated control and LPS induced. The plate is incubated for 30 min before adding LPS. After incubation 100 µl of 2 µg/ml stock of LPS was added to all the wells. The plate was further incubated at 37°C under a humidified atmosphere of 95% air and 5% CO₂ for 20 hrs. After incubation, the cells were collected by centrifugation at 3000 rpm for 5 min at 4°C. The supernatants were discarded and the cell pellets were washed with Phosphate buffered saline before RNA isolation processes.

RNA Isolation

The total RNA was extracted from the cell pellets using TRIZOL method [19]. 1 ml of TRIZOL reagent was added into cell pellet and homogenised by vortexing. The homogenised samples were incubated for 5 minutes at room temperature for complete dissociation of nucleoprotein complexes. After incubation, the samples were centrifuged at 12000 rpm for 10 min to remove cell debris. The supernatants were transferred in a fresh tube and 0.2 ml of chloroform was added to each tube. Then they were vortexed vigorously for 15 seconds and incubated for 3 min at room temperature. After incubation, they were centrifuged at 12000 rpm for 15 min at 4°C. After centrifugation, around 0.5ml of the upper aqueous phase was transferred carefully without disturbing the interphase into fresh tube. The volume of the aqueous phase was measured 0.5 ml of isopropanol was added into all the tubes and gently inverted the tubes for mixing. The samples were incubated for further 10 min at room temp and centrifuged for 10000 rpm for 10 min. The precipitated pelleted RNAs were washed by adding 1 ml of 75% ethanol and centrifuged





for 10 min at 8000 rpm. The washing step was repeated twice. The RNA pellets were air dried for 10 min and dissolved using 100µl of RNase free water. RNA was quantified using a spectrophotometer and the purity of the sample was determined using A260/280 readings. Samples with A260/280 readings above 1.8 are free of any protein contamination. 100ng of sample was run on RNA gel to check for DNA contamination after the samples were treated with DNase I from NEB [Catalogue#: M0303S] as per manufacturers protocol to eliminate any possible DNA contamination.

cDNA Conversion

All the required kit components and reagents are thawed on ice. Required volumes of each component were mixed as per the manual instructions. Master mix prepared for 6 samples was equally distributed into 0.2ml PCR vials. To each vial 200 ng of respective RNA sample was added and final volume was made to 20µL using molecular grade water. The reaction mixture was completely mixed with pipetting the reaction mixture up and down 2-5 times. The samples were then loaded into a thermal cycler Himedia personal and the following program was run. After completing the cDNA conversion step the samples were stored at -20°C until further process.

Real Time PCR Analysis

Real time assay was performed for 4 samples mentioned above for the following genes (Table-1). All the components required for the setup were thawed on ice prior to setup. A master mix with each primer set was prepared for required number of samples and 2 additional samples to compensate for the pipetting losses. All reactions are performed in duplicates along with NTC (non-template control). 38 µl of the mix was aliquot into corresponding wells, to each master mix 2 µl of respective sample is added to make to a final volume of 40 µl. Sample was mixed 2-5 times with pipette and 20 µl was transferred into replicate vial. All the sample tubes were covered with Optical film/Optical cap (Agilent: #401425). Sample tubes were briefly vortexed and centrifuged to bring down the contents and to eliminate any air bubbles. The samples were loaded onto the Real time PCR machine Strat gene Mx3000P and the two-step program was run.

Statistical analysis

The RT-PCR data was collected and analyzed on MxPro Software from Agilent Technologies. All the CT values were exported to excel file for final reporting. All the results were statistically expressed as Mean ± Standard error mean (SEM) using SPSS Software (version 12.0)

RESULTS

To verify the cytotoxic effects of Vitexin, Vitexin was treated at different concentrations on human monocytes THP-1 cells in reference to the standard drug for Rheumatic arthritis prescription, Prednisone. The MTT assay was performed in quadruplicate and cumulative variation was maintained less than 20% between the data points and Vitexin shows growth inhibition in THP-1 cells at IC₅₀ of 91.3 µg/ml (Figure 2). From the cytotoxic assay results it is known that Vitexin significantly at, 95% confidence interval reduces the differentiation of THP-1 monocytes in comparison with the control THP-1 cell line which was tested with different concentrations. (Figure 3 and Figure 4.) To assess the *in vitro* anti-inflammatory activity of Vitexin on THP-1 monocytes, Real Time PCR analysis of Vitexin in three different concentrations (50µg/ml, 100µg/ml and 200 µg/ml) was performed to find out the mRNA expression levels of target pro-inflammatory cytokines. Amplification blots were analyzed and the CT values of Tumor necrosis factor α (TNF α), IL-1 β , and IL-6 before and after inducing inflammation using Lipopolysaccharide in reference to Prednisone were observed and recorded. CT values of Prednisone, a standard anti-inflammatory drug used as positive control, and β -Actin as a housekeeping gene were noted. The mRNA expression levels of Tumor necrosis factor α (TNF α), IL-1 β , and IL-6 are reported as β actin gene normalized gene expression charts with respect to Vitexin and Prednisone treatment (Figure 5). The mRNA expression levels of cytokines in the LPS induced untreated cell line group represent the inflammatory rate in comparison with untreated cell lines. LPS stimulated the



**Gayathri Devi and Bhagavathy**

expressions of TNF α , IL-1 β , and IL-6 in THP -1 cell lines was found to be 8.6%, 9.32%, 13.6% respectively in terms of means normalized gene expression.

DISCUSSION

Earlier studies reported that THP-1 cell lines are one of the best *in vitro* cell line models for studying immune complexes upon treatment [20, 21]. Vitexin treated genetically identical cell lines mimicked a reliable inflammatory pathway upon treatment. Gene expression levels of TNF α were considerably decreased at the Vitexin treatment of about 200 μ g/ml on comparison with standard Prednisone treatment of 50 μ g/ml. Vitexin at 50 μ g/ml shows a moderate anti-inflammatory activity on IL-6 expressions on comparison with the other two concentrations of Vitexin. IL-1 β expressions were increased 10 times from the untreated cells after LPS stimulation. Vitexin concentrations of about 100 μ g/ml and 200 μ g/ml showed a significant reduction in the expression of IL-1 β gene. Similar results have been reported earlier that Vitexin has significant effect on cytokine expressions and immune cell downregulations [22]. These results may confirm that the treatment of Vitexin at minimal concentration shows a potent pharmacological effect on expression of inflammatory genes with a special note on downregulation of TNF alpha which plays a crucial role in sequestering immune cells at the synovium. Effect of Vitexin on downregulation of inflammatory genes may act as a demonstration of potent anti-inflammatory activity of flavonoid, Vitexin and may support the studies reported earlier regarding inhibition of pain- like behavior [23] in experimental models.

CONCLUSION

This present study may evident that Vitexin is a potent flavonoid from an easily available traditional plant *V. negundo* which shows a notable pharmacologically beneficial role on inflammation. This study may further ensure the *in vivo* anti-arthritic study of Vitexin is needed to scientifically validate the traditional usage of the whole plant *Vitex negundo* in treating rheumatism. Further studies may reveal that Vitexin is a potent lead which may be a competitive substitute of TNF α inhibitors.

ABBREVIATIONS

(DMARDS) Disease modifying anti-inflammatory drugs, (NSAIDS) Non-steroidal anti-inflammatory drugs, (TNF α) Tumor necrosis factor α , (IL-1 β) and (IL-6) Interleukins, (SFs) synovial fibroblasts, (FLS) Fibroblast-like Synoviocytes, (MMPs) Matrix Metallo-Proteinases, (NF κ β) Nuclear factor kappa light chain enhancer of activated β cells, (IK β Kinase) IKappa B kinase, (LPS) Lipopolysaccharide, (MEM) Minimum essential medium, (DMSO) Dimethyl sulfoxide, (FCS) Fetal calf serum, (NTC) Non-template control, (CT) Cycle Threshold

REFERENCES

1. Basiru, Ajiboye & Ibukun, Emmanuel & Edobor, Genevieve & Ojo, Oluwafemi & Onikanni, Sunday. (2013). Qualitative and quantitative analysis of phytochemicals in senecio biafrae leaf. International journal of inventions in pharmaceutical sciences, 1. 428-432.
2. Yuan, H., Ma, Q., Ye, L., & Piao, G. (2016). The Traditional Medicine and Modern Medicine from Natural Products. Molecules (Basel, Switzerland), 21(5), 559.
3. Ha, SY., Shim, YB., Lee, MY. *et al.* (2021). Comparative Cost-Effectiveness of Tofacitinib with Continuing Conventional Synthetic Disease-Modifying Anti-Rheumatic Drugs for Active Rheumatoid Arthritis in South Korea. Rheumatol Ther 8, 395-409.
4. Gitanjali Devi. (2021). Medicinal plant: Vitex negundo. International Journal of Current Research, 13, (05), 17592-17594





Gayathri Devi and Bhagavathy

5. Koirala, Niranjan & Dhakal, Chiran & Munankarmi, Nabin & Ali, Shinawar & Hameed, Aneela & Cruz-Martins, Natália & Sharifi-Rad, Javad & Imran, Muhammad & Arif, Atta & Hanif, Muhammad & Basnyat, Ram & Salehi, Bahare. (2020). Vitex negundo Linn.: phytochemical composition, nutritional analysis, and antioxidant and antimicrobial activity. *Cellular and molecular biology*, 66, 1-7.
6. Roy, S. K., Bairwa, K., Grover, J., Srivastava, A., & Jachak, S. M. (2013). Analysis of Flavonoids and Iridoids in Vitex Negundo by HPLC-PDA and Method Validation. *Natural Product Communications*.
7. Liu, N., Wang, K.S., Qi, M. et al. Vitexin compound 1, a novel extraction from a Chinese herb, suppresses melanoma cell growth through DNA damage by increasing ROS levels. (2018). *J Exp Clin Cancer Res* 37, 269.
8. Babaei F, Moafizad A, Darvishvand Z, Mirzababaei M, Hosseinzadeh H, Nassiri-Asl M. (2020) Review of the effects of vitexin in oxidative stress-related diseases. *Food Science and Nutrition*, 8,2569–2580.
9. Yahaya, M.A.F., Bakar, A.R.A., Stanslas, J. et al. (2021) Insights from molecular docking and molecular dynamics on the potential of vitexin as an antagonist candidate against lipopolysaccharide (LPS) for microglial activation in neuroinflammation. *BMC Biotechnology* 21, 38.
10. Guo, Q., Wang, Y., Xu, D., Nossent, J., Pavlos, N. J., & Xu, J. (2018). Rheumatoid arthritis: pathological mechanisms and modern pharmacologic therapies. *Bone research*, 6, 15.
11. Salaffi, F., Di Carlo, M., Carotti, M., Farah, S., Ciapetti, A., & Gutierrez, M. (2019). The impact of different rheumatic diseases on health-related quality of life: a comparison with a selected sample of healthy individuals using SF-36 questionnaire, EQ-5D and SF-6D utility values. *Acta bio-medica : Atenei Parmensis*, 89(4), 541–557.
12. Carmona-Rivera, C., Carlucci, P. M., Goel, R. R., James, E., Brooks, S. R., Rims, C., Hoffmann, V., Fox, D. A., Buckner, J. H., & Kaplan, M. J. (2020). Neutrophil extracellular traps mediate articular cartilage damage and enhance cartilage component immunogenicity in rheumatoid arthritis. *JCI insight*, 5(13), e139388.
13. Choy, E. H., & Panayi, G. S. (2001). Cytokine pathways and joint inflammation in rheumatoid arthritis. *The New England journal of medicine*, 344(12), 907–916.
14. Choi, H. M., Oh, D. H., Bang, J. S., Yang, H. I., Yoo, M. C., & Kim, K. S. (2010). Differential effect of IL-1 β and TNF α on the production of IL-6, IL-8 and PGE2 in fibroblast-like synoviocytes and THP-1 macrophages. *Rheumatology international*, 30(8), 1025–1033.
15. Mirastschijski, U., Lupše, B., Maedler, K., Sarma, B., Radtke, A., Belge, G., Dorsch, M., Wedekind, D., McCawley, L. J., Boehm, G., Zier, U., Yamamoto, K., Kelm, S., & Ågren, M. S. (2019). Matrix Metalloproteinase-3 is Key Effector of TNF- α -Induced Collagen Degradation in Skin. *International Journal of Molecular Sciences*, 20(20), 5234.
16. Muhammad Umar Ijaz, Hussain Ahmed, Asma Ashraf, Sidra Aziz, K.A. Al-Ghanim, Mumtaz Akhtar, M. Nadeem Riaz, Shahid Mahboob. (2021) Vitexin attenuates cisplatin-induced renal toxicity by reducing oxidative stress and inflammation, *Journal of King Saud University - Science*, 33(8)101657, 1018-3647.
17. Chinchu, J. U., Mohan, M. C., Devi, S., & Kumar, B. P. (2018). Evaluation of anti-inflammatory effect of Varanadi Kashayam (decoction) in THP-1-derived macrophages. *Ayu*, 39(4), 243–249.
18. Carmichael, J., DeGraff, W. G., Gazdar, A. F., Minna, J. D., & Mitchell, J. B. (1987). Evaluation of a tetrazolium-based semiautomated colorimetric assay: assessment of chemosensitivity testing. *Cancer research*, 47(4), 936–942.
19. Simms, D., Cizdziel, P. E., & Chomczynski, P. (1993). TRIzol: A new reagent for optimal single-step isolation of RNA. *Focus*, 15(4), 532-535.
20. Baxter, E. W., Graham, A. E., Re, N. A., Carr, I. M., Robinson, J. I., Mackie, S. L., & Morgan, A. W. (2020). Standardized protocols for differentiation of THP-1 cells to macrophages with distinct M(IFN γ +LPS), M(IL-4) and M(IL-10) phenotypes. *Journal of immunological methods*, 478, 112721.
21. Conn D. L. (2001). Resolved: Low-dose prednisone is indicated as a standard treatment in patients with rheumatoid arthritis. *Arthritis and rheumatism*, 45(5), 462–467.
22. Nikfarjam, B. A., Hajiali, F., Adineh, M., & Nassiri-Asl, M. (2017). Anti-inflammatory effects of quercetin and vitexin on activated human peripheral blood neutrophils-The effects of quercetin and vitexin on human neutrophils. *Journal of Pharmacopuncture*, 20(2), 127-131.
23. Borghi, S. M., Carvalho, T. T., Staurengo-Ferrari, L., Hohmann, M. S., Pinge-Filho, P., Casagrande, R., & Verri, W. A., Jr (2013). Vitexin inhibits inflammatory pain in mice by targeting TRPV1, oxidative stress, and cytokines. *Journal of natural products*, 76(6), 1141–1149.





Table-1 Primer Details for RT PCR Analysis

| Gene | Primer | Primer Sequence | Size of Amplicon (bp) |
|---|---------|-----------------------|-----------------------|
| Human IL-1α NCBI Ref. Sequence: NM_000576.2 | Forward | AACCTCCTCTCTGCCATCAA | 260 |
| | Reverse | GGAAGACCCCTCCCAGATAG | |
| Human IL-6 NCBI Ref. Sequence: NM_000600.4 | Forward | AAAGAGGCACTGGCAGAAAA | 259 |
| | Reverse | CAGGGGTGGTTATTCATCT | |
| | Reverse | GGCCTTGCTCTTGTTTCAC | |
| Human TNF-β NCBI Ref. Sequence: NM_000594.3 | Forward | AACCTCCTCTCTGCCATCAA | 100 |
| | Reverse | GGAAGACCCCTCCCAGATAG | |
| β-actin NCBI Ref. Sequence: NM_001101 | Forward | CATCGAGCACGGCATCGTCA | 211 |
| | Reverse | TAGCACAGCCTGGATAGCAAC | |

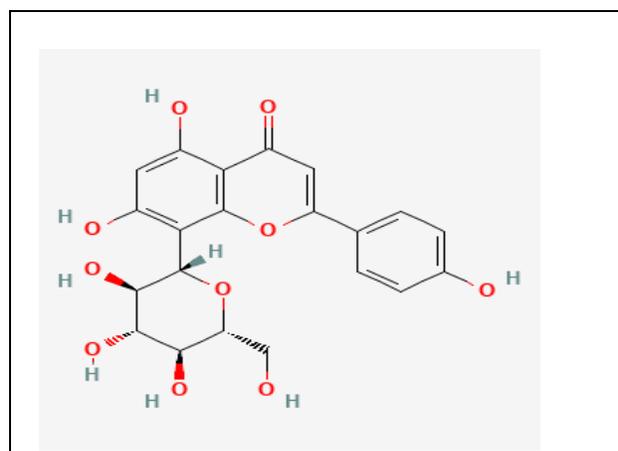


Figure 1: Vitexin

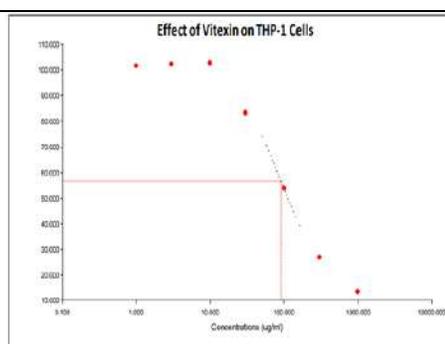


Figure 2: IC50 curve for Vitexin on THP-1 Cell lines

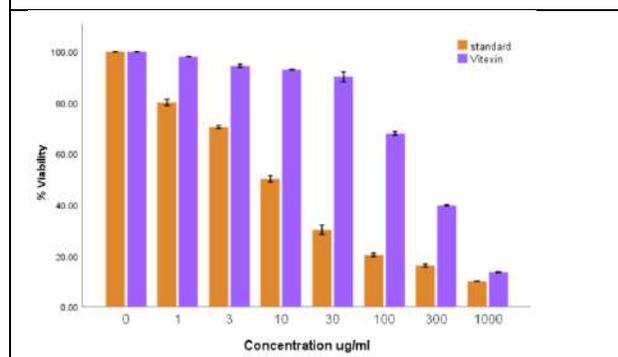


Figure 3: % Viability of THP-1 cell lines

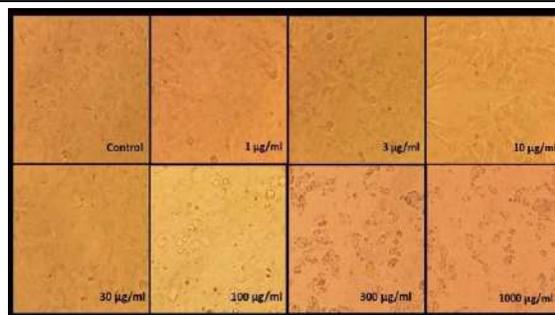


Figure 4: Differentiation of THP-1 Cell lines corresponding to varying concentrations of Vitexin in comparison with control





Gayathri Devi and Bhagavathy

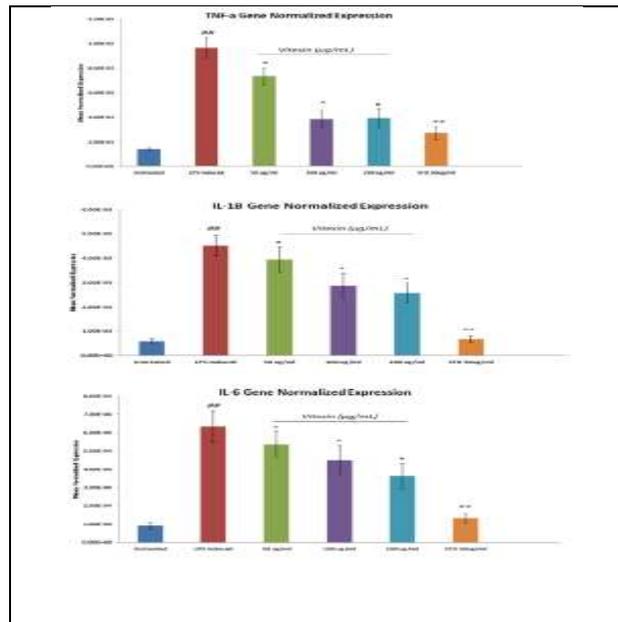


Figure 5: LPS induced Vitexin modulated gene expressions of TNF α , IL-1 β , and IL-6 in THP -1 cell lines in comparison with standard- Prednisone expressed as β -actin equivalents. Data are presented as Mean \pm S.D (**p<0.01, *p<0.05, **p<0.001 compared to control)

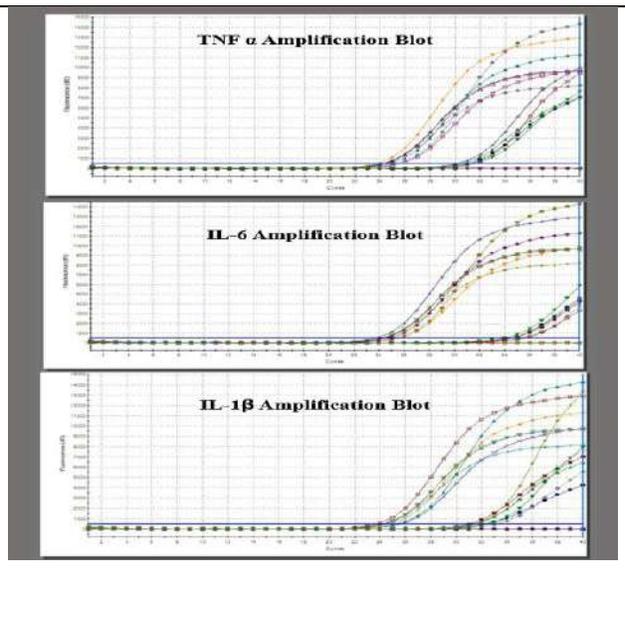


Figure 6: The RT-PCR amplification CT data from MxPro Software, Agilent Technologies





Birth Weight and Sex of Crossbred Calves in an Organized Dairy Farm

George Sherin K^{*1}, K. Lalu², M. K. Muhammad Aslam³ and M.T. Dipu⁴

¹Assistant Professor and Head, Base Farm Kolahalamedu, Kerala Veterinary and Animal Sciences University, Kerala, India

²Assistant Professor, CDST, Thiruvananthapuram, Kerala Veterinary and Animal Sciences University, Kerala, India

³Assistant Professor, Base Farm Kolahalamedu, Kerala Veterinary and Animal Sciences University, Kerala, India

⁴Assistant Professor, Department of Animal Nutrition, CVAS, Mannuthy, Kerala, India.

Received: 01 Dec 2021

Revised: 03 Jun 2022

Accepted: 05 July 2022

*Address for Correspondence

George Sherin K

Assistant Professor and Head,
Base Farm Kolahalamedu,
Kerala Veterinary and Animal
Sciences University, Kerala, India.
Email: skgeorge31@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Calf birth weight is considered as an important trait in dairy cattle breeding programs. A study was conducted to determine the birth weight and sex of crossbred calves in an organized dairy farm. The investigation was carried out at Base Farm Kolahalamedu, situated at Vagamon Village of Idukki District in Kerala state. The data related to birth weight and sex of calves born to cows inseminated with the crossbred Jersey (CBJ) and crossbred Holstein Freisian (CBHF) bull semen during a period of 2 years (2019 and 2020) were collected separately and grouped. Secondary sex ratio (SSR) and relative female ratio (RFR) was also determined. In total, 63 calves were born live during the study period of which 26 calves with mean body weight of 28.65 ± 0.42 were born to cows inseminated with CBHF semen and 37 calves with mean body weight of 25.54 ± 0.39 were born to cows inseminated with CBJ semen. In total 33 female calves and 30 male calves were born during the study period. The calculated SSR was 47.62: 52.38 while the RFR was 1.1. The study revealed that in crossbreeding programmes, birth weight of calves is influenced by the breed of the sire and the proportion of male and female calves born are nearly the same.

Keywords: weight, dairy, cattle, Idukki, study period.





George Sherin *et al.*,

INTRODUCTION

Calf birth weight is considered as an important trait in dairy cattle breeding programs and is positively correlated with future milk production of the herd (Ranhbar *et al.*, 2016). However, increased calf birth weight is associated with dystocia and calf mortality which may lead to economic losses (Meijering, 1984). In Kerala, crossbreeding of cattle with exotic dairy cattle breeds such as Holstein Friesian, Jersey and Brown Swiss for the last few decades had improved the birth weight of calves and average milk production of cows. Cross breeding allow to combine the desirable characteristics from the breeds involved resulting in heterosis or hybrid vigour (Deepti *et al.*, 2021). Generally in cross breeding programmes of the country exotic inheritance is maintained without exceeding 62.5% since beyond this crossbred acquires the problems with adaptability and lower disease resistance.

METHODOLOGY

The study was carried out at Base Farm Kolahalamedu, situated at Vagamon Village of Idukki District in Kerala state with an altitude of 1100 m above sea level, with an annual rainfall of 2300 mm. Crossbred cattle with a herd strength of nearly 150 animals are maintained in the farm in a semi intensive system. Animals are housed in well ventilated sheds with asbestose roofing laid over stacked and cemented stone walls under proper hygiene. Animals are left out for grazing from morning till noon for nearly 6 hrs in a day. While housed in the shed, animals are offered with adlibitum fodder (Setaria grass), adlibitum water and concentrate mixture as per the requirement (Package of Practices). Animals in estrus are identified during grazing and are inseminated randomly with crossbred Jersey (CBJ) or crossbred Holstein Friesian (CBHF) semen supplied by Kerala Livestock Development Board. The data related to birth weight of calves born to cows inseminated with the CBJ and CBHF bull semen during a period of 2 years (2019 and 2020) were collected separately and grouped. Birth weight of calves were recorded soon after birth in a digital weighing balance. Student "t" test was performed to study the variations in birth weight between the calves born to cows inseminated with CBJ and CBHF semen.

Sex of the calves born during the period was also recorded and the secondary sex ratio (SSR) was calculated (Fischer., 1930) as $(A/C) \times 100 : (B/C) \times 100$, where A is the number of male, B is the number of female and C is the total of male and female born. $(A+B)$. Relative female ratio (RFR) was calculated as the ratio of the number of female calves with the number of male calves (Yilmaz *et al.*, 2010).

RESULTS AND DISCUSSION

In total, 63 live calves were born during the study period of which 26 calves were born to cows inseminated with CBHF semen and 37 calves were born to cows inseminated with CBJ semen. Mean birth weight (kg \pm SEM) of calves born to cows inseminated with CBHF semen (28.65 \pm 0.42) was higher ($p < 0.05$) than the calves born to cows inseminated with CBJ semen (25.54 \pm 0.39). Hick son *et al.*, (2015) also found that Jersey calves were lighter than Holstein Freisian calves born to dairy cows in New Zealand. In total 33 female calves and 30 male calves were born during the study period. The calculated SSR was 47.62: 52.38 while the RFR was 1.1. In a study conducted at an organized dairy farm in Andaman and Nicobar islands (Perumal *et al.*, 2019) the proportion of male and female calves born was 49.75: 50.25 and the RFR value was nearly 1.

CONCLUSION

In crossbreeding programmes using the crossbred bull semen of Jersey and Holstein Freisian breeds, calves born to cows inseminated with the semen of CBHF bulls were comparatively heavier. It was also observed that crossbreeding with semen of CBJ and CBHF bulls maintains a similar proportion of male and female calves born in an organized dairy farm.





George Sherin *et al.*,

REFERENCES

1. Deepti, K.B., Jain, A., Dubay, A. and Yadav, A. 2021. Crossbreeding in cattle: A review. *Ind. J. Pure App. Biosci.* 9(1): 450-456
2. Fisher, R. A. 1930. *The Genetical Theory of Natural Selection*, Oxford University Press, Oxford, UK .
3. Hick son, R.E., Zhang, I.L. and McNaughton, L.R. 2015. Birth weight of calves born to dairy cows in New Zealand. *Proc. New Zeal. Soc . Anim. Prodn.* 75: 257-259.
4. Meijering, A. 1984. Dystocia and stillbirth in cattle–A review of causes, relations and implications. *Livest. Prod. Sci.* 11:143–177.
5. Package of Practices recommendations. 2016. Directorate of Entrepreneurship, Kerala Veterinary and Animal Sciences University.
6. Perumal, P., De, A.K., Bhattacharya, D., Kundu, A., Sunder, J., Ravi, S.K., Bala, P.A., Alyethodi, R.R. and Ahmed S.K.Z. 2019. Birth rate and birth weight of crossbred calves in Andaman and Nicobar islands. *Int. J. Bioresour. Stress. Manag.* 10 (3): 323-328.
7. Rahbar, R., Abdullah pour, R. and Sadeghi-Sefidmazgi, A. 2016. Effect of calf birth weight on milk production of Holstein dairy cattle in desert climate. *J. Anim. Behav. Biometeorol*, 4 (3): 65-70.
8. Yilmaz, I., Eyduran, E. and Kaygisiz, A. 2010. Determination of some environmental factors related to sex ratio of Brown Swiss calves. *The J. Anim. Plant Sci.* 20 (3): 164-169.





Role of Essential Oils in Inflammation: A Review

Anakha Tomson¹, Sonia Ninan^{2*} and Manju Maria Mathews ³, Sneha Ann Sanju¹

¹VIIIth Semester, B.Pharm Student, Nirmala College of Pharmacy, Muvattupuzha, Kerala, India

²Assistant Professor in Pharmaceutics, Nirmala College of Pharmacy, Muvattupuzha, Kerala, India

³Professor in Pharmaceutics, Nirmala College of Pharmacy, Muvattupuzha, Kerala, India

Received: 27 Apr 2022

Revised: 15 Jun 2022

Accepted: 02 July 2022

*Address for Correspondence

Sonia Ninan

Assistant Professor in Pharmaceutics,
Nirmala College of Pharmacy,
Muvattupuzha, Kerala, India.
Email: thesonianinan@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Inflammation is at the root of numerous physiological and pathological processes. Many kinds of inflammation have well-understood pathogenic characteristics, but their physiological activities are mostly unknown. Infection and tissue injury are two of the most common causes of inflammation, and they both cause the recruitment of leukocytes and plasma proteins to the injured tissue location. An essential oil is described as a product derived by hydro distillation, steam distillation, or dry distillation of a plant or some components of it, or by a suitable mechanical method without heating. They are aromatic oily liquids that are volatile, have a strong odour, are rarely coloured, and have a lower density than water. Essential oils, which act on the primary pathways involved in the pathogenesis of inflammation, have shown encouraging outcomes in preclinical research. Essential oils are particularly useful in treating minor to medium wounds, skin abrasions, excoriations, skin infections, and other topical health issues when administered at the proper concentration.

Keywords: Essential oil, Inflammation, Inflammatory mediators, lysosomes, Anti-inflammatory, Leukocytes.

INTRODUCTION

Inflammation occurs when infectious microorganisms such as bacteria, viruses, or fungi infiltrate the body, settle in specific tissues, and circulate in the bloodstream. In most cases, both the innate and adaptive immune responses are implicated in the development of inflammation. During various forms of inflammatory responses, a variety of inflammatory mediators are synthesized and released. Profaned anti-inflammatory mediators are the two primary groups of inflammatory chemicals. Some mediators, such as interleukin (IL)-12, do, however, have both pro- and anti-inflammatory effects [1]. Heat, redness, discomfort, swelling, and disrupted physiological activities characterize





Anakha Tomson et al.,

inflammation, which is a body response to injury, infection, or destruction. Inflammation is the body's natural protective response to tissue damage caused by physical trauma, toxic chemicals, or infectious pathogens. It is the body's response to inactivate or eliminate invading pathogens, remove irritants, and prepare tissues for repair. The release of chemical mediators from wounded tissue and migratory cells sets it [2]. Inflammation is a complicated and necessary component of the body's reaction to biological, chemical, or physical stimuli, as well as the cellular and molecular events that initiate and govern interactions among the numerous players involved in the inflammatory process. The immune systems cells migrate to the site of injury in the acute phase of the inflammatory response, which is aided by soluble mediators such as cytokines, chemokines, and acute-phase proteins [3]. In recent years, at least 300 types of essential oils out of 3000 have become commercially relevant in a variety of industries, including cosmetics, food, beverage, agronomics, and medicines. The bioactive components found in essential oils include limonene, geranial acetate, corvine, and others. Essential oils are used to preserve food additives, treat common ailments and traditional medicines, and are also employed by aroma therapists. Natural antioxidants are employed in essential oils. Natural antioxidants are widely used in anti-inflammatory drugs and foods [4]. Essential are fragrant compounds found naturally in plants. EOs have a long history of usage in traditional medicine and have recently acquired favor in the beauty industry [5]. One intriguing category of possibilities for clinically acceptable are discovered as essential oils and their volatile constituents. Essential oils had previously been demonstrated to be effective in distributing a variety of medications through the skin, including vitamins [6].

Cellular Markers of Inflammation

During the inflammatory response, adhesion molecules regulate the contacts between leukocytes and endothelial cells. The over expression of cell surface ligands early in inflammation triggers a complicated cascade of events that leads to cell-to-cell contacts. Once inflammatory cells arrive at the site of damage, they interact with the endothelium, other parenchyma cells, immune cells, and extracellular matrix proteins to maintain the response, which can result in either resolution or persistent inflammation [10]. Although there are a variety of methods for studying inflammation in living tissues of acute or chronically instrumental models, the study of inflammation in humans is limited unless the inflammation is superficial and accessible using current microscopic techniques. Micro bubbles that cling to inflammatory areas and can be detected using a whole-body imaging approach are an emerging technology. These could make it easier to examine inflammatory indicators in individual organs of patients in the future [11]. The majority of previous investigations of inflammation depended on the collection of venous blood samples, or to a lesser extent, urine or lymph samples. Such samples will only be beneficial if the inflammation has progressed to the point where inflammation markers can be detected globally. Then there are two options for testing: circulating cells and plasma [12]. Various inflammatory illnesses have been linked to oxidative stress. Inflammation is a crucial part of the body's defence against harmful stimuli, and it's also important at the start of wound healing. A slowed resolution of inflammation, on the other hand, might lead to a chronic, exacerbated reaction with more tissue damage [13]. Inflammatory-mediated tissue damage plays a key role in the development of various inflammatory skin disorders, such as sunburn and psoriasis. Excess reactive oxygen species released in the skin over an extended period of time might worsen inflammatory damage and induce chronic inflammation [14]. Several antioxidants and pro-oxidants govern the cellular redo balance; nevertheless, in cases of chronic inflammation, the antioxidant system may be depleted, resulting in persistent oxidative stress [15].

Biochemical Mechanisms in Inflammation

In vertebrates, inflammation is a symptom of severe cell injury. Disturbance in local fluid exchange triggers the inflammatory response. The most significant change is an increase in capillary permeability on a local level. The release of leucotaxine by wounded cells at the site of inflammation contributes significantly to this. This appears to be a polypeptide and is a diffusible material. It also has the ability to cause leucocyte migration across the endothelium wall [16]. The leucocytos is promoting factor is another mediator found in inflammatory exudates. In addition to the thermos table leucocytos is factor, this component gives a plausible explanation for leucocytosis in inflammation. The immunological implications of inflammation are examined, with the significance of inflammation as a regulator of bacterial invasiveness being highlighted [17]. The release of a toxic euglobulin called necrosis is





Anakha Tomson *et al.*,

thought to be responsible for the pattern of harm seen in inflammation. Fever has been linked to two factors: pyrexia, a thermos table component, and a thermo labile factor. The wounded cell is unable to produce inflammatory mediators as rapidly as it would under normal conditions[18]. Regulatory proteins, peptides, and enzymes produced as a result of inflammatory gene activation are particularly significant. Regulatory proteins, particularly tissue protein hormone cytokines, which are growth factors of inflammatory and immune cells and their proliferation and differentiation, play a key role in the beginning and regulation of inflammation. Almost all regulatory and effectors molecules, as well as inflammatory processes mediated by them, are influenced by cytokines [19]. The majority of cytokines actions are Para or anticrime, but they also circulate in the plasma: they are generally represented by transforming growth factor and macrophage colony stimulating factor, and tumor necrosis factor is also present in inflammation [20].

Essential Oils and Inflammation

Inflammatory disorders are caused by the body's response to tissue damage, and if the response is insufficient or the stimulus persists, the inflammation will advance from acute to chronic, leading to cancer, neurological, and autoimmune diseases. It is vital to hunt for new biologically active molecules with anti-inflammatory action due to the complexity of processes that occur in inflammation and the bad effects of medications used in clinical practice. Essential oils, which act on the primary pathways involved in the pathogenesis of inflammation, have shown encouraging outcomes in preclinical research [21]. Essential oils are particularly useful in treating minor to medium wounds, skin abrasions, excoriations, skin infections, and other topical health issues when administered at the proper concentration. Although aromatic herbs have traditionally been used to treat wounds, the use of pure essential oils for wound treatment is uncommon[22]. Essential oils have a variety of bioactive properties, including antioxidant, anti-inflammatory, antibacterial, antiviral, and ant carcinogenic properties. Consumers seeking less expensive, more "natural" alternatives to disease-fighting pharmaceuticals have increased demand for plant essential oils. Essential oils are biodegradable, widely available, and "less hazardous" than synthetic preservation agents in food and cosmetic applications. This optimism has sparked worries and prompted research into the safety and efficacy of essential oils in diverse systems in order to better understand their pharmacological properties and health significance [23].

CONCLUSION

Essential oils, commonly referred to as volatile oils, are concentrated plant products that contain volatile fragrance components. On humans, animals, and other plants, these combinations of volatile chemicals have a variety of biological effects. Essential oils are extracted through distillation and expression and are widely utilized in fragrances, cosmetics, and cleaning goods, as well as in food and beverage flavoring. However, essential oils are also very beneficial in the treatment of a variety of ailments, and their therapeutic use has grown in popularity, as has the use of many of its constituents as single scent compounds.

REFERENCES

1. Azab A, Nassar A, Azab AN. Anti-inflammatory activity of natural products. *Molecules*. 2016 Oct;21(10):1321.
2. Chandra S, Chatterjee P, Dey P, Bhattacharya S. Evaluation of in vitro anti-inflammatory activity of coffee against the denaturation of protein. *Asian Pacific Journal of Tropical Biomedicine*. 2012 Jan 1;2(1):S178-80.
3. Germolec DR, Shipkowski KA, Frawley RP, Evans E. Markers of inflammation. *Immunotoxicity Testing*. 2018:57-79.
4. Irshad M, Subhani MA, Ali S, Hussain A. Biological importance of essential oils. *Essential Oils-Oils of Nature*. 2020 Jan 8:1.
5. Han X, Beaumont C, Stevens N. Chemical composition analysis and in vitro biological activities of ten essential oils in human skin cells. *Biochimie Open*. 2017 Dec 1;5:1-7.



**Anakha Tomson et al.,**

6. Jiang Q, Wu Y, Zhang H, Liu P, Yao J, Yao P, Chen J, Duan J. Development of essential oils as skin permeation enhancers: Penetration enhancement effect and mechanism of action. *Pharmaceutical Biology*. 2017 Jan 1;55(1):1592-600.
7. Weissmann G. The role of lysosomes in inflammation and disease. *Annual review of medicine*. 1967 Feb;18(1):97-112.
8. Richardson KT. Pharmacology and pathophysiology of inflammation. *Archives of Ophthalmology*. 1971 Dec 1;86(6):706-24.
9. Larsen GL, Henson PM. Mediators of inflammation. *Annual review of immunology*. 1983 Apr;1(1):335-59.
10. Nathan C. Points of control in inflammation. *Nature*. 2002 Dec;420(6917):846-52.
11. Laskin DL, Pendino KJ. Macrophages and inflammatory mediators in tissue injury. *Annual review of pharmacology and toxicology*. 1995 Apr;35(1):655-77.
12. Marcadenti A, Mosele F, Ludwig MS, Heck TG, de Abreu-Silva EO. Diet and Inflammation: Effects of Macronutrients and Dietary Patterns. *Int. J. of Cardiology and Lipidology Research*. 2015 Mar 21;2(1):7-13.
13. Kerr J. The use of essential oils in healing wounds. *International Journal of Aromatherapy*. 2002 Dec 1;12(4):202-6.
14. Alhakmani F, Kumar S, Khan SA. Estimation of total phenolic content, in-vitro antioxidant and anti-inflammatory activity of flowers of *Moringa oleifera*. *Asian Pacific journal of tropical biomedicine*. 2013 Aug 1;3(8):623-7.
15. Wagener FA, Carels CE, Lundvig D. Targeting the redox balance in inflammatory skin conditions. *International journal of molecular sciences*. 2013 May;14(5):9126-67.
16. Dekel N, Gnainsky Y, Granot I, Mor G. Inflammation and implantation. *American journal of reproductive immunology*. 2010 Jan;63(1):17-21.
17. Bektas A, Schurman SH, Sen R, Ferrucci L. Aging, inflammation and the environment. *Experimental gerontology*. 2018 May 1;105:10-8.
18. Menkin V. Biochemical mechanisms in inflammation. *British Medical Journal*. 1960 May 21;1(5185):1521.
19. Kulinsky VI. Biochemical aspects of inflammation. *Biochemistry (Moscow)*. 2007 Jun;72(6):595-607.
20. Libby P. Inflammatory mechanisms: the molecular basis of inflammation and disease. *Nutrition reviews*. 2007 Dec 1;65(suppl_3):S140-6.
21. Adorjan B, Buchbauer G. Biological properties of essential oils: an updated review. *Flavour and Fragrance Journal*. 2010 Nov;25(6):407-26.
22. Mirke NB, Shelke PS, Malavdkar PR, Jagtap PN. In vitro protein denaturation inhibition assay of *Eucalyptus globulus* and *Glycine max* for potential anti-inflammatory activity. *Innovations in Pharmaceuticals and Pharmacotherapy*. 2020;8:28-31.
23. Wei A, Shibamoto T. Medicinal activities of essential oils: role in disease prevention. In *Bioactive foods in promoting health 2010 Jan 1* (pp. 59-70). Academic Press.
24. Schmid-Schönbein GW. Analysis of inflammation. *Annu. Rev. Biomed. Eng.*. 2006 Aug 15;8:93-151.
25. Zunszain PA, Hepgul N, Pariante CM. Inflammation and depression. *Behavioral neurobiology of depression and its treatment*. 2012:135-51.
26. Serhan CN, Savill J. Resolution of inflammation: the beginning programs the end. *Nature immunology*. 2005 Dec;6(12):1191-7.
27. Wagener FA, Carels CE, Lundvig D. Targeting the redox balance in inflammatory skin conditions. *International journal of molecular sciences*. 2013 May;14(5):9126-67.
28. Pérez G S, Zavala S M, Arias G L, Ramos L M. Anti-inflammatory activity of some essential oils. *Journal of Essential Oil Research*. 2011 Sep 1;23(5):38-44.





Anakha Tomson et al.,

Table 1. Examples of Inflammation in the Microcirculation

| Inflammation | Description |
|------------------------------|---|
| Localized Endothelial Injury | Since antiquity, cardinal symptoms of inflammation, the body's primordial reaction to tissue injury or infection, have been identified as localised loss of this selective barrier function combined with emigration of white blood cells and pus production[24]. |
| Physiological Shock | Entrapment of platelets and leukocytes in the microcirculation of distant organs, blood coagulation and widespread capillary occlusion, increased permeability and tissue swelling, red cell aggregation, reduction of central blood pressure, cell apoptosis, and parenchymal tissue failure are all symptoms of this type of inflammation[25]. |
| Ischemia | Ischemia followed by reperfusion causes a different type of inflammation. Any prolonged drop in microcirculation blood flow is followed by a time of reperfusion accompanied by classic indications of inflammation. Although cell injury may occur during ischemia, reperfusion frequently exacerbates injury or even death of previously healthy cells, the level of which is determined by the duration and severity of blood flow loss during ischemia[26]. |
| Tissue Burn | The burn site may be subjected to repeated platelet adhesion and a repeat of the cycle, which begins with the formation of a platelet thrombus and ends with the release of the thrombus in the form of an embolus. A few cells are seen migrating into the tissue in the early stages of this type of tissue injury[26]. |

Table 2. Chronic Inflammation of the Skin [27]

| Conditions | Description |
|-------------|--|
| Sunburn | UV-induced oxidative damage is caused by either direct UV radiation damage or indirect UV-induced oxidative damage caused by activated immune cells and dysregulated cellular communication. |
| Psoriasis | The involvement of elevated reactive oxygen species levels in psoriasis pathogenesis is thought to be a significant element in the pathogenesis of psoriasis. |
| Burn injury | After skin burn, molecular signals, including inflammatory mediators and oxidants, are released at the injury site, further contributing to tissue damage and ischemic tissue necrosis. |

Table 3. Anti-Inflammatory Activity Of Some Essential Oils [28]

| Essential Oils | Activity |
|---|---|
| <i>Ageratum fastigiatum</i> (Asteraceae) | This plant is used as an anti-inflammatory, analgesic, and antibacterial in medicine. Germacrene D, humulene, and cedrene were the primary chemicals discovered in the essential oil. |
| <i>Citrus sinensis</i> L. (Rutaceae) | Anti-inflammatory, antidepressant, anti-spasmodic, antiseptic, aphrodisiac, carminative, diuretic, tonic, sedative, and cholagogue qualities can be attributed to orange essential oil. |
| <i>Denmettia tripetala</i> (Annonaceae) | Fever, typhoid, cough, worm infestation, vomiting, and other ailments are |





Anakha Tomson et al.,

| | |
|---------------------------------------|--|
| | treated with the leaves in combination with other therapeutic plants.stomach pains Anti-inflammatory and anti-antinociceptive. |
| <i>Fortunella japonica</i> (Rutaceae) | Vitamins A and C are abundant. Major components are d, l-limonene and carvone. Oil has anti-inflammatory properties. |

| | |
|---|---|
| | |
| <p>Fig.1.Turmeric Essential Oil</p> | <p>Fig.2. Lavender Essential Oil</p> |
| | |
| <p>Fig.3.Tea Tree Essential Oil Greendorse Patchouli Essential Oil</p> | |





Analyse Various Anomaly Detection Technique in Video Surveillance System with Different Approaches

Kaushikkumar S. Patel^{1*}, Kaushika D.Patel² and Nilesh Prajapati³

¹Ph.D Scholar, Gujarat Technological University, Gandhi Nagar, Gujarat, India

²Assistant Professor, Birla Vishvakarma Mahavidyalaya, Vallabh Vidyanagar, Gujarat, India

³Associate Professor, Birla Vishvakarma Mahavidyalaya, Vallabh Vidyanagar, Gujarat, India

Received: 18 Apr 2022

Revised: 12 Jun 2022

Accepted: 02 July 2022

*Address for Correspondence

Kaushikkumar S. Patel

Ph.D Scholar,

Gujarat Technological University,

Gandhi Nagar, Gujarat, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Surveillance cameras are being installed in many primary daily living places to maintain public safety. In this video-surveillance context, anomalies occur only for a very short time, and very occasionally. Hence, manual monitoring of such anomalies may be exhaustive and monotonous, resulting in a decrease in reliability and speed in emergency situations due to monitor tiredness. This chapter presents a review and systematic study on the moving object detection and surveillance of the video as they are important and challenging task in many computer vision applications. Such as human detection algorithm, vehicles detection, threat, security. Video surveillance in a dynamic environment, especially for human and vehicles and for specific object in case of security is one of the current challenging research topics in computer vision it is a key technology to fight against terrorism, crime, public safety and for efficient management of accidents and crime scene going on now a day. The paper also presents the concept of real time implementation computing task in video surveillances system. In this review paper various methods are discussed were evaluation of order to access how well they can detect moving object in an outdoor/indoor section in real time situation we would like to review the existing methods of modelling video representations using deep learning techniques for the task of anomaly detection and action recognition.

Keywords: Computer Vision, Threat Detection, Anomaly detection, Image Processing



**Kaushikkumar S. Patel et al.,**

INTRODUCTION

Visual (or video) surveillance devices have long been in use to gather information and to monitor people, events and activities. Visual surveillance technologies, CCD cameras, thermal cameras and night vision devices, are the three most widely used devices in the visual surveillance market [1]. Visual surveillance in dynamic scenes, especially for humans, is currently one of the most active research topics in computer vision and artificial intelligence. It has a wide spectrum of promising public safety and security applications, including access control, crowd flux statistics and congestion analysis, human behavior detection and analysis, etc [2] Visual surveillance in dynamic scene with multiple cameras as shown in Fig. 1, attempts to detect, recognize and track certain objects from image sequences, and more importantly to understand and describe object behaviors. The main goal of visual surveillance is to develop intelligent visual surveillance to replace the traditional passive video surveillance that is proving ineffective as the number of cameras exceed the capability of human operators to monitor them. The goal of visual surveillance is not only to put cameras in the place of human eyes, but also to accomplish the entire surveillance task as automatically as possible [19]. The capability of being able to analyze human movements and their activities from image sequences is crucial for visual surveillance. The video process of surveillance systems has inherited difficult challenges while approaching a computer vision application, i.e., illumination variation, viewpoint variation, scale (view distance) variation, and orientation variation. Existing surveillance solutions to object detection, tracking, and identification from video problems tend to be highly domain specific. An indication of the difficulty of creating a single general purpose surveillance system comes from the video surveillance and monitoring (VSAM) project at CMU [20] and other institutions [4, 7]. developing general surveillance algorithms, a visual surveillance system usually has had to be designed as a collection of separate algorithms which are selected on a case by case basis.

x

Surveillance cameras are increasingly being used in public places e.g., streets, intersections, banks, shopping etc. to increase public safety. However, the monitoring capability of law enforcement agencies has not kept pace. The result is that there is a glaring deficiency in the utilization of surveillance cameras and an unworkable ratio of cameras to human monitors. One critical task in video surveillance is detecting anomalous events such as traffic accidents, crimes or illegal activities. Generally, anomalous events rarely occur as compared to normal activities. Therefore, to alleviate the waste of labor and time, developing intelligent computer vision algorithms for automatic video anomaly detection is a pressing need. The goal of a practical anomaly detection system is to timely signal an activity that deviates normal patterns and identify the time window of the occurring anomaly. Therefore, anomaly detection can be considered as coarse level video understanding, which filters out anomalies from normal patterns. Once an anomaly is detected, it can further be categorized into one of the specific activities using classification techniques.[8]

Related Work

Anomaly detection. Anomaly detection is one of the most challenging and long-standing problems in computer vision [11,12,13,14]. For video surveillance applications, there are several attempts to detect violence or aggression in videos. Datta et al. proposed to detect human violence by exploiting motion and limbs orientation of people. Kooij et al. [25] employed video and audio data to detect aggressive actions in surveillance videos. Gao et al. proposed violent flow descriptors to detect violence in crowd videos. More recently, Mohammad et al. [30] proposed a new behaviour heuristic-based approach to classify violent and non-violent videos. Beyond violent and non-violent patterns discrimination, authors in [11] proposed to use tracking to model the normal motion of people and detect deviation from that normal motion as an anomaly. Due to difficulties in obtaining reliable tracks, several approaches avoid tracking and learn global motion patterns through histogram-based methods, topic modeling, motion patterns, social force models, mixtures of dynamic textures model, Hidden Markov Model (HMM) on local patio-temporal volumes [26], and context-driven method. Given the training videos of normal behaviors, these approaches learn distributions of normal motion patterns and detect low probable patterns as anomalies. Following the success of sparse representation and dictionary learning approaches in several computer vision problems, researchers in [11, 12] used sparse representation to learn the dictionary of normal behaviors. During testing, the patterns which have large reconstruction errors are considered as anomalous behaviors. Due to successful demonstration of deep learning





Kaushikkumar S. Patel et al.,

for image classification, several approaches have been proposed for video action classification [13]. However, obtaining annotations for training is difficult and laborious, specifically for videos. Recently, used deep learning based auto encoders to learn the model of normal behaviors and employed reconstruction loss to detect anomalies. Our approach not only considers normal behaviors but also anomalous behaviors for anomaly detection, using only weakly labeled training data describe an approach for real-time automatic detection of abandoned luggage in video captured by surveillance cameras. The approach is comprised of two stages:

- (i)static object detection based on background subtraction and motion estimation
- (ii)abandoned luggage recognition based on a cascade of convolution neural networks (CNN).

To train our neural networks we provide two types of examples: images collected from the Internet and realistic examples generated by imposing various suitcases and bags over the scene's background. We present empirical results demonstrating that our approach yields better performance than a strong CNN baseline method [9].

Most works for abandoned objects detection use background subtraction as a low-level preliminary step [14], [15], [16], [17], [18], [19], [20], [21] to detect foreground regions or objects, although Smith et al. [17] start directly by tracking multiple objects in the scene using trans-dimensional Markov Chain Monte Carlo (MCMC). After background subtraction, some works aim to reduce false positive detections using object tracking and classification methods [22], while other approaches employ edge detection frameworks [21], [22] or generative models. Some frameworks model the abandoned objects detection problem as finite state automata [21], [22], [23], while others use temporal logic based inference as an alternative solution [14]. Different from all other works, Kong et al. [20] try to detect abandoned objects on the road using a moving camera. Ferryman et al. present a threat assessment algorithm that combines the concept of ownership with automatic understanding of social relations in order to infer abandonment of objects. Similar to Perkily et al. , Lin et al. combine short-term and long-term background models to extract foreground objects. Swatch describes an algorithm for the detection of stable regions by comparing these regions with the contours of moving objects. Dahi et al. [22] present a method based on static edge detection and classification. Pham et al. [21] propose a two-stage method for unattended object detection. The first stage tries to detect all possible abandoned objects, preventing false negatives. In the second stage, their method reduces false alarms by using similarity matching between first-stage candidates and the background model. Different from all previous methods, we use a cascade of convolution neural networks in the second stage to recognize abandoned versus attended luggage items or other objects. For a complete review of recent works on abandoned object detection, the reader is referred to the survey of Cuevas et al. [23]. The proposed approach (summarized in Figure 1) begins with dividing surveillance videos into a fixed number of segments during training. These segments make instances in a bag. Using both positive (anomalous) and negative (normal) bags, we train the anomaly detection model using the proposed deep MIL ranking loss.[24]A Soccer Event Recognition data generator was developed for synthetic data generation, and it was developed by Lia Mora et.al [25]. It was built upon an open source high quality game engine. The development of advanced software for sport analytics were achieved through automatic event detection from wearable sensors or from images. This software generated the data from soccer games, with automatically generated event ground truth. A complete event detection system evaluated by using a dataset with 1 million events, and 500 min of game were included in this work.A deep learning based key pose recognition method was proposed by Cao Zhi chao, and Jingling Zhang [26]. This technique was used for sport analysis. An FCN network was used for foreground extraction and the background interference were removed by using weightlifting technique. A selection strategy were help to extract the key pose. Further the key pose algorithm was used to select the high quality key pose frame. This is very important in sports trai





Kaushikkumar S. Patel *et al.*,

Research Gap

Reinforcement learning is the learning of a mapping from situations to actions so as to maximize a scalar reward or reinforcement signal. There is very less research in terms of reinforcement learning in this area. With challenges such as low-quality feeds, occlusion, viewpoint variations, background clutter etc. The task is both challenging and error-prone. Data Preprocessing is still too costly and highly supervised.

CONCLUSION

The literature survey that has been done during the research work. The related work that has been proposed by many researchers has been discussed. The most of the research papers related to moving object detection, human object detection and surveillance have been shown, which is about different methods and algorithms to diagnose the surveillance of video.

REFERENCES

1. W. Hu, T. Tan, L. Wang, and S. Maybank, "A Survey on Visual Surveillance of Object Motion and Behaviors," *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Application and Review*, Vol. 34, No. 3, pp. 334-352, 2004.
2. R. Collins, A. Lipton, T. Kanade, H. Fujiyoshi, D. Duggins, Y. Yin, D. Tolliver, N. Enomoto, and O. Hasegawa, "A System for Video Surveillance and Monitoring," Technical Report CMU-RI-TR-00-12, Carnegie Mellon University, 2000.
3. A. Dick and M. Brooks, "Issues in Automated Visual Surveillance," in *Proceedings of International Conference on Digital Image Computing: Techniques and Applications*, pp. 195-204, 2003.
4. R. Collins, A. Lipton, T. Kanade, H. Fujiyoshi, D. Duggins, Y. Yin, D. Tolliver, N. Enomoto, and O. Hasegawa, "A System for Video Surveillance and Monitoring," Technical Report CMU-RI-TR-00-12, Carnegie Mellon University, 2000.
5. P. Kumar, A. Mittal, and P. Kumar, "Study of Robust and Intelligent Surveillance in Visible and Multi-modal Framework," *Informatics* 32, pp. 63-77, 2008.
6. Y. Ivanov and A. Bobick, "Recognition of Visual Activities and Interactions by Stochastic Parsing," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. 22, No. 8, pp. 852-872, 2000.
7. A. Bobick and J. Davis, "The Recognition of Human Movement Using Temporal Templates," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. 23, No. 3, pp. 257-267, 2001. [24] Performance Evaluation and Tracking and Surveillance (PETS) 2007; Web site: <http://pets2007.net/>
8. Waqas Sultani, Chen Chen, "Real-world Anomaly Detection in Surveillance Videos" *IEEE Computer Vision Foundation*,
9. J. Wang, Y. Song, T. Leung, C. Rosenberg, J. Wang, J. Philbin, B. Chen, and Y. Wu. Learning fine-grained image similarity with deep ranking. In *CVPR*, 2014.
10. S. Wu, B. E. Moore, and M. Shah. Chaotic invariants of lagrangian particle trajectories for anomaly detection in crowded scenes. In *CVPR*, 2010.
11. C. Lu, J. Shi, and J. Jia. Abnormal event detection at 150 fps in matlab. In *ICCV*, 2013.
12. B. Zhao, L. Fei-Fei, and E. P. Xing. Online detection of unusual events in videos via dynamic sparse coding. In *CVPR*, 2011.
13. A. Karpathy, G. Toderici, S. Shetty, T. Leung, R. Sukthankar, and L. Fei-Fei. Large-scale video classification with convolutional neural networks. In *CVPR*, 2014.
14. M. Bhargava, C.-C. Chen, M. S. Ryoo, and J. K. Aggarwal, "Detection of abandoned objects in crowded environments," in *Proceedings of AVSS, 2007*, pp. 271-276.
15. H.-H. Liao, J.-Y. Chang, and L.-G. Chen, "A Localized Approach to Abandoned Luggage Detection with Foreground-Mask Sampling," in *Proceedings of AVSS, 2008*, pp. 132-139.





Kaushikkumar S. Patel et al.,

16. F. Porikli, Y. Ivanov, and T. Haga, "Robust abandoned object detection using dual foregrounds," *EURASIP Journal on Advances in Signal Processing*, vol. 2008, p. 30, 2008.
17. Y.-L. Tian, R. Feris, and A. Hampapur, "Real-Time Detection of Abandoned and Removed Objects in Complex Environments," in *Proceedings of VS Workshop*, 2008.
18. M. Bhargava, C.-C. Chen, M. S. Ryoo, and J. K. Aggarwal, "Detection of object abandonment using temporal logic," *Machine Vision and Applications*, vol. 20, no. 5, pp. 271–281, 2009.
19. J. Wen, H. Gong, X. Zhang, and W. Hu, "Generative model for abandoned object detection," in *Proceedings of ICIP*, 2009, pp. 853–856.
20. J.-Y. Chang, H.-H. Liao, and L.-G. Chen, "Localized Detection of Abandoned Luggage," *EURASIP Journal on Advances in Signal Processing*, vol. 2010, no. 1, 2010.
21. P. Forczmanski and M. Seweryn, "Surveillance Video Stream Analysis Using Adaptive Background Model and Object Recognition," in *Proceedings of ICCVG*, 2010, pp. 114–121.
22. S. Kwak, G. Bae, and H. Byun, "Abandoned luggage detection using a finite state automaton in surveillance video," *Optical Engineering*, vol. 49, no. 2, pp. 027 007–1–027 007–10, 2010. [10] G. Szwoch, P. Dalka, and A. Czyzewski, "A Framework for Automatic Detection of Abandoned Luggage in Airport Terminal." Springer, 2010, pp. 13–22.
23. C. Cuevas, R. Martnez, and N. Garca, "Detection of stationary foreground objects: A survey," *Computer Vision and Image Understanding*, vol. 152, pp. 41–57, 2016
24. Real-world Anomaly Detection in Surveillance Videos Waqas Sultani1
25. A Soccer Event Recognition data generator was developed for synthetic data generation
26. A deep learning based key pose recognition method
27. Real-Time Deep Learning Method for Abandoned Luggage Detection in Video
28. Real-World Anomaly Detection in Surveillance Videos
29. Weapon Detection using Artificial Intelligence and Deep Learning for Security Applications
30. A Soccer Event Recognition data generator was developed for synthetic data generation
31. A deep learning based key pose recognition method
32. A Multimodal Saliency Model for Videos With High Audio – Visual Correspondence

Table 1. Related Work

| Sr. No | Title ,Year ,Author | Approach | Performance Parameter | Result |
|--------|--|---|--|--|
| 1 | Real-Time Deep Learning Method for Abandoned Luggage Detection in Video[27] SorinaSmeureanu et al. | 1)static Object Detection 2) Cascade of convolutional neural network (CNN) | i) Background Subtraction + motion estimation | i) Detect Luggage ii) Detect Abandonment |
| 2 | Real-World Anomaly Detection in Surveillance Videos[28] Waqas et al. | 1) deep learning approach 2) Divide surveillance video into fixed number of segments during training | 1) Assign bags to each video type i) Negative (Normal) ii) Positive (Anomalous) | detect real world anomalies in surveillance videos |
| 3 | Weapon Detection using Artificial Intelligence and Deep Learning for Security Applications[29], 2020 Harsh Jain ,et al. | Algorithm (SSD or fast RCNN) chosen for gun detection | implemented for larger datasets by training us ing GPUs and high-end DSP and FPGA kits | accurate gun detection and classification |





Kaushikkumar S. Patel et al.,

| | | | | |
|---|--|---|---|--|
| 4 | A Soccer Event Recognition data generator was developed for synthetic data generation[30], Lia Morra et.al | The development of advanced software for sport analytics were achieved through automatic event detection from wearable sensors or from images | It was built upon an open source high quality game engine | the SoccER software suite, which comprises both a synthetic spatio-temporal data generator and an event detection system targeting the soccer domain |
| 5 | A deep learning based key pose recognition method[31] was proposed by Cao Zhi chao, and Lingling Zhang | An FCN network was used for foreground extraction and the background interference were removed by using weightlifting technique | key pose algorithm was used to select the high quality key pose frame | our algorithm can select high image quality key pose frame, which is important for sports training |
| 6 | A Multimodal Saliency Model for Videos With High Audio – Visual Correspondence[32],2020 XionguoMin ,et al. | Multi Model Saliency(MMS) | Privacy preservation And resist most attacks Delivery ratio | Detect scenes with high audio visual correspondence |





Prevalence of Infertility Cases and Its Associated Factors in Kamrup District of Assam, India: An Infertility Clinic - Based Survey

Uma Dutta^{1*}, and Barnali Haloi², Trishna Kalita², Bhaigyaroti Muchahary² and Enush Daimari²

¹Associate Professor and HoD, Department of Zoology, Cotton University, Guwahati -781001, Assam, India.

²Ph.D. Research Scholar, Department of Zoology, Cotton University, Guwahati -781001, Assam, India

Received: 29 Apr 2022

Revised: 03 June 2022

Accepted: 02 July 2022

*Address for Correspondence

Uma Dutta

Associate Professor and HoD,

Department of Zoology,

Cotton University, Guwahati -781001,

Assam, India.

Email: umadutta@yahoo.com ,umadutta@cottonuniversity.ac.in.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Infertility has turned to be a global health issue in recent times. The increasing trend in infertility has been observed worldwide including in India. In India, especially in Assam, the problem of infertility is not given due attention because it is not a life-threatening condition. The study was conducted through a survey in two renowned fertility clinics of Guwahati, Assam for a period of 12 months from January 2018 to January 2019, following a standard bilingual questionnaire. The survey was carried out among a total of 1433 infertile females. Data were statistically analyzed by the chi-square method to find out any association between the lifestyle factors considered for this study and infertility. The maximum number of females having infertility were found to reside in an urban locality. Moreover, primary infertility was reported to be more in frequency as compared to secondary infertility during the study period. In all the 3 age groups, the maximum number of infertile females had faced stress in day-to-day life. From the analysis of the data, we found an association between stress and infertility but no association was found for drinking and smoking habits with female infertility. Therefore, a detailed and long-term study is essentially required to know about the problem in-depth and also to find out some remedial measures to help solving this growing problem.

Keywords: Female infertility, primary infertility, secondary infertility, lifestyle factors, stress, smoking.



**Uma Dutta et al.,**

INTRODUCTION

Infertility has become a global health concern in recent years. Infertility is a disease defined by the failure to achieve a successful pregnancy after 12 months or more of regular, unprotected sexual intercourse or due to an impairment of a person's capacity to reproduce either as an individual or with her/his partner [1]. Approximately 8 to 10% of couples around the globe suffer from infertility [2]. Currently the infertility rate among the Indian population is 10 to 14%, which is found to be higher in urban areas [3]. It was found to be 15% at a study in Kashmir and in Uttar Pradesh, the prevalence of infertility was found to be 10.14% [4,5]. But there is no specific data for the infertility rate in Assam.

Primary infertility is when a pregnancy has never been achieved by a person, and secondary infertility is when at least one prior pregnancy has been achieved. The WHO estimates of primary infertility in India are 3.9% for age-standardized to 25-49 yr. and 16.8% for age-standardized to 15-49 years [7]. Human fertility was found to be affected by physical, genetic, socio-economic factors, environmental or occupational contaminants. Lifestyle factors, such as psychological stress, age at marriage, nutrition, weight, exercise, smoking and alcohol consumption also have a negative influence on fertility [6]. In patriarchal societies like India, psychosocial, social, emotional, and physical consequences faced due to childlessness are harsher in women than in men [3]. Finding the cause of infertility might or might not help infertile couples but it can reduce the burden of various social stigma faced by women.

METHODS

The study was conducted through a survey following a standard questionnaire. Randomized case studies from females facing fertility problems were undertaken in two renowned fertility clinics- Institute of Human Reproduction and Pratiksha hospitals, Guwahati for a period of 12 months from January 2018 to January 2019. A total of 1433 married females were surveyed during the period. Before our commencement of the investigation, ethical consent and permission was taken from the authorities of the two clinics. Moreover, before collecting information from the patients, the details of the questionnaire and the purpose of the survey were explained to them. Couples voluntarily participated in this study and written consent was also obtained from each individual prior to the study.

The participants were given a self-questionnaire to answer. The questionnaire was in bilingual format, containing questions in both English and the local language for the convenience of the participants. The questionnaire contained questions regarding the problems they faced in getting pregnant, the form of infertility (primary or secondary), when did they face the problem, type of treatment they are undergoing (if any), use of any other medication for any kind of health problems, whether any records of operations or accidents, etc. The questionnaire also included a set of questions enquiring about the type of lifestyle followed (smoking and drinking habits), the persistence of stress in day-to-day life (physical, mental, or working) or not, and any genetic cause of infertility in the family history. During the survey, some important criteria were taken into consideration such as age groups (Group I- 21 to 30 years, Group II- 31 to 40 years, Group III- 41 to 50 years), locality (rural or urban), religion (Hindu, Muslim, Christian or others), caste (Tribal and Non-tribal), duration of the marriage, age at the time of marriage

Statistical Analysis

The data obtained for the presence or absence of stress in the participants and also the data for drinking or smoking habits were analyzed using Microsoft excel 2007. A Chi-square test was done to find out if there was any association between the variables.



**Uma Dutta et al.,**

RESULTS

A total of 1433 females having infertility were studied during the survey. Table 1 shows the group-wise distribution of the total number of cases according to different parameters like locality, religion, caste, marital duration, and age at the time of marriage. The total study population was divided into three categories based on age range. In the Group I the age range was from 21-30 years, in Group II the age range was from 21-30 years and it was 31-40 years in the case of group III. Group I had a total of 484 people, group II had 635, and group III had 314 people.

It was found that most numbers of infertility cases were found to be in females of age group 31-40 (Table 1). Results showed that the maximum number of the cases surveyed belonged to urban localities. The maximum number of the cases belonged to the marital duration of 0-4 years in the case of both group I and group II; whereas in Group III, the maximum number of the cases belonged to the marital duration of 5-9 years followed by 10-14 years (Table 1). Results showed that in maximum infertility cases the age at the time of marriage was above 25 years in all three groups. In all three groups, the majority belonged to non-tribal population and most of them followed Hinduism. The studied cases showed that the number of primary infertility cases is higher in younger age groups, i.e. in both groups I and group II. But in group III, secondary infertility cases were found to be more in number than primary infertility cases. Results revealed that out of the total cases studied, maximum cases of primary infertility were found in Group I i.e. 72.72%. In Group II there was not much difference in the number of primary and secondary infertility patients as 55.12% showed primary infertility and 44.88% showed secondary infertility. However, in Group III, more number of the cases showed secondary infertility i.e., 57.32% of the total cases. Group I also showed the highest difference between the percentage of primary and secondary infertility showing females.

It is seen that in all the three age groups, females experiencing stress in day-to-day life are more in number (Table-2). The number of females suffering from work-related stress was highest in group I whereas, females suffering from mental stress were highest in the case of group II. Group III had the lowest number of females having stress in day-to-day life. In all three groups, only a few cases were found to have infertility cases in the family history. In all the age groups, number of females admitting that they have a habit of smoking and drinking were lower as compared to those who did not have these habits. Highest number of females having a habit of smoking and drinking belonged to group II and the lowest number belonged to group III (Table-2).

All the values obtained for cases having infertility issue in their family history were less than 10% in all age groups (Table 3). Since the values were very less compared to people having no cases of infertility in their family history, the data was not considered for further statistical analysis to find any association between the variables. The percentage of females having stress was higher than those who did not have stress in day-to-day life in the case of all the three groups. The percentage of females having stress was highest in age group I and lowest in group III (Table 4). The p-value obtained after chi-square analysis was found to be 0.020445, hence showing a significant association between stress and infertility in females (at $p < 0.05$). In all the groups studied, the percentage of females having the habit of smoking and drinking was very less than those who did not have the habit of smoking and drinking. Among the three groups, the highest number of females having the habit of smoking and drinking belonged to group III (Table 5). After chi-square analysis, the p-value was found to be 0.826959; hence there was no association found between alcohol consumption and smoking with infertility in females (at $p < 0.05$).

DISCUSSION

Analysis of the results revealed that out of the total cases studied the maximum number of the cases belonged to urban areas. This may be attributed to the fact that the urban areas are more polluted and people are more prone to harmful chemicals present in the environment released from vehicles, industries, etc. The actual link between environmental pollution and decreased fertility cannot be established clearly and is even hard to be measured.





Uma Dutta *et al.*,

However, according to different reports published, more than 50 chemicals found in the workplace and environment are known to be associated with adverse reproductive outcomes in men and women [8]. Many earlier experiments on lab animals and wildlife populations show that chemical exposure can cause reproductive damage [9]. The results also revealed that the maximum number of cases having infertility problems were found to be more than 25 years of age at the time of marriage.

The advancing age of marriage nowadays can be one of the major factors leading to increasing infertility worldwide. As maternal age increases, fertility is found to decrease gradually as reported by Fidler (1999).⁸ Advancing age decreases the egg and ovulatory function [10]. In the age group I (21-30 years) and group II (31-40 years) about 82% and 57% of the cases reported to have primary infertility respectively, whereas in the age group III (41-50 years); secondary infertility was found to be more prevalent. From these findings, it can be concluded that primary infertility was more common in the city as compared to secondary infertility. However, this finding can be viewed from a different angle. Many couples facing problems conceiving for the second time, are usually satisfied with one child and do not prefer to go for infertility treatment as it is often very painful especially for the female. This may be one of the factors for less number of secondary infertility cases being reported as compared to primary infertility.

The findings of the present study also depicted that a very high percentage of the studied cases were suffering from some kind of stress physical, working, or mental. This indicates that stress has a negative impact on reproduction. Earlier reports show that the hypothalamic-pituitary-adrenal (HPA) axis, when activated by stress, exerts an inhibitory effect on the female reproductive system. Corticotrophin- Releasing hormone (CRH) inhibits hypothalamic Gonadotropin- Releasing hormone (GnRH) secretion, and glucocorticoids inhibit pituitary luteinizing hormone and ovarian estrogen and progesterone secretion which in turn affects fertility [11]. In our study too, we found a significant association between the presence of stress in the infertile female population. The findings were similar to previous studies [12]. Very few females have mentioned about the infertility problem in the family history. Although the cases are few, the possibility of genetic factors causing infertility cannot be ruled out. The genetical disorders of infertility can be broadly classified as chromosomal aberrations, single-gene disorders, and polygenic disorders [15]. Chromosomal aberrations include 47-XXX syndrome, Turner syndrome, etc; single-gene disorders include fragile X syndrome, galactosemia, leiomyomas, etc; and polygenic disorders include endometriosis and polycystic ovarian syndrome [15].

Smoking prevalence and alcohol consumption among the women of reproductive age group has increased over the years. Although most of the studied cases have come up with a negative answer still positive repliers represent a significant fraction. Smoking is associated with reproductive life impairment such as the early onset of menopause, higher infertility risk, lower fecundity rate, and lower IVF success rates as was reported by Dechanet *et al.* (2010) [13]. Earlier studies have also confirmed that alcoholic women have a variety of menstrual and reproductive disorders, absence of ovulation, and infertility [14]. In our study, we found no association between smoking or alcohol consumption and infertility in females of the population studied. It may be attributed to the fact that women in these areas are less habituated to smoking or alcohol consumption, as it is related to social stigma; leading to a lower number of cases having smoking or drinking habits in the sample data.

CONCLUSION

Infertility has turned out to be a global health issue over the past decade. The increasing trend in infertility is also observed in India, including Assam. Many infertility cases are not a result of genetic or physiological defects rather they are a result of the toxic environment we live in, poor choices of food we eat on daily basis, lifestyle choices, advancing maternal age, etc. Though genetic or any kind of physiological defects cannot be overcome by natural remedies, lifestyle choices and day to day activities which impact reproductive health can be changed to increase fertility.





Uma Dutta et al.,

ACKNOWLEDGMENTS

The author(s) are very much thankful for the help and cooperation of all the participants. The author(s) would like to acknowledge the help and cooperation extended by the staff of the Institute of Human Reproduction, Bharalumukh, Guwahati and Pratiksha Hospital, Borbari, Guwahati.

Ethical Approval and consent to participate

This study was approved by Institutional Ethics Committee and proper consent was obtained from participants before the study.

Conflict of Interest

No conflict of interest has been declared by the authors.

REFERENCES

1. Practice Committee of the American Society for Reproductive Medicine. Definitions of infertility and recurrent pregnancy loss: a committee opinion. *Fertility and sterility*. 2020 Mar;113(3):533-5.
2. Kumar D. Prevalence of female infertility and its socio-economic factors in tribal communities of Central India. *Rural and remote health*. 2007 Apr-Jun;7(2):456. doi: 10.22605/RRH456.
3. Manimekhalai K, Poulpunitha S, Veeramani P. Infertility: An Alarming Situation In India. *International Journal of Scientific and Technology Research*. 2020 Dec;9(2):2606-9.
4. Zargar AH, Wani AI, Masoodi SR, Laway BA, Salahuddin M. Epidemiologic and etiologic aspects of primary infertility in the Kashmir region of India. *Fertility and sterility*. 1997 Oct;68(4):637-43.
5. Kazmi S, Prakash S, Parveen K, Shaikh S, Prakash G. Prevalence and sociodemographic covariates of infertility in Allahabad district. *International Journal of Community Medicine and Public Health*. 2018 Aug;5(8):3372-6. doi: 10.18203/2394-6040.IJCMPh20183064.
6. Mittal S. Investigating infertility. *Indian Journal of Medical Research*. 2018 Mar;148(3):356-7.
7. Mahanta P. A clinico-epidemiological study of infertile couples among the suburban/rural population of Bokakhat, Assam. *Journal of Evolution of Medical and Dental Sciences*. 2016 Mar;5(24):1296-99.
8. Fidler AT, Bernstein J. Infertility: from a personal to a public health problem. *Public Health Reports*. 1999 Nov;114(6):494-511. doi: 10.1093/phr/114.6.494.
9. McLachlan JA. Environmental signaling: what embryos and evolution teach us about endocrine disrupting chemicals. *Endocrine reviews*. 2001 Jun;22(3):319-41. doi: 10.1210/edrv.22.3.0432.
10. American Society of Reproductive Medicine. Patient's fact sheet: infertility. Available at <http://www.asrm.org/Patients/FactSheets/Infertility-Fact.pdf> [Accessed 26 Feb 2004].
11. Kalantaridou SN, Makriganakis A, Zoumakis E, Chrousos GP. Stress and the female reproductive system. *Journal of reproductive immunology*. 2004 Jun;62(1-2):61-8. doi: 10.1016/j.jri.2003.09.004.
12. Wiweko B, Anggraheni U, Elvira SD, Lubis HP. Distribution of stress level among infertility patients. *Middle East Fertility Society Journal*. 2017 Jun;22(2):145-8. doi: 10.1016/j.mefs.2017.01.005.
13. Dechanet C, Anahory T, Mathieu Daude JC, Quantin X, Reyftmann L, Hamamah S, Hédon B, Déchaud H. Effects of cigarette smoking on reproduction. *Human reproduction update*. 2011 Jan;17(1):76-95. doi: 10.1093/humupd/dmq033.
14. Mello NK, Mendelson JH, Teoh SK. An overview of the effects of alcohol on neuroendocrine function in women. In: Zakhari S, editor. *Alcohol and the endocrine system*. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism. NIAAA Research Monograph No. 23; 1993. pp.139-69.
15. Zorrilla M, Yatsenko AN. The genetics of infertility: current status of the field. *Current genetic medicine reports*. 2013 Dec;1(4):247-60. doi: 10.1007/s40142-013-0027-1.





Uma Dutta et al.,

Table-1: Group-wise distribution of studied cases according to different parameters taken into consideration during study.

| Age Group | Locality | Religion | Caste | Marital duration | Age at the time of marriage | No. of cases having primary infertility | No. of cases having secondary infertility |
|-------------------------|------------------------|-------------------------------------|-------------------|--|--|---|---|
| Group I (21-30 years) | Rural-159 Urban-325 | H- 245 M-115 C- 72 O-52 | T- 196 NT- 288 | 0-4 yrs: 371 5-9 yrs: 113 10-14 yrs: 0 15+ yrs: 0 | Below 25 yrs-215 Above 25 yrs-269 | 352 | 132 |
| Group II (31-40 years) | Rural-233 Urban-402 | H- 262 M- 176 C- 123 O- 74 | T- 264 NT- 371 | 0-4 yrs: 293 5-9 yrs: 214 10-14 yrs: 78 15+ yrs: 50 | Below 25 years- 131 Above 25 years- 504 | 350 | 285 |
| Group III (41-50 years) | Rural-105 Urban-209 | H- 110 M- 63 C- 96 O- 45 | T- 119 NT- 195 | 0-4yrs: 39 5-9 yrs: 124 10-14 yrs: 98 15+ yrs: 53 | Below 25 years- 81 Above 25 years- 233 | 134 | 180 |

- H- Hindu, M- Muslim, C- Christian, O- Others; T- Tribal, NT- Non-Tribal.

Table-2: Group-wise distribution of the studied cases regarding lifestyle habits and infertility cases in family history.

| Age Group | Presence of Stress | Infertility problem in the family history | Consumption of Alcohol/ Smoking |
|-------------------------|---|---|---|
| Group I (21-30 years) | Y- 347 (Mental- 120 Physical-91 Working-136) N- 137 | Y – 39 N – 445 | Y- 124 (Alcohol-75 Smoking-49) N- 360 |
| Group II (31-40 years) | Y- 550 (Mental-245 Physical-188 Working-117) N- 85 | Y – 51 N – 584 | Y- 188 (Alcohol-103 Smoking-85) N- 447 |
| Group III (41-50 years) | Y- 207 (Mental- 89 Physical-70 Working-48) N-107 | Y – 21 N – 293 | Y- 97 (Alcohol-41 Smoking-51) N- 217 |

- Y- Yes and N- No

Table 3: Percentage wise distribution of studied cases according to presence of infertility cases in family history.

| Age group | Presence of infertility cases in family history | Percentage |
|-----------|---|------------|
| Group I | Yes – 39 | 8.06% |
| | No – 445 | 91.94% |
| Group II | Yes – 51 | 8.03% |
| | No – 584 | 91.97% |
| Group III | Yes – 21 | 6.69% |
| | No – 293 | 93.31% |





Uma Dutta et al.,

Table 4: Group-wise stress level distribution of studied cases has been shown in percentage and the p-value obtained.

| Age group | Presence of stress | Percentage | P-value |
|-----------|--------------------|------------|----------|
| Group I | Yes – 347 | 71.69 | 0.020445 |
| | No – 137 | 28.31 | |
| Group II | Yes – 550 | 86.61 | |
| | No – 85 | 13.39 | |
| Group III | Yes – 207 | 65.92 | |
| | No – 107 | 34.08 | |

Table 5: Percentage-wise distribution of studied cases for their habit of consumption of alcohol and smoking along with the p-value obtained.

| Age group | Consumption of alcohol/ smoking | Percentage | P value |
|-----------|---------------------------------|------------|----------|
| Group I | Yes – 124 | 25.62 | 0.826959 |
| | No – 360 | 74.38 | |
| Group II | Yes – 188 | 29.61 | |
| | No – 447 | 70.39 | |
| Group III | Yes – 97 | 30.89 | |
| | No – 217 | 69.11 | |

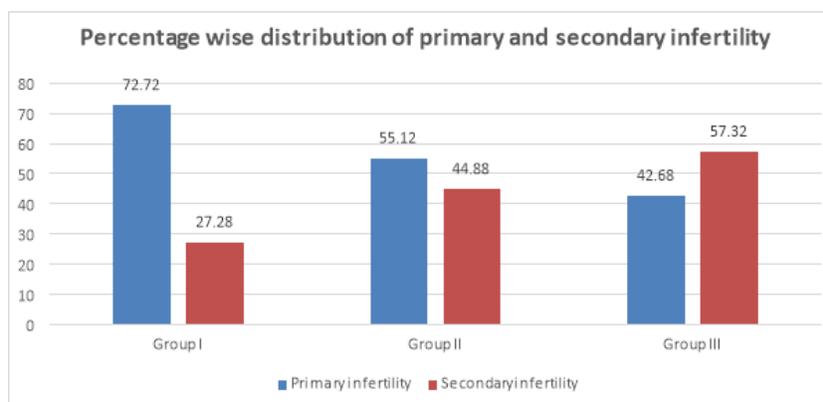


Figure 1: Graphical representation of the group-wise distribution of studied cases in terms of the type of infertility being faced by them.





Effect of Physiotherapy on COVID 19 Survivors: A Literature Review

Advita Neville Deepak^{1*}, Madhavan G Iyenger², Megha Tadvi³, Hetvi Vasava⁴, Hardik Parmar⁴ and Juhee Vyas⁴

¹Ph.D Scholar, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

²Professor (M.S.), Parul Institute of Medical science and Research, Parul University, Vadodara, Gujarat, India.

³MPT Scholar, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

⁴BPT Intern. Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

Received: 05 May 2022

Revised: 07 June 2022

Accepted: 04 July 2022

*Address for Correspondence

Advita Neville Deepak

Ph.D Scholar,

Parul Institute of Physiotherapy,

Parul University,

Vadodara, Gujarat, India.

Email: dr.advita@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The long-term problem experienced by survivors of COVID 19 after discharge from hospital is currently unknown but there is some emergency evidence. In the long-term, the multifaceted aspects of post intensive care syndrome, which can persist for many months or years after discharge, may also manifest in reduced exercise capacity, independence with activities of daily living, and health-related quality of life. To study the effect of physiotherapy in respiratory rehabilitation and telerehabilitation on Covid 19 survivors. We searched PubMed and Google scholar for take an evidence article which proves that physiotherapy treatments are beneficial for post COVID patients. Total 103 articles were search which includes a physiotherapy treatment use to improve post COVID patients health. And by screening articles were exclude remaining 47 articles were re-read and excluded with reason which has not clear findings and not relevant methodology. A total of 27 studies were finally included in the review. We include article related to effect of physiotherapy in post COVID 19 patients. According to the researches proves that physiotherapy beneficial for post COVID 19 rehabilitation. Because of giving some physical exercise to patient and activity task their functional activity improves. According to this literature review physiotherapy in useful for Covid 19 survivor whether it is based on mental health or strength base physiotherapy helps to improve strength, lung capacity , reduce anxiety, dyspnoea and also useful for ICU patients. Chest physiotherapy may improve respiratory functions and quality of life in patients with COVID-19, especially after discharge.

Keywords: Covid-19 Survivors, Respiratory Rehabilitation, Telerehabilitation, Exercises





Advita Neville Deepak, et al.,

INTRODUCTION

According to WHO Coronavirus diseases (COVID- 19) is an infectious disease caused by a newly discovered coronavirus [1]. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes.[2] The first case of corona virus diseases presents with pneumonia of unknown the town of Wuhan, China. It was reported to the country office of WHICH, China on Dec 31, 2019 [3]. Sincethen, the diseases had rapidly spread to the rest of the world accounting for high mobility and mortality. In December 2019, a new infectious respiratory disease emerged in Wuhan, Hubei province, China and was named by the World Health Organization as COVID-19 (coronavirus disease 2019) [4]. A new class of corona virus, known as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) has been found to be responsible for occurrence of this disease.[5] India is in mid of coronavirus pandemic, otherwise known as coronavirus diseases 2019, or sars-cov-2, which began in the late January 2020 when three Indian student travels to the southern state of Kerala from Wuhan in China.[6] As of June 11,2020, there are 137,448 active cases in India of which 141,028 cases have recovered and 8102 death.[7] The long-term problem experienced by survivors of COVID 19 after discharge from hospital is currently unknown but there is some emergency evidence [8] An Italian study followed up 143 individual 7 weeks post discharge and found 53% reporting fatigue, 43% breathlessness and 27% joint pain.[9] Patients with severe COVID-19 require hospitalization and oxygen support.[10] Those whose illness may be complicated by acute respiratory distress syndrome (ARDS), sepsis and septic shock, or multi-organ failure, including kidney, liver and cardiac injury will typically require invasive mechanical ventilation in the ICU [11].

As COVID-19 is a novel disease, the short- and long-term consequences for patients who have experienced severe disease requiring admission to the ICU are anticipated based on knowledge gained from the general critical care population, in particular those with ARDS.[12] Mechanical ventilation, coupled with sedation and/or paralysis, as well as potentially prolonged bed rest and immobilization, can have many detrimental musculoskeletal effects including reduced muscle strength and physical function.[13] Other effects may include impairments in respiratory function, cognitive status, swallow, and communication, as well as the potential for delirium. In the long-term, the multifaceted aspects of post intensive care syndrome, which can persist for many months or years after discharge, may also manifest in reduced exercise capacity, independence with activities of daily living, and health-related quality of life.[14] The development of rehabilitation medicine has been promoting the transformation of traditional, passive, and fractured medical care models into a human-oriented healthcare system that covers all stages of life.[15] This article has been prepared to provide information to physiotherapists in the management of hospital admitted patients with confirmed or suspected COVID-19. Physiotherapists who work in primary healthcare facilities are likely to have a role in supporting these patients who would benefit from the respiratory physiotherapy assessment and management of productive cough which is a less but not unusual symptom (34%). [16] However, physiotherapists who work in the intensive care unit (ICU) provide airway clearance techniques for ventilated patients who show signs and symptoms of inadequate airway clearance.¹⁶Pulmonary rehabilitation should be provided throughout the disease's management process, regard-less of whether the patient is hospitalized or at home.[17] They can also help in positioning patients with severe respiratory failure associated with COVID-19, inclusive of using susceptible position to optimize oxygenation. The purpose of respiratory rehabilitation within the hospital is to enhance the signs and symptoms of dyspnoea, relieve anxiety, and maximize function.[18] However, the rehabilitation should be carried beyond the hospital stay within the community to ensure there is retention and improvement in the high-quality of life. The aim of the current study is to study the effect of physiotherapy on covid 19 survivors.

With the Objectives

To access the literature of effectiveness of physiotherapy in respiratory system on post covid 19 survivors.

To access the literature of effectiveness of physiotherapy on mental health and behaviour in post covid 19 survivors.

To access the literature of effectiveness of physiotherapy in ICU patients of post covid 19 survivors.

To access the literature of effectiveness of physiotherapy in telerehabilitation on covid 19 survivors.



**Advita Neville Deepak, et al.,**

METHODOLOGY

PRISMA, Preferred Reporting Item for Systematic Review and Meta-analysis. We searched Pub Med and Google scholar for take a evidence article which proves that physiotherapy treatments are beneficial for post covid patients. For that total 103 article were search which includes a physiotherapy treatment use to improve post covid patients health on PubMed and Google scholar. After reading all abstract and methodology duplicate are remove remaining 100 reviews were screening whole methodology and result. And by screening 53 articles were exclude remaining 47 articles were re-read and excluded with reason which has not positive findings and not relevant methodology. A total of 27 studies were finally included in the review (Figure 1). Firstly all 103 articles were found which are related to positive effect of physiotherapy in covid 19 patient. Then which are not relate with each other and conclusion is not positive that all are excluded from review and after the entire factor which have to included review that total number of article are 27. Given the high percentage of hospitalized patients requiring intensive care, it is likely that in the weeks and months following an increase in the number of acute patients admitted to hospitals and ICUs, there will be a considerable number of COVID-19 survivors requiring rehabilitation.[19] For this reason, it is a common opinion that a rehabilitation program must be developed that is tailored to the specific needs of each patient. Partly owing to the rapid onset of the COVID-19 pandemic, there is currently little scientific evidence to guide the approach to rehabilitation in patients with COVID-19.[20] The evidence in the field indicates that considerable reorganization of services is required with acute emergencies taking precedence over rehabilitation, which may involve complete conversion of beds, wards, and even hospice facilities.[20] Rehabilitation beds are often used for the care of acutely ill patients, with physiatrists being sent to emergency rooms¹⁶ and in some cases becoming directly involved in the care of patients with COVID-19, detracting them from rehabilitation care.²⁰

DISCUSSION

COVID-19 is a highly infectious respiratory disease that leads to respiratory, physical, and psychological dysfunction in patients. In most patients (81%), COVID-19 infection confers mild disease with fever (88.7%), cough (57.6%), and dyspnoea (45.6%). However, for a considerable number of patients, generally, those age > 65 years with co morbidities such as hypertension and diabetes, the infection can have very serious sequelae. Among patients requiring hospitalization, a relatively high percentage (20.3%) require management in the ICU, often for acute respiratory distress syndrome (ARDS).[21] Research shows that regular exercises are a powerful tool in enhancing the quality of life, in managing mood swings and its illnesses (depression and anxiety), in attenuating psychological stress and in modulating the perception of pain. Exercise helps to change the brain structure and function to stimulate a healthier neurological phenotype.[21] In hospitalized patients with COVID-19, the aim of respiratory rehabilitation is to improve symptoms of dyspnoea, relieve anxiety and depression, reduce complications, prevent and improve dysfunction, reduce disability, preserve function to the maximum extent, and improve quality of life. Based on current evidence in discharged patients with SARS and Middle East respiratory syndrome (MERS) as well as the clinical experience of patients with ARDS, patients discharged after COVID 19 infection may have poor fitness and have breathing difficulties after exertion.[22] A large number of COVID-19 patients will need outpatient and home rehabilitation care, and the negative impact that COVID19 has had on rehabilitation medicine units can cause difficulties in meeting patients' needs. Remodeling of hospitals with reduced hospital rehabilitation services could increase waiting lists and the need to resort to a private office. Where appropriate, repurposing of clinics and athletic facilities or gyms to establish temporary post-acute care facilities could rapidly expand the available space for adapted physical activity [22]. Adequate control of metabolic disorders is important to reduce the risk of severe COVID-19. We should try to avoid the deleterious consequences of physical inactivity and positive energy balance by maintaining physical activity and exercise levels in a safe home environment and adhering to a healthy diet. Of course, this is also important for people without metabolic disorders to avoid the reported deleterious effect of physical inactivity and positive energy balance, which may prompt the development of metabolic syndrome and its co morbidities. COVID-19 varies from a mild self-limiting flu-like illness to full-blown pneumonia, respiratory failure and death.[23] the role of respiratory rehabilitation in managing patients with different chronic respiratory



**Advita Neville Deepak, et al.,**

diseases has been scientifically confirmed, its effectiveness and safety when initiated after ICU discharge for adults with COVID-19 have not been established.[23] Therefore, this review and met analysis is intended to provide useful recommendations for patients with COVID-19 discharged from the acute care to manage this disease from the perspective of respiratory rehabilitation. Telerehabilitation is the provision of rehabilitation services through telecommunication networks or the internet offering remote treatments to the people in their homes or from a distance. Since COVID-19 emerged and caused the collapse of health systems, many patients are not able to receive their face-to-face treatments. Chronic patients are unable to continue their follow-up as usual, professionals could not attend all of the consultations and the high contagious nature of the disease forced a new treatment approach, that is, telerehabilitation to be used widely [24]. In patients with COVID-19, there seem to be no reports on the use of chest physiotherapy immediately post-exudation. However, following discharge, rehabilitation involving respiratory muscle training, cough exercise, diaphragmatic training, stretching exercise, and home exercise has been applied. These forms of training and exercise, when performed for two sessions per week for 6 weeks, resulted in improved FEV1 (L), FVC (L), FEV1/FVC%, diffusing lung capacity for carbon monoxide (DLCO%), endurance, and quality of life and a reduction in anxiety and depression symptoms [25]. Exercise training in COVID-19 patients is almost always characterized by respiratory problems of various degrees. Thus, performing respiratory rehabilitation in COVID-19 patients helps to ameliorate dyspnoea, alleviate anxiety and depression, reduce complications, prevent and improve dysfunction, reduce morbidity, preserve functions, and improving quality of life is imperative.[26] We include article related to effect of physiotherapy in post COVID 19 patients. According to the researches proves that physiotherapy beneficial for post COVID 19 rehabilitation. In behavior related patients who are affected to COVID physiotherapy is useful for improve their mental health. In ICU patients who are admitted because of long term sitting and placed in one position their lung capacity is decreased. Because of giving some physical exercise to patient and activity task their functional activity improves. Post COVID 19 patients have respiratory problem so, because of giving exercise related to the musculoskeletal and giving chest physiotherapy their lung capacity not decreased and that remain normal. Apart from this during COVID patient have not physical task and living sedentary life their functional and lung capacity decreased and also patient mental health is also affected this review has clear that physiotherapy is beneficial for post COVID 19 patients. This study provides preliminary evidence that an exercise training program may be safe and potentially effective in recovering cardio respiratory functional capacity, functionality, fatigue, exertional dyspnoea, and other persistent symptoms in COVID-19 survivors [27].

CONCLUSION

COVID 19 is worldwide diseases which spread though out the world and according to this literature review physiotherapy in useful for COVID19 survivor whether it is based on mental health or strength base physiotherapy helps to improve strength, lung capacity , reduce anxiety ,dyspnoea and also useful for ICU patients. Chest physiotherapy may Improve respiratory functions and quality of life in patients with COVID-19, especially after discharge.

REFERENCES

1. Gupta MM. Impact of Coronavirus Disease (COVID-19) pandemic on classroom teaching: Challenges of online classes and solutions. *Journal of Education and Health Promotion*. 2021;10.
2. Borak J. Airborne transmission of COVID-19. *Occupational Medicine*. 2020 Jul 17;70(5):297-9.
3. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *Jama*. 2020 Mar 17;323(11):1061-9.
4. Chakraborty I, Maity P. COVID-19 outbreak: Migration, effects on society, global environment and prevention. *Science of the Total Environment*. 2020 Aug 1;728:138882.
5. Pandey SC, Pande V, Sati D, Upreti S, Samant M. Vaccination strategies to combat novel corona virus SARS-CoV-2. *Life sciences*. 2020 Sep 1;256:117956.



**Advita Neville Deepak, et al.,**

6. Sharma A, Tiwari S, Deb MK, Marty JL. Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2): a global pandemic and treatment strategies. *International journal of antimicrobial agents*. 2020 Aug 1;56(2):106054.
7. Verma CV, Arora RD, Shetye JV, Karnik ND, Patil PC, Mistry HM, Kubal SV, Kolwankar NS, Dalvi AA, Vichare SA, Desai UD. Guidelines of physiotherapy management in acute care of COVID-19 at dedicated COVID center in Mumbai. *Physiotherapy-The Journal of Indian Association of Physiotherapists*. 2020 Jan 1;14(1):55.
8. George PM, Barratt SL, Condliffe R, Desai SR, Devaraj A, Forrest I, Gibbons MA, Hart N, Jenkins RG, McAuley DF, Patel BV. Respiratory follow-up of patients with COVID-19 pneumonia. *Thorax*. 2020 Nov 1;75(11):1009-16.
9. Halpin SJ, McIvor C, Whyatt G, Adams A, Harvey O, McLean L, Walshaw C, Kemp S, Corrado J, Singh R, Collins T. Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: a cross-sectional evaluation. *Journal of medical virology*. 2021 Feb;93(2):1013-22.
10. Grein J, Ohmagari N, Shin D, Diaz G, Asperges E, Castagna A, Feldt T, Green G, Green ML, Lescure FX, Nicastri E. Compassionate use of remdesivir for patients with severe Covid-19. *New England Journal of Medicine*. 2020 Jun 11;382(24):2327-36.
11. Hashemian SM, Shafigh N, Afzal G, Jamaati H, Tabarsi P, Marjani M, Malekmohammad M, Mortazavi SM, Khoundabi B, Mansouri D, Moniri A. Plasmapheresis reduces cytokine and immune cell levels in COVID-19 patients with acute respiratory distress syndrome (ARDS). *Pulmonology*. 2021 Nov 1;27(6):486-92.
12. Simpson R, Robinson L. Rehabilitation after critical illness in people with COVID-19 infection. *American journal of physical medicine & rehabilitation*. 2020 Jun;99(6):470.
13. deJonghe B, Lacherade JC, Sharshar T, Outin H. Intensive care unit-acquired weakness: risk factors and prevention. *Critical care medicine*. 2009 Oct 1;37(10):S309-15.
14. Parker AM, Brigham E, Connolly B, McPeake J, Agranovich AV, Kenes MT, Casey K, Reynolds C, Schmidt KF, Kim SY, Kaplin A. Addressing the post-acute sequelae of SARS-CoV-2 infection: a multidisciplinary model of care. *The Lancet Respiratory Medicine*. 2021 Nov 1;9(11):1328-41.
15. Ninot G. The Market for Non-pharmacological Interventions. In *Non-Pharmacological Interventions 2021* (pp. 193-219). Springer, Cham.
16. Kalirathinam D, Guruchandran R, Subramani P. Comprehensive physiotherapy management in covid-19—a narrative review. *ScientiaMedica*. 2020 May 26;30(1):e38030-.
17. Thomas P, Baldwin C, Bissett B, Boden I, Gosselink R, Granger CL, Hodgson C, Jones AY, Kho ME, Moses R, Ntounenopoulos G. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. *Journal of physiotherapy*. 2020 Apr 1;66(2):73-82.
18. Yang LL, Yang T. Pulmonary rehabilitation for patients with coronavirus disease 2019 (COVID-19). *Chronic diseases and translational medicine*. 2020 Jun 1;6(02):79-86.
19. Spruijt MA, Holland AE, Singh SJ, Tonia T, Wilson KC, Troosters T. COVID-19: interim guidance on rehabilitation in the hospital and post-hospital phase from a European Respiratory Society and American Thoracic Society-coordinated international task force. *European Respiratory Journal*. 2020 Dec 1;56(6).
20. Demeco A, Marotta N, Barletta M, Pino I, Marinaro C, Petraroli A, Moggio L, Ammendolia A. Rehabilitation of patients post-COVID-19 infection: a literature review. *Journal of International Medical Research*. 2020 Aug;48(8):0300060520948382.
21. Craft LL, Perna FM. The benefits of exercise for the clinically depressed. *Primary care companion to the Journal of clinical psychiatry*. 2004;6(3):104.
22. Thomas P, Baldwin C, Bissett B, Boden I, Gosselink R, Granger CL, Hodgson C, Jones AY, Kho ME, Moses R, Ntounenopoulos G. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. *Journal of physiotherapy*. 2020 Apr 1;66(2):73-82.
23. Martinez-Ferran M, de la Guía-Galipienso F, Sanchis-Gomar F, Pareja-Galeano H. Metabolic impacts of confinement during the COVID-19 pandemic due to modified diet and physical activity habits. *Nutrients*. 2020 Jun;12(6):1549.
24. Heneghan NR, Nazareth M, Johnson WJ, Tyros I, Sadi J, Gillis H, Rushton AB. Experiences of telehealth e-mentoring within postgraduate musculoskeletal physical therapy education in the UK and Canada: a protocol for parallel mixed-methods studies and cross-cultural comparison. *BMJ Open*. 2021 Feb 5;11(2):e042602.





Advita Neville Deepak, et al.,

25. Soril LJ, Damant RW, Lam GY, Smith MP, Weatherald J, Bourbeau J, Hernandez P, Stickland MK. The effectiveness of pulmonary rehabilitation for Post-COVID symptoms: A rapid review of the literature. *Respiratory medicine*. 2022 Mar 2:106782.
26. Calabrese M, Garofano M, Palumbo R, Di Pietro P, Izzo C, Damato A, Venturini E, Iesu S, Virtuoso N, Strianese A, Ciccarelli M. Exercise training and cardiac rehabilitation in COVID-19 patients with cardiovascular complications: state of art. *Life*. 2021 Mar;11(3):259.
27. Longobardi I, do Prado DM, Goessler KF, de Oliveira Júnior GN, de Andrade DC, Gualano B, Roschel H. Benefits of home-based exercise training following critical SARS-CoV-2 infection: a case study.

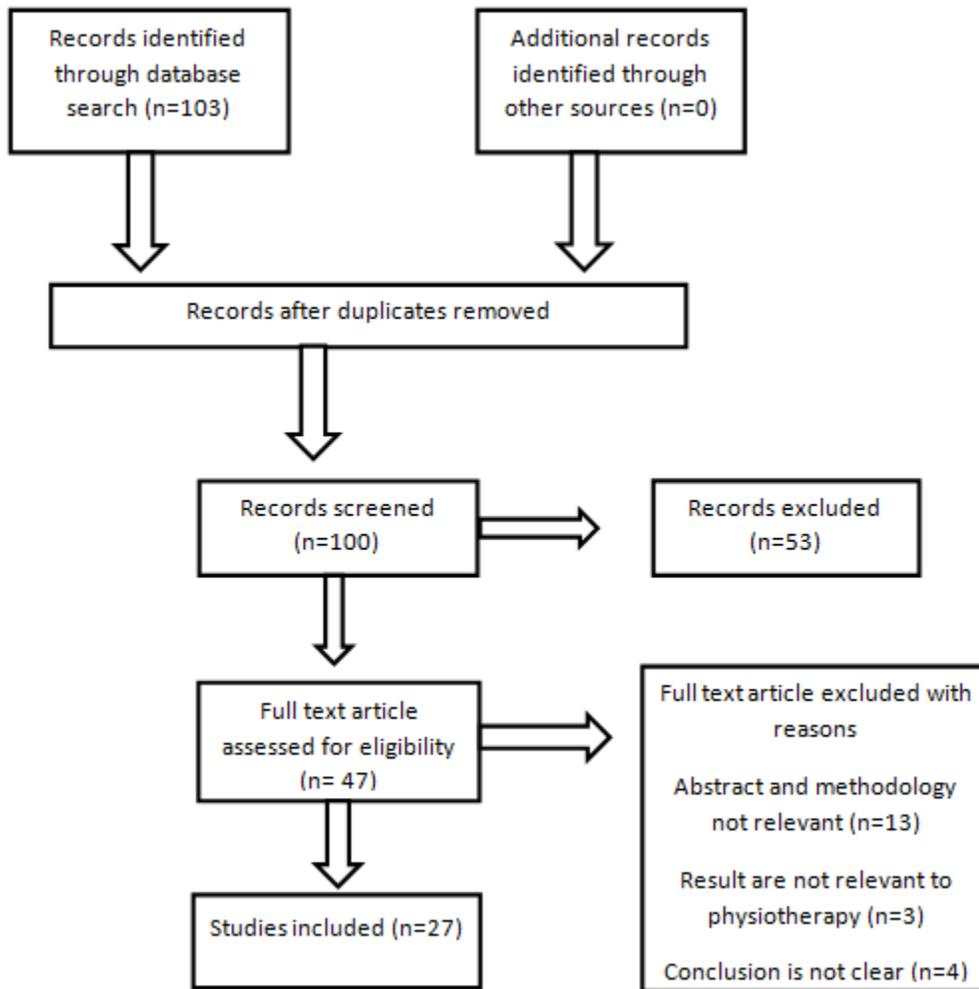


Figure 1. PRISMA flowchart





Stone Man Disease – A Case Study

Pragna Gondaliya^{1*} and Jayesh Parmar²

¹Associate professor at Shri K.K. Sheth Physiotherapy College, and PhD Scholar, Faculty of Physiotherapy, Marwadi University, Rajkot, Gujarat, India.

²Professor and Principal, at Shri K.K. Sheth Physiotherapy College, Affiliated with Saurashtra University, Rajkot, Gujarat, India.

Received: 19 Apr 2022

Revised: 03 June 2022

Accepted: 04 July 2022

*Address for Correspondence

Pragna Gondaliya,

Faculty of Physiotherapy,

Marwadi University,

Rajkot, Gujarat, India.

Email:gondaliyapragna@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A stone man disease is extremely rare autosomal dominant genetic disorder. It is characterized by postnatal progressive heterotopic ossification of the connective tissue and fusion of axial and appendicle skeleton. This disease has worldwide prevalence of about 1 in 2 million births. Patients with stone man disease are misdiagnosed mostly.¹ So far, the number of reported existing cases worldwide is about 801. Clinical examination shows presence of hard bony swelling on body and muscle tissue converted into fibrous hard tissue and ankylosis of joint leads to reduce or loss of joint range of motion. Also, other clinical features are easy fatigue and difficulty or inability to do sitting, squatting and rotational activity. also, all activity of daily living is affected severely. Physiotherapy management has never been reported previously, and people can take our case study as a reference for the role of a physiotherapy treatment in a case of stone man disease to the best of our knowledge.

Keywords: fibro dysplasia ossificans progressive, munchmeyer disease, heterotopic ossification

INTRODUCTION

Stone man disease is also known as Fibro dysplasia ossificans progressive (FOP) and Münchmeyer disease. It is a connective tissue disease characterized by congenital malformation of great toes, thumbs and vertebra. It is also associated with progressive ossification of striated skeletal muscles. It is a severe, disabling disorder with no current cure or treatment. Stone man disease is an extremely rare disorder with a worldwide prevalence of 1 case in 2 million individuals. The average lifespan of these patients is approximately 40 years. Death is usually caused by respiratory infections [2]. It has no racial or gender predisposition. The disorder develops postnatally in the first 10 years of life. Genetic inheritance pattern is autosomal dominant and can be inherited from either



**Pragna Gondaliya and Jayesh Parmar**

parent it is caused by mutation of the gene ACVR1. The mutation affects the body's repair mechanism and cause ossification of fibrous tissue including muscle, tendons, and ligaments. Minor trauma can cause joints to become permanently fused as new bone forms and replaces the damaged muscle tissue. This new bone formation (known as "heterotopic ossification") eventually forms a secondary skeleton and progressively restricts the patient's ability to move[3]. Minor trauma, biopsy, injection may flare up the disease. Excessive bone growth occur during flare ups may leads to loss of mobility of affected joints, including if the jaw/mandible is involved, then patient cannot able to open mouth and patient find difficulty in eating and speaking. Ossification of bone of internal ear may leads to conductive hearing loss. Bone growth can also result in the immobilization of the hip, knee and ankle, which affect individual ability to walk. Extra bone formation around rib cage restricts chest expansion and hamper breathing and patient develop restrictive lung disease progressively.

There is reduction or loss of all the joint range of motion in addition muscle tissue gets converted into fibrous tissue or hard connective tissue resulting in reduction in muscle strength. Therefore, is such individual's activity of daily living are affected like walking, bathing, dressing, feeding etc. ending with patient's dependency on others for ADLs. Low fiber diet and decreased water intake may also increase the risk of developing kidney stones in people with FOP. There is no cure for stone man disease. Physiotherapy treatment is only given for maintenance of range of motion of all the joints, muscle strength and prevention of fall. Furthermore, we can teach patient breathing exercise, energy conservation technique and modification in ADLS.

CASE REPORT

A case of 25-year-oldlean and thin female came to our clinic before 5 years. When she got fracture of greater trochanter of femur on right side spontaneously while she was walking without any history of trauma. then she consulted orthopedic surgeon and has been conservatively treated for that fracture. So lower limb traction was given for femur fracture for 1 month and was advised for physiotherapy. So, she came to our physiotherapy department for treatment. On examination, the patient had multiple hard swelling on his back, right shoulder, right hip. Also reduce ROM of cervical, thoracic and lumbar spine. Also, shoulder, elbow and knee joint ROM was restricted gradually. On palpation revealed hard par spinal muscle and whole of lateral aspect of thigh muscles. Also, there was a hard swelling on right hip joint. So, she advised for x-ray of right hip joint. X-ray was taken and it shows myositis ossification at right side femur. (fig).

Gradually she got hard swelling on her upper back and right shoulder near arm pit. (fig)Then her all joint ROM was restricted and she found difficulty in her all ADL. She was unable to do bathing, dressing, feeding, squatting, driving etc. so she had consulted to doctors. Doctors has taken x-rays of multiple joints. It reveals she is a case of stone man disease. Also, patient had bilateral hallux valgus progressive deformity. (fig) She is not able to do sitting, stair climbing, feeding and all others ADL since last 1 year as gradually progression of stiffness in all the joints. She is only able to assume standing and supine lying position. She is totally dependent on her parents for ADLs. Also, her elbow was fixed in 90-degree ROM bilaterally. (fig) also her jaw movement is restricted. Therefore, she is unable to perform mouth opening activity leading to difficulty in eating. On examination, her blood pressure is 130/90 mm hg and pulse rate are 80 beats per minute and respiratory rate is 25 beats per minute. And Pulmonary function test shows restrictive disease of chest wall.

On gait examination, step length and stride length were reduced, also heel strike is absent and she is walking with hip in external rotation bilaterally and knee flexion was absent in swing phase. Results of laboratory studies were normal. Genetic analysis testing could not be performed. Conventional radiographs showed heterotopic ossification involving spine, neck, shoulder, right side hip. Patients is taking symptomatic treatment for pain and her family was educated about disease. Now patient is doing her all ADLS with modification. Counseling was done and prevention of trauma was advised.





Pragna Gondaliya and Jayesh Parmar

DISCUSSION

FOP (myositis ossificans progressive) is autosomal dominant connective tissue disorder characterised by extra skeletal endochondral ossification. It may be associated with mutation in bone morphogenic protein-4 (BMP4) antagonist gene which leads to increased production of BMP [4]. FOP is an autosomal dominant connective tissue disorder. Progressive heterotrophic bone formation occurs in connective tissue and skeletal muscle. The ossification usually starts from neck, spine and shoulder girdle and progressively immobilize all the joints of axial and appendicle skeleton during first decade of life [5]. In early stages, patients may not have any symptom, and since it is a rare entity, the diagnosis may be missed. This patient had bony hard swellings with restricted movements. Diagnosis of FOP was confirmed on the basis of two classical features, first congenital great toe malformations and second heterotopic ossification in specific anatomical patterns and mature bone tissue on histopathology of the biopsy [6]. Imaging examinations such as radiography and computed tomography showed the heterotopic bones and are useful to confirm the diagnosis. Physical rehabilitation should be focused on enhancing activities of daily living through approaches like hydrotherapy, relaxation and massage. but, avoid stretching and passive range of motion that can lead to disease flare-ups. Patients has severe restrictive spirometry because of chest wall fixation and depended upon diaphragmatic respiration. So, giving diaphragmatic breathing exercise is crucial. Greater risk of presenting with complications of respiratory infections, which are a frequent cause of death [8]. The severity of chest restriction is independent of sex, age, duration of disease, and extent of other physical disability. Infections also flare-up the condition. Hence, prophylaxis against influenza and other respiratory tract infections is important.

The role of physiotherapist in stone man disease is to maintain available range of motion and prevent secondary complication like dyspnoea, restricted range of motion, deformity, pressure sores etc. These individuals are at risk for pressure sores due to the reduction in soft tissue and increased bone mass. Also, physiotherapist can teach energy conservation technique to prevent fatigue, and life style modification technique such as enabling the use of bath with shower, long handle spoon for eating, straw for drinking, increasing intake of juice or liquid food to prevent dehydration. Deep breathing exercise can be given to patient to avoid secondary respiratory complications. patients and their families should be educated about the disease, and proper counseling of families should be provided.

ACKNOWLEDGEMENTS

We are thankful to patient's family for their cooperation in this case study.

Conflicts of interest

There are no conflicts of interest.

Financial support and sponsorship

Nil.

Declaration of patient consent

Informed written signed consent was taken from patient.

REFERENCES

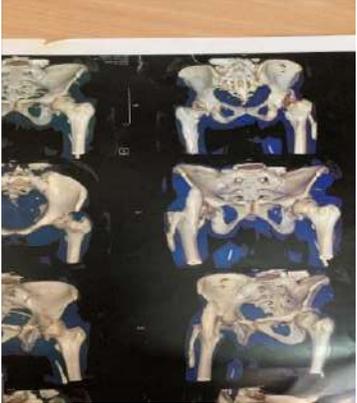
1. Zakir Ali Shas, Sascha Rausch, Uzmas Arif & Bilals El Yafawi fibrodysplasia ossificans progressive: a case report. Journal of medical case reports 2019(364), volume 13.





Pragna Gondaliya and Jayesh Parmar

2. Frederick S Kaplan, Michael A Zasloff, Joseph A Kitterman, Eileen M Shore, Charles C Hong, David M Roche, Early mortality and cardiorespiratory failure in patient with fibrodysplasia ossificans progressive, *J Bone joint surg Am*2010 Mar;92(3):686-91.
3. Kaplan, Frederick S, Shen Qi, Lounev, Vitali, Seemann, et. Al. Skeletal metamorphosis in fibrodysplasia ossificans progressive (FOP). *J Bone Miner Metab.*2008;26(6):521-530
4. Kaplan FS, Le Merrer M, Glaser DL, Pignolo RJ, Goldsby RE, Kitterman JA, et al. Fibrodysplasia ossificans progressiva. *Best Pract Res Clin Rheumatol.* 2008; 22:191–205.
5. Cummings, Michael R. *Human Heredity: Principles and Issues* Cengage Learning, 2011, [2009]. p. 77
6. Pinkowski, Jen. Here’s what happens when your body tissues turn to bone. National geographic. Archived from the original on 3 march 2019.
7. Geeta kamal, Anju Gupta, Sapna Batla and Nishkarsh Gupta. Anaesthetic management of a child with stone man syndrome: *Indian J Anaesth.*2017 ,Mar;61(3):266-268.
8. Lanchoney TF, Olmsted EA, Shore EM, et al. Characterization of bone morphogenetic protein 4 receptor in fibrodysplasia ossificans progressiva. *Clin Orthop Relat Res.* 1998; 346:38–45.

| | |
|---|--|
|  |  |
| <p>Fig.1 Patient with stone man disease</p> | <p>Fig.2 Heterotrophic ossification at femur</p> |
|  |  |
| <p>Fig. 3 Bilateral great toe malformation with hallux valgus deformity</p> | <p>Fig.4 Restricted elbow ROM</p> |





Standardization of Poly Herbal Siddha Medicine Moolanivarana Ilagam

N.Santhini^{1*}, T.Lakshmi Kantham² and R. Meena Kumari³

¹PG Scholar, Department of Maruthuvam, National Institute of Siddha, Tambaram Sanatorium, Chennai 47, Tamil Nadu, India.

²Associate Professor, HoD(i/c), Department of Maruthuvam, National Institute of Siddha, Tambaram Sanatorium, Chennai 47, Tamil Nadu, India.

³Director, National Institute of Siddha, Tambaram Sanatorium, Chennai 47, Tamil Nadu, India.

Received: 18 May 2022

Revised: 20 June 2022

Accepted: 04 July 2022

*Address for Correspondence

N.Santhini

PG Scholar, Department of Maruthuvam,
National Institute of Siddha,
Tambaram Sanatorium,
Chennai 47, Tamil Nadu, India.

Email: chanthuzanvi26@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Most of the traditional systems of medicines are effective but they lack standardization. AYUSH has given preliminary guidelines for the standardization of the conventionally used formulations. Standardization of herbal formulations is essential in order to assess the quality of drugs, based on the concentration of their active principles, physical and chemical standards. Physicochemical analysis and preliminary photochemical analysis were done based on the standard Guidelines. Another analytical technique like High-Performance thin layer chromatography (HPTLC) fingerprinting was done using CAMAG. The preliminary photochemical analysis showed the presence of Sugar, Alkaloids, Tannic acid, steroids, coumarin, saponins, and phenol are present in the trial drug. The drug was free of microbial contamination; heavy metals and pesticides were below the deductible limit. The results obtained indicate that the drug is of standard quality and can be used as a reference standard in laying pharmacopeia standard.

Keywords: Moolanivarana ilagam, Standardisation, Herbal drug, Siddha medicine.

INTRODUCTION

In the Siddha system of medicine, there are 2-types of medicines available. According to the mode of usage, these are classified into 2-types, one is internal medicines and another one is external medicines [1]. Totally there are 32 types of internal medicines and 32-types of external medicine. Among them, Ilagam is internal medicine, which is



**Santhini et al.,**

soft waxy consistency in nature [2]. There is improving the awareness and general acceptability of the use of herbal drugs. Most of the medicines we use today come from natural sources [3]. The World Health Organization (WHO) estimated that about the majority of the human population depends on traditional herbal medicines for their primary health care sector. WHO-specific guidelines for the assessment of the safety, efficacy, and quality of herbal medicines are most important. a large number of herbal formulations available in the market, standards for their quality are yet to be laid for many of them [4]. Standardization of a drug, means confirmation of its purity, quality, and identity, throughout all phases of its cycle. The Standardization of any drug is done by stepwise quality control methods as prescribed by Pharmacopeia laboratory standards of Indian Medicine [5]. Siddha pharmacopeia has given preparations in a variety of forms as Chooranam(powder), Maathirai(tablet), Manapagu(syrup), Nei(medicated ghee) for the treatment of different diseases. Due to the combination nature and inherent variability of the chemical constituents of the herbal-based drugs, it is difficult to establish quality control parameters and modern analytical techniques are expected to help in encompassing this problem. In the literature survey, no scientific study has been conducted to standardize this Ilagam so far. Consequently, a scientific investigation was undertaken to evaluate Moolanivaranallagam. This research paper describes the evaluation of Moolanivaranallagam , Which is Siddha polyherbalmedicine The formulation is official in Siddha classical text SigichaRathinaDeepamand therapeutically useful in the treatment of Ratha Moolam (Internal Hemorrhoid) It consists of Thennampoo (*Cocos nucifera*), Mathulai (*Punica granatum. Linn*), Marul (*Sansevieria roxburghiana, Schult*), Kaatukarunai (*Tacca pinnatifida, Forst*), Karikarunai (*Amorphophallus paeoniifilius*), Sengatharipatai (*Capparis aphylla*), Aavaraipattai and seed (*Cassia auriculata. Linn*), Kalipakku (*Areca catechu, Linn*), Puliyangottaithol (*Tamarindus indica. Linn*), Elam (*Elattaria cardamomum. Marton*) Lavangapattai (*Cinnamomum verum, Presl*), Kirambu (*Syzygium aromaticum. Linn*), Jathikkai (*Myristica fragrans. Linn*), Jathipathiri (*Myristica fragrans. Linn*), Milagu(*piper nigra.Linn*), Athimadhuram (*Glycyrrhiza glabra. Linn*), Kostam (*Costus speciosus. J.E.Smith*), Vasambu (*Acorus calamus. Linn*), Seeragam (*Cuminum cyminum. Linn*), Vilampisin (*Limonia acidissima. Linn*), Vaal milagu (*Piper cubeba. Linn*), Kachukatti (*Acacia catechu*).Herbal drug Standardization is an essential measurement for ensuring the quality control of herbal drugs. so the current study has been carried out to assess its Phytochemical, Physicochemical, and other standardization parameters as a part of their scientific validation^[6].Because of the complex nature and inherent variability of the constituents of herbal-based drugs, it is difficult to establish quality control parameters & modern analytical techniques are expected to help in circumventing this problem. Furthermore, the constituents responsible for the claimed therapeutic effects are clearly unknown or only partly explained. many of the herbal formulations, specifically the classical formulations of traditional medicine, are polyherbal. Even though official standards are not available. The unique processing procedures followed for the manufacture of these drugs turn the single drugs into a very complex mixture, from which identification, separation, and analysis of the components are very challenging.

MATERIAL AND METHODS

The ingredients were purchased from local raw material traders, Chennai. The poly herbal formulation consists of 22 ingredients. The required raw drugs were authenticated by the Department of Medicinal Botany in National Institute of Siddha. After that the raw drugs were purified as per the guidelines mentioned in the Siddha literature of "Chikitcharathma Theepam Then the trial drugs were prepared in the Gunapadam laboratory of National Institute of Siddha by standard operative procedures.

Standardization Parameters

The various standardization parameters studied were organoleptic properties, microscopical studies, physicochemical investigations, preliminary phytochemical analysis, Heavy metal analysis, microbial evaluation and analysis of aflatoxins.

ORGANOLEPTIC PROPERTIES

The sensory characters of the drug were carefully noted and the interpretation illustrated in Table 1.



**Santhini et al.,****PHYSICO CHEMICAL ANALYSIS****Percentage Loss on Drying**

Test drug was accurately weighed in evaporating dish. The sample was dried at 105°C for 5 hours and then weighed. Percentage moisture content of the sample was calculated with reference to the shade dried material.

Determination of Total Ash

Test drug was accurately weighed in silica dish and incinerated at the furnace a temperature 400 °C until it turns white in color which indicates absence of carbon. Percentage of total ash will be calculated with reference to the weight of air-dried drug.

Determination of Acid Insoluble Ash

The ash obtained by total ash test will be boiled with 25 ml of dilute hydrochloric acid for 6mins. Then the insoluble matter is collected in crucible and will be washed with hot water and ignited to constant weight. Percentage of acid insoluble ash will be calculated with reference to the weight of air-dried ash.

Determination of Alcohol Soluble Extractive

Test sample was macerated with 100 ml of Alcohol in a closed flask for twenty-four hours, shaking frequently during six hours and allowing it to stand for eighteen hours. Filter rapidly, taking precautions against loss of solvent, evaporate 25 ml of the filtrate to dryness in a tared flat bottomed shallow dish, and dry at 105°C, to constant weight and weigh. Calculate the percentage of alcohol-soluble extractive with reference to the air-dried drug.

Determination of Water Soluble Extractive

Test sample was macerated with 100 ml of chloroform water in a closed flask for twenty-four hours, shaking frequently during six hours and allowing it to stand and for eighteen hours. Filter rapidly, taking precautions against loss of solvent, evaporate 25 ml of the filtrate to dryness in a tared flat bottomed shallow dish, and dry at 105°C, to constant weight and weigh. Calculate the percentage of water-soluble extractive with reference to the air-dried drug[6][7].

PHYTOCHEMICAL SCREENING

The primary phytochemical screening test was conducted for each extracts of *Moolanivarana Ullagam* as per the standard operating processes [9]. Key metabolites of Carbohydrates, Proteins, alkaloids, Triterpenoids were investigate for their existence of standard measures. The following tests were performed for this analysis

Test for alkaloids: Mayer's Test

Test for phenols: Lead acetate test

Test for steroids

Test for Carbohydrates - Benedict's test

Test for Cyanine

Anthocyanin

Proteins: Biuret Test

Triterpenoids: Liebermann–Bur chard test

Test for tannins

Test for saponins

Test for coumarins



**Santhini et al.,**

HEAVY METAL ANALYSIS BY AAS

Methodology

Atomic Absorption Spectrometry (AAS) is a very common and reliable technique for detecting metals and metalloids in environmental samples. The total heavy metal content of the sample was performed by Atomic Absorption Spectrometry (AAS) Model AA 240 Series. In order to determination the heavy metals such as mercury, arsenic, lead and cadmium concentrations in the test item.

Sample Digestion

Test sample was digested with 1mol/L HCl for determination of arsenic and mercury. Similarly, for the determination of lead and cadmium the sample were digested with 1mol/L of HNO₃[9].

High Performance Thin Layer Chromatography

High-performance thin-layer chromatography (HPTLC) is a valuable quality assessment tool for the evaluation of botanical materials efficiently and cost-effectively. HPTLC method offers a high degree of selectivity, sensitivity, and rapidity combined with single-step sample preparation. Thus this method can be conveniently adopted for routine quality control analysis [10].

PESTICIDES RESIDUES

Test sample were extracted with acetone and followed by homogenization for brief period. Further filtration was allowed and subsequent addition of acetone to the test mixture. Heating of test sample was performed using a rotary evaporator at a temperature not exceeding 40°C until the solvent has almost completely evaporated. To the residue add a few millilitres of toluene and heat again until the acetone is completely removed. Resultant residue will be dissolved using toluene and filtered through membrane filter [9][11].

AFLATOXIN ASSAY

Standard aflatoxin was applied on to the surface to pre coated TLC plate in the volume of 2.5 µL, 5 µL, 7.5 µL and 10 µL. Similarly, the test sample was placed and Allow the spots to dry and develop the chromatogram in an unsaturated chamber containing a solvent system consisting of a mixture of chloroform, acetone and isopropyl alcohol (85: 10: 5) until the solvent front has moved not less than 15 cm from the origin. Remove the plate from the developing chamber, mark the solvent front and allow the plate to air-dry. Locate the spots on the plate by examination under UV light at 365 nm [12].

TEST FOR SPECIFIC PATHOGEN

Test sample was directly inoculated in to the specific pathogen medium (EMB, DCC, Mannitol, Cetrimide) by pour plate method. The plates were incubated at 37°C for 24 - 72h for observation. Presence of specific pathogen identified by their characteristic color with respect to pattern of colony formation in each differential media.

RESULTS

Organoleptic Characters

The drug Moolanivaranailagam was a semi solid dark brownish in color with a strongly aromatic in odor (Figure 1). The inferences are tabulated in Table 1.

Physiochemical analysis

Results of quantitative analysis for Total ash, Acid insoluble ash, alcohol soluble extractives, Water-soluble extractive, Loss on drying at 105° C were analyzed and results were shown (Table-3). Ash value is useful in determining authenticity and purity of the drug and also these values are important quantitative standards.



**Santhini et al.,**

Percent weight loss on drying or moisture content was found to be 5.4% w/w. The less value of moisture content could prevent bacterial, fungal or yeast growth. Phytochemical analysis revealed the presence of tannin, coumarin, phenol, steroid, triterpenoid, and tannins (Table 3).

HEAVY METAL ANALYSIS BY AAS

Results of the present investigation have clearly shows that the sample has no traces of heavy metals such as Arsenic, Mercury and Cadmium, whereas the sample shows the presence of Lead at 0.95 ppm.

High Performance Thin Layer Chromatography

HPTLC finger printing analysis of the sample reveals the presence of eight prominent peaks corresponds to presence of eight versatile phytochemicals present with in it. Rf value of the peaks ranges from 0.00 to 0.85.

Analysis of Pesticides Organochlorine, Organophosphorus and Pyrethroids

The results showed that there were no traces of pesticides residues such as Organo chlorine, Organo phosphorus, Organocarbamates and pyrethroids in the sample provided for analysis.

Aflatoxin Assay by TLC (B1,B2,G1,G2)

Result: The results shown that there were no spots were being identified in the test sample loaded on TLC plates when compare to the standard which indicates that the sample were free from Aflatoxin B1, Aflatoxin B2, Aflatoxin G1, Aflatoxin G2.

Microbial Contamination by Pour Plate Method

No growth / colonies was observed in any of the plates inoculates with the test sample.

CONCLUSION

The present study was carried out as per WHO Pharmacopeia standards, AYUSH guidelines for various Standardization parameters such as Physiochemical parameters like acid insoluble ash, Total ash, and Water & alcohol soluble extractive values. The presence of various phytoconstituents can serve as the basis for screening different pharmacological activities. Plants serve as a vast source for varied phytoconstituents exhibiting pharmacological properties. A preliminary photochemical screening test had reveals the presence of tannin, coumarin, saponin, steroid, alkaloid. The antimicrobial activity revealed the absence of microorganisms, This study also reveals that the study drug is sterile and free of bacteria, fungi, and specific pathogens like Salmonella, Staphylococcus aureus, E-coli and pesticide residues, thereby confirming the nontoxic nature of the formulations. Many of the case studies have reported, adverse effects due to heavy metals in Ayurvedic and other herbal drugs. Hence, heavy metals need to be detected in this preparations. In this study, all the samples were contain below the deductible limitof heavy metals which confirms the non-toxic nature of this drug. As a whole, moolanivaranailagam was moved its safety over the defined standardization method. The results showed that the Moolanivaranailagam is a safe and free from any toxic material.

REFERENCES

1. Uthamarayam, Siddhamaruthuvangachurukkam, Directorate of Indian Medicine and Homeopathy, 3rd edition 2003, pg no 45.
2. R.Thiyagarajan, Gunapadam ThathuSeevam, Directorate of Indian Medicine and Homeopathy, 8th Edition 2013, pg no 57.





Santhini et al.,

3. EapenSaumy M.S. and Mrs.Grampurohit, N.D.(2002). Chemical Evaluation of Navayasachurna, Indian Drugs, 39(2): 101 – 105.
4. Sharma AK, Gaurav SS, Balkrishna A. A rapid and simple scheme for the standardization of polyherbal drugs. Int J Green Pharm 3, (2009),134-140
5. Bele A Archana&KhaleAnubha. Standardization of Herbal Drugs: An Overview;International research J of Pharmacy, 2 (12) (2011), 56-60 WHO.Guidelines for the assessment of Herbal Medicines. WHO Technical Report Series, no. 863. World Health Organization, Geneva, 1996.
6. India Pharmacopeia I Volume I, Government of India, Ministry of Health and Family welfare, Indian Pharmacopeia commission, 2014.
7. Pharmacopoeial Laboratory for Indian Medicine (PLIM) Guideline for standardization and evaluation of indian medicine which include drugs of Ayurveda, Unani and Siddha systems. Department AYUSH .Ministry of Health & Family Welfare, Govt. of India
8. Brain KR, Turner TD. The Practical Evaluation of Phytopharmaceuticals. Bristol: Wright Sciencetchnica; 1975:36-45
9. Lohar DR. Protocol for Testing of Ayurvedic, Siddha &Unani medicines. Government of India, Department of AYUSH,Ministry of Health & Family Welfare: Pharmacopoeial laboratory for Indian medicines, Ghaziabad.2007:47-52.
10. Wagner H. Plant Drug Analysis. A thin Layer chromatography Atlas.2nd ed. Heidelberg: Springer-Verlag Belgium; 2002:305, 227.
11. WHO guideline for assessing the quality of herbal medicines with reference to contaminants and residues. WHO Geneva. 2007.
12. Luciana de CASTRO. Determining Aflatoxins B1, B2, G1 and G2 in Maize Using Florisil Clean Up with Thin Layer Chromatography and Visual and Densitometric Quantification. Ciênc. Tecnol. Aliment. vol.21 no.1 Campinas. 2001

Table 1. Organoleptic Parameters of moolanivaranailagam

| | |
|---------------|-----------------------|
| State | Semi solid |
| Nature | Not applicable |
| Odour | Strong Characteristic |
| Touch | Greasy |
| Flow Property | Free Flowing |
| Appearance | Brownish |

Table 2: Physicochemical interpretation results

| S.No | Parameter | Mean (n=3) SD |
|------|--------------------------------|-----------------|
| 1. | Loss on Drying at 105 °C (%) | 21.5 ± 2.74 |
| 2. | Total Ash (%) | 0.7533 ± 0.1301 |
| 3. | Acid insoluble Ash (%) | 0.055 ± 0.01153 |
| 4. | Water soluble Extractive (%) | 9.68 ± 0.7279 |
| 5. | Alcohol Soluble Extractive (%) | 13.7 ± 1.058 |

Table 3: Phytochemical Screening of Moolanivaranailagam :

| S.no | Test | observation |
|------|------------|-------------|
| 1. | Alkaloids | + |
| 2. | Flavanoids | - |
| 3. | Glycosides | - |





Santhini et al.,

| | | |
|-----|----------------------|---|
| 4. | Steroids | + |
| 5. | Triterpenoids | - |
| 6. | Coumarin | + |
| 7. | Phenol | + |
| 8. | Tanin | + |
| 9. | Protein | - |
| 10. | Saponins | - |
| 11. | Sugar | + |
| 12. | Nthocyanin | - |
| 13. | Betacyanin | - |

Table 4: Heavy Metal Analysis of Moolanivaranailagam

| Name of the Heavy Metal | Absorption Max Δ max | Result Analysis | Maximum Limit |
|-------------------------|-----------------------------|-----------------|---------------|
| Lead | 217.0 nm | 0.95 PPM | 10 ppm |
| Arsenic | 193.7 nm | BDL | 3 ppm |
| Cadmium | 228.8 nm | BDL | 0.3 ppm |
| Mercury | 253.7 nm | BDL | 1 ppm |

Table 5: HPTLC RESULT

| Peak | Start Rf | Start Height | Max Rf | Max Height | Max % | End Rf | End Height | Area | Area % |
|------|----------|--------------|--------|------------|-------|--------|------------|---------|--------|
| 1 | 0.00 | 7.4 | 0.04 | 180.0 | 18.76 | 0.06 | 2.0 | 3878.1 | 8.75 |
| 2 | 0.08 | 2.6 | 0.11 | 71.5 | 7.45 | 0.12 | 3.2 | 678.1 | 1.53 |
| 3 | 0.13 | 9.0 | 0.13 | 21.6 | 2.25 | 0.14 | 0.4 | 136.0 | 0.31 |
| 4 | 0.19 | 16.7 | 0.28 | 301.5 | 31.41 | 0.40 | 115.5 | 23744.6 | 53.59 |
| 5 | 0.41 | 115.6 | 0.42 | 116.5 | 12.14 | 0.48 | 65.1 | 3918.2 | 8.84 |
| 6 | 0.56 | 41.9 | 0.57 | 44.9 | 4.68 | 0.62 | 25.5 | 1382.3 | 3.12 |
| 7 | 0.67 | 7.7 | 0.82 | 184.5 | 19.23 | 0.85 | 28.8 | 10105.3 | 22.81 |
| 8 | 0.85 | 29.2 | 0.86 | 39.1 | 4.08 | 0.89 | 1.1 | 462.5 | 1.04 |

Table 6: screening for pesticide in Moolanivaranailagam

| Pesticide Residue | Sample MI | AYUSH Limit (mg/kg) |
|--|-----------|---------------------|
| I.Organo Chlorine Pesticides | | |
| Alpha BHC | BQL | 0.1mg/kg |
| Beta BHC | BQL | 0.1mg/kg |
| Gamma BHC | BQL | 0.1mg/kg |
| Delta BHC | BQL | 0.1mg/kg |
| DDT | BQL | 1mg/kg |
| Endosulphan | BQL | 3mg/kg |
| II.Organo Phosphorus Pesticides | | |
| Malathion | BQL | 1mg/kg |
| Chlorpyriphos | BQL | 0.2 mg/kg |
| Dichlorovos | BQL | 1mg/kg |
| III. Organocarbamates | | |
| Carbofuran | BQL | 0.1mg/kg |
| III.Pyrethroid | | |
| Cypermethrin | BQL | 1mg/kg |





Santhini et al.,

Table 7: screening for Aflatoxin

| Aflatoxin | Sample MI | AYUSH Specification Limit |
|-----------|-----------------------|---------------------------|
| B1 | Not Detected – Absent | 0.5 |
| B2 | Not Detected – Absent | 0.1 |
| G1 | Not Detected – Absent | 0.5 |
| G2 | Not Detected - Absent | 0.1 |

Table 8: screening for specific pathogen in moolanivaranailagam

| Organism | Specification | Result | Method |
|-------------------------------|---------------|---------------------------|----------------------------|
| <i>E-coli</i> | Absent | Absent | As per AYUSH specification |
| <i>Salmonella</i> | Absent | Absent | |
| <i>Staphylococcus aureus</i> | Absent | Absent | |
| <i>Pseudomonas aeruginosa</i> | Absent | Absent | |
| Test | Result | Specification | As per AYUSH/WHO |
| Total Bacterial Count | Absent | NMT 10 ⁵ CFU/g | As per AYUSH |
| Total Fungal Count | Absent | NMT 10 ³ CFU/g | specification |



Fig:1 Moolanivaranailagam

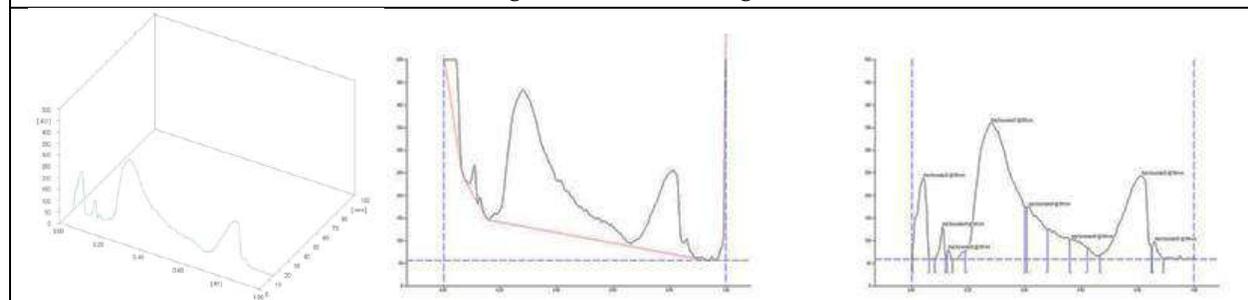


Fig.2. HPTLC Result





Effect of Magnification on Tangible and Intangible Periodontal Outcomes While Performing Scaling and Root Planing

Neha Saksena^{1*} and Amit Bhardwaj²

¹Ph.D Scholar, Department of Periodontology, Faculty of Dental Sciences, SGT University, Gurgaon, Haryana, India.

²Professor and Head, Department of Periodontology, Faculty of Dental Sciences, SGT University, Gurgaon, Haryana, India.

Received: 02 May 2022

Revised: 08 June 2022

Accepted: 05 July 2022

*Address for Correspondence

Neha Saksena,

Ph.D Scholar,

Department of Periodontology,

Faculty of Dental Sciences,

SGT University, Gurgaon,

Haryana, India.

Email:drnehasaksena@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Severe Periodontal disease is attributed to be the 11th most prevalent condition in the world. To bring periodontium back to health, periodontal treatment begins with the mechanical removal of plaque, calculus, and deposits from supragingival and sub gingival areas, which can be accomplished surgically or non-surgically, along with a strict plaque control program. Dentists commonly use the naked eye to perform Scaling and Root Planing, a gold standard procedure however, the biologically desirable result is not usually obtained. With the introduction of microsurgery in Periodontics, multiple benefits such as improved diagnostic abilities, better visual acuity, better treatment precision, and treatment outcomes are seen. This paper attempts to review the impact of magnification tools like the surgical operating microscope, and the magnification loupes on periodontal outcome measures while performing the Scaling and Root Planing thus highlighting the role of magnification devices in non-surgical periodontal therapy.

Keywords: Scaling and Root Planing, Chronic Periodontitis, Periodontal Outcomes, Magnification, Surgical Operating Microscope, Magnification Loupe.



**Neha Saksena and Amit Bhardwaj**

INTRODUCTION

Periodontitis is an infection-driven inflammatory disease of the periodontium. It greatly affects oral health and overall health negatively and causes it to be the primary cause of tooth loss [1]. Severe periodontal disease is attributed to be the 11th most prevalent condition with a high prevalence of 20% to 50% around the globe, as reported in 2016 by the Global Burden of Disease Study making this multifactorial disease a global public health concern [2,3]. Good oral hygiene has been considered the mainstay of periodontal health. To bring periodontium back to health, periodontal treatment begins with the mechanical removal of plaque, calculus, and deposits from supragingival and sub gingival areas, which can be accomplished surgically or non-surgically, along with a strict plaque control program [4]. The physical disruption of supra- and sub gingival periodontal pathogens present in the bio film is described as the Scaling and Root Planing procedure [5,6]. Multiple studies reported equivalent outcomes with the use of hand instruments as well as ultrasonic devices, however, ultrasonic instrumentation takes 20 to 50% less time [7].

The Minnesota studies by Philstrom and colleagues in the early 1980s were among the first to directly compare nonsurgical and surgical periodontal care. They compared Scaling and Root Planing with Open Flap Debridement to Scaling and Root Planing alone in a randomized control trial [8,9]. Long-term findings of probing pocket depth for up to 6 mm in both groups showed similar results, indicating that non-surgical periodontal therapy alone is viable and acceptable. Several studies later followed suit, concluding that assessing the clinical outcomes of non-surgical periodontal therapy significantly impacted periodontal status and that surgical treatment should be assessed and planned only after non-surgical periodontal therapy [10].

Over the years, Scaling and Root Planing have been established as the gold standard procedure for non-surgical periodontal therapy as it alone can reduce plaque index and bleeding on probing in nearly half of the affected periodontal sites [11]. Scaling and Root Planing combined with oral hygiene instructions have a positive impact on the periodontium, thus it is also now considered to be the modern periodontal treatment milestone [12]. Dentists use the naked eye to perform periodontal procedures while treating patients however, the biologically desirable result is not usually obtained. This might be due to several limitations like decreased visual acuity, improper tooth anatomy, inaccessible areas, operator muscle fatigue, or decreased patience from the patient or operator [13,14]. Tibetts & Shanelac introduced Microsurgery in the field of Periodontics in the year of 1992 [15].

Its increasing uses in both surgical and non-surgical procedures has shown multiple benefits such as improved diagnostic abilities, better visual acuity, better treatment precision, and treatment outcomes, improved work position of the clinician and accurate clinical case documentation has been achieved by a magnified view [14,16,17,18]. Dentistry is a visually demanding profession and the use of magnification devices has become the standard of care in various dental procedures. Despite it, limited use of magnification is seen in the field of non-surgical periodontal therapy. This review attempts to highlight the role of magnification devices in the Scaling and Root Planing procedure by summarizing the impact of assessed outcome measures in the clinical studies available in the literature.

CLINICAL OUTCOMES

Literature shows five studies that measure clinical outcomes of non-surgical periodontal therapy assisted with the help of various magnification tools. Indices like the Plaque index given by Silness P and Loe H in 1964 and Gingival Index given by Loe H and Silness P in 1963 respectively were measured by all the studies. The most recent study done by Penmetsa G et al showed a statistically insignificant reduction in the Plaque Index and Gingival Index.[19] Their result was similar to the previously published studies [16, 20, 21, 22]. Penmetsa G et al was the only study to evaluate the Bleeding Index by Muhlemann HR & sons and showed a statistically significant reduction among the two groups where scaling procedure was done conventionally and under the surgical operating microscope [19].

Corbella et al 2018 evaluated the use of magnification loupes in the supragingival scaling procedure. They divided patients into three groups, one was treated the conventional way without any magnification aid, the second group



**Neha Saksena and Amit Bhardwaj**

was treated under 2.5x loupes and the third with 2.5x loupes with adjunctive illumination. They expressed their result as the full-mouth bleeding score percentage and full-mouth plaque score percentage. However, the reduction seen was not statistically significant among the groups [22]. Probing pocket depth measured by Penmetsa G et al in 2021 among two groups showed a statistically significant reduction among the conventionally performed scaling group and scaling under a surgical operating microscope group [19]. Similar results were seen in another study conducted by the same authors in 2020 however the groups compared were divided on basis of different magnification variables of the surgical operating microscope [20]. They compared the effect of Root Planing under magnification variables 0.4, 0.6, and 1 of the surgical operating microscope at baseline and after 4 weeks of therapy. Contrasting results to the above were obtained in the study done by Savitha M and Venugopalan V. Their control group received only Scaling and Root Planing as the mode of intervention and the test group received Scaling and Root Planing under the surgical operating microscope. They measured probing pocket depth with a UNC-15 probe and the only study to measure the Relative Clinical attachment using an acrylic stent at baseline and 6 weeks after therapy. The reduction achieved was statistically insignificant in intergroup comparison but statistically significant in the intergroup comparison [21].

Wound Healing index (Watchell) was measured as a clinical parameter for the first time by Penmetsa G et al in 2020 after 2 weeks of Root Planing done under magnification [20]. A healing score of 1 was seen in 42.2% of individuals treated under magnification variables of 0.4 and 24.4% of individuals treated under magnification variables of 1. A much better healing score was seen in 55.5 % of the individuals under the magnification variable of 0.6 which was statistically significant as well. Scaling and Root Planing under normal unaided vision can inadvertently cause disruption in the tooth anatomic structure and surrounding soft tissues negatively affecting the clinical outcomes and prolonging the healing period after non-surgical periodontal therapy. A magnified view enhances the target area of treatment thereby achieving maximum clinical efficiency, rapid wound healing, and minimizing iatrogenic errors by dentists.

PATIENT-REPORTED OUTCOMES

Any parameter assumed to be connected to the periodontal disease process and is used to assess the efficacy of periodontal therapy is referred to as a periodontal endpoint [23]. Endpoints that directly measure how a patient feels, functions, or survives are known as true endpoints [24]. True endpoints such as oral health-related quality of life measurements or self-reported symptoms are those that patients can feel and describe as compared to surrogate endpoints such as the changes in periodontal attachment level that can be measured by the clinician [25,26]. The importance of reporting patient-reported outcomes is much emphasized in the literature. Penmetsa GS et al in 2021, Corbella et al and Pervez MF and Manjunath N in 2018 reported true endpoints like pain perception, patient comfort, and satisfaction levels of Scaling and Root Planing procedures done with the aid of magnification devices. Questionnaire analysis by Penmetsa GS et al had shown a positive response to less pain perception, more comfort to the patient, and satisfaction under Surgical Operating Microscope than under a conventional approach during manual scaling [19]. This was in contrast to the earlier published studies. The previous studies used the Visual Analogue Scale (VAS) to assess pain and quality of treatment and concluded similarly that no statistically significant difference was seen among the groups [22,23]. However, patient-centered outcomes are seen to play a role in their compliance with supportive periodontal treatment thus it is an important parameter to be recorded and reported [27].

CLINICIAN RELATED OUTCOMES

The development of musculoskeletal diseases is one of the most common occupational hazards in dentistry.[28]A qualitative study involving dental hygiene students and clinical educators at Vancouver Community College (VCC) in British Columbia found that surgical magnification had physical health benefits. Participants in the study reported less neck, back, and shoulder pain, less time leaning forward, less eye tiredness, and better vision. Thus, the ergonomic benefits of microscopy may be one of the key elements in its widespread adoption by the dental profession [29]. Clinicians' comfort in terms of ergonomics showed a more positive response while performing Scaling and Root Planing under a surgical microscope when analyzed through questionnaire analysis [19,20]. Among



**Neha Saksena and Amit Bhardwaj**

magnification tools, Surgical Operating Microscope enhances the ergonomic benefits to the clinician the most. Additionally, improvement in the quality and longevity of clinical work is documented. The widespread use of microscopes to perform Scaling and Root Planing aids in achieving the primary goal of periodontal therapy while also protecting the musculoskeletal health of the dental healthcare practitioner, allowing them to have the best of both worlds.

STEREOMICROSCOPIC OUTCOMES

The Scaling and Root Planing procedure being an important component of phase 1 periodontal therapy is primarily responsible for the reduction in clinical signs such as gingival inflammation and pocket probing depth [29]. Despite that, several studies found a considerable number of treated teeth that would still have sub gingival bio film and calculus after Scaling and Root Planing [30]. It is well understood by oral health care professionals that time, patience, persistence, experience, ability, and training are all required for a well-done Scaling and Root Planing [31]. Root surface analysis of teeth has been done by techniques like Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDAX), and Atomic Force Microscopy (AFM).

Our literature search revealed studies where the application of these techniques to analyze the effect of magnification during the Scaling and Root Planing procedure is used. A study was done to check the presence of any residual calculus after Scaling and Root Planing when done with or without magnification. They calculated the Remaining Calculus Index (RCI) via Scanning Electron Microscopy and found less residual calculus in the group where Scaling and Root Planing was done under magnification [32]. In addition to the Remaining Calculus Index, a study done by Dadwal A et al investigated other indices like Loss of Tooth Substance Index and Roughness loss of tooth substance Index. They concluded that Scaling and Root Planing with the use of Magnification Loupe showed better results like smooth root surface appearance, reduced surface roughness due to fewer instrument marks, and less remaining calculus with minimal presence of smear layer in comparison to the group not assisted with magnification [33].

In another study, a detailed elemental, as well as micro-morphological analysis of root surface, was done by Energy Dispersive X-ray Analysis (EDAX), Atomic Force Microscopy (AFM), and Scanning Electron Microscopy (SEM).^[14] They were able to show that Scaling and Root Planing was done under an operating microscope, the root surface had no evidence of remaining debris, smear layer, or diseased cementum as compared to the group where Scaling and Root Planning was done without magnification. Thus, the efficacy of Scaling and Root Planing is significantly enhanced by the use of high-quality magnification tools. Hence, laboratory evidence suggests an improved prognosis of periodontal treatment and magnification aids have a powerful role in the long-term success of periodontal therapy.

MICROBIOLOGICAL OUTCOMES

Periodontal Health is determined by three key factors namely Host, Environment, and Microbiological. Uncontrolled growth of micro biota or the presence of virulent bacteria leads to periodontal diseases. Bacteria present in the bio film can infiltrate the root surface irregularities and the underlying periodontium. Light and Scanning Electron Microscopy, as well as culture studies, have shown the presence of invasive bacteria in the cementum and radicular dentin of periodontally infected teeth [34]. Several studies suggest that radicular dentin and cementum may serve as a reservoir for periodontal pathogenic bacteria, allowing them to recolonize the previously treated periodontal areas that can contribute to reinfection [35].

Research by Savitha AM and Veenugopalan V is the only study that reports reduced levels of the red-complex bacteria after 6 weeks of Scaling and Root Planing when done under a surgical microscope. Out of the three bacteria, reduced levels of *Treponema denticola* were statistically significant [21]. Hence, the total eradication of potential periodontal pathogens residing in seen in plaque and calculus deposits is critical. Inadequate Scaling and Root Planing will not improve periodontal health and will likely lead to a rapid re-infection of the periodontal pocket. Treatment procedure assisted via magnification tools improves visual acuity which helps in achieving a satisfactory





Neha Saksena and Amit Bhardwaj

result. It is suggested that more studies should measure the microbiological outcomes while doing non-surgical periodontal therapy under high magnification.

CONCLUSION

The elimination of calculus and bio film deposits is the main goal of Scaling and Root Planing to establish a biologically compatible root surface. Their presence shows a strong correlation to periodontal destruction. The proportions and curvature of the unseen sub-gingival tooth surfaces can be visualized with a magnified image of the supragingival contours of a tooth surface, assisting in the detection and removal of calculus and leading to a better periodontal disease treatment outcome.

The incorporation of magnification into conventional dental procedures increases precision and accuracy thus becoming an integral part of the current dental industry. Magnification tools such as Magnification Loupes and Dental Operating Microscope are most commonly used by dental care professionals to perform high-quality dental procedures, thus maximizing the probability of a positive prognosis. It improves clarity and execution of treatments, better documentation of medical records, and better ergonomics for the operator. Further, patients not only benefit from a better understanding of the dental procedures but also from education to maintain periodontal health and prevent any oral diseases in the future. Thus, its overall benefits encompass both dental health care providers and the patients. Despite the steep learning curve associated with it, a surgical operating microscope and other magnification aids should be considered while performing Scaling and Root Planing to provide distinct advantages to the clinician and the patient.

ACKNOWLEDGMENTS

No acknowledgments

REFERENCES

1. Könönen E, Gursoy M, Gursoy UK. Periodontitis: A Multifaceted Disease of Tooth-Supporting Tissues. *Journal of Clinical Medicine*. 2019; 8(8):1135.
2. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017;390(10100):1211-1259.
3. Sanz M. European workshop in periodontal health and cardiovascular disease. *European Heart Journal Supplements* 2010;12(B):B2.
4. Shaddox LM, Walker CB. Treating chronic periodontitis: current status, challenges, and future directions. *Clin CosmetInvestig Dent* 2010;2:79-91.
5. Badersten A, Nilveus R, Egelberg J. Effect of nonsurgical periodontal therapy. II. Severely advanced periodontitis. *J Clin Periodontol* 1984;11(1):63-76
6. Checchi L, Pelliccioni GA. Hand versus ultrasonic instrumentation in the removal of endotoxins from root surfaces in vitro. *J Periodontol* 1988;59(6):398-402.
7. Dragoo MR. A clinical evaluation of hand and ultrasonic instruments on subgingival debridement. 1. With unmodified and modified ultrasonic inserts. *Int J Periodontics Restorative Dent* 1992;12(4):310-323.
8. Pihlstrom BL, Ortiz-Campos C, McHugh RB. A randomized four-years study of periodontal therapy. *J Periodontol* 1981;52(5):227- 242.
9. Pihlstrom BL, McHugh RB, Oliphant TH, Ortiz-Campos C. Comparison of surgical and nonsurgical treatment of periodontal disease. A review of current studies and additional results after 61/2 years. *J Clin Periodontol* 1983;10(5):524-541.



**Neha Saksena and Amit Bhardwaj**

10. Lang NP, Salvi GE, Sculean A. Nonsurgical therapy for teeth and implants-When and why? *Periodontol* 2000 2019;79(1):15-21.
11. Cobb CM. Clinical significance of non-surgical periodontal therapy: an evidence-based perspective of scaling and root planing. *J Clin Periodontol* 2002;29(2):6-16.
12. Isola G, Polizzi A, Santonocito S, Dalessandri D, Migliorati M, Indelicato F. New Frontiers on Adjuvants Drug Strategies and Treatments in Periodontitis. *Sci Pharm* 2021;89(4):46.
13. Low SB. Clinical considerations in nonsurgical mechanical therapy. *Periodontol* 2000 1995;9:23-26.
14. Mohan R, Agrawal S, Gundappa M. Atomic force microscopy and scanning electron microscopy evaluation of efficacy of scaling and root planing using magnification: A randomized controlled clinical study. *Contemp Clin Dent* 2013;4(3):286-294.
15. Shanelec DA. Periodontal microsurgery. *J EsthetRestor Dent* 2003;15(7):402-7.
16. Parvez MF, Manjunath N. Comparative evaluation of conventional scaling with and without magnification loupes. *IOSR J Dent Med Sci* 2018;17(5):73-76.
17. Tanwar J, Hugund SA, Dodani K. Non-surgical periodontal therapy: A review. *J Oral Res Rev* 2016;8(1):39-44.
18. Sunell S, Rucker L. Surgical magnification in dental hygiene practice. *Int J Dent Hyg* 2004;2(1):26-35.
19. Penmetsa GS, Kondapally M, Gangolu M, Rajyalakshmi M, Lahari K, Srividya I. Clinical Evaluation of Periodontal Status and Patient Comfort Levels Assessment Before and After Manual Scaling Under Conventional Approach and Surgical Operating Microscope: A Comparative Analysis. *European Journal of Molecular & Clinical Medicine* 2021;8(2):2053-2063.
20. Penmetsa GS, Panda KD, Manthena AK, Korukonda RR, Gadde P. Evaluating the efficacy of different magnification variables during root planing procedure under a surgical operating microscope in chronic periodontitis: A randomized clinical trial. *J Indian Soc Periodontol* 2020;24(1):32-36.
21. Savita AM, Venugopalan V. Comparative Evaluation of Scaling And Root Planing On Red Complex Bacteria With And Without Magnification - A Pilot Study. *International Journal of Scientific Research* 2019;8(9):77-79.
22. Corbella S, Taschieri S, Cavalli N, Francetti L. Comparative evaluation of the use of magnification loupes in supragingival scaling procedures. *J Investig Clin Dent* 2018;9(2):e12315.
23. Hujuel PP. Endpoints in periodontal trials: the need for an evidence-based research approach. *Periodontol* 2000 2004;36:196-204.
24. Fleming TR, DeMets DL. Surrogate end points in clinical trials: are we being misled? *Ann Intern Med* 1996;125:605-613.
25. Leao A, Sheiham A. The development of a socio-dental measure of dental impacts on daily living. *Community Dent Health* 1996;13(1):22-26.
26. Hujuel PP, DeRouen TA. A survey of endpoint characteristics in periodontal clinical trials published 1988-1992, and implications for future studies. *J Clin Periodontol* 1995;22(5):397-407.
27. Wang H, Li Q, Zhao X, Pan Y. Effects of different factors influencing clinical compliance of Chinese patients with chronic periodontitis. *Quintessence Int* 2016;47(8):643-652.
28. Lietz J, Kozak A, Nienhaus A. Prevalence and occupational risk factors of musculoskeletal diseases and pain among dental professionals in Western countries: a systematic literature review and meta-analysis. *PLoS One* 2018;13(12):e0208628.
29. Mombelli A. Microbial colonization of the periodontal pocket and its significance for periodontal therapy. *Periodontol* 2000 2018;76(1):85-96.
30. Heitz-Mayfield LJ, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs. non-surgical debridement for the treatment of chronic periodontitis. *J Clin Periodontol* 2002;29(3):92-102.
31. Brayer WK, Mellonig JT, Dunlap RM, Marinak KW, Carson RE. Scaling and root planing effectiveness: the effect of root surface access and operator experience. *J Periodontol* 1989;60(1):67-72.
32. Sonika S, Esther Nalini H, Arun Kumar Prasad P, Renuka Devi R. Comparative Evaluation of Scaling and Root Planing with and Without Magnification Loupe - a Randomised Controlled Clinical trial. *International Journal of Current Advanced Research* 2019;08(09):19986-19989.





Neha Saksena and Amit Bhardwaj

33. Dadwal A, Kaur R, Jindal V, Jain A, Mahajan A, Goel A. Comparative evaluation of manual scaling and root planing with or without magnification loupes using scanning electron microscope: A pilot study. J Indian Soc Periodontol 2018;22(4):317-321.
34. Adriaens PA, De Boever JA, Loesche WJ. Bacterial invasion in root cementum and radicular dentin of periodontally diseased teeth in humans. A reservoir of periodontopathic bacteria. J Periodontol 1988;59(4):222-230.
35. Cobb CM, Sottosanti JS. A re-evaluation of scaling and root planing. J Periodontol 2021;92(10):1370-1378.





Operative Summary: Status of Obesity Prevalence and Therapy

Binthu Mathavan S^{1*}, A.Praveen², Babu S³, Shankar Lal Bika⁴, Dilshith A Kabeer¹, Ganesa Murthy A⁵ and Sanjeev Kumar¹

¹Assistant Professor, Dept. of Physical Education, Central University of Punjab, Bathinda, India-151401.

²Associate Professor, Department of Physical Education and Sports, Pondicherry University, Puducherry-605014, India.

³Associate Professor, Dept. of Mechanical Engineering, PSG College of Technology, Coimbatore, India-641004.

⁴Associate Professor and Dean, Dept. of Education, Central University of Punjab, Bathinda, India-151001

⁵Sr.Project Officer (LS), Information and Library Network (INFLIBNET) Centre, Gandhinagar, Gujarat, India-382007.

Received: 02 May 2022

Revised: 03 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Binthu Mathavan S

Assistant Professor,

Dept. of Physical Education,

Central University of Punjab,

Bathinda, India-151401.

Email: binthu.mathavan@cup.edu.in.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Obesity is a disorder, not a disease that can be reduced and prevented with widespread awareness, increasing physical activity, diet and food habits leading to better health consequences. About 2.8 Million death rates recorded with survey results by NCD (Obese/Overweight) are because of excessive food intake, sedentary lifestyle (man's work altered by machines and advanced technology). The objective of this study is to discuss Obesity prevalence, causes, remedies and PA processes for a better and healthy society in the world and to launch the 2018-2030 health policy success by WHO. This inquiry collected data from 1975 to 2016 for adults aged between 5-19 years and five years and below from WHO published sources that discussed in depth. According to this study, policies launched for the healthy society of this world by various health organizations could come up with better policy play in the future to positively influence this society, especially with PA and Awareness. This study suggests that all developed, developing, and low-income countries of the world pay more attention to the crisis of obesity and emphasize that increasing PA and awareness may lead to a reduced NCD death rate globally. The discussed PA might positively influence balance/loss of weight management until used frequently with systematic processes.

Keywords: Obesity, Prevalence, Physical Activities, Non-Communicable Diseases



**Binthu Mathavan et al.,**

INTRODUCTION

According to the world population review of 2019, almost 35 countries have 30+ averages in the BMI index. As per Global data, Nauru is the country with the greatest obesity prevalence, 61% of the population having above 30 BMI index, respectively. Rendering current estimates by WHO, overweight and obesity are associated with more deaths globally than underweight. In the year 2016, extra than 1.9 billion adults over 18 years old were overweight. In these, about 650 million adults were obese. 39% of adults aged 18 years and above (40% women and 39% men) was overweight, respectively. As per the 2016 assessment led by WHO, about 13% of the world's adults were inside the wall of obesity. In this, 15% of women and 11% of men were obese.

The world prevalence of obesity has approximately triplicated from 1975 to 2016 [1], as per Dinsa. G.D and others in the year 2012, about 3 to 30% men and 1 to 50% women populations were affected either overweight / obesity in upper-middle and low-income countries such as India, Bangladesh, Vietnam, Russia, Poland and so on. Several studies state that socioeconomic status and energy (food) consumption are associated with developing overweight /obesity for both gender, men and women. In the entire world, technological development and implementation like machinery-based work have enlarged at various working sectors either in Government& private instead of human (physical) based work nature. Consuming hybrid food contains usage has been increased instead of using natural food products in human's daily food routine. These mentioned factors affecting directly to impact increase obesity/overweight towards all categories like men, women, childhood and indolence, almost more than three decades Obesity and Under nutrition both are a significant double burden in African and South Asian countries of this world.

Added Value for this Study

This study explained obesity prevalence in 1975 and after 2010 in the following age categories: under the age of 5, years 5-19 and the adult population globally. Here, the author discussed the causes of weight gain, overweight, diet & habits, lifestyle, preventive measures of obesity, and surgery outlook. Current health policy and suggestions made. Communicated elementary, medium, and high-level standard home-based physical activities with high positive impact in various positions according to the need and capability of affected obese (NCD) populations as per expert's concern. The laboring man can understand this study in such a way author explained.

Dual Burden in Diet and Nutrition

Overweight/ Obesity and Under nutrition were considered a double burden in most countries, mainly African and south Asian countries. However, present-day% of the under nutrition population has been reduced compared to previous decades when triggered obesity. Hence, every country was trying to find a solution simultaneously to prevent and reduce under nutrition and obesity among the population around the world. In this regard, various health organizations launched health policies to promote a healthy society [2], which is the biggest challenge of the Government to manage these double burdens.

Current Policy for Healthy Society

The global action plan on physical activity 2018-2030 was launched on 8th June 2018 by Dr. Tedros, Director-General, WHO in Lisbon at football city of Portuguese. He advised the worldwide population to enhance various sports and games by watching by participating. For this 85-year-old participants placed dance & recommendations, were our society to stay active and healthy as much as possible. For the closing ceremony, various skills, games, enjoyments, and physical exercises were displayed by young children for promoting PA among youthful groups of Globe[4]. The main motto of this plan was 'More Active People for a Healthier World and Set the World Moving'. The main target of the construction of this plan was to minimize physical inactivity by 15% in 2030. We can strengthen our society's health quality, such as physical, mental, moral, emotional, and social wellness. WHO also triggered a new campaign movement, "Let's Be Active", and for all sponsoring agencies and researchers to re-develop the city and execute 20 policy endorsements. Additionally, this plan was authorized by World Health Assembly in 2018 May [4].



**Binthu Mathavan et al.,****Successive Process of Policy to Healthy Society**

A policy can be converted to regional languages by the health organization of each nation. It may help to reach and to guideline easier for society to react. Several policies have been launched for making a healthy society by various organizations globally. Hence, which may have a positive impact when they found a Policy to get monitoring, evaluation and suggestion process from the community, completed most of the policies before awareness among people, especially rural population. Since health organizations before launching Policy, Government may create awareness about Policy and its impact on society not only urban, rural population too. Before 2012, around 43 policies across ten countries focused on increasing physical activity in children and youth for making a healthy society [5]. Researchers propose that more research investigations be done before launching various health policies to make practical quality policy launch for a healthy community.

Evaluation and efficiency of Policy also can through further research. It might help minimize errors and lead to a path to make better policies in the future⁵. For this, the author recommends that the Government launch several policies, research projects, conferences, and seminars related to promoting physical activity and awareness via various stakeholders, several researchers, social media, and television advertisements to make our society active and healthy. Researchers suggest that governments, NGOs, stakeholders, and institutions must make awareness society about the global burden(NCD). Conducting conferences, seminars, workshops, advertisements, campaigns, sports camps, clinical evaluations, and school health programs may reach launched policy success and reduce physical inactivity globally. As per the above diagram, in 1980, the world adult men population was 27%, and women were 25%. The total adult population in 2014 was 39%, of which 40% of women and 38% of men accounted for; hence, women adult population increased globally from 1980 to 2014 by 15%. It clearly shows that each year around 0.3% to 0.5% has been increased since 1980. The male population increased by 11%, and it is declared that about 0.3% to 0.4% inclined per year. This result shows we added a 4% difference between the men and women population; this evaluation delivers a more significant number of women populations' maintained sedentary life than males. Researchers projected that in the year 2030, both men and women, 6-8% of adult overweight/obese population might arise until WHO health society policy ineffective.

There is a quote, "today's youth tomorrow's pillar of the nation." Still, according to the above diagram, data evaluated by WHO worldwide, our pillars are getting weaker in health. Most of the countries are aged between 5-19 years old. Fig.2 shows in 2016 overweight/obesity affected population was 18% instead of 4% in 1975, almost 14% of the population were increased in the last four decades. In 1975, 8% men and in 2016, 18%, around 10% were increased in each decade. 2.5% approximately increased in Globe in 5-19 age categories. Women, overweight /obese population, was 6% in the year 1975 and 19% in the year 2016; it shows that 13% women population was increased in last four decades. Approximately 3.5% were increased in each decade in the 5-19-year category around the world. Hence, this data discovered that the women population sustained were physically inactive/sedentary life compared to men population in the last four decades.

According to the above diagram, in this Globe, below five years overweight/obese population in 1975 was 1% in the year 2000, it was 5% in the year 2010, and in the year 2013, it was 6.3. As per this data, results declared that every year, 0.1% to 0.3% of populations under the age of 5 were increased as per WHO evaluation. To 2016 data, out of 100% overweight /obese population, 6% were male, and 8% were female. Children mentioned that female children were dominating males in maintaining sedentary life. Here the author's suggestion is five years old kids and below was affect more because of parent's poor active behavior patterns like watching more time in TV, mobile, PC even while consuming food. If parents are playfully involved in front of kids, they react to that, so keep active in a home for a better healthy life. Author following procedures for our healthy life and society.





Binthu Mathavan et al.,

Responsibility to Tackle Obesity in Various Phases

Government[6]

- Effective policymaking & spreading out with multiple languages
- Should monitor compulsory physical activity class in school children and it
- Make availability of playing area/ children's park especially in an urban area
- Can conduct awareness program/seminar/conference in schools and colleges
- Using current technologies for an awareness

Society [6]

- Effective policymaking & spreading out with multiple languages
- Should monitor compulsory physical activity class in school children and it
- Make availability of playing area/ children's park especially in an urban area
- Can conduct awareness program/seminar/conference in schools and colleges
- Using current technologies for an awareness

Society [6]

Exercise Preferences/Suggestions

The following Exercise may help your better health, which means that the given PA might be the suitable one affected by NCD (overweight/obese). When you perform the maximum number of Exercises, it will increase the intensity of PA adaptation, which helps you to your body healthy. It may be a preventive / remedy process of NCD (Overweight/Obese) for this society. You can choose any Exercise upon your capability, upload animated slides, and share link references in this study for easy access to social benefit.

- **Lying Series:** frog lift, superman, butt burnout, side leg lift, prone leg lift, the leg twist, the sidekick, the peddler, the locust, butt-sculpting lift, lying half-jack, scissors split leg, cross leg split, marching hip raises leg lift with the knee in, jack splits [19, 23, 26].
- **Sitting Series:** forward bend with holding legs, leg split with forward bending, single-leg has with side bending, raise legs and trunk, cycling, single and double leg ducking, air leg split, cross leg, single leg up and down, double legs up and down [27, 29].
- **Chair Exercises:** sit and touch the floor, straight leg raise, double leg duck, cycling (leg split up and down, cross, and parallel), back kick holding the chair, side launch, and squad plain [20].
- **Standing Series:** jumping with leg split, freehand exercises, twisting in stands, jumping with lower body twist, side leg raise with a jump, single leg jump, double leg jump in multi directions [21, 22, 24, 28].
- **Core Exercises:** Crunches-Reverse crunch, bicycle crunch, good leg crunch, long arm crunch, oblique crunch, toe-touch crunch, crunch with a twist [25].Planks-plank with single leg raise, side plank, knee plank, forearm plank, reverse plank, single-leg plank, single hand plank, side plank with leg raise, dolphin plank [17].

CONCLUSION

According to this investigation, the above-discussed phenomena directly/indirectly auxiliary for rapid inclination is high in the prevalence of overweight/obesity. Health policymaking and its impact play a vital role incredibly healthy society. Through effective policy awareness, people can react positively for better health; hence good policy plan with maximum attention around culture may act as key to open "obese lock" affected populations which may lead to prevent non-communicable diseases like Diabetes, Coronary diseases, cancer and so on. To tackle and society work together and concentrate on achieving our target (healthy community) by involving several participants in sports and games, traditional sports, campaigns, awareness programs about PA and health, family health monitoring and healthy lifestyle maintenance. Proper diet management as required to manage daily routine without struggle, by preparing and following weekly health diet may lead to maintain a healthy weight and lifestyle management in future. In the obese category, class I and II populations may manage with proper diet and suitable physical



**Binthu Mathavan et al.,**

exercises, but in obese class III or BMI 40 above persons consult with a physician and get guidance like surgery or other solutions manage healthy weight and life. Additionally, to tackle or prevent childhood choose good healthy packed food product items. Government can use revised arrangements of traditional policy communications like food labelling or marketing regulation to provide healthy food to society [30]. According to researchers Andrew and Rajesh Vedanthan (2013) recommended that to prevent cardiovascular non-communicable diseases in Asian countries, they can promote nutrition quality, physical activity, natural food product consumption and health monitoring (Diet, Energy produce and energy expenditure) awareness peoples by conducting several kinds of research, conference and other awareness programs. As per researchers, PA is required before and after school and must not replace PT classes with other school subjects. The above-explained remedy/preventive measures, exercise preferences for affected NCD populations, suggested exercises would be positively helpful to reduce and prevent overweight and reduce the death rate of NCD worldwide, particularly childhood obesity. As a people of this world, each one should be aware of NCD and its impact on our life, by maintain physical active ever against NCD with your family and make our society healthy and kindly step forward to “Global action plan on physical activity 2018-2030” by WHO reach more tremendous success.

REFERENCES

1. Population review around the world.<http://worldpopulationreview.com/countries/most-obese-countries>.
2. Overview of non-communicable diseases and the role of fiscal policies to promote healthy diets. <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>.
3. Hawkes C, Demaio AR, Branca F. Double-duty actions for ending malnutrition within a decade. *Lancet Glob Health* 2017; 5: e745–46.
4. World Health Organization. (2019). Global action plan on physical activity 2018-2030: more active people for a healthier world. World Health Organization.
5. Pate, R. R., Trilk, J. L., Byun, W., & Wang, J. (2011). Policies to increase physical activity in children and youth. *Journal of Exercise Science & Fitness*, 9(1), 1-14.
6. Kushner RF. Evaluation and management of obesity. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J (Eds). *Harrison's Principles of Internal Medicine*, 18th edition. USA: McGraw-Hill; 2012. pp. 629-36.
7. Deepa, M., Farooq, S., Deepa, R., Manjula, D., & Mohan, V. (2009). Prevalence and significance of generalized and central body obesity in an urban Asian Indian population in Chennai, India (CURES: 47). *European journal of clinical nutrition*, 63(2), 259-267.
8. Buchwald, H., & Oien, D. M. (2013). Metabolic/bariatric surgery worldwide 2011. *Obesity surgery*, 23(4), 427-436.
9. Lowry, R., Lee, S. M., Fulton, J. E., Demission, Z., & Kann, L. (2013). Obesity and other correlates of physical activity and sedentary behaviours among US high school students. *Journal of obesity*, 2013.
10. Pate, R. R., Flynn, J. I., & Dowda, M. (2016). Policies for promotion of physical activity and prevention of obesity in adolescence. *Journal of Exercise Science & Fitness*, 14(2), 47-53.
11. Young Men's Christian Association. Healthy Family Home. <http://www.ymca.net/healthy-family-home/index.html>.
12. Garrett, J. L., & Ruel, M. T. (2005). Stunted child–overweight mother pairs: prevalence and association with economic development and urbanization. *Food and nutrition bulletin*, 26(2), 209-221.
13. Haddad, L. (2005). What can food policy do to redirect the diet transition? International Food Policy Research Institute (IFPRI) discussion paper 165 (December 2003). *Food and nutrition bulletin*, 26(2), 238-240.
14. World Health Organization. (2000). Obesity: preventing and managing the global epidemic.
15. Di Cesare, M., Bentham, J., Stevens, G. A., Zhou, B., Danaei, G., Lu, Y., ... Cisneros, J. Z. (2016). Trends in the adult body-mass index in 200 countries from 1975 to 2014: A pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *The Lancet*, 387(10026), 1377–1396.
16. Dennison, B. A., Erb, T. A., & Jenkins, P. L. (2002). Television viewing and television in bedroom associated with overweight risk among low-income preschool children. *Paediatrics*, 109(6), 1028-1035.





Binthu Mathavan et al.,

17. Plank and lying exercise <https://www.cosmopolitan.com/health-fitness/how-to/a35234/exercises-you-can-do-without-getting-out-of-bed/>
18. <https://www.buzzfeed.com/jessicaprobos/lazy-people-exercise-moves>
19. https://www.workandmoney.com/s/10minuteyogaroutine3a7e2b5bfee54695?utm_campaign=10minuteyogac1f85489d8614520&utm_source=tab&utm_medium=cpc&utm_term=hearstlocalnews-chron
20. Chair exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/chair-exercises-in-home>
21. Jumping exercise for obese majority. <https://www.slideshare.net/MathauBindu/jumping-exercises-161853826>
22. Launching exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/launching-exercises>
23. Lying position exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/lying-position-exercises>
24. Partner exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/partner-exercises>
25. Plank and crunch exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/plank-and-chrunches>
26. Push-up position exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/push-up-position-exercises>
27. Sitting series exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/sitting-exercises>
28. Standing position exercise for obese prevalence. <https://www.slideshare.net/MathauBindu/standing-series-exercises>
29. Yoga for obese prevalence. <https://www.slideshare.net/MathauBindu/yoga-poses-for-stability>
30. Childhood overweight and obesity. <https://www.who.int/dietphysicalactivity/childhood/en/>
31. Moran, A., & Vedanthan, R. (2013). Cardiovascular disease prevention in South Asia gathering the evidence. *Global heart*, 8(2), 139.
32. Dinsa, G. D., Goryakin, Y., Fumagalli, E., & Suhrcke, M. (2012). Obesity and socioeconomic status in developing countries: a systematic review. *Obesity Reviews*, 13(11), 1067-1079.

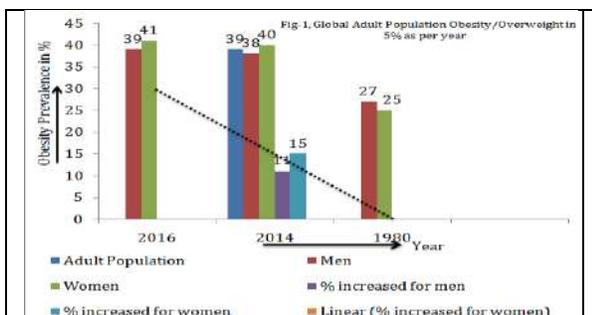


Figure 1: % of the Global Overweight/Obesity Adult Population in 1980, 2014 and 2016.

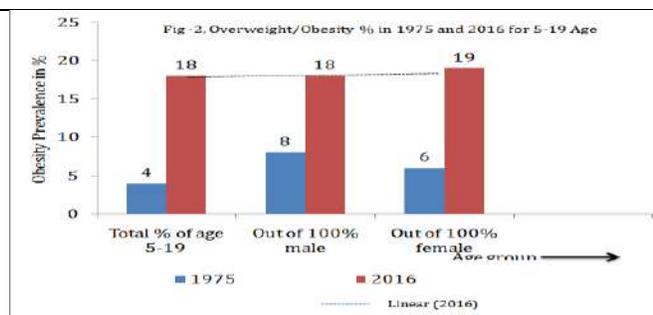


Figure 2: % of the Global 5-19 Age Overweight/Obesity Population in 1975 and 2016.

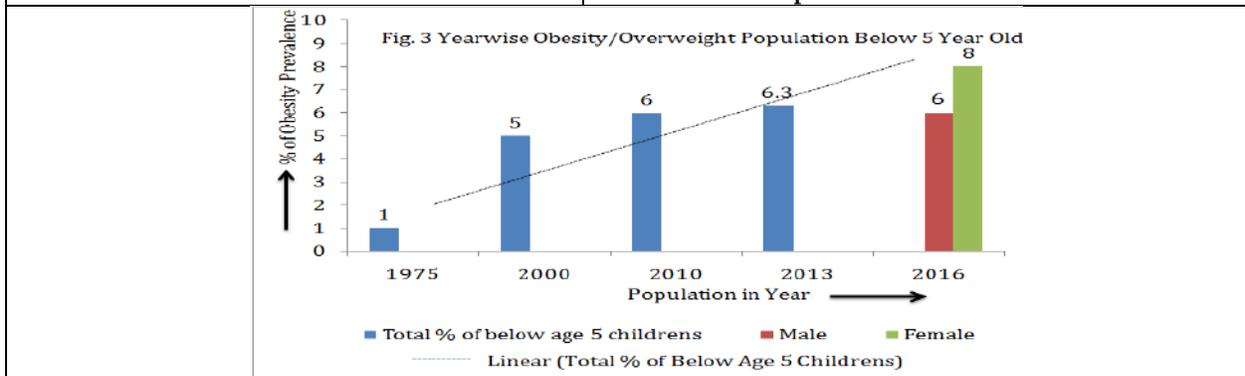


Figure 3: % of Global under Age Five Overweight/Obesity Population in 1975 and after 2000.





Influence of Integrated Nutrient Management on Growth and Yield of Finger Millet (*Eleusine coracana* L. Gaertn)

Shagun^{1*}, Priyanka Bankoti Rawat², Sanjay Kumar³ and Vibhuti Singh Jhala¹

¹Research Scholar, Department of Agronomy, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun- 248 001, Uttarakhand, India.

²Professor, Department of Agronomy, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun- 248 001, Uttarakhand India.

³Assistant Professor, Krishi Vigyan Kendra, G.B. Pant University of Agricultural and Technology, Dhakrani, Dehradun- 248142, Uttarakhand India.

Received: 17 May 2022

Revised: 12 June 2022

Accepted: 04 July 2022

*Address for Correspondence

Shagun

Research Scholar,
Department of Agronomy,
School of Agricultural Sciences,
Shri Guru Ram Rai University,
Dehradun- 248 001, Uttarakhand, India.
Email: shagungupta01@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The present investigation was carried out to find the effect on growth and yield of Finger Millet (*Eleusine coracana* L. Gaertn) by adopting nutrient management practices under different establishment method. The experiment was conducted in Crop Research Centre, School of Agricultural Sciences, Shri Guru Ram Rai University, Pathribhag, Dehradun, Uttarakhand. The treatments consisting of two establishment methods in main plots and six nutrient management practices in sub plots (twelve combination) was laid out in split plot design (SPD) with three replications. The result revealed that, the values for plant height were not influenced by establishment methods however tallest plants were obtained under V₂:VL Mandua- 352 at harvest. Application of: 75%RDF+ Vermicompost (1t/ha) led to tallest plants followed by 75%RDF+FYM and 100%RDF, it also establish significant effect on plant height at harvest. Dry matter content was highest in 75%RDF+ Vermicompost (1t/ha) at 60 and 90 DAT in 2019 and 2020. Number of tillers/m², number of earhead/m², number of earhead/plant was found highest when RDF was incorporated with vermicompost and FYM whereas 75% RDF+PSB showed no significant influence growth and yield. Control treatment showed lowest result as compared to other nutrient management practices. This study indicate that use of INM i.e. RDF along with vermicompost, FYM, PSB will increase the production of the Finger millet and also improve the soil health if used for longer period of time.

Keywords: Finger Millet (*Eleusine coracana* L.), Nutrient Management, Establishment Method, DAT.





Shagun et al.,

INTRODUCTION

Finger millet is important minor millet grown in India and also known as 'Ragi'. Among the millets of the world, finger millet [*Eleusine coracana* L. Gaertn.] ranks fourth in importance after sorghum, pearl millet and foxtail millet.[1] This is a hardy popular food and wonder grain crop next to wheat, maize and rice in India. This grain is valued as staple food.[2] It is also known as dry land crop cultivated in both tropical and sub tropical regions and mainly cultivated in Andhra Pradesh, Gujarat, Jharkhand, Karnataka, Maharashtra, Odisha, Uttarakhand and Tamil Nadu[3]. It is a staple food crop in many hilly regions of Uttarakhand and Himachal Pradesh. Ragi may be grown as a hot weather crop, from May to September. It is monocropped in India under irrigation or transplantation. In rainfed it is mostly intercropped with cereals, castor bean, groundnut and pulses. It is mostly grown in area with low resources in agronomic management. It is cultivated both as grain and also provides fodder for cattle which reduces the large pressure on grazing fields, forests and helps to reduce soil erosion problems and balance the delicate ecosystem in the Himalayas. To improve productivity, integrated nutrient management (INM) is an important practice in modern agriculture where conjunctive use of chemical fertilizer and organic amendments would prove advantageous to the soil health management and improvement of soil fertility as well as the overall crop productivity [4][5]. INM uplift all form of biodiversity and build up a large population of natural enemies of insect, pest disease and weeds, so their population remain in control by biological pressure and do not reach a serious level. Small millets occupy an important place especially in hilly areas of Uttarakhand and INM is most important for marginal and poor farmers of hilly areas of country who are not able to purchase and supply these crop nutrients through high cost chemical fertilizers. In order to see effect of a field investigation was conducted during kharif, 2019 and 2020.

MATERIALS AND METHODS

The experiment was conducted in Crop Research Centre block during Kharif season in two years 2019 and 2020, in Department of Agronomy, School of Agricultural Sciences, Shri Guru Ram Rai University (30°30' N latitude and 78°30' E longitude), Dehradun, Uttarakhand. The climate of Dehradun is generally temperate, although it varies from tropical, from hot in summers to severely cold, depending upon the season and the altitude. Overall climate of the region generally consists of the cool winters, warm summers, rainy monsoons and a balmy spring. Summer temperatures do not go too high but in winters the temperature may fall below the freezing point. The maximum and minimum temperature recorded during the growing season of crop in 2019 from June to December was 37°C and 2.77°C respectively whereas in 2020 from June to December was 35.60°C and 1.5°C. The other important aspect of the climate of this region is the monsoon. It was recorded that Dehradun received 1489.6mm and 1032.8mm rainfall from the month of June to December 2019 and 2020 respectively. The experimental soil was sandy loam in texture, neutral in soil reaction (pH 7.1), high in organic carbon (2.22%), very low in available nitrogen (0.007 kg ha⁻¹), high in available phosphorus (23.16 kg ha⁻¹), low in available potassium (69.20 kg ha⁻¹). The experiment was conducted in split plot design (SPD) with establishment method in main plots and nutrient management practices in sub-plots with three replications. The details of treatments in this study are given below:

Establishment methods (Main Plot)

V1: VL Mandua- 347

V2: VL Mandua- 352

Nutrient management practices (Sub Plot)

N1 : Control (0:0:0) (N:P:K)

N2: 100% RDF (40:20:20) (N:P:K) (Recommended dose of fertilizers)

N3: 75% RDF (30:15:15) (N:P:K) + Farm yard manure (4t/ha)

N4: 75% RDF (30:15:15) (N:P:K)+ Vermicompost (1t/ha)

N5: 75% RDF(30:15:15) (N:P:K) + 50% PSB (phosphate solubilising bacteria) (20g/seed)





Shagun et al.,

N6: 50% RDF (20:10:10) (N:P:K)+ FYM (2t/ha) + Vermicompost (0.5t/ha) + PSB (20g/seed)

RESULT AND DISCUSSION

The data was collected at different growth stages and on maturity of the crop and has been analyzed and represented in tables and figures (1-4). It is also narrated in following paragraphs.

Growth Parameter

Plant height

Four plants were selected randomly in each net plot in two lines and tagged. The plant height of these tagged plants was measured with the help of meter scale at 30, 60, and 90 DAT and at harvest stage. The values were averaged and expressed in cm. The plant height was measured from the ground surface to the tip of the tallest plant part. Influence of integrated nutrient management was observed in plant height. However use of PSB showed no significant impact on plant height. Using different level of nutrient management influenced plant height significantly at different growth stages are given in Table 1 and Fig. 1. The plant grew taller as the age of crop advanced and the height was similar in V1 and V2 varieties both the years. Among nutrient management treatments no significant difference in plant height was observed at all the growth stages except at 60 DAT where 75%RDF+Vermicompost (1t/ha), being at par with 75% RDF+ FYM (4t/ha), caused significant increase in plant height compared to other treatments. Similar result was observed by Babu 2006[6]. However, the minimum plant height was recorded with control over all the growth stages due to less availability of N.

Dry matter accumulation

One meter row of finger millet plants from sampled area were selected and cut just above the ground level with the help of sickle at 30, 60 and 90 DAT and harvest stage. These cut plants were allowed to sundry for 48 hours. After sun drying, these plants were dried in the oven at 65 ±5 0C temperature for 48-72 hours or till the samples attained a constant weight and then average weight was expressed in gram per plant. Dry matter production increased progressively with advancement in age of the crop up to harvest but the trend of dry matter accumulation varied at different stages of crop growth. Data pertaining to dry matter content at various stages are given in Table 2. No significant difference was found among V1 and V2 in both the years but 75%RDF+Vermicompost(1t/ha) was found maximum at 60 DAT and at harvest in 2019 and 60 DAT and 90 DAT in 2020 at par 75% RDF+ FYM(4t/ha) .Earlier researcher also noted similar type of observation Govind et al. 2009[7] . Dry matter content was found maximum in second year and control being the lowest one. It is also illustrated in Fig. 2 by graphical representation.

Yield Parameters

Number of tillers/m²

Number of tillers (m⁻²) was recorded by taking two sample rows in each plot and tillers were counted at 30, 60 and 90 DAT and at harvest also. In case of number of tillers(m⁻²) Table 3 and Fig. 3, the similar trend was observed as noted earlier with plant height and dry matter accumulation. There was non-significant difference between the establishment methods (V1 and V2). As expected, control (0% RDF) resulted in least number of tillers. 75%RDF+Vermicompost(1t/ha) significantly enhanced number of tillers/m² of finger millet at 30, 60 DAT and harvest in 2019 and 2020 over all the other nutrient management. But at all the stages 75%RDF+Vermicompost(1t/ha) was closely followed 75% RDF+ FYM(4t/ha) which is statistically at par increasing of number of tillers/m². The result are in conformity with findings of Panda. P. et al (2021)[8] and Pallavi, et al (2016)[9]

Number of earhead/m²

The number of ear head from the net plot area was counted and was computed on hectare basis. The vermicompost provides better physical conditions for plant growth. It increases the water holding capacity, porosity and nutrient availability which help in more nutrient uptake. Farmyard manures increase microbial population which





Shagun et al.,

mineralized the nutrients and thus increase the yield of crops the similar results were also found by Melese (2016) [10]. The highest number of ear head (m⁻²) counted at harvest was recorded with 75%RDF+Vermicompost(1t/ha), which was statistically similar to 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB in 2019 and 2020. All the nutrient management was significantly superior over control. In establishment method there was no significant difference among both the varieties V1and V2, but V2 has slightly high number of ear head m⁻². Data pertaining the above information is mentioned in Table 4 and Fig 4.

Number of ear head/plant

Number of ear head plant ⁻¹ was calculated by dividing the number of ear head by number of plants on net area basis. In establishment method non-significance difference is observed, but V2 had high number of earhead/plant. In 2019 75%RDF+Vermicompost(1t/ha) showed superior result in V1 whereas 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB in V⁻² and vice versa in 2020. The highest number of earhead/plant counted at harvest was recorded with 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB, which was statistically similar to 75%RDF+Vermicompost (1t/ha) in 2019 and 75%RDF+Vermicompost(1t/ha) followed by 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB and 100% RDF in 2020. Significantly superior to rest of the treatments because of the slow and prolonged release of nutrients through vermicompost maintained a considerable amount of nutrient source for a longer period Prasad and Singh (1983)[11]. Minimum number of earhead/plant was obtained with control management due to poor nutrient supply. It can be seen in Table 4 and Fig. 4.

CONCLUSION

Based on the above research study it clearly indicate that use of RDF along with organic manure such as vermicompost and FYM resulted best in growth and yield of finger millet. Use of biofertilizer (PSB) alone with RDF indicates no influence on growth and yield. It is well established that use of INM for longer term will improve the soil health and productivity of finger millet.

REFERENCES

1. Upadhyaya, HD., Gowda, C.L.L and Reddy, G.V. "Morphological diversity in finger millet germ plasm introduce from Southern and Eastern Africa." An open access journal published by ICRISAT. 2007
2. Agri Farming. "Finger millet farming (Ragi) Information guide". 2021, <http://www.agrifarming.in>
3. Harika, J.V., Maitra, S., Shankar, T., Bera, M. and Manasa, P. "Effect of Integrated Nutrient Management on Productivity, Nutrient Uptake and Economics of Finger Millet (*Eleusine coracana* L. Gaertn)", International Journal of Agriculture, Environment and Biotechnology, 2019b, 12(3): 273-279.
4. Maitra, S., Reddy, M. D., Nanda, S. P., "Nutrient Management in Finger millet (*Eleusine coracana* L. Gaertn) in India". International Journal of Agriculture, Environment and Biotechnology, 2020, 13(1): 13-21.
5. Palaniappan S.P., Annadurai K. "Organic Farming- Theory and Practices". Scientific Publishers, Jodhpur, India, 1999, pp 243.
6. Babu B.G.," Productivity and quality of finger millet (*Eleusine coracana* L. Gaertn.) cultivars as affected by nutrient management system". M.Sc. (Ag) thesis, Acharya N. G. Ranga Agricultural University, Hyderabad, 2006, pp 125.
7. Govindappa, M., Vishwanath, A.,P., Harsha, K.,N., Thimmegowda, P., Jnanesh, A.,C. "Response of finger millet (*Eleusine coracana* L.) to organic and inorganic sources of nutrients under rainfed condition". Journal of Crop Weed 2009; 5(1):291-293.
8. Panda, P., Maitra, S., Panda, S., K., Shankar, T., Adhikary. R., Sairam. M. and Gaikwad. D.J. "Influence of nutrient levels on productivity and nutrient uptake by finger millet (*Eleusine coracana* L. Gaertn) varieties".Crop Research, 2021. 56(3 & 4): 128-134





Shagun et al.,

9. Pallavi, C.H., Joseph, B., Aariff Khan, M.A. and Hemalatha, S., "Economic Evaluation of Finger Millet under different Nutrient Management Practices. International Journal of Current Microbiology and Applied Sciences", 2016, 5(8): 690-698.
10. Melese, W., "Effect of farm yard manure application rate on yield and yield components of lettuce (*Lactuca sativa*) at jimma southwestern Ethiopia " International Journal of Research – GRANTHAALAYAH, 2016. 4. 75-83. 10.5281
11. Prasad, B., Singh, R.P., Roy, H. K. and Sinha, H. "Effect of fertilizer, lime and manure on some physical and chemical properties of a red loam soil under multiple cropping". Journal of Indian Society Soil Science. 2021, 31: 601-603.

Table 1: Plant height (cm) as influenced by the treatments at different crop growth stages

| Treatments | Plant height (2019) | | | | Plant height (2020) | | | |
|---|---------------------|--------|--------|------------|---------------------|--------|--------|------------|
| | 30 DAT | 60 DAT | 90 DAT | At Harvest | 30 DAT | 60 DAT | 90 DAT | at harvest |
| Establishment methods | | | | | | | | |
| V ₁ : VL Mandua- 347 | 58.06 | 81.23 | 94.48 | 108.46 | 59.16 | 82.09 | 95.86 | 110.37 |
| V ₂ : VL Mandua- 352 | 57.36 | 82.18 | 95.65 | 109.04 | 59.66 | 82.75 | 96.3 | 111.02 |
| | 0.57 | 0.31 | 0.18 | 0.15 | 0.14 | 0.13 | 0.07 | 0.019 |
| S.E.m (±) | NS | NS | 1.20 | NS | NS | NS | 0.477 | 0.12 |
| Nutrient Management | | | | | | | | |
| Control (N:P:K) | 50.59 | 69.47 | 82.21 | 102.04 | 54.16 | 70.01 | 83.31 | 104.01 |
| 100% RDF | 62.21 | 86.75 | 98.55 | 109.46 | 66.01 | 88.32 | 100.18 | 112.75 |
| 75% RDF+ FYM(4t/ha) | 61.02 | 87.42 | 97.21 | 112.08 | 62.12 | 88.89 | 97.92 | 113.76 |
| 75%RDF+Vermicompost(1t/ha) | 60.23 | 89.33 | 101.44 | 113.40 | 61.22 | 89.88 | 102.89 | 115.04 |
| 75% RDF+50%PSB | 55.10 | 75.43 | 95.25 | 107.15 | 55.30 | 74.68 | 95.56 | 108.67 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 57.11 | 81.83 | 95.74 | 108.41 | 58.65 | 82.76 | 96.63 | 109.94 |
| S.E.m (±) | 0.65 | 0.4 | 0.22 | 0.24 | 0.24 | 0.23 | 0.33 | 0.25 |
| C.D. (5%) | 1.94 | 1.19 | 0.67 | 0.73 | 0.71 | 0.69 | 1.0 | 0.76 |

Table 2: Dry matter accumulation (g/plant) as influenced by the treatments at different crop growth stages

| Treatments | Dry matter accumulation (2019) | | | | Dry matter accumulation (2020) | | | |
|---------------------------------|--------------------------------|--------|--------|------------|--------------------------------|--------|--------|------------|
| | 30 DAT | 60 DAT | 90 DAT | At Harvest | 30 DAT | 60 DAT | 90 DAT | at harvest |
| Establishment methods | | | | | | | | |
| V ₁ : VL Mandua- 347 | 3.8 | 12.16 | 16.33 | 24.74 | 3.91 | 12.4 | 17.08 | 26.03 |
| V ₂ : VL Mandua- 352 | 3.9 | 12.22 | 16.57 | 24.79 | 3.96 | 12.44 | 17.23 | 26.15 |
| S.E.m (±) | 0.05 | 0.001 | 0.08 | 0.037 | 0.007 | 0.008 | 0.07 | 0.04 |
| C.D. (5%) | NS | 0.008 | NS | NS | 0.04 | NS | NS | NS |
| Nutrient Management | | | | | | | | |
| Control (N:P:K) | 2.23 | 10.66 | 14.34 | 20.01 | 2.43 | 10.40 | 15.34 | 21.01 |
| 100% RDF | 4.25 | 12.26 | 17.01 | 26.42 | 4.80 | 12.87 | 17.98 | 27.0 |





Shagun et al.,

| | | | | | | | | |
|---|------|-------|-------|-------|------|-------|-------|-------|
| 75% RDF+ FYM(4t/ha) | 4.0 | 12.73 | 17.86 | 26.76 | 4.25 | 12.78 | 17.65 | 27.88 |
| 75%RDF+Vermicompost(1t/ha) | 4.85 | 12.86 | 16.56 | 27.36 | 4.55 | 13.25 | 18.04 | 29.36 |
| 75% RDF+50%PSB | 3.8 | 11.80 | 16.60 | 22.79 | 3.56 | 12.30 | 16.88 | 24.50 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 3.92 | 12.86 | 16.34 | 25.25 | 4.01 | 12.89 | 17.06 | 26.80 |
| S.E.m (±) | 0.06 | 0.03 | 0.13 | 0.06 | 0.02 | 0.05 | 0.13 | 0.06 |
| C.D. (5%) | 0.20 | 0.10 | 0.41 | 0.18 | 0.08 | 0.14 | 0.41 | 0.20 |

Table 3: Number of tillers (m⁻²) as influenced by the treatments at different crop growth stages

| Treatments | Number of tillers (2019) | | | Number of tillers (2020) | | |
|---|--------------------------|--------|------------|--------------------------|--------|------------|
| | 30 DAT | 60 DAT | at harvest | 30 DAT | 60 DAT | at harvest |
| Establishment methods | | | | | | |
| V ₁ : VL Mandua- 347 | 106 | 101 | 99 | 107 | 102 | 99 |
| V ₂ : VL Mandua- 352 | 107 | 102 | 100 | 109 | 103 | 101 |
| S.E.m (±) | 0.20 | 0.00 | 0.06 | 0.11 | 0.18 | 0.42 |
| C.D. (5%) | NS | 0.00 | 0.44 | 0.77 | NS | 1.26 |
| Nutrient Management | | | | | | |
| Control (N:P:K) | 79 | 77 | 85 | 81 | 76 | 86 |
| 100% RDF | 113 | 105 | 102 | 115 | 105 | 103 |
| 75% RDF+ FYM(4t/ha) | 125 | 122 | 116 | 126 | 123 | 114 |
| 75%RDF+Vermicompost(1t/ha) | 134 | 123 | 119 | 133 | 124 | 120 |
| 75% RDF+50%PSB | 95 | 93 | 86 | 94 | 92 | 87 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 96 | 93 | 92 | 98 | 94 | 91 |
| S.E.m (±) | 0.75 | 0.27 | 0.27 | 0.33 | 0.24 | 0.45 |
| C.D. (5%) | 2.23 | 0.82 | 0.81 | 1.00 | 1.60 | 1.33 |

Table 4: Number of ear head m⁻² and number of ear head plant⁻¹ as influenced by the treatments at different crop growth stages

| Treatments | 2019 | | 2020 | |
|---------------------------------|------------------------------------|--|------------------------------------|--|
| | Number of ear head m ⁻² | Number of ear head plant ⁻¹ | Number of ear head m ⁻² | Number of ear head plant ⁻¹ |
| Establishment methods | | | | |
| V ₁ : VL Mandua- 347 | 87 | 3.5 | 87 | 3.8 |
| V ₂ : VL Mandua- 352 | 88 | 3.71 | 89 | 4 |
| S.E.m (±) | 0.03 | 0.06 | 0.10 | 0.38 |
| C.D. (5%) | 0.25 | NS | 0.68 | 1.13 |
| Nutrient Management | | | | |
| Control (N:P:K) | 70 | 2.58 | 72 | 3.0 |
| 100% RDF | 89 | 4.0 | 87 | 4.10 |





Shagun et al.,

| | | | | |
|---|------|------|------|------|
| 75% RDF+ FYM(4t/ha) | 91 | 3.96 | 92 | 4.01 |
| 75%RDF+Vermicompost(1t/ha) | 96 | 4.10 | 97 | 4.59 |
| 75% RDF+50%PSB | 84 | 3.01 | 82 | 3.28 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 96 | 4.16 | 97 | 4.55 |
| S.E.m (±) | 0.43 | 0.10 | 0.05 | 0.05 |
| C.D. (5%) | 1.29 | 0.30 | NS | 0.15 |

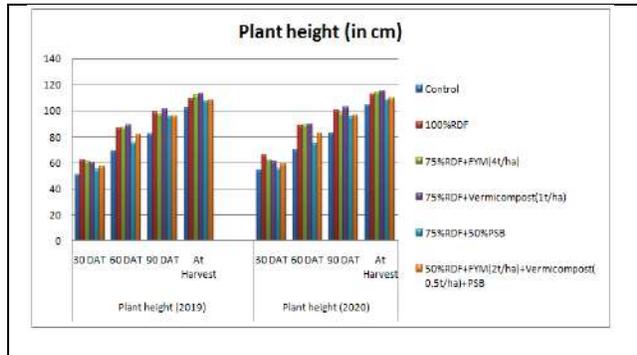


Fig 1: Plant height (cm) as influenced by the treatments at different crop growth stage

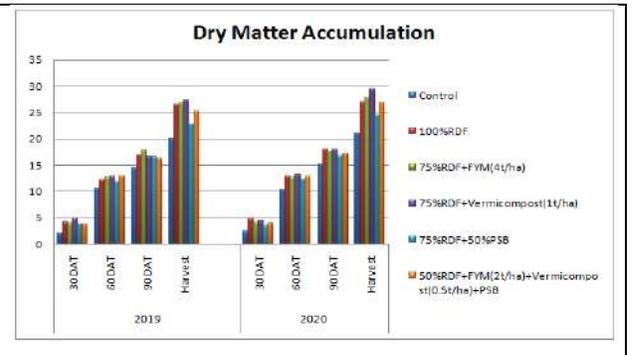


Fig 2: Dry matter accumulation (g/plant) as influenced by the treatments at different crop growth stages

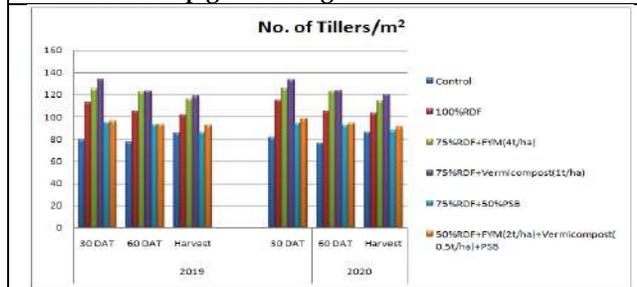


Fig 3: Number of tillers (m⁻²) as influenced by the treatments at different crop growth stages

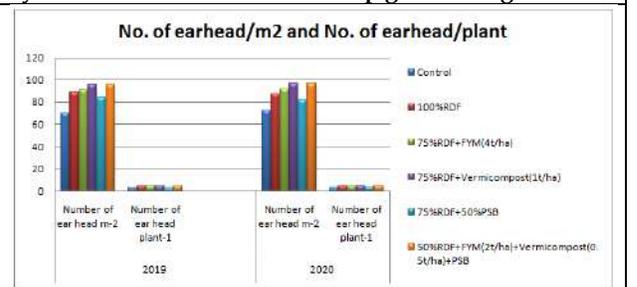


Fig 4: Number of ear head m⁻² and number of ear head plant⁻¹ as influenced by the treatments at different crop growth stages





A Study To Assess The Effectiveness of Cabbage Juice on Reducing Epigastric Pain Among Patients with Acid Peptic Disease at Selected Hospital Cuddalore

Manikandan.T^{1*} and G.Muthamilselvi²

¹Ph.D Scholar, Vinayaka Missions College of Nursing Puducherry (U.T), Vinayaka Mission's Research Foundation - (Deemed to be University) Salem, Tamil Nadu, India

²Principal and Research Supervisor, Vinayaka Missions College of Nursing Puducherry (U.T), Vinayaka Mission's Research Foundation - (Deemed to be University) Salem, Tamil Nadu, India.

Received: 30 Mar 2022

Revised: 28 May 2022

Accepted: 09 July 2022

*Address for Correspondence

Manikandan.T

Ph.D Scholar,

Vinayaka Missions College of Nursing Puducherry (U.T),

Vinayaka Mission's Research Foundation - (Deemed to be University)

Salem, Tamil Nadu, India

Email: mani.parnam@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A quasi experimental study was conducted to assess the effectiveness of cabbage juice on reducing epigastric pain among patients with acid peptic disease at Government head quarters hospital cuddalore. A total of 30 subjects who fulfilled the inclusion criteria were selected by using convenient sampling technique. Data were collected through demographic variables and health profile, pain scale measurement and analyzed through descriptive and inferential statistics pre-test level of pain were assessed followed by cabbage juice consumption to the experimental group. The post test level of pain was checked after 7days. The test accomplishes that the majority of 11 (73.3%) patients had moderate pain, 2 (13.3%) patients had mild pain and 2 (13.3%) patients had severe pain in pre test. Whereas the majority of 13 (86.7%) patients had moderate pain, 2 (13.3%) patients had mild pain on post test in experimental group. In comparison clearly depicts that the 't' value 10.424 (p value < 0.001) shows that there was a significant reduction in pain level on post test when compared to the pre test in experimental group. It also shows that residence has the significant association with the level of pain since the 'p' value is 0.003 in experimental group Rest of the variables had no significant association with the pain level since the 'p' value is greater than 0.05.

Keywords: Acid peptic disease, cabbage juice, effectiveness, pain.





INTRODUCTION

A peptic ulcer is a excavation (hollowed out area) that forms in the mucosal wall of the stomach, in the pylorus (opening between stomach and duodenum), in the duodenum (first part of small intestine), or in the esophagus. A peptic ulcer is frequently referred to as a gastric, duodenal, or esophageal ulcer, depending on its location, or a peptic ulcer disease erosion of a circumscribed area of mucous membrane. This erosion may extend as deeply as the muscle layers or through the muscle to the peritoneum. The prevalence of peptic ulcer disease for worldwide estimated to be included the total population of 2027, aged 20 - 69 years the overall prevalence was 10.5% in men and 9.5% in women, a sex ratio close to one and a higher duodenal gastric ratio than previously reported from this region. A substantial 1% prevalence of asymptomatic ulcers was also observed. Peptic ulcer is the primarily reported cause of death approximately 6500 persons in the United State each year. Before 1983 the major causes of acid peptic disease were considered to excess acid, diet, smoking and stress. Approximately 60% respondents believed that ulcers were caused by too much stress 17% believed that eating spicy food causes ulcers and 27% believed that a bacterial infection caused ulcers.

STATEMENT OF THE PROBLEM

A study to assess the effectiveness of cabbage juice on reducing epigastric pain among patients with acid peptic disease at government head quarters hospital cuddalore.

OBJECTIVES

- To assess the pretest level of epigastric pain among patients with acid peptic disease.
- To determine the effectiveness of cabbage juice on reducing epigastric pain among patients with acid peptic disease.
- To associate the post test level of epigastric pain among patients with acid peptic disease with selected demographic variables.

METHODOLOGY

Quantitative research approach using quasi experimental pretest post test design 30 patients both male and female (15 – experimental, 15 - control) were chosen by non probability convenient sampling technique who met inclusive criteria in government head quarters hospital cuddalore. The necessary administrative permission was obtained from the hospital authorities. After taking the informed consent, the data were collected by using demographic proforma, health profile and pre test level of epigastric pain was measured by numerical pain intensity scale. Cabbage juice 100 ml once a day was given to the experimental group subjects in early morning for 7 days. Post test level of pain was measured by pain scale reading 7 days after intervention. The data collected from subjects were compiled and analysed by using descriptive statistics such as number, percentage, mean and standard deviation to describe the demographic variables.

RESULTS AND DISCUSSION

Result reveals that in pre test, majority of 10 (66.7%) patients had moderate pain, 3 (20%) patients had mild pain and 2 (13.3%) patients had severe pain among control group. majority of 11 (73.3%) patients had moderate pain, 2 (13.3%) patients had mild pain and 2 (13.3%) patients had severe pain among experimental group. In post test, majority of 11 (73.3%) patients had moderate pain, 2 (13.3%) patients had mild pain and 2 (13.3%) patients had severe pain. The comparison was done by chi-square test. The p value 0.884 (which is greater than 0.05) shows that there is no significant reduction in pain level on post test in control group. Where as In post test, majority of 13 (86.7%) patients had mild pain, 2 (13.3%) patients had moderate pain in pretest. The comparison was done by chi-square test. The p



**Manikandan and Muthamilselvi**

value <0.001 (which is lesser than 0.05) shows that there is a significant reduction in pain level on post test in experimental group.

Comparison of pain level on pre test and posttest shows that the Mean and Standard deviation of pre test was 5.2 ± 2.007 and median was 5. And the mean and standard deviation of post test was 4.933 ± 1.83 and median was 5. The comparison was done by 't' test and the p value 0.103 (which is greater than 0.05) shows that there is no significant reduction in pain in control group. Whereas In experimental group, the Mean and Standard deviation of pre test was 5.467 ± 1.807 and median was 6. And the mean and standard deviation of post test was 1.733 ± 0.883 and median was 2. The comparison was done by 't' test and the p value <0.001 (which is lesser than 0.05) shows that cabbage juice significantly reduce pain in post test. Study also depicts that none of the demographic variables had significant relation with the pain scale since the 'p' value is greater than 0.05 in control group. Whereas residence has the significant relation with the level of pain ($p=0.003$). The rest of the demographic variables had no significant relation with the pain scale since the 'p' value is greater than 0.05 in experimental group.

Similar Study conducted at municipality hospital, nariman point mumbai to assess the effectiveness of fresh cabbage juice on rapid healing of peptic ulcer. 13 Patients were selected and given fresh cabbage juice. The average crater healing time for 7 of these patient who had duodenal ulcer was 10.4 days but average time as reported was 37 days in control group. The average crater healing time for 6 patients with gastric ulcer treated with cabbage juice was only 7.3 days. Compared with 42 days in control group. Thus the study concluded that anti peptic ulcer dietary factor may play an important role in genesis of peptic ulcer in man.

CONCLUSION

Assessed effectiveness of cabbage juice on reducing epigastric pain among patients with acid peptic disease. The study revealed that accomplishes that 11 (73.3%) patients had moderate pain, 2 (13.3%) patients had mild pain and 2 (13.3%) patients had severe pain on pre test. Show that 13 (86.7%) patients had mild pain, 2 (13.3%) patients had moderate pain on post test. The 't' value 10.424 (p value < 0.001) shows that there is a significant reduction in pain level on post test when compared to the pre test. Thus the study was highly effective in reducing pain level among patients with acid peptic disease.

REFERENCES

1. Ansari & Kaur. "Text Book of Medical Surgical Nursing. 1stedition, Pee Vee Publication, Hyderabad, Volume 1, Page No. 450; 2011
2. Basavanthappa. B.T. "Medical Surgical Nursing, Jaypeebrothers publication, New delhi, Page no.431; 2007
3. Brunner &Suddarth. "Text Book of Medical Surgical Nursing," 10th Edition, Lippincott Publication, Page No. 987; 2004
4. Black. M. Joyce. "Medical Surgical Nursing Clinical Management For Continuity Of Care", 3rd Edition, New Delhi: W B Sundars Company, Page No. 754; 2003
5. S Rosenstock, prospective cohort study to identify risk factors for PUD estimate their relative impact on ulcer incident accepted publication, 2017: 186- 193.
6. Sharma SK Maharajan DK, 2016, the prevelance of peptic ulcer disease in patient who came for upper gastrointestinal endoscopy, kathmadu university Medical journal ,Vol.7; No. 2 issue 26: 135 -138.
7. Sami Rokayya, chun – Juan Li, 2016, antioxidant and anti- inflammatory activity of cabbage phytochechemicals, Asian Pacific journal of cancer prevention, vol 14:6657 – 6662.





Manikandan and Muthamilselvi

Table 1. Distribution of acid peptic disease patients by their Health Profile

| Sl. No | Health Profile | Control Group | | Experimental Group | | |
|--------|--|---------------|------------|--------------------|------------|-------|
| | | Frequency | Percentage | Frequency | Percentage | |
| 1 | Age at onset of acid peptic disease <20 Years | 3 | 20% | 1 | 6.7% | |
| | 20-30 Years | 5 | 33.3% | 8 | 53.3% | |
| | >30 Years | 7 | 46.7% | 6 | 40% | |
| 2 | Duration of acid peptic disease 6 month – 1 year | 2 | 13.3% | 1 | 6.7% | |
| | 1 – 2 years | 3 | 20% | 2 | 13.3% | |
| | 2 – 3 years | 3 | 20% | 1 | 6.7% | |
| | 3 years and above | 7 | 46.7% | 11 | 73.3% | |
| 3 | How many meal per day 2 times | 1 | 6.7% | 2 | 13.3% | |
| | 3 times | 10 | 66.7% | 10 | 66.7% | |
| | 4 times | 4 | 26.7% | 3 | 20% | |
| 4 | Are you able to follow regular timings of meal Yes | 6 | 40% | 8 | 53.3% | |
| | No | 9 | 60% | 7 | 46.7% | |
| 5 | Family history of acid peptic disease Yes | 6 | 40% | 6 | 40% | |
| | No | 9 | 60% | 9 | 60% | |
| 6 | Symptoms of acid peptic disease | | | | | |
| | Abdominal pain | Yes | 15 | 100% | 15 | 100% |
| | | No | 0 | 0% | 0 | 0% |
| | Abdominal bloating | Yes | 2 | 13.3% | 8 | 53.3% |
| | | No | 13 | 86.7% | 7 | 46.7% |
| | Heart burn | Yes | 11 | 73.3% | 11 | 73.3% |
| | | No | 4 | 26.7% | 4 | 26.7% |
| | Bad odour of mouth | Yes | 7 | 46.7% | 6 | 40% |
| | | No | 8 | 53.3% | 9 | 60% |
| | Dysphagia | Yes | 3 | 20% | 5 | 33.3% |
| | | No | 12 | 80% | 10 | 66.7% |
| | Vomiting | Yes | 6 | 40% | 9 | 60% |
| | | No | 9 | 60% | 6 | 40% |
| | Indigestion | Yes | 7 | 46.7% | 5 | 33.3% |
| No | | 8 | 53.3% | 10 | 66.7% | |
| 7 | Pain Very mild | 0 | 0% | 0 | 0% | |
| | Tolerable | 2 | 13.3% | 3 | 20% | |
| | Very distressing | 3 | 20% | 6 | 40% | |
| | Very intense | 7 | 46.7% | 6 | 40% | |
| | Excrudating unbearable | 3 | 20% | 0 | 0% | |





Manikandan and Muthamilselvi

Table 2. Effectiveness of cabbage juice on epigastric pain among Acid Peptic disease patients Comparison of pain scale of pre and post test

| Sl. No | Group | Test | Mean | Standard Deviation | Median | 't' Value | P Value |
|--------|--------------------|-----------|-------|--------------------|--------|-----------|------------|
| 1 | Control Group | Pre Test | 5.2 | 2.007 | 5 | 1.739 | 0.103 (NS) |
| | | Post Test | 4.933 | 1.83 | 5 | | |
| 2 | Experimental Group | Pre Test | 5.467 | 1.807 | 6 | 10.424 | <0.001 (S) |
| | | Post Test | 1.733 | 0.883 | 2 | | |

(S – Significant, NS – Not Significant)

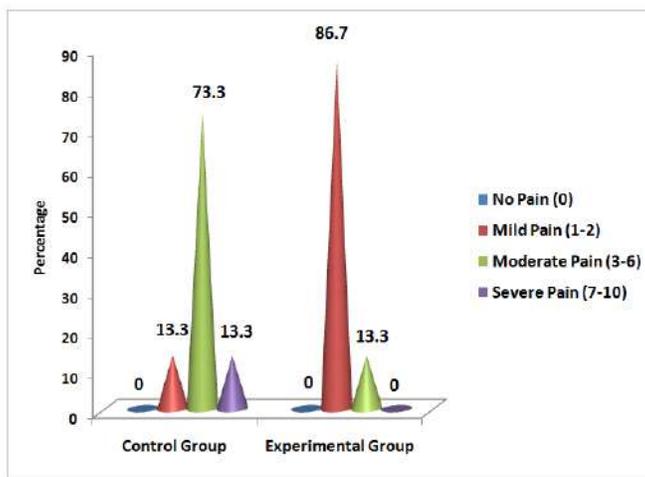


Fig.1. Comparison of Post test level of pain among experimental and control group





Comparative Study of Live (Infusoria) and Commercial Feed on the Growth and Survival Rate of Common Carp (*Cyprinus carpio*)

Ishfaq Mohiuddin Lone^{1*} and T. Ramesh Kumar²

¹Research Scholar, Department of Zoology, Annamalai University, Annamalai Nagar, Cuddalore, Tamil Nadu, India

²Professor, Department of Zoology, Annamalai University, Annamalai Nagar, Cuddalore, Tamil Nadu, India.

Received: 09 May 2022

Revised: 03 June 2022

Accepted: 08 July 2022

*Address for Correspondence

Ishfaq Mohiuddin Lone

Research Scholar,

Department of Zoology,

Annamalai University, Annamalai Nagar,

Cuddalore, Tamil Nadu, India

Email: lone6449@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In the present experiment, the fingerlings of common carp (*Cyprinus carpio*) were sourced from a nearby fish pond and acclimatized for 5 days before starting the experiment. In this study, feeding experiments were conducted for 28 days. Triplicates were maintained for all the treatments and controls. The commercial diet was prepared with Soybean meal 36.18 %, Rice bran 13.81 %, mustard oil cake 36.18 %, and wheat bran 13.81 % by the Pearson method. Fishes were fed with commercial feed given in treatments T1 and T2, while in treatments T3 and T4 fishes were fed with live feed (infusoria). Fishes were fed @ 15% body weight and the daily feed was given two times a day at 8 am and the at 4 pm. Common carp fries fed with live feed (infusoria) had significantly better weight, SGR, and length 732.624 ± 5.539 g, 7.569 ± 0.024 %, and 2.94 ± 0.07 cm respectively than those fed with formulated diet having a weight 701.418 ± 4.651 g, SGR 7.433 ± 0.021 % and length 2.820 ± 0.006 cm. Biochemical investigations revealed that a higher protein, carbohydrate, and lipid content in feed improved common carp fry growth. The results obtained were subjected to statistical analysis. The results of this feeding experiment indicate that infusoria could be an excellent live feed for increased production.

Keywords: *Cyprinus carpio*, Growth performance, Feed ingredients, Infusoria, water quality, diet.





INTRODUCTION

The field of aquaculture has been advocated all over the world for its contribution to an economic system, nutrition, and healthy meals for humans [1,2]. In comparison to other fields, aquaculture is a very cheap and yielding protein [3]. Aquaculture production across the globe is largely influenced by the culture of major carps and other cyprinids [4]. The common carp (*Cyprinus carpio*), a major aquaculture species in many Asian and European countries, belongs to the class Actinopterygii, order Cypriniforms, and the family Cyprinidae, which is the biggest freshwater fish family. It is most commonly found in freshwater habitats, such as lakes, ponds, and rivers, and less rarely in brackish water situations[5]. In medieval times fishes, especially the common carp (*Cyprinus carpio*) were domesticated for food [6]. Common carps are omnivorous and they mostly feed on aquatic insects, insect larvae, mollusks, and zooplanktons. Zooplankton intake is dominant in fish ponds wherever the density of stocking is very high [7].

Despite these questions still exist relating to fish food including, the class of organisms to be used, consumption processes, the bitesize, and nutritive value of plankton [8]. At present each protein and energy-rich traditional dietary elements are in short supply. consequently, there may be want to include unexplored unconventional domestically available cheaper feedstuffs in fish feeds. To lessen the dependence on animals primarily based on protein in the fish diet, plant-based protein feedstuffs are used which also decreases the feed price of artificial fish meals[9]. One of the key directions in enhancing fish feeds over the last few decades has been the search for protein source alternatives to fish meals and determining their dietary appropriateness in diets [10].

This tendency is a reaction to rising demand for formulated diets, as well as constrained assets of the fish meal, which are about to reach a higher exploitation threshold. The complete substitute of fish meal with soybean protein becomes a success only in some cases [11,12]. Fish meal has been a crucial source of protein in fish diets because of its excessive protein quality and palatability. But fish meal may be very costly and can drastically increase the feed costs. Overall or partial substitute of fish food with less costly animal protein, such as poultry by-product meal (PBM) may additionally help to reduce feed charges, although these sources may be lower in digestibility, palatability, and essential amino acids [13,14]. In aquaculture, the physio-chemical conditions of water and the presence of different forms of vegetation and fauna have effective management of productivity.

Water quality is decided via ecological parameters. Important water quality parameters are temperature, pH, hardness, dissolved oxygen, and alkalinity. The right variety of these factors is essential for the fish subculture [15]. Feeds and feed conveyance constitute major monetary expenses in intensive fish culture [16]. The role of synthetic feed in intensive fish farming cannot be neglected as the dietary requirements of fish rely on the feed provided. The quality and quantity of feed consumed pronouncedly affect the development rate, the productivity of feed transformation, and the chemical composition of fish [17,18,19]. Having considered the above facts, this examination was completed along these lines, to evaluate the impact of live feed (infusoria) and formulated feeds on the growth and survival rate of common carp (*Cyprinus carpio*).

MATERIALS AND METHODS

Experimental Fish

Common carp (*Cyprinus carpio*) become selected for the prevailing test. The motive of its choice changed into that it has high-quality increase charge, smooth availability, huge distribution, business significance, and many others. It is far tolerant and hardy fish for higher survival in huge types of aquatic habitats. Its seed has been in high demand utilizing the aqua-farmers for a variety of functions which include monoculture and polyculture. Given the constant call for fry and fingerlings, research has been consequently undertaken in aquaria and ponds.



**Ishfaq Mohiuddin Lone and Ramesh Kumar****Experimental Design**

Aquarium tanks (24 ×12 ×12 inches) have been used for the experimental work and they were located at the cement stand. Aquariums were located in a safe area wherein there has been no direct sunlight and all the aquaria were blanketed with satisfactory mesh to save the falling of dirt, unwanted organisms into the tank, and jumping of fish out of the tank. Before stocking the fish, the tanks were washed cleanly for the maintenance of hygiene. Aeration was continuously supplied from air compressors via air stones each day and about 40% of the water from each aquarium was changed with clean pond water. 25 fishes were introduced into each of the individual tanks. Triplicates were maintained for each treatment including control. To get rid off the algal bloom on the partitions of the aquarium, the tanks were scraped with the scraper. Observations were made for mortality and excess feed and feces were siphoned out after two days. During this period certain physio-chemical parameters of water quality viz. temperature, pH, dissolved oxygen, carbon dioxide, hardness, salinity, and alkalinity were recorded shown in Table 1.

Experimental fish and their acclimatization:

Common carps fry (*Cyprinus carpio*) were collected from a private farm and shifted to the laboratory in bags filled with oxygen. Fishes were acclimatized for 50 hours, by placing the bags in 500l FRP containers till water temperature equalized inside the bags and splashing the containers' water slowly into the bag to acclimatize the fishes. These containers were provided with aeration by two air stones. Common carp fries were fed with artificial feeds and afterward gradually changed to control diet.

Feed preparation: Commercial feed

The goal of feed preparation in common carp fishes is to uphold health, improve the coloration and overall enhance the reproductive performance. Feed formulation was done based on Pearson's square method shown in Table 2. All of the materials, including soybean meal (SBM), mustard oil cake (MOC), rice bran, and wheat bran, were purchased locally, dried, and powdered. Proximate analysis was performed on the selected ingredients prior to formulation. Moisture, crude protein, crude fibre, ether extract, and ash were determined in the diets using standard procedures (AOAC, 1995), as indicated in Table 3.

Live feed: Infusoria Culture

Using banana peelings in a glass aquarium containing about 30 liters of water as shown in Fig. 1. Cover the container with cloth which prevent the entry of mosquitoes and flies, however, will permit the excess air. Maintain the container in a groovy vicinity wherein the natural air is available. In 1-2 days, the water turns milky and emits a foul odor. That is due to the multiplication of the massive number of microorganisms inflicting decay of banana peelings. A thin layer of sludge will be formed on the surface of the water. In about 4-5 days the water will become transparent with a mild yellowish color. This is due to floating spores of infusoria in the air that have settled on the water feeding on bacteria which multiplies in huge numbers. Eventually, the film of slime on the water surface breaks up and disintegrates. The culture is then ready for early-stage feeding of the fish larvae. Once the peak density of culture is achieved it must be harvested. If not, the culture density will quickly lower due to lack of area and oxygen depletion. The culture will preserve itself for up to 2-3 weeks if a few drops of milk are added.

Feeding

Common carp fish fries were stocked at the rate of 25 fries in each aquarium and cultured by feeding different feed ingredients. The fingerlings were fed twice daily in the morning and evening at a fixed feeding @ 15% body weight for 28 days.

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using MS Excel.



**Ishfaq Mohiuddin Lone and Ramesh Kumar**

RESULTS

Growth

The actual weight of the fish was observed and after feeding to different diets, average weight increment data were calculated once in 7 days for different treatments. Observations on the growth during the first week (7th day) revealed that weight increment was highest in the T4, and the lowest weight values were observed in the control with intermediate weight gain in T1. Observations on the 28th day showed that the highest weight increment of 0.297 g for T4 and the lowest value of the weight increment observed was 0.275 g for control. The highest average weight value of 0.344 ± 0.003 g was recorded for the treatment T4 and the lowest average weight values of 0.322 ± 0.001 g were recorded for control. On the completion of the experiment, the highest average weight of 0.344 ± 0.003 g for the T4 and the lowest average weight of 0.322 ± 0.001 g for control were observed shown in Table 4 and Fig.2.

Total Length (cm)

The total average length of common carp fry (*Cyprinus carpio*) has been increased from the initial length after being treated with different diets shown in Table 5 and Fig 3. The highest length of 2.940cm was observed in T4 followed by 2.937cm in T3, 2.873cm in T2, and 2.820 cm in T1. The lowest length was observed in the control with a 2.743cm average gain in length.

Total percentage Weight Gain (%)

The percent weight gain of common carp (*Cyprinus carpio*) after feeding to different diets was found to be highest in the T4 treatment (infusoria) with 732.624 % and the lowest in the control with 685.106 % with the intermediates of T3, T2, and T1 respectively shown in Table 6 and Fig 4.

Specific Growth Rates (SGR)

The specific growth rate for common carp (*Cyprinus carpio*) treated with different diets was calculated and presented in Table 7 and Fig.5. Common carp fed with infusoria feed T4 reported the highest value of 7.569 g and the lowest value of specific growth rate of 7.359g in control. The specific growth rate for T3, T1 and T2 were 7.483 g, 7.433 g, and 7.411 g respectively.

Survival Rate (%)

Survival percentages of common carp (*Cyprinus carpio*) in various treatments are presented in Table 8 and Fig. 6. Survival percentages varied from 90 to 100% at the end of the experiment. At the end of the 28th day, the survival was the highest control, T1 and T2 i.e., 100% followed by T3 with a 95% survival rate and the lowest in T4 with a 90% survival rate.

DISCUSSION

In aquaculture, the physical and chemical parameters of water, various types of biotic flora, and fauna determines the nature of aquatic organisms and their productivity. Water quality is determined by ecological parameters viz; temperature, pH, dissolved oxygen, hardness, alkalinity. The optimum range of these parameters is necessary for successful fish farming [20,21]. One of the most important requirements for the effective culture of any fish is the availability of sufficient feed. The availability of high-quality feed or feed ingredients is a critical aspect in commercial fish farming. In fish culture, daily feed consumption, feed quality, and feeding frequency are all factors that influence growth and productivity. The main factor for fish growth is favorable water temperature [22,23].

After completion of the present experiment, "comparative study of commercial and live feed on the growth and survival rate of common carp", fish growth was not significantly different between the commercial and live feed, but the best growth was observed in live feed (Infusoria). The live and commercial treatments, as well as the control,





Ishfaq Mohiuddin Lone and Ramesh Kumar

showed no significant change ($P < 0.05$). Because of the increased protein content compared to commercial feed, the mean, net weight, and length of fish in treatment T4 (Infusoria) were the highest. During this period maximum average length, average net weight, and SGR of 2.94 ± 0.07 cm, 0.344 ± 0.1 g and 7.56 ± 0.02 % respectively of common carp fry were obtained from T4 treatment (Infusoria). However, after the experimental work, the fishes in treatment T4 showed the lowest survival rate of 90% followed by T3 at 95%. The highest survival rate was observed in T1, T2, and control. In a trial conducted by Mustafa Yildiz (2004) over 58 days, he indicated that the growth performance of rainbow trout (*Oncorhynchus mykiss*) has achieved a weight gain of 171.5 g from an initial body weight of 132.0 ± 1.0 g to the final weight of 303.5 ± 5.7 g in the diet 3. The fish reached a length of 27.7 ± 0.2 cm from 22.5 ± 0.1 cm while the SGR was recorded to be 1.2 ± 0.0 %. Onder Yildirim (2009) experimented to investigate the growth performance, feed used, and body constitution of *Tilapia zillito* under different diets. He recorded that the growth was highest in diet 2 with the final body weight of 8.66 ± 0.68 g and the percentage weight gain $245.36 \pm 22.74\%$ and SGR 2.98 ± 0.17 g.

CONCLUSION

Ichthyologists have tried for many years to substitute the costly fish meal component of the fish diet with less costly plant-based protein feedstuffs. For maximal fish growth, the feed must contain the highest protein content possible. A high protein content in the feed is required for maximal fish growth. For appropriate fish growth, not only the right amount of protein but also the right levels of other balanced amino acids are crucial. Not only the optimal quantity of protein but also the essential levels of other balanced amino acids are also important for the normal growth of fish. The present study suggests that the infusoria and protein-rich formulated feed can be employed as an optimal feed, and their usage in hatchery seed production will result in a sustainable and economically successful aquaculture industry.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

- Hussain, M., Hussain, S. M., Afzal, M., Javid, A., Abdullah, S., Raza, S. A., & Iqbal, M. (2011). Effect of low level of mineral phosphorus and a medium level of nitrogen on planktonic productivity and increase in fish production. *The Journal of Animal & Plant Sciences*, 21(4), 642-645.
- Reddy, Y. A., Sadasivaiah, B., Rajakullaiswamy, K., Indira, P., & Pullaiah, T. (2013). Ichthyofauna of Thummalapalle Uranium Mining area, Andhra Pradesh, India. *World Journal of Zoology*, 8(1), 62-66.
- Sahu, B. B., Meher, P. K., Mohanty, S., Reddy, P. V. G. K., & Ayyappan, S. (2000). Evaluation of the carcass and commercial characteristics of carps.
- Bostock, J., McAndrew, B., Richards, R., Jauncey, K., Telfer, T., Lorenzen, K., ... & Corner, R. (2010). Aquaculture: global status and trends. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 2897-2912.
- Barus, V. (2002). *Cyprinus carpio* (Linnaeus, 1758). *The freshwater fishes of Europe*, 5, 85-179.
- Balon, E. K. (2006). The oldest domesticated fishes, and the consequences of an epigenetic dichotomy in fish culture. *J Ichthyol Aquat Biol*, 11(2), 47-86.
- Peteri, A. (2006). Inland Water Resources and Aquaculture Service (FIRI). Cultured Aquatic Species Information Programme-Cyprinus carpio. Cultured Aquatic Species Fact Sheets. FAO-Rome.
- Kumar, M. S., Binh, T. T., Burgess, S. N., & Luu, L. T. (2005). Evaluation of optimal species ratio to maximize fish polyculture production. *Journal of Applied Aquaculture*, 17(1), 35-49.
- Rumsey, G. L. (1993). Fish meal and alternate sources of protein in fish feeds update 1993. *Fisheries*, 18(7), 14-19.
- Watanabe, T. (2002). Strategies for further development of aquatic feeds. *Fisheries Science*, 68(2), 242-252.
- Adelizi, P. D., Rosati, R. R., Warner, K., Wu, Y. V., Muench, T. R., White, M. R., & Brown, P. B. (1998). Evaluation of fish-meal free diets for rainbow trout, *Oncorhynchus mykiss*. *Aquaculture Nutrition*, 4(4), 255.




Ishfaq Mohiuddin Lone and Ramesh Kumar

12. Kaushik, S. J., Coves, D., Dutto, G., & Blanc, D. (2004). Almost total replacement of fish meal by plant protein sources in the diet of a marine teleost, the European seabass, *Dicentrarchus labrax*. *Aquaculture*, 230(1-4), 391-404
13. Emre, Y., Sevgili, H., & Diler, İ. (2003). Replacing fish meal with poultry by-product meal in practical diets for mirror carp (*Cyprinus carpio*) fingerlings. *Turkish Journal of Fisheries and Aquatic Sciences*, 3(2).
14. Hu, M., Wang, Y., Wang, Q., Zhao, M., Xiong, B., Qian, X., ... & Luo, Z. (2008). Replacement of fish meal by rendered animal protein ingredients with lysine and methionine supplementation to practical diets for gibel carp, *Carassius auratus gibelio*. *Aquaculture*, 275(1-4), 260-265.
15. Hussain, M., Hussain, S. M., Afzal, M., Javid, A., Abdullah, S., Raza, S. A., & Iqbal, M. (2011). Effect of low level of mineral phosphorus and medium level of nitrogen on planktonic productivity and increase in fish production. *The Journal of Animal & Plant Sciences*, 21(4), 642-645.
16. Shamoushaki, M. M. N., Galogah, K. M., & Mazini, M. (2012). Optimization of feeding frequency in *Cyprinus carpio* (Linnaeus, 1758). *World Journal of Fish and Marine Sciences*, 4(5), 443-448.
17. Hassan, M. A., Jafri, A. K., Alvi, A. S., Samad, R., & Usmani, N. (1995). Dietary energy and protein interaction-an approach to optimizing energy: protein ratio in Indian major carp, *Cirrhinus mrigala* (Hamilton) fingerling. *Journal of Aquaculture in the Tropics*, 10, 183-192.
18. Jena, J. K., Aravindakshan, P. K., Chandra, S., Muduli, H. K., & Ayyappan, S. (1998). Comparative evaluation of growth and survival of Indian major carps and exotic carps in raising fingerlings. *Journal of Aquaculture in the Tropics*.
19. Hasan, A. J. Z., & Khan, U. (2013). Protein sparing effect and the efficiency of different compositions of carbohydrates, lipids and protein on the growth of rohu (*Labeo rohita*) fingerlings. *World Journal of Fish Marine Science*, 5, 244-250.
20. Hussain, M., Hussain, S. M., Afzal, M., Javid, A., Abdullah, S., Raza, S. A., & Iqbal, M. (2011). Effect of low level of mineral phosphorus and medium level of nitrogen on planktonic productivity and increase in fish production. *The Journal of Animal & Plant Sciences*, 21(4), 642-645.
21. Shukla, P. A. L. I. A. V. I., & Singh, A. (2013). A seasonal variations of plankton population of Maheshara Lake in Gorakhpur, India. *World J Zool*, 8(1), 09-16.
22. Brett, J. R. (1979). Environmental factors and growth. *Fish physiology, vol. VIII. Bioenergetics and growth*, 599-677.
23. Corey, P. D., Leith, D. A., & English, M. J. (1983). A growth model for coho salmon including effects of varying ration allotments and temperature. *Aquaculture*, 30(1-4), 125-143.
24. Yıldız, M. (2004). The study of fillet quality and the growth performance of rainbow trout (*Oncorhynchus mykiss*) fed with diets containing different amounts of vitamin E. *Turkish Journal of Fisheries and Aquatic Sciences*, 4(2).
25. Yildirim, O., Türker, A., Ergün, S., Yigit, M., & Gülsahin, A. (2009). Growth performance and feed utilization of *Tilapia zillii* (Gervais, 1848) fed partial or total replacement of fish meal with poultry by-product meal. *African Journal of Biotechnology*, 8(13).

Table 1: Range and average values (\pm Standard deviation) of selected water quality parameters during the experimental period

| Parameter | Treatment | | | | |
|------------------|-----------------------------------|---------------------------------------|---------------------------------------|-----------------------------------|-----------------------------------|
| | Control | T ₁ (Commercial Fish Feed) | T ₂ (Commercial Fish Feed) | T ₃ (Infusoria) | T ₄ (Infusoria) |
| Temperature (°C) | 30.1-30.9 (30.470 \pm 0.139) | 29.7-30.6 (30.180 \pm 0.183) | 29.75-31.5 (30.550 \pm 0.309) | 29.2-30.7 (30.080 \pm 0.299) | 29.4-30.9 (30.260 \pm 0.283) |
| DO (mg/l) | 4.15-5.99 (5.357 \pm 0.317) | 4.5-6.54 (5.889 \pm 0.372) | 5.35-7.47 (6.772 \pm 0.374) | 7.27-7.99 (7.530 \pm 0.148) | 5.73-6.39 (6.137 \pm 0.109) |
| pH | 7.10-7.89 (7.427 \pm 0.146) | 7.20-7.94 (7.466 \pm 0.134) | 7.17-8.0 (7.559 \pm 0.166) | 7.23-7.99 (7.670 \pm 0.168) | 7.30-7.91 (7.669 \pm 0.107) |
| Salinity (ppt) | 0.25-0.40 (0.310 \pm 0.029) | 0.15-0.30 (0.230 \pm 0.025) | 0.30-0.35 (0.320 \pm 0.012) | 0.20-0.45 (0.310 \pm 0.043) | 0.20-0.35 (0.290 \pm 0.029) |





Ishfaq Mohiuddin Lone and Ramesh Kumar

| | | | | | |
|------------------------|------------------------------|------------------------------|------------------------------|--------------------------------|------------------------------|
| CO ₂ (mg/l) | 5-10 (7.000±0.837) | 5-13 (8.800±1.428) | 4-10 (7.067±1.293) | 3.33-8.0 (4.933±0.806) | 5-13 (9.200±1.428) |
| Hardness (mg/l) | 178-181.5 (179.000±0.625) | 174-196.5 (184.000±3.811) | 174-207.5 (189.000±6.271) | 185.5-219.5 (200.700±6.133) | 199.5-249 (227.000±8.612) |
| Alkalinity (mg/l) | 112-138 (124.400±4.864) | 111.5-151 (130.200±6.846) | 121-154.5 (140.200±9.350) | 130-177.5 (158.000±8.459) | 144-200 (173.100±9.558) |

Table 2: Commercial Feed formulation for the experiments (Ingredients g/100g):

| Diet Ingredients | Percentage of ingredients (Pearson Method) |
|----------------------------|--|
| Mustard oil cake (MOC) (%) | 36.18 |
| Soybean meal (%) | 36.18 |
| Wheat bran (%) | 13.81 |
| Rice bran (%) | 13.81 |

Table3: Proximate composition of the ingredients (% on dry matter basis):

| Feeds proximate composition | Commercial feed |
|-----------------------------|-----------------|
| Moisture | 9 % |
| Crude protein | 27 % |
| Crude fiber | 11.08 % |
| Crude fat | 65 % |
| Ash | 9.04 % |

Table 4: Weekly average net weight gain of common carp with experimental diets

| Treatments | Fish weight gain (g) | | | | Net weight gain (g) |
|---------------------------------------|--------------------------|--|---|---|--------------------------|
| | 0-7 th days | 7 th -14 th days | 14 th -21 st days | 21 st -28 th days | |
| Control | 0.075±0.001 ^d | 0.089±0.001 ^c | 0.082±0.001 ^d | 0.077±0.001 ^c | 0.322±0.001 ^e |
| T ₁ (Commercial Fish Feed) | 0.079±0.001 ^c | 0.093±0.003 ^a | 0.083±0.001 ^c | 0.075±0.001 ^d | 0.330±0.002 ^d |
| T ₂ (Commercial Fish Feed) | 0.079±0.001 ^c | 0.087±0.001 ^d | 0.083±0.002 ^c | 0.079±0.002 ^b | 0.327±0.002 ^c |
| T ₃ (Infusoria) | 0.081±0.001 ^b | 0.090±0.000 ^b | 0.086±0.001 ^b | 0.079±0.001 ^b | 0.335±0.003 ^b |
| T ₄ (Infusoria) | 0.084±0.001 ^a | 0.093±0.001 ^a | 0.087±0.002 ^a | 0.081±0.001 ^a | 0.344±0.003 ^a |

Mean in the column with different superscripts are significantly different

Table 5. Weekly observations on the mean length of common carp under different treatments

| Treatments | Initial length (cm) | Mean length (cm) | | | | Total length |
|---------------------------------------|---------------------|---------------------------|--|---|---|--------------------------|
| | | 0-7 th days | 7 th -14 th days | 14 th -21 st days | 21 st -28 th days | |
| Control | 0.3 | 0.024±0.001 ^e | 0.990±0.012 ^d | 0.500±0.115 ^d | 0.690±0.006 ^c | 2.743±0.012 ^e |
| T ₁ (Commercial Fish Feed) | 0.3 | 0.025±0.0001 ^d | 0.885±0.0009 ^e | 0.517±0.009 ^c | 0.740±0.006 ^a | 2.820±0.006 ^d |





Ishfaq Mohiuddin Lone and Ramesh Kumar

| | | | | | | |
|---|-----|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| T₂ (Commercial Fish Feed) | 0.3 | 0.055±0.001 ^c | 1.023±0.009 ^c | 0.467±0.009 ^e | 0.723±0.009 ^b | 2.873±0.009 ^c |
| T₃ (Infusoria) | 0.3 | 0.123±0.003 ^b | 1.027±0.001 ^b | 0.523±0.009 ^b | 0.667±0.009 ^d | 2.937±0.012 ^b |
| T₄ (Infusoria) | 0.3 | 0.125±0.001 ^a | 1.040±0.012 ^a | 0.597±0.009 ^a | 0.630±0.006 ^e | 2.940±0.070 ^a |

Mean in the column with different superscripts are significantly different

Table 6. Weekly and total percent gain in body weight of common carp under different treatments

| Treatments | Percent weight gain | | | | Total percent weight gain |
|---|---------------------------|--|---|---|----------------------------|
| | 0-7 th days | 7 th -14 th days | 14 th -21 st days | 21 st -28 th days | |
| Control | 157.45±1.228 ^e | 73.291±1.335 ^b | 39.112±0.550 ^b | 26.516±0.370 ^b | 685.106±1.228 ^e |
| T₁ (Commercial Fish Feed) | 167.38±3.091 ^d | 74.036±2.371 ^a | 37.595±0.533 ^d | 25.015±0.673 ^e | 701.418±4.651 ^c |
| T₂ (Commercial Fish Feed) | 168.09±1.228 ^e | 68.792±1.010 ^e | 36.983±1.990 ^e | 26.755±0.690 ^a | 696.454±4.314 ^d |
| T₃ (Infusoria) | 171.63±1.418 ^b | 70.237±0.721 ^d | 40.911±1.625 ^a | 25.933±0.178 ^d | 712.766±5.629 ^b |
| T₄ (Infusoria) | 178.72±2.457 ^a | 70.745±0.421 ^c | 38.904±0.899 ^c | 25.964±0.158 ^c | 732.624±5.539 ^a |

Mean in the column with different superscripts are significantly different

Table 7. Weekly Specific Growth Rate (SGR) of common carp fed with an experimental diet

| Treatments | Specific growth rate (%) | | | | |
|---|---------------------------|--|---|---|--------------------------|
| | 0-7 th days | 7 th -14 th days | 14 th -21 st days | 21 st -28 th days | 0-28 th days |
| Control | 13.509±0.068 ^e | 7.853±0.110 ^b | 4.716±0.056 ^b | 3.360±0.042 ^b | 7.359±0.006 ^e |
| T₁ (Commercial Fish Feed) | 13.970±0.239 ^d | 7.913±0.195 ^a | 4.581±0.069 ^e | 3.189±0.077 ^e | 7.433±0.021 ^c |
| T₂ (Commercial Fish Feed) | 14.087±0.065 ^c | 7.478±0.086 ^e | 4.690±0.099 ^d | 3.387±0.078 ^a | 7.411±0.019 ^d |
| T₃ (Infusoria) | 14.275±0.074 ^b | 7.600±0.060 ^d | 4.763±0.054 ^a | 3.294±0.020 ^d | 7.483±0.025 ^b |
| T₄ (Infusoria) | 14.642±0.126 ^a | 7.643±0.030 ^c | 4.694±0.093 ^c | 3.298±0.018 ^c | 7.569±0.024 ^a |

Mean in the column with different superscripts are significantly different

Table 8: Survival (%) of common carp in different treatments

| Treatments | Survival (%) |
|---|-----------------------|
| Control | 100±0.00 ^b |
| T₁ (Commercial Fish Feed) | 100±0.00 ^b |
| T₂ (Commercial Fish Feed) | 100±0.00 ^b |
| T₃ (Infusoria) | 95±0.03 ^a |
| T₄ (Infusoria) | 90±0.02 ^a |

Mean in the column with the same superscripts are not significantly different





Ishfaq Mohiuddin Lone and Ramesh Kumar



Figure 1. Infusoria Culture

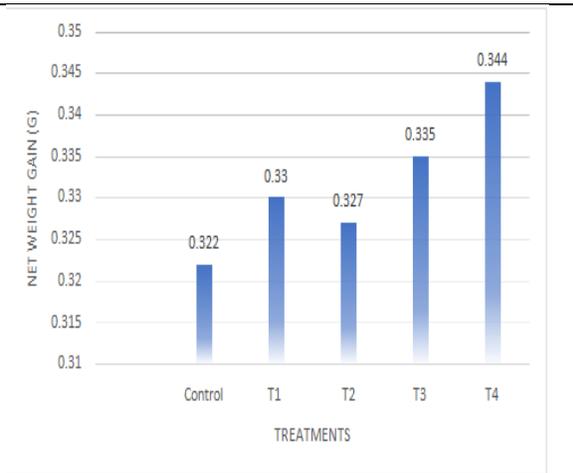


Figure 2. Net weight gain of common carp fed with an experimental diet

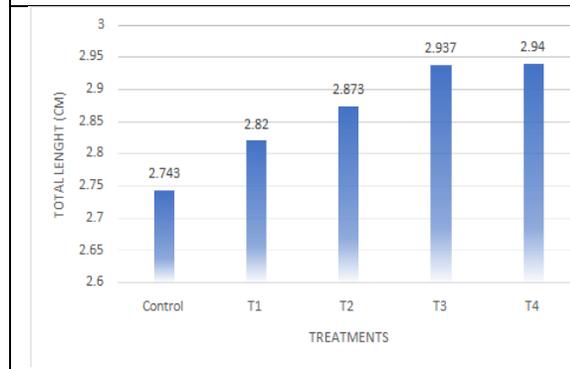


Figure 3. The total length of common carp fed with the experimental diet

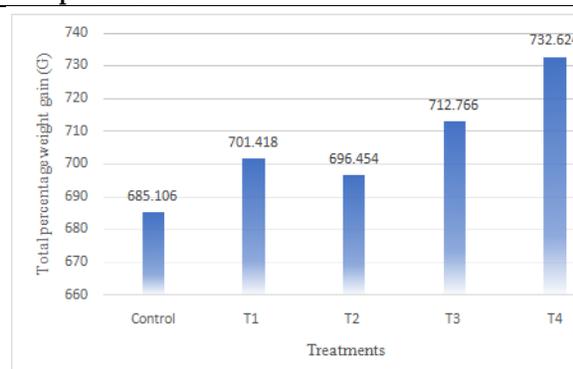


Figure 4. Total percentage weight gain of common carp fed with the experimental diets

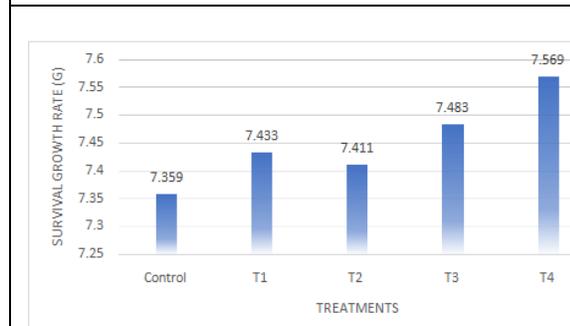


Figure 5. SGR of common carp fed with the experimental diet

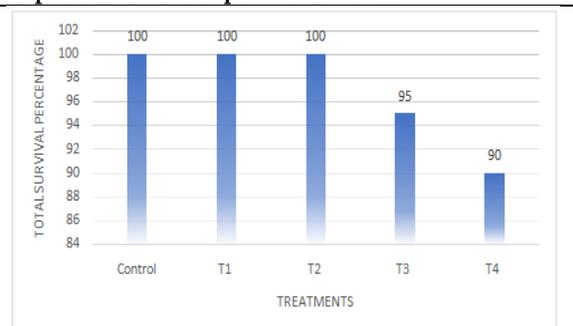


Figure 6. Total Survival percentage of common carp in different treatment





Algal Diversity and Related Physico-Chemical Parameters in Paddy Fields of Kanchepuram District, Tamil Nadu

Devagi R¹ and M. Ayyappan^{2*}

¹Ph.D Research Scholar, Department of Botany, Government Arts College, Thiruvannamalai, Tamil Nadu, India

²Assistant Professor, Department of Botany, Government Arts College, Thiruvannamalai, Tamil Nadu, India

Received: 08 June 2022

Revised: 20 June 2022

Accepted: 09 July 2022

*Address for Correspondence

M. Ayyappan,

Assistant Professor,

Department of Botany,

Government Arts College,

Thiruvannamalai, Tamil Nadu, India

Email: ayyap_pn@yahoo.co.in.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The current research examined at the seasonal change in physico-chemical parameters and algal diversity, community structure and abundance of paddy fields in Kanchipuram district, Tamil Nadu, from April 2021 to March 2022. Soil pH, EC, organic carbon, N, P, K, sulphur, calcium, magnesium, zinc, iron, manganese and copper were statistically analyzed. Algal productivity showed a substantial ($P < 0.05$) seasonal change as well as a high influence of these characteristics. There have been 56 species identified, grouped into eight classes: Chroococcaceae (20%), Nostocaceae (18%), Oscillatoriaceae (16%), Stigonemataceae (12%), Rivulariaceae (10%), Mastigocladaceae (9%), Microchaetaceae (8%) and Scytonemataceae (7%). The most dominant species were found in the classes Chroococcaceae and Nostocaceae during the study period. Seasonal differences as well as availability of nutrients have a substantial impact on algae species. During the monsoon, algae had their highest population density, while during the summer; they had the lowest population density. Shannon and Wiener diversity indexes were found to be higher during the monsoon season and lower during the summer season in a statistical examination of algal species. The results of this study show that distinct types of algae are widely distributed in the rice fields of three study locations in Kanchipuram district.

Keywords: Algae; Paddy field; Cyanophyceae; Seasons; Morphology





INTRODUCTION

Algae are the primary producers in most of the aquatic ecosystems and the organisms like zooplanktons, small and larger fish serves as primary and secondary consumers thus forming a complete food chain. The environmental pollution can be measure using the phytoplankton community because they are the best indicators (Hosmani and Bharathi, 1982). When the algal species diversity is rich it indicates that the nutrient level is high and there is no eutrophication (Ajayan *et al.*, 2013). Eutrophication can be measured by studying the phytoplankton population of the water bodies. Presence of pollution tolerating algae like *Oscillatoria*, *Spirogyra*, *Scenedesmus*, *Pinnularia*, *Gomphonema* and *Euglena* can be used as the pollution indicator. Many algae occur according to the variations in the resources and the struggle for space and nutrients between and among themselves (Ramachandr *et al.*, 2011).

Blue-green algae a group of gram negative photoautotrophic bacteria are the one of the most ancient component of earth present in the Archaean and Proterozoic Eras (2.7 billion years ago) that were responsible creating our oxygenic atmosphere through their photosynthetic activities (Ananya *et al.*, 2014). The paddy fields are the suitable ecosystem for growth and reproduction of blue-green algae (Vaishampayan *et al.*, 2001). The blue green algae are ecologically beneficial in paddy fields for sustaining soil fertility, reclaiming of alkaline soil and can contribute 25-30 kg N₂ per season. They are ubiquitous in nature and dominantly present in paddy fields. Various studies were reported on identification of blue-green algae from various Indian paddy fields and only few from Madhya pradesh (Verma *et al.*, 2012). Nitrogen deficiency is a common problem of rice soils worldwide. Several species of blue-green-algae or cyanobacteria with nitrogen fixing capacity are currently used as bio-fertilizer, especially to wetland paddy, in many parts of the world (Ghadai *et al.*, 2010). Cyanobacteria as a fertilizer supplement are capable of replacing 30 - 40 percent of urea nitrogen requirement to paddy and they have other positive roles in soil management (Choudhary and Kennedy 2004). Role of cyanobacteria in paddy fields is a much explored theme of research.

Rice (*Oryza sativa* L.) is one of the first leading ancient (3,000B.C.) cultivated crops of the world. This is of the genus *Oryza sativa* and the Poaceae family, has 22 known species and has great economic significance (Bajaj and Mohanty 2005). Worldwide, rice species commonly cultivated are *Oryza glaberrima* and *Oryza sativa* (L.). This is one of the most common staple food crops, serving more than half a billion people worldwide, primarily in Asian countries, as a source of food and calories. These are adapted to various climatic conditions, and can be grown at high and low altitudes in both dry and wetland environments. Nearly 90 percent of the world's rice is obtained from Asia (around 640 million tons), China and India being the main contributors. The world population in 2050 is projected to be 9 billion, entailing an incessant increase in food production to ensure food security.

MATERIALS AND METHODS

Collection of samples

Soil samples were obtained from three local paddy fields in Kanchipuram district of Tamil Nadu, namely Siruveripakam (12.8522°N, 79.74545°E), Thimmasamudram (12.8352°N, 79.7001°E), and Damal (12.8341785°N, 79.7036352°E), Site-A, B, and C in Table-1, respectively. From cropping seasons from April 2021 to March 2022, soil samples were collected at one-month intervals between morning and noon. 5-8 locations of upper 0.5 cm soil crust from study regions were sampled for representative, randomised, and mixed soil surface samples. The sites were chosen based on the varying textures of soils and soil resources used to irrigate them, in order to observe a variety and large number of Blue-green algal species, as well as other microalgae.

Isolation and Identification of samples

Soil samples were thoroughly mixed, dried, and sieved before being kept in sterile polythene bags in 100g portions from each field. The algal strains were isolated using BG-11 and Chu-10 media as enrichment medium. 1g soil sample was inoculated in 50 mL sterilized media, and flasks were incubated at 28±2°C for 30 days with cool white





Devagi and Ayyappan

fluorescent light tubes under a 16/8 h light. Dilution and pour plate methods were used to isolate microalgae. The keys provided by Desikachary (1959) in Table-3 were used to identify taxa.

Microscopic analysis

The morph metric examination of isolated microalgae was done using a light microscope. Data on trichome form, filament colour, akinete and heterocyst shape, size, location and quantity were documented using camera-lucida drawings. A digital camera was also used to capture microphotographs of prominent shapes.

Physico-chemical properties of soil

Totally nine different parameters pH, EC, organic carbon, N, P, K, sulphur, calcium, magnesium, zinc, iron, manganese and copper content were taken into consideration for the measurement of fertility levels in soils. The soil pH and conductivity of the soil samples were determined by using digital pH meter and conductivity meter respectively. The available organic carbon, N, P, K, sulphur, calcium, magnesium, zinc, iron, manganese and copper contents were estimated in the laboratory as per procedures described by Trivedi and Goel (1986). Table-2 shows the results of the soil analysis acquired throughout the study period.

Environment relationships and population dynamics of algae

Correlation of algae to environmental factors such as region, season, and physiochemical soil parameters are described. Relative abundance of species in the community is determined by the formula $Y/X \times 100$, where 'X' is the total number of samples collected and 'Y' is the number of samples from which algae was isolated. Diversity index (Shannon Wiener Index) and species richness of all species of microalgae in different season were worked out (Shannon and Weaver 1949) using the formula:

$$H_s = \sum_{i=1}^s (P_i) (\ln P_i)$$

where, H_s is diversity in a sample of 's' species or kinds, 'S' is the number of species, P_i is the relative abundance of i^{th} species or kinds, N is the total number of individuals, n_i is the number of individuals of i^{th} species, 'ln' is log base 2. Species richness was calculated with the following formula:

$$D = \frac{n}{\sqrt{N}}$$

Whittaker 1977, where 'n' is the number of different species in the sample and N is the total number of individual organism in the sample. Species evenness was calculated by the following formula $E = H / \ln(S)$. All the data of species richness and diversity index were statistically analyzed.

RESULTS AND DISCUSSION

Algal diversity in different study sites

The algae collected from three rice fields were identified to the species level in this investigation. A total of 56 algal species were discovered, divided into eight groups. Chroococcaceae, Oscillatoriaceae, Nostocaceae, Microchaetaceae, Mastigocladaceae, Scytonemataceae, Rivulariaceae and Stigonemataceae were the taxonomic groups in which all the detected species were placed. Table -3 lists all of the species that were discovered. Table -4 shows the distribution of species in different families of algae in three study sites; table -5 shows the distribution of algae; table -6 shows the distribution of algae percentages in seasons and sites; table -7 shows the distribution of total number of species and percentage of species; and table -8 shows the Shannon and Weiner diversity indices and relative abundance.



**Devagi and Ayyappan****Number of species and total isolates**

A total of 56 species belonging to 20 genera under eight groups were reported from the three rice fields (site-I, site-II, and site-III) of Kanchipuram district, which are located in Tamil Nadu. Oscillatoriaceae (10), Nostocaceae (9), Microchaetaceae (4), Mastigocladaceae (5), Scytonemataceae (4), Rivulariaceae (6) and Stigonemataceae (7) were the most numerous families, with 11 species each. *Oscillatoria* topped the species list with seven species, followed by *Nostoc* (6), *Chroococcus* (6), *Microchaete*, *Scytonema* and *Plectonema* (4). Three species of *Anabaena*, *Rivularia* and *Stigonema* were found. Table-3 showed that *Aphanothece*, *Gloeocapsa*, *Microcystis*, *Lyngbya*, *Tolypothrix* and *Calothrix* each had two species, while *Synechococcus*, *Arthrospira*, *Mastigocladus*, *Mastigocladopsis*, *Camptylonemopsis* and *Gloeotrichia* each had only one.

Qasima Agha *et al.*, (2021) reported the total of 51 genera with 109 algal species was recorded belonging to classes: Cyanophyceae, Chlorophyceae and Bacillariophyceae. Results of soil samples analyzed for their texture and physicochemical properties showed that soils from 8 localities were loamy while at Sibi and Noshki it was sandy. Silty loamy soil was recorded from Khanozai, Hana-Urak and Ziarat (silt 37-25%) maximum number of algae was recorded from these sites, these soils proved to be best as maximum number of algae were recorded from these sites. The most common algal species recorded from these sites belonged to Cyanophyceae, followed by Bacillariophyceae and least species were from Chlorophyceae. Common Cyanobacteria identified from almost every site were the species of *Anabaena*, *Chroococcus*, *Lyngbya*, *Oscillatoria* and *Phormidium*. The common diatoms included species of *Hantzschia*, *Navicula*, and *Nitzschia*. The green algae included species of *Chlorococcum*, *Chlorella*, *Cladophora*. However, less number of algal species was recorded from Kardgap, Noshki, Sibi, and Punjabi due to sandy loamy soil (sand 55-72%) and low water availability. These are desert areas with high temperature and low rainfall however; more blue green algae and diatoms were found from the soils of vegetable and cereal crops farms. In addition, Ahmed and Kalita (2002) recorded abundance of unicellular chroococcalean forms in paddy fields. They isolated 53 chroococcalean forms from paddy fields of Nagaon. Moreover, Out of 94 species, 71 species were found only in fresh soil and water samples. Their complete absence in culture conditions was noteworthy. Only 23 species were observed in culture media. *Staurosirella* was the only species which appeared in both culture media and fresh samples. The algal flora of a particular region or crop fields depends on the agro-ecological conditions and interaction between algal flora and the crop in an agro-ecosystem by Zancan *et al.*, 2006).

Environmental Correlations

Using Pearson's correlation coefficient, the algal species richness and diversity index was correlated to region, seasons, and growth stage, as well as soil parameters such as soil pH, EC, organic carbon, N, P, K, sulphur, calcium, magnesium, zinc, iron, manganese, and copper contents in different Kanchipuram district regions in relation to crop stages and growth stages. Crop seasons were shown to be positively linked with species richness ($P < 0.05$) and species quantity ($P < 0.05$). A significant positive correlation was existed with species richness to total nitrogen ($P < 0.05$), phosphorus ($P < 0.05$) and potash ($P < 0.05$) were shown to be positively linked with the number of species. Soil pH ($P < 0.05$), organic carbon ($P < 0.01$), and magnesium ($P < 0.01$) all had significant negative correlations with the number of species. According to Das *et al.*, (2013) bio-fertilizers made by Cyanobacteria are cost effective and eco-friendly for farmlands production. The phosphorus concentration in soils of all ten locations showed significantly positive correlation with soil O.M. same findings were also observed that total amount of N and P in soil was influenced by O.M. content. The amount of phosphorus was found to be directly influenced by the algal growth as maximum species were recorded from the sites where high P was recorded. Phosphorus and Potassium are essential elements as there plays an important role in photosynthesis. Ahmed *et al.*, (2011) reported high N and P concentrations produced greater vegetative cover. Soil conditions help in improving plant and animal communities, soil microorganisms are necessary for maintaining the stability and fertility of soils (Metting, 1981). The results showed that good algal growth was observed at the sites where sufficient water, N, P and K was found. Bio fertilizers are better eco-friendly and free of cost as compare to chemical fertilizers. Similar observations were made by Ahmed (2011).





Devagi and Ayyappan

The pH determines the solubility of CO₂ and minerals in the medium and directly or indirectly influences the growth, establishment and diversity of algal flora. The pH of the soil varied from 5.03–5.85, i.e., acidic range in four different study sites. The development of soil acidity is generally caused by leaching out of bases and genesis from base-poor acidic rocks or because of continuous usage of chemical fertilizers (Lin *et al.*, 2019). Further, the electrical conductivity (EC) varied from 0.27–0.345 dS/m, and it is found to be in good range as per the standard soil parameters. In case, if the EC grows above 2 m mhos/cm, makes soil salty in nature and harmful to the crops and algal species due to the presence of metal ions (Sharma and Bhardwaj, 2017; Ghadage and Karande, 2019).

CONCLUSION

Algae seem to be a major aspect of the rice field ecosystem all over the world. They are a prominent autotrophic component of all soil biotic communities. Rich algal flora grows in areas with high quantities of nutrients and appropriate environmental conditions. As a result, it is critical to protect algal genetic resources in local ecosystems and to do more systematic research on them, which can only be done after the ecology and habitats of distinct algal forms are understood.

REFERENCES

- Ahmad I, M.S.A. Ahmad, M. Hussain, M. Ashraf, M.Y. Ashraf 2011. Spatio-temporal variations in soil characteristics and nutrient availability of an open scrub type rangeland in the sub-mountainous Himalayan tract of Pakistan. *Pak. J. Bot.*, 43(1): 565-571.
- Ahmed, S.U. and M.C. Kalita 2002. Nitrogen fixing potential of Blue green algae isolated from rice field soils of Hojai sub division, Nagaon, Assam. *Phykos* 41: 17-20.
- Ajayan K.V, Selvaraju M, Thirugnanamoorthy K. 2013. Phytoplankton Population of Ananthapura Temple Lake of Kasaragod, Kerala, *Insight Bot.*, 3 (1): 6–14.
- Ananya Kamal A, Ahmad I. Z. 2014. *International Journal of Innovation and Applied Studies.*, 7: 251-261.
- Bajaj S, Mohanty, A. 2005. Recent advances in rice biotechnology towards genetically superior transgenic rice. *Plant. Biotechnol. J.* 3: 75-307.
- Choudhary A.T, Kennedy I. R. 2004. Prospects and Potentials for System of Biological Nitrogen Fixation in Sustainable Rice Production. *Biology and Fertility of Soils*, 39, 219-227. <http://dx.doi.org/10.1007/s00374-003-0706-2>.
- Das T, R. Bhattacharyya, A. Sharma S. Das, A. Saad, H. Pathak. 2013. Impacts of conservation agriculture on total soil organic carbon retention potential under an irrigated agro-ecosystem of the western Indo-Gangetic Plains. *Europ. J. Agron.*, 51: 34-42.
- Desikachary T.V. 1959. Cyanophyta A Monograph., New Delhi: Indian Council of Agricultural Research, New Delhi., pp. 685.
- Ghadage S.J, V.C Karande. 2019. The distribution of blue-green algae (Cyanobacteria) from the paddy fields of Patan and Karad tehsils of Satara District, Maharashtra, India. *JoTT.*, 11: 14862-69. <http://doi.org/10.11609/jott>.
- Ghadai A.K, Sahoo S, Raut S. 2010. Agro ecological Survey of Cyanobacterial Population in Paddy Field Soils of Gunupur. *International Journal of Agricultural Sciences*, 2, 28-32.
- Hosmani S.P, Bharathi S.G. 1982. Use of Algae in Classifying Water Bodies, *Phykos.*, 21: 48-55.
- Lin W, Lin M, Zhou H, Wu H, Li Z, Lin W. 2019. The effects of chemical and organic fertilizer usage on rhizosphere soil in tea orchards. *PLoS One.*, 14:1-16. <https://doi.org/10.1371/journal.pone.0217018>.
- Metting B. 1981. The Systematics and Systematics and Ecology of Soil Algae Publisher. *Bot. Rev.*, 47: 195-312.
- Qasima Agha, Mudassir Asrar, Saadullah Khan Leghari, Mohammad Abass Somalani 2021. Algae, Soil Fertility and Physicochemical Properties in Agricultural Fields of Balochistan, Pakistan, *Pak. J. Bot.*, 52 (4): 1-5.
- Ramachandr TV, Sajina K, Supriya G. 2011. Lipid Composition in Microalgal Community under Laboratory and Outdoor Conditions, *Indian Journal of Science and Technology.*, 4 (11): 1488-1494.
- Shannon C.E, Weaver W. 1949. The Mathematical Theory of Communication, *University of Illinois Press*, Urbana.





Devagi and Ayyappan

17. Sharma P, Bhardwaj N. 2017. Algal biodiversity in some water bodies of Kota, Rajasthan, India. *Int. Res. J. Biological. Sci.*, 6:7-14.
18. Trivedi R. K, Goel P. K. 1986. Chemical and Biological Methods for Water Pollution Studies, *Environmental Publication*, India.
19. Vaishampayan A, Sinha R. P, Hader D. P, Dey T, Gupta A. K, Bhan U, Rao A. L. 2001. *Bot Rev.*, 67: 453–516.
20. Verma R, Singh U.B, Singh G.P. 2012. Seasonal distribution of phytoplankton in Laddia dam in Sikar district of Rajasthan. *Vegetos.* 25 (2): 165-173.
21. Whittaker R.H. 1977. Evolution of species diversity in land community. In: Hecht M.K., Stee W.C. and Wallace B. (eds.) *Evolutionary Biology*, Plenum, New York.
22. Zancan S, Trevisan R, Paoletti M.G. 2006. Soil algae composition under different agro-ecosystems in North-Eastern Italy. *Agric Ecosyst Environ.*, 112:1-12.

Table-1: Collection of soil samples

| S. No. | Name of Site | Nature of the sample |
|--------|--------------------------|----------------------|
| 1. | Site-I (Siruveripakam) | Soil sample-A |
| 2. | Site-II (Thimmasamudram) | Soil sample-B |
| 3. | Site-III (Damal) | Soil sample-C |

Table-2: Physicochemical analyses of the soil of three study sites

| Parameters | Site-I | Site-II | Site-III |
|-----------------------------------|--------|---------|----------|
| Soil reaction (pH) | 5.77 | 5.09 | 5.33 |
| Electrical conductivity (EC) dS/m | 0.34 | 0.33 | 0.37 |
| Organic Carbon (OC) % | 0.64 | 0.61 | 0.59 |
| Nitrogen (N) kg/ha | 256.05 | 198.44 | 189.07 |
| Phosphorus (P) kg/ha | 5.80 | 4.98 | 9.44 |
| Potash (K) kg/ha | 166 | 240 | 189 |
| Sulphur (S) kg/ha | 67.9 | 55.8 | 39.5 |
| Calcium (Ca) me/100g | 23.4 | 32.8 | 27.6 |
| Magnesium (Mg) me/100g | 6.9 | 8.6 | 4.6 |
| Zinc (Zn) ppm | 0.86 | 1.4 | 2.3 |
| Iron (Fe) ppm | 77.8 | 62.3 | 35.9 |
| Manganese (Mn) ppm | 122.45 | 44.78 | 29.6 |
| Copper (Cu) ppm | 15.30 | 12.61 | 9.68 |

Table-3: Variation of soil microalgae of Kanchipuram district paddy fields in different sites with seasons

| S. No | Name of Species | Site-I | | | Site-II | | | Site-III | | |
|-------------------------------|----------------------------------|--------|-----|----|---------|-----|----|----------|-----|----|
| | | Win | Sum | Mn | Win | Sum | Mn | Win | Sum | Mn |
| Family- Chroococcaceae | | | | | | | | | | |
| 1. | <i>Chroococcus montanus</i> | + | - | + | - | - | + | - | + | + |
| 2. | <i>Chroococcus cohaerens</i> | - | + | + | + | + | - | + | - | + |
| 3. | <i>Chroococcus minute</i> | + | - | + | - | - | - | + | + | + |
| 4. | <i>Chroococcus dispersus</i> | - | - | + | + | + | - | + | - | - |
| 5. | <i>Synechococcus aeruginosus</i> | - | - | + | + | + | - | + | - | + |
| 6. | <i>Aphanothece microscopica</i> | - | + | + | - | - | + | + | - | + |
| 7. | <i>Aphanothece naegelii</i> | + | - | + | - | - | + | - | + | + |
| 8. | <i>Gloeocapsa decorticans</i> | + | + | - | + | + | - | + | + | - |





Devagi and Ayyappan

| | | | | | | | | | | |
|---------------------------------|-----------------------------------|---|---|---|---|---|---|---|---|---|
| 9. | <i>Gloeocapsa aeruginosa</i> | - | - | + | - | - | + | - | - | + |
| 10. | <i>Microcystis pulverea</i> | + | - | + | - | - | + | - | - | - |
| 11. | <i>Microcystis flos-aquae</i> | - | + | - | + | + | - | + | + | - |
| Family: Oscillatoriaceae | | | | | | | | | | |
| 12. | <i>Oscillatoria simplissima</i> | - | - | + | + | - | + | + | - | + |
| 13. | <i>Oscillatoria subuliformis</i> | + | - | - | - | + | - | - | - | + |
| 14. | <i>Oscillatoria acuta</i> | + | + | - | + | - | - | + | - | - |
| 15. | <i>Oscillatoria agarrdhii</i> | - | - | + | - | - | + | - | - | + |
| 16. | <i>Oscillatoria ambhubia</i> | + | + | - | + | + | - | + | - | + |
| 17. | <i>Oscillatoria amoena</i> | + | - | + | - | - | + | - | - | - |
| 18. | <i>Oscillatoria animalis</i> | + | - | + | - | - | + | - | + | + |
| 19. | <i>Arthrospira spirulinoides</i> | - | + | - | - | - | + | + | - | - |
| 20. | <i>Lyngbya allorgei</i> | - | - | + | - | - | + | - | + | - |
| 21. | <i>Lyngbya palmarum</i> | + | - | + | - | - | - | + | + | + |
| Family: Nostocaceae | | | | | | | | | | |
| 22. | <i>Nostoc commune</i> | + | - | + | + | - | - | + | - | - |
| 23. | <i>Nostoc calcicola</i> | - | + | - | - | - | + | + | - | + |
| 24. | <i>Nostoc elliposporum</i> | + | - | + | - | + | + | - | - | + |
| 25. | <i>Nostoc passerinianum</i> | - | + | - | + | - | - | + | - | - |
| 26. | <i>Nostoc piscinale</i> | + | - | + | - | + | + | - | - | + |
| 27. | <i>Nostoc linckia</i> | - | + | - | + | - | - | + | - | + |
| 28. | <i>Anabaena circinalis</i> | - | + | + | + | - | + | + | - | + |
| 29. | <i>Anabaena ambigua</i> | + | - | + | - | - | + | - | + | + |
| 30. | <i>Anabaena volzii</i> | + | + | + | + | + | - | + | - | + |
| Family: Microchaetaceae | | | | | | | | | | |
| 31. | <i>Microchaete aequalis</i> | + | - | + | - | - | + | - | + | + |
| 32. | <i>Microchaete calothricoides</i> | - | - | + | + | + | - | + | - | + |
| 33. | <i>Microchaete tenera</i> | - | + | + | - | - | + | - | - | - |
| 34. | <i>Microchaete uberrima</i> | + | - | + | + | - | - | + | + | + |
| Family: Mastigocladaceae | | | | | | | | | | |
| 35. | <i>Mastigocladus laminosus</i> | + | - | - | + | + | + | + | - | - |
| 36. | <i>Mastigocladopsis jogensis</i> | - | + | + | - | - | - | + | - | + |
| 37. | <i>Camptylonemopsis iyengarii</i> | + | - | + | - | - | + | - | - | + |
| 38. | <i>Tolypothrix nodosa</i> | + | - | + | + | + | - | + | + | - |
| 39. | <i>Tolypothrix tenuis</i> | - | + | - | + | - | + | + | - | + |
| Family: Scytonemataceae | | | | | | | | | | |
| 40. | <i>Scytonema crustaceum</i> | + | - | + | - | - | + | - | + | + |
| 41. | <i>Scytonema hofmanni</i> | - | + | + | + | - | - | + | - | + |
| 42. | <i>Scytonema guyanense</i> | - | - | + | - | - | + | - | + | - |
| 43. | <i>Scytonema multiramsum</i> | + | - | + | - | + | + | + | - | + |
| Family: Rivulariaceae | | | | | | | | | | |
| 44. | <i>Rivularia hansgirgi</i> | - | - | + | - | - | - | + | - | + |
| 45. | <i>Rivularia beccariana</i> | + | - | + | + | - | - | + | - | - |
| 46. | <i>Rivularia manginii</i> | + | - | + | + | + | + | - | + | + |
| 47. | <i>Calothrix clavatoidea</i> | - | + | - | + | - | + | + | - | + |
| 48. | <i>Calothrix brevissima</i> | + | - | + | - | - | - | - | - | + |
| 49. | <i>Gloeotrichia pilgeri</i> | + | - | - | + | - | + | + | - | - |





Devagi and Ayyappan

| Family: Stigonemataceae | | | | | | | | | | |
|-------------------------|--------------------------------|----|----|----|----|----|----|----|----|----|
| 50. | <i>Stigonema minutum</i> | + | - | + | - | - | + | - | + | + |
| 51. | <i>Stigonema lavardei</i> | + | + | - | + | + | - | + | - | + |
| 52. | <i>Stigonema dendroideum</i> | - | - | + | - | - | + | - | + | - |
| 53. | <i>Plectonema tomasinianum</i> | + | - | - | + | - | + | - | + | - |
| 54. | <i>Plectonema indica</i> | + | - | + | - | - | + | - | + | + |
| 55. | <i>Plectonema gracillimum</i> | - | - | - | + | + | - | + | - | - |
| 56. | <i>Plectonema hansgirgi</i> | + | + | + | - | - | + | + | - | + |
| Total species = | | 32 | 19 | 40 | 26 | 17 | 32 | 33 | 20 | 37 |

Win=winter, Sum=summer, Mn=monsoon

Table-4: Distribution of species in different families of algae in three study Sites

| S. No | Algae Family | Site – A (Siruveripakam) | Site – B (Thimmasamudram) | Site – C (Damal) |
|-------|------------------|-----------------------------|------------------------------|---------------------|
| 1. | Chroococcaceae | 18 | 15 | 18 |
| 2. | Oscillatoriaceae | 15 | 11 | 14 |
| 3. | Nostocaceae | 16 | 13 | 15 |
| 4. | Microchaetaceae | 7 | 5 | 8 |
| 5. | Mastigocladaceae | 8 | 8 | 8 |
| 6. | Scytonemataceae | 7 | 5 | 7 |
| 7. | Rivulariaceae | 9 | 8 | 9 |
| 8. | Stigonemataceae | 11 | 10 | 11 |
| | Mean | 11.375 | 9.375 | 11.25 |
| | Std | 4.373214 | 3.583195 | 3.991061 |

Table-5: Distribution of algae in three study Sites

| S. No | Different Sites | Total No of Species |
|-------|---------------------------|---------------------|
| 1. | Site – A (Siruveripakam) | 91 |
| 2. | Site – B (Thimmasamudram) | 75 |
| 3. | Site – C (Damal) | 90 |
| | Total = | 256 |

Table 6: Distribution percentage of algae in seasons and sites

| Seasons | Site – A (Siruveripakam) | Site – B (Thimmasamudram) | Site – C (Damal) |
|---------|-----------------------------|------------------------------|---------------------|
| Winter | 35.16 | 34.66 | 35.55 |
| Summer | 20.87 | 22.66 | 22.22 |
| Monsoon | 43.95 | 42.66 | 41.11 |

Table 7: Distribution of total number of species and percentage of species

| S. No | Algae Family | Total No. of Species | Percentage of Species |
|-------|------------------|----------------------|-----------------------|
| 1. | Chroococcaceae | 51 | 19.92 |
| 2. | Oscillatoriaceae | 40 | 15.62 |
| 3. | Nostocaceae | 44 | 17.18 |
| 4. | Microchaetaceae | 20 | 7.81 |
| 5. | Mastigocladaceae | 24 | 9.37 |
| 6. | Scytonemataceae | 19 | 7.42 |





Devagi and Ayyappan

| | | | |
|----|-----------------|----|-------|
| 7. | Rivulariaceae | 26 | 10.15 |
| 8. | Stigonemataceae | 32 | 12.50 |

Table 8. Shannon and Weiner diversity indices of microalgae from different sites

| Sites | Species Richness | Relative Abundance | Diversity Index (Shannon & Weiner) |
|------------------------------|------------------|--------------------|------------------------------------|
| Site – A (Siruveripakam) | 91 | 1.021978 | 7.748041 |
| Site – B (Thimmasamudram) | 75 | 1.00 | 7.496078 |
| Site – C (Damal) | 90 | 1.00 | 7.584146 |





Phytochemical and Pharmacological Activity of *Commiphora wightii* (Guggul): A Review

Rupak Kumar Swain^{1*}, Jnyanaranjan Panda², Deepak Sarangi¹, Sujit kumar Patro¹ and Ritesh Kumar Dash¹

¹Assistant Professor, Roland Institute of Pharmaceutical Sciences, Berhampur, Odisha, India.

²Professor, Roland Institute of Pharmaceutical Sciences, Berhampur, Odisha, India.

Received: 13 May 2022

Revised: 05 June 2022

Accepted: 08 July 2022

*Address for Correspondence

Rupak Kumar swain

Assistant Professor,

Roland Institute of Pharmaceutical Sciences,

Berhampur, Odisha, India

Email: rupak.55@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The drug Guggul (scented bdellium, gum guggul) is a type of oleo-gum-resin that is derived from the stems and branches of plant named *Commiphora wightii* (Arn.), and *Commiphora mukul* (Hook) belonging to the family Burseraceae. Guggulu is found to contain valuable volatile oils, Gum resins, guggulipids, guggulsterols and other steroids. Guggulu is widely and extensively used in Ayurvedic systems of Indian medicines since ancient times because of its medicinal importance. The main secondary metabolites play a key role in imparting medicinal activity to the drug in treatment of inflammation, atherosclerosis, and many more. Guggul significantly helps lowering cholesterol and triglycerides and also provides potent relief from inflammatory response. Guggul is very effective in treatment of arthritis, gout. The major active chemical contents of this oleo-gum resin are Z-guggulster one, E-guggulster one, and other sterols. It is an important class of chemicals in Ayurveda.

Keywords: Hypolipidemic, Anti-inflammatory, Resin, Secondary metabolites, Phytochemicals.

INTRODUCTION

Medicinal plants have been widely and actively used in ancient traditional medicines for treatment of various ailments [1,2,3]. The importance towards herbal drugs has been widely increased now days this drugs have negligible side effects and enhances immunity [4]. Phytochemical are formed during metabolic processes are referred as secondary metabolites are of importance like Alkaloids, Glycosides, gums, flavonoids, terpenes, tannins, volatile oils [5]. Guggul is a resin that is produced by making incision to the stems and branches of *C. wightii* (Arn.)





Rupak Kumar swain *et al.*,

Bhand, and *C. mukul* (Engl.), Family Burseraceae [6]. The traditional method of collection of the resin is done by tapping a cutting to the stem and branches of the tree, the liquid resin starts oozing out and is enable to solidify and collected. the guggul tree produces around 250-500 gm of resin during the collection [7] & [8]. It is a popular by various names such as guggula, guggul, guggal, and Indian bdellium [9]. Guggul found in the form of light yellow or ambered coloured masses, combined with scented fragrance and has bitter principles of taste [10]. The Sanskrit meaning of the word “Guggul” meaning who that guards us from ailments, this refers to the ayurvedic property of the drug suitable for removal of ‘ama’, the toxic substance which pile up as a effect of inactive digestion and circulation as a result of decreased metabolism [11].

Scientific Classification

Kingdom : Plantae
Subkingdom : Tracheobionta
Super division : Spermatophyta
Division : Magnoliophyta
Class : Eudicots
Subclass : Rosidae
Order : Sapindales
Family : Burseraceae
Genus : *Commiphora*
Species : *mukul* or *wightii* [12].

Chemical Constituents

Guggulsterone is a plant steroid found in the resin of *Commiphora weightii* . Guggulsterone exist in two isomeric forms, Z- guggulsterone and E- guggulsterone. In humans it acts as farnesoid X receptor, which is believed to result in decline cholesterol production in liver. Z- guggulsterone a chemical content of guggulu prohibits the growth the human prostate cancer cells by causing death [13].

Volatile oils and terpenoids

Monoterpenoids

The essential oil obtained from *C. weightii* contains myrcene, dimyrcene and polymyrcene in major quantity. [14] Other contents are present such as, (±) linalool, eugenol, cineole , d-limonene, α-pinene α- terpineol , d-α-phellandrene , (±) geraniol, bornyl acetate [15].

Diterpenoids

Diterpenoid contains camphorene, cembrene-A, cembrene and cembrenoids.

Triterpenoids

It consist of Myrrhanol-A, B and C, Myrrhanone A & B, commipheryl, commipheryl, and octanordammaranetriperpenoid, are polypodane type triterpenoids. Other two triterpenoidal chemicals have been identified as mansumbinone and mansumbinoic acid.

Sesquiterpenes

It contains a Bicyclicsesquiterpene, as cadinene.

Steroids

It contains E-guggulsterone, Z-guggulsterone, guggulsterol-I-VI, are the major steroidal contents. Other phytosterols like Sigmasterol and Campesterol are also present.





Rupak Kumar swain et al.,

Flavonoids

It carries a new flavone entity Muscanone, as well as Naringenin, it also contains quercetin, quercetin-3-O- α -L-arabinose), quercetin-3-O- β -D-glucuronide, quercetin-3-O- α -L-rhamnoside, quercetin-3-O- β -D-galactoside.[16] [17]

Tetrols

A crystallised matter was secluded from the resin found to be a combination of octadecan-1,2,3,4-tetrol, [18] nonadecan-1,2,3,4-tetrol and eicosan-1,2,3,4-tetrol. [19] and eicosan-1,2,3,4-tetrol [20].

Lignans

Two specific lignans have been isolated named as sesamin [21] and diayangambin [22]

Sugars

Some important sugars are Levo-arabinose, Dextro-galactose, Levo-fructose (small quantity), and 4-O-methyl-D-glucuronic acid are produced on total hydrolysis of gum segment of resin.

Amino acids

The amino acids exhibited by guggul are essential and non-essential amino acids such as tyrosine, tryptophan, valine, leucine, and isoleucine, cystine, histidine, lysine, glutamic acid, threonine, alanine arginine, aspartic acid, serine [23].

Extraction of guggul

The extraction of oleo resin of guggulu with non polar organic solvents produces Guggulipid. The extraction of guggulipid depends much on the quality of raw material used. The guggulipid after adjusting the PH of the mixture forms a main neutral part containing the phytochemical constituents of the resin. The neutral part on further extraction leads to the formation of ketonic part containing two part E-Guggulosterone & Z- Guggulosterone. The isomeric forms of guggulosterone in the authentic state are effective in controlling hypertension and lipids.[35-42]

Targeted Molecular Actions

Reports suggest Guggulosterone have been known to modulate several receptors at molecular level like enzymes, genes, cytokines and growth factors.

Farnesoid X receptor

Guggulosterones have shown to be as Farnesoid X receptor (FXR) antagonist.[46] FXR is mainly found in kidney, liver, and small intestine [47]. it regulates bile salts, cholesterol, lipid, and blood glucose metabolism.[48-50] Guggulosterone resulted in reduced hepatic cholesterol in rats induced with high cholesterol diet, but was ineffective in FXR absent rats. expectation of hinderence of FXR receptor could be the result lowering of cholesterol action. [51]

Bile salt pump

CYP7A1 enzyme is responsible for the alteration of cholesterol to bile acids in the liver and bile salt export pump is accountable for the excretion of bile acids via the liver [52,53]. The over expression of BSEP proclamation by guggulosterone lack the triggering to FXR to subdue CYP7A1 enzyme which entertains the breakdown of cholesterol into bile acids by bile acids of the negative response withholding of CYP7A1. This increased BSEP regulation of Guggulosterone demonstrated a feasible device by which Guggulosterone showed it's anticancer and hypolipidemic results.

Nuclear factor

It is reported that Guggulosterone may function between the repression of nuclear factor kappa-B (NF- κ B) acceleration.[54]NF- κ B is a nuclear transcription agent needed to illustrate genes intricated for cell multiplication, cell penetration, metastasis, development of new blood vessels (angiogenesis) and defiance to chemotherapy. [55],[56] activated NF- κ B inhibits apoptosis in a number of tumour cells also is involved in chemresistance. We have





Rupak Kumar swain *et al.*,

come to know that guggulsterone decreases the NF- κ B actuated influenced by numerous tumor supporter like cigarette smoke, tumor necrosis factor (TNF) [57].

Inflammatory mediators cytokines

Reports suggested that guggulsterone exercises its Antiinflammatory effects by suppressing cytokines. The ethanolic extract of guggul was found to possess anti-inflammatory properties like repress inflammatory mediators like IFN- γ , IL-12, TNF- α , and IL-1 β , but no suppressive anti-inflammatory activity observed in case of cytokine IL-109 [58]. To gather a better idea on the effect of guggulsterone on the cytokine mediated inflammation, researchers observed the consequence of guggulsterone on IL-1 β - and IFN- γ -inspired β -cell destruction in islet of Langerhans. [59] exploration of rat insulinoma cells in the company of IL-1 β and IFN- γ persuaded cell destruction, corresponding to nitric oxide and prostaglandin E2 creation. Cytokine mediated toxicity and production of NO and PGE2 was completely inhibited by Guggulsterone. Guggulsterone inhibited the extent of inducible nitric oxide synthase (iNOS) enzyme and cyclo-oxygenase-2 mRNA and translation. Favouring the inhibition of NF- κ B. The depression of JAK/STAT pathway produces the cytoprotective repercussions of guggulsterone. This output proposed that guggulsterone inhibited cytokine-influenced cell destruction [60].

Cyclooxygenase-2

Cyclooxygenase-2 (COX-2) known to convert arachidonic acid into prostaglandins and prostanoids. COX-2 is accountable to the inflammation and ache. Guggulsterone exhibited suppression of TNF-inspired COX-2 supporter undertaking and protein expression in artificial environment in a dose-related manner. [61] As previously stated, guggulsterone inhibited cytokine-persuade expression of Cyclooxygenase-2 messenger RNA and protein in rat insulinoma cells.[62] Another study revealed the isolation of 14 compounds obtained from methanol extract obtained from water boiled guggul COX Inhibitory activities and lipid peroxidation. At the concentration of 100ppm, the part accommodate cembrenoids and lignin prevented lipid peroxidation by 50% and other isolated chemicals resulted in 20% to 40% inhibitory effect with regards to control. At this application cembrenoids prevented COX-1 and COX-2 and guggulsterone. All the 14 chemical isolated from guggul prohibited COX-1 at this concentration [63].

Pharmacological Properties of Guggul

Hypolipidemic Activity

Guggul is popular in Ayurveda for the therapy of lipids and cholesterol. The hypolipidemic property is derived from an ancient slokas in Sanskrit in an ancient Ayurvedic form Sushruta samhita. The slokas allocate with the therapy for overweight and lipid disorders and other complexity. The lipid lowering property was observed in animals and in humans with complications of overweight and hyperlipidemia. In a careful and scientific observation in animals like rabbits, it was observed that guggul not only significantly lowered cholesterol but also protected the animals from atherosclerosis and significantly decreased the body mass of animals. In a related fashion the clinical study demonstrated that guggul also helps lower cholesterol in patients with overweight and hyperlipidemia. The Central Drug Research Institute (CDRI), Lucknow, is holding out specific studies on pharmacological and chemical property of guggul.[64] Z-guggulsterones and E-guggulsterones are mainly accountable for hypolipidemic pursuit of the guggulu [65],[66].The hypolipidemic exertion of guggul is clearly observed in diverse animal models and in clinical trials studies [67].

Anti-Inflammatory and Anti-arthritis Activity

The observation of many research study observations confirms the anti-inflammatory and anti-arthritis activities of guggul.[68-73] & The 50% methanolic extract was initiated to possess anti-inflammatory outcome on granuloma in mice. And also inhibited macrophages in mice. The efficacy of guggul extract in osteoarthritis (OA) models have been stated in many animal studies and in clinical investigational research studies. The main objective was to study the activity of guggul in pain, inflammation in osteoarthritis [74] [75].





CONCLUSION

The resin of commiphora species of guggul has excellent source of ancient ayurvedic medicine for therapy of inflammation, arthritis obesity, lipidemia and wound. It is the oldest, most promising and versatile drug in ancient ayurvedic system of medicine. More emphasize is been paid by the researchers towards the anti-inflammatory activity and hypolipidemic exertion of guggul. The potency and therapeutic activity of herbal drugs is increasing due to its less side effects as compared to synthetic drugs. It potentially regulates different enzymes, receptors, nuclear factors and cytokines which are mediating inflammation, lipids and other chronic ailments. Many patents have been accepted taking guggul in herbal formulations and cosmetics. Further invitro and invivo clinical data on different pharmaco kinetic and pharmacodynamic parameters will help researchers in providing poly herbal formulation with enhanced vitality.

REFERENCES

1. Adebajo, A. O., Adewumi, C. O. and Essein, E. E. (1983). Anti-infective agent of higher plants. International Symposium of Medicinal Plants. (5th edn.), University of Ife, Nigeria: 152- 158.
2. Agrawal, H., Kaul, N., Paradkar, A. R. and Mahadik, K. R. (2004). HPTLC method for guggulsterone I. Quantitative determination of E- and Z-guggulsterone in herbal extract and pharmaceutical dosage form. Journal of Pharmaceutical and Biomedical Analysis, 36(1): 33-41.
3. Awe, I. S. and Sodipo, O. A. (2001). Purification of saponins of root of *Bhiglia sapida* KoenigHoll. Nig. J. Biochem. Mol. Biol. (Proceedings Supplement.
4. Van der Watt JJA. Madoqu 1974; 8(1): 5-23.
5. Banson, A. and Adeyemo, S. O. (2007). Phytochemical and antimicrobial evaluation of ethanolic extract of *Dra-caena manni* Bark. Nig. J. Biotech., 18(1-2): 27-32)
6. Dept of AYUSH. Ayurvedic Pharmacopiea of India. Reprint ed.Ministry of Healthand Family welfare; 2001.part 1 vol1, Page no: 91.
7. (The Ayurvedic Pharmacopoeia of India (Formulations), Department of Indian Systems of Medicine and Homeopathy, Ministry of Health and Family Welfare, Government of India, New Delhi, India, 1st edition, 2007.
8. (The Ayurvedic Pharmacopoeia of India, Department of Indian Systems of Medicine and Homeopathy, Ministry of Health and Family Welfare, Government of India, New Delhi, India, 1st edition, 2001.
9. (Indian Pharmacopoeia, The Controller of Publications, New Delhi, India, 1996.
10. The Ayurvedic Pharmacopoeia of India, Department of Indian Systems of Medicine and Homeopathy, Ministry of Health and Family Welfare, Government of India, New Delhi, India, 1st edition, 2001.
11. Shastry VVS. History of gugglu, based on Ayurvedic literature. Bull Indian Inst History Med 1997; 6:102-116) & (Dwivedi A et al. Ph.D thesis. Study of Guggulu, Dept. of Rasa Sastra, faculty of Ayurvda, IMS, BHU, Varanasi; 1998.
12. Mujahid B. Khan, Rohit Chavan, Ninad Sathe *Commiphora mukul* Engl. – “ Divya” : A Review Ayurlog: National Journal of Research in Ayurved Science-2014; 3(2): 1-1. ISBN 978-93-5173-179-3.
13. SK tiwari, Giridhar rao, O.P Tiwari., Avdesh Sharma. Sachin dixit. MP Goswami, & Pankaj saini., Quantitative estimation of bioactive compounds of 5 important commercially medicinal plants through chemofinger printing (HPLC) for the identification of quality planting material. SFRI Technical bulletin No.88. series II bark & seds. Genetics, tree improvement & Biotechnology division, state forest research institute , Jabalpur (M.P) 2019.
14. A. Bhati, “Essential oil from the resin of *Commiphora mukul*, Hook. Ex. stocks,” Journal of the Indian Chemical Society, vol. 27, pp. 436–440, 1950.
15. V. K. Saxena and R. N. Sharma, “Constituents of the essential oil from *Commiphora mukul* gum resin,” Journal of Medicinal and Aromatic Plant Sciences, vol. 20, pp. 55–56, 1998.
16. M. O. Fatope, S. K. S. Al-Burtomani, J. O. Ochei, A. O. Abdulnour, S. M. Z. Al-Kindy, and Y. Takeda, “Muscanone: a 3-O-(1,8,14- trimethylhexadecanyl) naringenin from *Commiphora wightii*,” Phytochemistry, vol. 62, pp. 1251-1255, 2003





Rupak Kumar swain et al.,

17. H. K. Kakrani, "Flavonoids from the flowers of *Commiphora mukul*," *Fitoterapia*, vol. 52, no. 5, pp. 221-223, 1981
18. L. Mester, M. Mester, and S. Nityanand, "Inhibition of platelet aggregation by 'guggulu' steroids," *Planta Medica*, vol. 37, no. 4, pp. 367-369, 1979
19. A. Bordia and S. K. Chuttani, "Effect of gum guggula on fibrinolysis and platelet adhesiveness in coronary heart disease," *Indian Journal of Medical Research*, vol. 70, no. 6, pp. 992-996, 1979.
20. S. Panda and A. Kar, "Gugulu (*Commiphora mukul*) induces triiodothyronine production: possible involvement of lipid peroxidation," *Life Sciences*, vol. 65, no. 12, pp. 137-141, 1999.
21. V. D. Patil, U. R. Nayak, and S. Dev, "Chemistry of Ayurvedic crude drugs-I: Guggulu (resin from *Commiphora mukul*)-1: steroidal constituents," *Tetrahedron*, vol. 28, no. 8, pp. 2341- 2352, 1972
22. (H. Matsuda, T. Morikawa, S. Ando et al., "Absolute stereostructures of polypodane- and octanordammarane-type triterpenes with nitric oxide production inhibitory activity from guggulugum resins," *Bioorganic and Medicinal Chemistry*, vol. 12, no. 11, pp. 3037-3046, 2004.
23. G. V. Satyavati, "Guggulipid: a promising hypolipidemic agent from gum guggul (*Commiphora wightii*)," *Economic and Medicinal Plant Research*, vol. 5, pp. 48-82, 1991
24. Sharma B, Salunke R, Srivastava S, Majumder C, Roy P. Effects of guggulsterone isolated from *Commiphora mukul* in high fat diet induced diabetic rats. *Food Chem Toxicol* 2009; 47: 2631-9.)
25. Singh K, Chander R, Kappor NK. Guggulsterone, a potent hypolipidemic, prevents oxidation of low density lipoprotein. *Phytother Res* 1997; 11: 291- 4.
26. Mishra V, Kaur R. Assessment of different quality control parameters of market variants of punarnavadi guggulu. *Int J Pharm Pharm* 2012; 4: 703-10.
27. Yu BZ, Kaimal R, Bai S, El-Sayed KA, Tatulian SA et al. Effect of guggulsterone and cembranoids of *Commiphora mukul* on pancreatic phospholipase A(2): Role in hypocholesterolemia. *J Nat Prod* 2009; 72: 24-8.
28. Database on Medicinal Plants used in Ayurveda. Central Council for Research in Ayurveda and Siddha, Department of ISM & H, Ministry of Health & Family welfare, Government of India, New Delhi, 2001. 223-229 p.
29. Kimura I, Yoshikawa M, Kobayashi S, Sugihara Y, Suzuki M et al. New triterpenes, myrrhanol A and myrrhanone A, from Guggulugum resins and their potent anti-inflammatory effect on adjuvant-induced air-pouch granuloma of mice. *Bioorg Med Chem Lett* 2001; 11: 985-9.
30. Tariq M, Ageel AM, Al-Yahya MA, Mossa JS, Al-Said MS, Parmar NS. Anti-inflammatory activity of *Commiphora molmol*. *Inflamm Res* 1986; 17: 381-2.
31. Nagababu E, Lakshmaiah N. Inhibitory effect of eugenol on non-enzymatic lipid peroxidation in rat liver mitochondria. *Biochem Pharmacol* 1992; 43: 2393-2400.
32. Yoo CB, Ki-Tae H, Kyu-Seok C, Joohun H, HeeJuhn P et al. Eugenol isolated from the essential oil of *Eugenia caryophyllata* induces a reactive oxygen species-mediated apoptosis in HL-60 human promyelocytic leukemia cells. *Cancer Lett* 2005; 225: 41-52.
33. Francis JA, Raja SN, Nair MG. Bioactive terpenoids and guggulsteroids from *Commiphora mukul* gum resin of potential anti-inflammatory interest. *Chem Biodivers* 2004; 1: 1842-53.
34. Kay MA. Healing with plants in the American and Mexican west. The University of Arizona Press, Tuscon, 1996. 221-4 p.
35. Satyavati GV, Dwarakanath C, Tripathi SN, Experimental studies on the hypocholesteremic effect of *Commiphora mukul* – Engl. (Guggul). *Ind. J. Med. Res.* 1969; 57 :1950-1962.
36. Arora RB, Das D, Kapoor SC, Sharma RC, Effect of some fractions of *Commiphora mukul* on various serum lipids in hypercholesterolemic chicks and their effectiveness in myocardial infarction in rats. *Ind. J. Exp. Biol.* 1973 ; 11: 166-168.
37. Kappurajan K, Rajagopalan SS, Rao TK et al. Effect of guggulu (*Commiphora mukul* –Engl.) on serum lipids in obese, hypercholesterolemic, and hyperlipidemia cases. *J. Asso. Physicians Ind.* 1978; 26(5): 367-373
38. Baldwa VS, Bhasin V, Ranka PC, Mathur KM, Effects of *Commiphora mukul* (Guggul) in experimentally induced hyperlipemia and atherosclerosis. *J. Asso. Physicians Ind.* 1981;29: 13-17.
39. Bajaj AG, Dev S. Chemistry of Ayurvedic crude drugs. *Tetrahed.* 1982; 38:2949-2954.



**Rupak Kumar swain et al.,**

40. Agarwal RC, Singh SP, Saran RK, Sinha N, Asthana OP, Gupta PP, Nityanand S, Dhawan BN, Agarwal SS. Clinical trial of Guggulipid- A new hypolipidemic agent of plant origin in primary hyperlipidemia. *Ind. J. Med. Res.* 1986; 84: 626-634.
41. Verma SK, Bordia A. . Effects of Commiphora mukul (gum guggulu) in patients of hyperlipidemia with special reference to HDL-cholesterol . *Ind. J.Med.* 1988.; 87: 356-360.
42. Chander R. Khanna AK , Kapoor NK. Lipid lowering activity of guggulosterone from commiphora mukul in hyperlipaemic rats. *Phytother.Res.* 1996; 10: 508-511.
43. Andre, P., S. Lhermite, and Pellicier, F. 1999. Products extracted from a plant of the genus Commiphora, particularly the Commiphora mukul plant, extracts containing same and applications thereof, for example in cosmetics. US Patent No. 5972341. Parfums Christian Dior, Paris, France. October 26, 1999. Abstract from BIOSIS 2000:292340.
44. McCook, J.P., J.M. Corey, P.L. Dorogi, J.S. Bajor, H.E. Knaggs, B.A. Lange, and E. Sharpe. 1997. Antisebum and antioxidant compositions containing guggulipid and alcoholic fraction thereof. US Patent No. 5690948. Elizabeth Arden Co., U.S.A. November 25, 1997. Abstract from CA 128:53057.
45. Andre, P., S. Lhermite, and F. Perlicier (patent assignee: Parfums Christian Dior, France). 1997. Antiwrinkle cosmetic compositions containing Commiphora extracts. World Patent No. 9710196. PCT Int. Appl. March 20, 1997. Abstract from CAPLUS 1997:315058. [Japanese Patent No. 2003036945 on March 5, 2003; US Patent No. 6630177 on October 7, 2003.
46. Urizar NL, Liverman AB, Dodds DT, Silva FV, Ordentlich P, Yan Y, Gonzalez FJ, Heyman RA, Mangelsdorf DJ and Moore DD: A natural product that lowers cholesterol as an antagonist ligand for FXR. *Science* 296: 1703-1706, 2002.
47. Seol W, Choi HS and Moore D: Isolation of proteins that interact specifically with the retinoid X receptor: Two novel orphan receptors. *Mol Endocrinol* 9: 72-85, 1995.
48. Owsley E and Chiang JY: Guggulsterone antagonizes farnesoid X receptor induction of bile salt export pump but activates pregnane X receptor to inhibit cholesterol 7 α hydroxylase gene. *Biochem Biophys Res Commun* 304: 191- 195, 2003.
49. Zhang Y, Castellani LW, Sinal CJ, Gonzalez FJ and Edwards PA: Peroxisome proliferator-activated receptor-gamma coactivator 1 α (PGC-1 α) regulates triglyceride metabolism by activation of the nuclear receptor FXR. *Genes Dev* 18: 157-169, 2004.
50. Stayrook KR, Bramlett KS, Savkur RS, Ficorilli J, Cook T, Christe ME, Michael LF and Burriss TP: Regulation of carbohydrate metabolism by the farnesoid X receptor. *Endocrinology* 146: 984-991, 2005.
51. Urizar NL, Liverman AB, Dodds DT, Silva FV, Ordentlich P, Yan Y, Gonzalez FJ, Heyman RA, Mangelsdorf DJ and Moore DD: A natural product that lowers cholesterol as an antagonist ligand for FXR. *Science* 296: 1703-1706, 2002
52. (Fuchs M: Bile acid regulation of hepatic physiology: III. Regulation of bile acid synthesis: past progress and future challenges. *Am J Physiol Gastrointest Liver Physiol* 284: G551- 557, 2003.
53. Kullak-Ublick GA, Stieger B and Meier PJ Enterohepatic bile salt transporters in normal physiology and liver disease. *Gastroenterology* 126: 322-342, 2004.
54. (Shishodia S and Aggarwal BB: Guggulsterone inhibits NF κ B and IkappaB α kinase activation, suppresses expression of anti-apoptotic gene products, and enhances apoptosis. *J Biol Chem* 279: 47148-47158, 2004.
55. Aggarwal BB: Nuclear factor-kappaB: The enemy within. *Cancer Cell* 6: 203-208, 2004.
56. Aggarwal BB, Takada Y, Shishodia S, Gutierrez AM, Oommen OV, Ichikawa H, Baba Y and Kumar A: Nuclear transcription factor NF-kappa B: role in biology and medicine. *Indian J Exp Biol* 42: 341-353, 2004.
57. Shishodia S and Aggarwal BB: Guggulsterone inhibits NF κ B and IkappaB α kinase activation, suppresses expression of anti-apoptotic gene products, and enhances apoptosis. *J Biol Chem* 279: 47148-47158, 2004.
58. Manjula N, Gayathri B, Vinaykumar KS, Shankernarayanan NP, Vishwakarma RA and Balakrishnan A: Inhibition of MAP kinases by crude extract and pure compound isolated from Commiphora mukul leads to down-regulation of TNF-alpha, IL-1beta and IL-2. *Int Immunopharmacol* 6: 122-132, 2006.



**Rupak Kumar swain et al.,**

59. Lv N, Song MY, Kim EK, Park JW, Kwon KB and Park BH: Guggulsterone, a plant sterol, inhibits NF-kappaB activation and protects pancreatic beta cells from cytokine toxicity. *Mol Cell Endocrinol* 289(1-2): 49-59, 2008.
60. Lv N, Song MY, Kim EK, Park JW, Kwon KB and Park BH: Guggulsterone, a plant sterol, inhibits NF-kappaB activation and protects pancreatic beta cells from cytokine toxicity. *Mol Cell Endocrinol* 289(1-2): 49-59, 2008.
61. Shishodia S and Aggarwal BB: Guggulsterone inhibits NFkappaB and IkappaBalpha kinase activation, suppresses expression of anti-apoptotic gene products, and enhances apoptosis. *J Biol Chem* 279: 47148-47158, 2004.
62. Lv N, Song MY, Kim EK, Park JW, Kwon KB and Park BH: Guggulsterone, a plant sterol, inhibits NF-kappaB activation and protects pancreatic beta cells from cytokine toxicity. *Mol Cell Endocrinol* 289(1-2): 49-59, 2008.
63. Francis JA, Raja SN and Nair MG: Bioactive terpenoids and guggulosteroids from *Commiphora mukul* gum resin of potential anti-inflammatory interest. *Chem Biodivers* 1: 1842-1853, 2004.
64. G. V. Satyavati, "Gum guggul (*Commiphora mukul*)—the success story of an ancient insight leading to a modern discovery," *Indian Journal of Medical Research*, vol. 87, no. 4, pp. 327–335, 1988.
65. S. M. de Morais, V. A. Facundo, L. M. Bertini et al., "Chemical composition and larvicidal activity of essential oils from piper species," *Biochemical Systematics and Ecology*, vol. 35, no. 10, pp. 670–675, 2007.
66. S. Sahni, C. A. Hepfinger, and K. A. Sauer, "Guggulipid use in hyperlipidemia: case report and review of the literature," *American Journal of Health-System Pharmacy*, vol. 62, no. 16, pp. 1690–1692, 2005.
67. The Ayurvedic Pharmacopoeia of India (Formulations), Department of Indian Systems of Medicine and Homeopathy, Ministry of Health and Family Welfare, Government of India, New Delhi, India, 1st edition, 2007.
68. (J. A. Francis, S. N. Raja, and M. G. Nair, "Bioactive terpenoids and guggulosteroids from *Commiphora mukul* gum resin of potential anti-inflammatory interest," *Chemistry and Biodiversity*, vol. 1, no. 11, pp. 1842–1853, 2004.
69. I. Kimura, M. Yoshikawa, S. Kobayashi et al., "New triterpenes, myrrhanol A and myrrhanone A, from guggul-gum resins, and their potent anti-inflammatory effect on adjuvant-induced airpouch granuloma of mice," *Bioorganic and Medicinal Chemistry Letters*, vol. 11, no. 8, pp. 985–989, 2001.
70. H. Matsuda, T. Morikawa, S. Ando et al., "Absolute stereostructures of polypodane- and octanordammarane-type triterpenes with nitric oxide production inhibitory activity from guggulgum resins," *Bioorganic and Medicinal Chemistry*, vol. 12, no. 11, pp. 3037–3046, 2004.
71. G. Chaudhary, "Pharmacological properties of *Commiphora wightii* Arn. Bhandari—an overview," *International Journal of Pharmacy and Pharmaceutical Sciences*, vol. 4, no. 3, pp. 73–75, 2012.
72. M. L. Gujral, K. Sareen, K. K. Tangri, M. K. Amma, and A. K. Roy, "Antiarthritic and anti-inflammatory activity of gum guggul (*Balsamodendron mukul* Hook)," *Indian Journal of Physiology and Pharmacology*, vol. 4, pp. 267–273, 1960.
73. (D. Khanna, G. Sethi, K. S. Ahn et al., "Natural products as a gold mine for arthritis treatment," *Current Opinion in Pharmacology*, vol. 7, no. 3, pp. 344–351, 2007.
74. I. Kimura, M. Yoshikawa, S. Kobayashi et al., "New triterpenes, myrrhanol A and myrrhanone A, from guggul-gum resins, and their potent anti-inflammatory effect on adjuvant-induced airpouch granuloma of mice," *Bioorganic and Medicinal Chemistry Letters*, vol. 11, no. 8, pp. 985–989, 2001.
75. B. B. Singh, L. C. Mishra, S. P. Vinjamury, N. Aquilina, V. J. Singh, and N. Shepard, "The effectiveness of *Commiphora mukul* for osteoarthritis of the knee: an outcomes study," *Alternative Therapies in Health and Medicine*, vol. 9, no. 3, pp. 74–79, 2003.





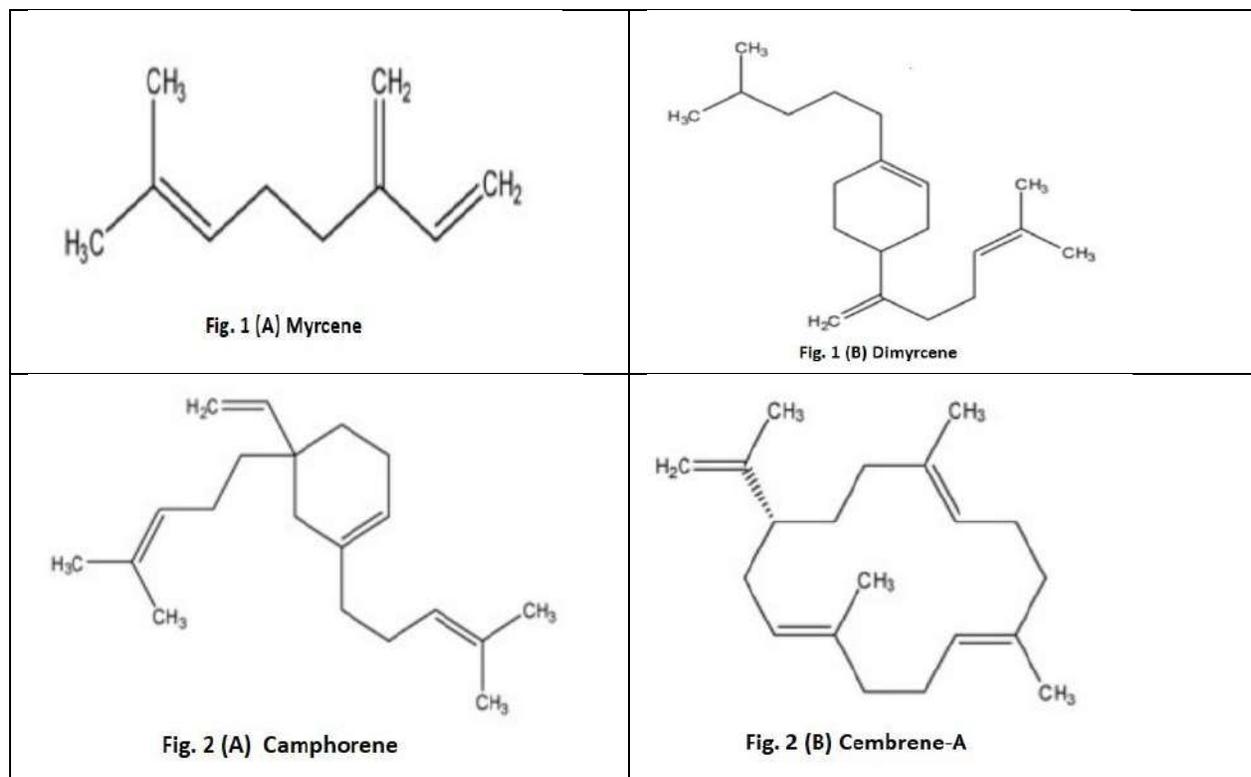
Rupak Kumar swain et al.,

Table.1 Phytochemical of the drug Guggul and pharmacological actions

| Phytochemicals | Pharmacological actions | References |
|----------------|--|------------|
| Guggulusterone | Having Hypolipidemic activity, Antiplatelet activity, Antioxidant activity, cardio protective properties | 24, 25, 26 |
| Cembranoids | Regulates the absorption of fat and cholesterol from gastrointestinal tract | 27 |
| α- pinene | Posses Antifungal and Antimicrobial activity | 28 |
| Myrrhanol | Having Potent Anti inflammatory properties | 29, 30 |
| Eugenol | Having Anti oxidant, cytotoxic, antimutagenic properties | 31,32,33 |
| L-arabinose | Important Source of sugars | 34 |

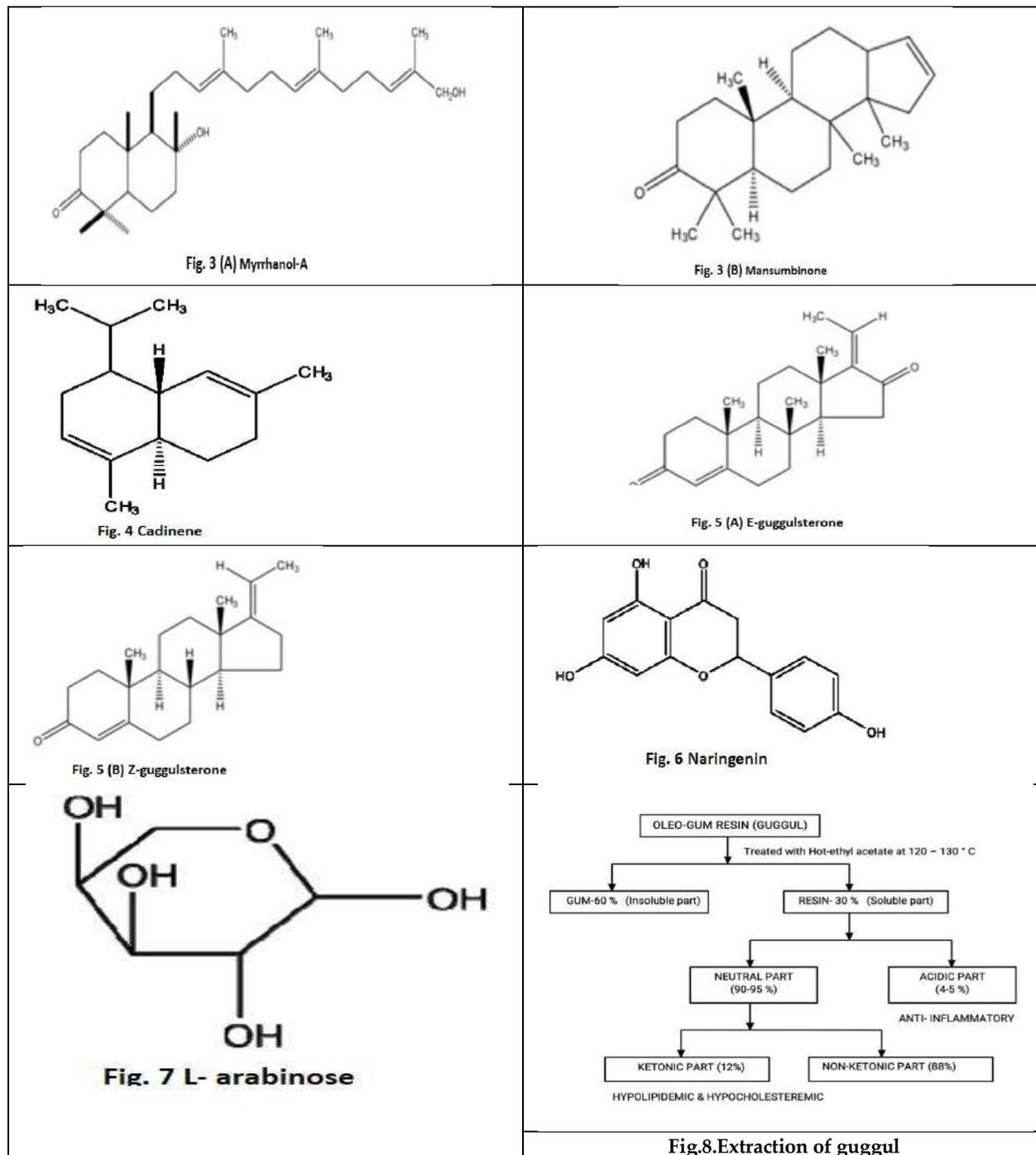
Table. 2 Patented formulation of Guggul

| PATENTS | PATENT DELEGATE | REFERENCE |
|--|--|-----------|
| Extracts of <i>C.mukul</i> were used in manufacturing pharmaceutical and cosmetic preparation | Parfums Christian Dior, at Paris, France | 43 |
| Antisebum and Antioxidant formulation manufactured using <i>C. mukul</i> or <i>C. wightii</i> guggulipid composition | Elizabeth Arden Co., at USA | 44 |
| Skin lightening and antiwrinkle Cosmetic preparation using <i>C.Mukul</i> | Parfums Christian Dior, at France | 45 |





Rupak Kumar swain et al.,





Caesarean Section One Hundred One years (1920-2021): It's Journey from Ancient to New Technology

Shaker Yousuf^{1*}, Vivek Kumar² and Ishfaq Bashir³

¹Student of MSc, Department of Medical Lab Science, Chandigarh University, Punjab, India.

²Assistant Professor, Department of Medical lab Science, Chandigarh University, Punjab, India.

³Ph.D Student, Department of Philosophy, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

Received: 11 June 2022

Revised: 18 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Shaker Yousuf

Student of MSc, Department of Medical Lab Science,
Chandigarh University, Punjab, India.

Email: shakiryousuf100@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In the United States, one out of every three women has a caesarean delivery, whereas in other areas of the world, up to four out of every five women have one. Caesarean section has a long history dating back over four centuries. Up the operation was carried out till the end of the nineteenth century. Because of its high mortality rate, it should be avoided. In 1926, the Munro Kerr was the first to use a modest transverse uterine incision. For the following 50 years, it was the standard method. Since the 1970s, novel surgical procedures have steadily gained popularity. Because of this, it has become the most often utilised approach today benefits during and after surgery. Concurrently, despite past initiatives to favour vaginal birth, Cesarean delivery rates have gradually climbed. Over the last ten years, from 5% to 30–32 per cent, with over the last ten years, expenses have risen, as have short- and long-term maternal, neonatal, and developmental difficulties. Efforts to minimise Because of the apparent safety of the procedure, the rate of caesarean deliveries has been generally unsuccessful. With the legal climate, and short-term postpartum benefits in the absence of indicators, a maternal request is made. In the United States, as the rate of caesarean births has risen in the United States, maternal health has suffered. Over the previous few decades, both mortality and morbidity have progressively increased. Disproportionately affecting black women over three decades in relation to other races prenatal data in abundance Cesarean-related abnormalities: diagnosis and treatment Placentation has helped altered women's results. However, there is less evidence available regarding the improvement of Caesarean-related gynaecological conditions' outcomes, in this review, the authors discuss the obstacles and opportunities for study, education, and change in the health impacts of caesarean birth for all women.

Keywords: caesarean delivery; caesarean section; surgical technique; uterine closure; vaginal birth after caesarean.



**Shaker Yousuf et al.,**

INTRODUCTION

Caesarean section (CS), which was once shunned because of its high mortality rate, is now used by one out of every three women in the United States [1] and up to four out of every five women in other parts of the world [2]. Its long history reflects changing surgical opinion throughout time on topics such as bleeding, infection, pain, sutures, and, more recently, hospitalization time and cost reductions.

HISTORY

Caesarean section has been thoroughly researched. Interestingly, historians have refuted the claim that Julius Caesar was born by this procedure, concluding that the operation's name does not come from his birth. Instead, they claim that King Numa Pompilius (715–673 BC) established the surgery in Roman legislation to be performed on women dying in the latter weeks of pregnancy. During Julius Caesar's rule, the Lex Regia was renamed Lex Caesarea, and the technique became known as the caesarean operation. Through an incision in the abdominal and uterine walls, a kid, either alive or dead, was removed from a dead or dying mother. The surgery was traditionally carried out by the patient, her husband, sow gelders, barbers, midwives, surgeons, or tribal natives. From razors to axes, a range of devices were used. Gored lacerations of a woman by horned animals, for example, resulted in primitive abdominal births occurring spontaneously during tough labour or inadvertently. Surprisingly, some women are said to have survived [3]. Caesarean section (CS), which was once shunned because of its high mortality rate, is now used by one out of every three women in the United States [1] and up to four out of every five women in other parts of the world [2]. Its long history reflects changing surgical opinion throughout time on topics such as bleeding, infection, pain, sutures, and, more recently, hospitalisation time and cost reductions..

The uterine walls were not sutured following the uterine incision and the removal of the baby during this time, instead relying on contractions and retraction to prevent haemorrhage. The majority of women died from haemorrhage or infection; maternal death rates after the procedure ranged from 52.5 to 100%, and the treatment was avoided at all costs. The tremendous progress in science and medicine during the nineteenth century made caesarean section a viable option for obstructed labour, though it was still dangerous. In 1876, Italian doctor Eduardo Porro published his method of amputating the body of the pregnant uterus and sewing the cervical stump as a way of delivery, recognising infection rather than haemorrhage as the primary cause of death [4]. In 1882, gynaecologist Max Sanger described the use of a second layer of sutures to close the vertical uterine incision and introduced approximation of the peritoneal borders to protect the uterus following delivery [5]. In contrast to the hysterectomy used in the Porro approach, the procedure was dubbed "conservative caesarean section.

" Although the conservative operation reduced maternal mortality significantly, the outcomes were restricted by the risk of infection. Sanger's relevance was recognised, and his work became the norm for classical operations today. For better results, an extra peritoneal caesarean approach was described in the early twentieth century, in the absence of antibiotics, as well as many changes to existing techniques for women with protracted labours or probable infections. The use of antiseptic method in abdominal surgery, as well as the selection of patients and specific operations, lowered maternal mortality to 1–2%, especially when done at a predetermined time before labour (or shortly after its commencement) and on uninfected women. As maternal mortality decreased and the procedure became better known in the 1920s, uterine rupture during labour, bleeding, and infection became the primary concerns. Because future conception was conceivable following a conservative CS, successful repeated CSs on the same person was documented. Following an unsuccessful attempt at vaginal birth, the occurrence of uterine rupture via the site of a prior classical incision led to the maxim "Once a caesarean, always a caesarean" [6].

With the absence of scar tissue by gross and histology at the site of a previous CS, even in the presence of a previous CS, such a belief was challenged and deemed to be incorrect, even if the anterior uterine wall has a slight vertical furrow on the exterior and interior surfaces. Intra-abdominal adhesions, as well as omental and intestinal adhesions, were frequently produced between the uterus and the abdominal wall. The placenta was found to be abnormally





Shaker Yousuf *et al.*,

adherent. in rare cases, by placental attachment that is solid and broad, as evidenced by the absence of decidua and profound chorionic effusion Invasion of villi into the myometrium [7, 8].

Caesarean surgical Technique Evolution 1920–1970

The Sanger procedure used interrupted deep sutures that went through the myometrium's thickness, avoiding the decidua. Muscles that are visible on the surface a continuous layer connects the peritoneum and the layer suture. The peritoneum, muscles, fascia, and parietal peritoneum are next. In distinct layers, the skin is closed [5]. The success of the for the next 40 years, the classic Sanger operation continued. The obstetrician John Martin Munro Kerr's procedure of double closure of the lower abdomen was introduced in 1926 by obstetrician John Martin Munro Kerr.[9, 10] In honour of the German gynaecologist who invented the abdominal incision in 1900, the Kerr incision included the creation of a bladder flap in the lower uterine segment, double layer closure of the uterine incision, emphasis not to include the decidua in the uterine closure, re-approximation of the bladder flap, and approximation of the parietal peritoneum. This lower segment approach was seen as the most important of the several caesarean operations at the time, and is considered the most significant advancement in obstetrical treatment.

The operation's popularity remained unchallenged, and it became the procedure of choice after that, as it minimised the risks of haemorrhage and infection [11] during this time, maternal mortality in most major hospitals in the United States continuously declined to near 1%, and the foetal salvage rate climbed. During this time, surgical skill became more refined, and blood banks, aseptic procedures, and antibiotics were introduced. From 1937 until 1944, the classical and low flap surgeries were performed in equal numbers. The lower segment method, on the other hand, was taught to all residents in training and covered in all major teaching texts beginning in the 1950s. When faced with obstetrical complications, it was widely acknowledged by all obstetricians as the best way of delivery for mother and baby. Cesarean section complications from 1920 to 2020, with immediate treatments. . With the development of antibacterial medicines, extra peritoneal surgery became less common. The principal disadvantage was the limited operative field and the unavoidable extension into the peritoneal cavity, whose integrity was being preserved. Only some indications, such as placenta previa and severe abruptio placentae, were treated with the classical section. From 1932 to 1963, the overall incidence of CS in the United States increased from 2.5 to 5.1 percent, then to 8% in 1970, as perinatal death fell from 9.8 to 2.9 percent and maternal mortality fell from 1.8 to 0.04 percent. [12]

1970–2021

In the 1970s, there was an increase in the CS rate, which was explained by better mother and foetal outcomes and increased safety From 5.5 percent of deliveries in 1970 to 16.5 percent in 1980 [13], the rate continued to rise until stabilising around 31–32 percent in the United States in 2019 . The widely used Pfannenstiel–Kerr approach has been challenged by new surgical procedures or adjustments to current ones. Joel-Cohen progressed blunt dissection of the abdominal incision and parietal peritoneum [14] The Misgav–Ladach modified Misgav–Ladach approaches were then merged with blunt uterine incision as the cornerstone of a new generation of caesarean techniques.[15,16] The multiple processes used since 1926 have now been adjusted to incorporate one or two layer uterine closure with no peritoneal layer approximation.[17] When compared to the Pfannenstiel–Kerr method, the new procedures provided advantages such as shorter operating times, less blood loss, quicker hospitalisation and recovery times, less postoperative pain, and lower costs [18, 19]. These discoveries prompted prominent medical centres in the United States and overseas to teach the newer techniques exclusively, resulting in a new generation of obstetricians who specialise in them.

The previous method has been replaced by a procedure with far fewer steps and a shorter operational time. These steps do not include endometrium or decidua care during uterine closure, whether single or double layer. The American College of Obstetricians and Gynaecologists, as well as other governing bodies that support physician autonomy in selecting preferred treatments, have recognised the safety of these novel approaches for post-partum outcomes [20]. Peritoneal closure's efficacy has been questioned and mostly abandoned [21]. Currently there is a lack



**Shaker Yousuf et al.,**

of data on the impact of these contemporaneous techniques on subsequent pregnancies and long term maternal outcomes [22]. worldwide c section rates have risen from around 7% in 1900 to 21% today, and are projected to continue increasing over this current decade. If this trend continues by 2030 the highest rates are likely to be in Eastern Asia (63%), Latin America (54%), western Asia (50%), Northern Africa (48%), Southern Europe (47%), Australia and New Zealand (45%), the research suggests [23].

Abnormal placentation

The rise in aberrant placentation that is proportional to the number of CSs appears to be a recent phenomenon. The rising caesarean birth rate, as well as the perceived safety of doing more caesareans, coincides with an increase in aberrant placentation. Cesarean delivery (CD) rates have risen drastically from 5.8% in 1970 to 31.9 percent in 2016, [24], resulting in an increase in placenta previa (PP), placenta accreta (PA), and caesarean scar pregnancy (CSP). Years after the previous CD, the emergence of these long-term diseases resulted in a substantial increase in maternal death and morbidity. The maternal mortality rate rose from 7.2 per 100,000 live births in 1987 to 17.4 per 100,000 in 2018 [26]. PA and PP account for a significant portion of maternal morbidity and mortality in modern obstetrics, accounting for 1.7 percent of all maternal fatalities in the United States [27, 28]. If the CD rate continues to climb, there will be an extra 6,236 instances of PP, 4,504 cases of PA, and 130 maternal deaths every year by 2020 [29]. In earlier observational studies, the prevalence of PA was estimated to be 1 in 4,000 deliveries in the 1970s [30], 1 in 2,500 deliveries in the 1980s [31], and 1 in 533 deliveries in 2002 [32]. According to a recent study, the total rate of PA in the United States is closer to 1 in 272 live births among women who had a birth-related hospital discharge diagnosis. [33]. A number of studies have documented a strong association between PP and previous CD with the incidence of PA. The risk is significantly increased when both factors are present. Clark concluded that a woman with one prior cesarean and a PP has a 24% risk of PA. The risk increases to 67% with four or more CSs and a PP [34]. Silver and many others have also reported an increase in PA with the number of previous CDs. In women with PP and prior CDs, the risk of PA is 11% after one procedure, 40% after two procedures and 61% after three procedures [35]. Systematic reviews and meta-analysis of PP and PA have emphasized the prevalence and incidence of PP complicated by PA, and found evidence of regional variation [36, 37].

The placenta accreta spectrum (PAS) describes the range of aberrant placental trophoblast adhesion to the uterine wall, as well as invasion into and through it. Morbidly adherent placenta was the previous name for it. Since its implementation in 1978, the frequency of CSP has risen in lockstep with the increase in the CD rate. Its true incidence is unknown, Antoine and Young; Cesarean section 100 years 1920–2020 7 possibly because the condition is underreported or under diagnosed [38]. CSP is projected to affect 1 in every 1,688 normal pregnancies [39]. The placenta accrete spectrum (PAS) describes the range of aberrant placental trophoblast adhesion to the uterine wall, as well as invasion into and through it. Morbidly adherent placenta was the previous name for it. Since its implementation in 1978, the frequency of CSP has risen in lockstep with the increase in the CD rate. Its true prevalence is unknown, most likely because to underreporting or under diagnosis [38]. CSP is projected to affect 1 in every 1,688 normal pregnancies [39].

CSP and PAS are thought to be symptoms of the same aberrant implantation spectrum, with identical histological findings of a pregnancy implanted in a previous CS scar [40]. Severe haemorrhage, uterine rupture, peripartum hysterectomy, organ injury, intensive care admission, protracted hospitalisation, and even mortality have all been linked to CSP and PAS. Both hysterectomies associated with CD and peripartum hysterectomy are most commonly indicated by PAS. Between 1969 and 2009, the rate of peripartum hysterectomy in the setting of previous CD grew from 27 to 57 percent, with PA as the primary indication rising from 5.4 to 46.5 percent [41]. . PA was noted to be the indication for peripartum hysterectomy in 33–50% of cases in reviewed studies [42]. PA, first described in 1937, occurs after manual removal of the placenta, endometritis or uterine curettage [43]. Today, it is primarily the result of uterine scar as a result of damage to the endometrium-myometrium interface of the uterine wall secondary to cesarean delivery [44]. The CS approach has changed through time and has become more stable in the last 50 years. Despite advances in surgical procedures, anaesthetic techniques, blood banking, and antibiotic therapy, caesareans remain a high-risk procedure. Both women and children may experience short- and long-term health consequences





Shaker Yousuf *et al.*,

as a result of the surgery. Every CD-owning woman doubles her chances of experiencing these unwanted outcomes. Joel-Cohen pioneered an abdominal entrance technique that emphasises blunt dissection [14]. Several variants of his technique grew more widespread than the Pfannenstiel– Kerr era [15–17]. As a result, providers are educated to improve the perceived short-term benefits while ignoring the potential long-term dangers.

Uterine rupture

Following a prior CS, uterine rupture is an uncommon but possibly dangerous complication of a subsequent pregnancy. It can occur before or during delivery and is frequently linked to the need for emergency CS, severe bleeding, placental or foetal evacuation into the abdomen, hysterectomy, or uterine repair. Because the new-born is frequently distressed, admittance to a neonatal critical care facility is required. The risk of uterine rupture varies depending on the clinical situation and is estimated to be between 0.5 and 4%. [45] After attempting vaginal birth after two previous CSs, uterine rupture is more common, increasing the likelihood of caesarean hysterectomy. Although uterine scar dehiscence is more common, it rarely causes life-threatening maternal and foetal problems [46]. The outcome of a trial of labour after a CS has been linked to uterine suture method, with no differences reported between single and double layer closure procedures [47]. With rising CDs, the risk of uterine rupture is expected to rise. Understanding the differences in uterine closure techniques used by different obstetricians could help with the inquiry.

Long-term gynaecological complication

In modern obstetrical practice, the relative safety of CD is based on short-term rather than long-term mother outcomes. Women are at a higher risk for a number of chronic gynaecological disorders after a CD, though. Surgical adhesions, pain, infertility or sub fertility, irregular bleeding, difficult intercourse, painful menses, and endometriosis are just a few of them [48–51]. These chronic disorders frequently necessitate close monitoring or surgical intervention, such as laparotomy or endoscopic exploration using hysteroscopy, laparoscopy, or robotic assistance [52, 53]. These operations come with an increased risk of consequences due to unexpected difficulties.

Chronic pain

There have been a few studies published on the risk of chronic pain in women after CD. Sun et al. [54] discussed the difficulties in anticipating discomfort following CD. Other researchers point to the impact of surgical technique on the risk of pain. Nerve entrapment, pelvic adhesions, uterine scar abnormalities, and endometriosis may occur as a result of emergency CD, abdominal incision selection, closure versus non closure of the visceral or peritoneal incision, and uterine closure technique [55– 58]. The likelihood of pain increases as the number of CDs increases. Women with repeated repeat CDs have a significantly higher risk of organ injury after surgery. Cesarean scar endometriosis is a rare complication. , it often presents as cyclic abdominal pain and incisional mass favouring a Pfannenstiel incision more than a midline vertical incision [50].

Pelvic adhesions

The cause of pelvic and abdominal adhesions following CD is poorly understood. Surgical approach appears to influence the risk of post cesarean adhesion formation, just as it does with pain. Adhesions are frequently linked to persistent discomfort and infertility in non-pregnant women [59]. Pregnant women are frequently confronted with difficult repeat CDs, organ injury, high blood loss, and prolonged operating time during delivery [35].

Fertility

There are very few studies in which the authors assessed the effect of CD on infertility or sub fertility. Pelvic adhesions might interfere with tubal function and patency. Cesarean scar defects have been related to infertility. Surgical intervention with laparoscopy, hysteroscopy or both combined has been successful in restoring fertility [60]





Shaker Yousuf *et al.*,

Irregular bleeding

The prevalence of caesarean uterine scar defect, or "niche," is rising at the same time as the long-term gynaecological consequences, which include dysmenorrhea, irregular uterine bleeding, infertility [61, 62], and improper placentation in subsequent pregnancies [63].

Tanos analysed five studies that looked at 5,123 patients with specialised symptoms. 65 per cent of patients had a uterine haemorrhage, 46.2 percent had chronic pelvic discomfort, 52 per cent had dysmenorrhea, 71.5 percent had infertility, and 24.2 percent had dyspareunia, according to him [46]. Long-term research on the impact of uterine closure procedures on these unexpected gynaecological and reproductive problems is desperately needed.

Neonatal morbidity

There is growing evidence that neonates born via CS have a different immune system, have a smaller intestinal micro biome, have late childhood obesity, and asthma [64–67]. To reinforce the evidence, more inquiry is required [68]. Prematurity and its consequences are the main causes of adverse perinatal outcomes in women who have had previous caesareans [69, 70]. Infants born by CD are more likely to develop respiratory problems and require NICU care than those born vaginally [71].

Healthcare-associated costs

Cesarean delivery expenses are frequently mentioned as significant advantages of various surgical methods employed over the last five decades. These prices usually include short-term advantages but exclude long-term complications, which are sometimes neglected as CD side effects.

However, the treatment of women with PA and the subsequent maternal and neonatal morbidity can be costly to the health care system. From 2001 to 2011, Mogos *et al.* showed a higher mean cost of inpatient care, adjusted for inflation, resulting in almost \$115 million in increased inpatient costs compared to non-PA impacted deliveries [33]. In addition, the expenditures of gynaecological exams and antenatal consultations in regard to niche and aberrant placentation must be considered.

Reducing cesarean section rates

The goal of "Healthy People 2020," the United States' federal prevention program for establishing a healthier population, is to reduce caesarean births to 24.7 percent. Or Low-risk females have a lower risk [72]. The relative safety, though, and the short-term benefits of CD often urge obstetricians to proceed without hesitation. The long-term hazards that are often unknown to the public pregnant women are rarely considered or discussed. Prior to surgery in the absence of a medical need, some people will. In part, pregnant women opt for a caesarean birth. Because of a lack of awareness of prospective dangers and fear of pelvic floor dysfunction and discomfort Women must be strong. Schooled on the potential short- and long-term hazards of a Both mother and child were born via caesarean section. Avoiding a CD and attempting a vaginal delivery after a previous CS are the most recommended methods for reducing PAS risk and should be promoted. Edward Cragin reported on the hazards of vaginal birth in women who had previously been delivered by CS in a 1914 speech and again in 1916, saying "once a caesarean, always a caesarean." [6]. Cragin was forecasting that a group of women who failed to deliver vaginally after several days in active labour would almost certainly need repeat CS.

Rickets and pelvic deformity were common at the time, oxytocin for labour augmentation was non-existent, there were no blood banks or antibiotics, and surgery was risky. The primary CS was performed in order to preserve the life of a disabled mother. In those days, fetal distress was not an indication for CS was used only to confirm a living fetus, and fetal monitoring did not exist. This is, in large part, why obstetricians and hospitals have refused to let women try natural labour following a CS for the past half-century. Changes in labour management in the United States kept the CS rate low throughout the 1960s. The use of forceps, oxytocin, vaginal delivery of breeches, and foetal monitoring by auscultation alone [73, 74] all contributed to a 4–6% reduction in the rate. Studies showing the relative safety of a trial of labour after a low transverse incision CD (TOLAC) resulted from a reconsideration of





Shaker Yousuf *et al.*,

Cragin's paradigm. [75–77]. Despite studies from greater numbers of patients confirming the relative safety of a labour trial following CS, the US CS rate continued to climb, rising from 5% in 1970 [78] to 20% in 1996, 31% in 2006, and remaining around 32% in recent years [1, 24]. The rise in labour following CD trials was reflected in an increase in the vaginal birth after caesarean (VBAC) rate (VBAC per 100 women having a prior CD) from 18.9 to 28.3 percent between 1989 and 1996, [35], resulting in a decrease in the total CS rate from 25 to 20.7 percent in 1996 [79]. Several published reports describing uterine ruptures and accompanying neonatal and maternal problems [80] questioned this significant fall in the CS rate in the mid-1990s.

VBAC was not recommended by practising obstetricians because of these dangers and the risk of professional liability. VBAC had reversed its trend by 2006, and the rate had dropped to 8.5 percent, resulting in a substantial increase in the total CD rate to 31.1 percent [79, 81, 82]. In some hospitals, policies have restricted or banned TOLAC altogether [83]. There are a number of reasons for this the current caesarean rate in the United States is due to clinical and social factors. For starters, CS is one of the safest and most reliable options. In the United States, the most common procedures are there were some in 2018 =1,208,176 caesareans were done, accounting for 21.7 percent of all deliveries.

The caesarean rate is influenced by a desire for a caesarean birth for convenience, patient views of social standing, and concern of pelvic anatomic disruption. Fertility treatment-induced pregnancies put a lot of pressure on the mother to have a caesarean birth. Electronic foetal monitoring became the standard of care for all patients as CS became a very safe and common procedure, and the focus switched to the foetus. Due to a misunderstanding of the significance of intrapartum hypoxia as a cause of cerebral palsy, this resulted in massive cash awards.

Any negative outcome for the new-born became indefensible in a lawsuit, which would similarly result in enormous monetary judgments for alleged misconduct. Vaginal delivery of breeches was abandoned, and the use of forceps and suction reduced. In the attempt to minimise the CS rate, appropriate labour management and consistent interpretation of foetal monitoring have long been promoted, albeit with little success. The CD rate in the United States has been in the 30–32 percent range over the past ten years. Other treatments, such as requiring a second opinion and following stringent standards, have been demonstrated to reduce the caesarean birth rate safely [86, 87]. Despite mounting pressure to reduce the rate of CSs, experts believe it will take at least 15 years for a significant reduction. However, as midwives, doulas, and other continuous labour assistance become more widely recognised, we hope to see a drop in caesarean births [88–90].

Some of the following steps might limit caesarean births and obtain the best outcomes

- Uniform criteria for diagnosing fetal jeopardy in labor using fetal monitoring.
- Diagnosing dystocia by standardized criteria.
- Using oxytocin for induction of labor and stimulation of arrested labor in a defined protocol.
- Extensive training, including simulation in operative vaginal delivery of vertex presentations [91, 92].
- Extensive training, including simulation in vaginal delivery of breech presentations [93].
- Developing ultrasound pelvimetry to supplement clinical evaluation of the pelvis prior to operative vaginal delivery, a new concept based on now-obsolete X-ray pelvimetry
- Counselling patients requesting primary or repeat CS regarding risks and suggesting a limit to three, recognizing progressively increasing risks [94].
- Employing proper surgical techniques to minimize complications at subsequent pregnancies and Malpractice law reform.

Maternal mortality/morbidity and disparate racial outcomes

CDs had a higher maternal mortality and morbidity rate than vaginal births [95, 96]. Clark discovered that CD was associated with an 8–10 times higher risk of maternal death than vaginal birth [97]. In comparison to other Westernized countries, the United States has extremely high rates [98]. Maternal mortality in the United States climbed from 7.2 per 100,000 live births in 1987 [25] to 17.4 per 100,000 live births in 2018, with 658 women dying





Shaker Yousuf *et al.*,

[26]. These higher death rates are largely due to racial and ethnic differences. After childbirth, black and African American women are three to four times more likely to die than women of other races and ethnicities.

In the United States, severe maternal morbidity has increased in recent years, with over 50,000 women suffering in 2014 [100]. Racial and ethnic disparities are also prominent in severe maternal morbidity. Severe maternal morbidity increased by 170 percent in each racial/ethnic group studied between 1997 and 2014, with black women (1.63 percent) having the highest frequency and white women (0.84 percent) having the lowest [101]. Mothers' comorbidities, such as hypertension, diabetes, obesity, and caesarean birth, are frequently cited as key contributors to increased morbidity [102, 103]. Caesarean birth was linked to racial and ethnic differences in maternal mortality and morbidity. These inequalities, which date back to 1935, when Title V of the Social Security Act was enacted, were emphasised in a trend analysis from 1935 to 2007 [104]. Recognizing the multifaceted nature of the disparity, improving health care outcomes for women of colour begins with equitable, high-quality health care services that consider co-morbid health conditions and socioeconomic status, as well as the importance of respect, dignity, and communication in the delivery of care. To reduce maternal fatalities and improve outcomes for women of colour, it is critical to recognise the impact of individual and structural racism on maternal health.

Future directions: cesarean surgical techniques

Currently, researchers are concentrating on the rising prevalence of PAS, as well as its prenatal diagnosis, epidemiology, and various techniques to improving maternal outcomes [63, 105]. In addition to CD, research focusing on discovering and preventing additional risk factors may help to reduce the substantial morbidity and economic burden associated with PA [33]. There are no research on the long-term effects of caesarean surgery methods on mothers. Several investigators have made recommendations to see if changing surgical procedures can reduce the likelihood of improper implantation in subsequent pregnancies [107]. Regardless of the number of subsequent pregnancies when the procedure was performed, no evidence of aberrant placental implantation was found in a study of a specific "endometrium-free double closure technique," or EFCT [108]. EFCT focuses on prevention and provides a surgical method that has the potential to minimise PAS and CSP, which are conditions that develop years after a caesarean birth. Unlike previously published data, preliminary review reveals that when EFCT is paired with peritoneal closure, a reduction in the incidence of debilitating disorders such as infertility, chronic pelvic discomfort, irregular bleeding, dyspareunia, and dysmenorrhea is conceivable.

The method of uterine closure appears to have an impact on niche development, which takes on its final shape with healing [108]. According to this study, needle placement through both the endometrium and myometrium causes endometrium to be present at the superficial level of the uterine closure, resulting in the formation of a uterine scar defect or "niche." [109]. The pathophysiology of CS-related aberrant placentation has long been linked to uterine scar defect and damaged endometrium [63, 106]. This new study provides the path for more research into the impact of caesarean procedure, namely the endometrium or decidua, on remote obstetrical and gynaecological issues in women who have had previous CDs. As a result, Sholapurkar recommends doing targeted research into the finer points of surgical technique in order to uncover and design preventive treatments [61].

Individual caesarean procedures are not monitored by any local or national agencies, despite the fact that the dangers and complications associated with them are increasing. For the performance of a CD, there are no protocols or conventional approaches. Currently, the operation is entirely based on individual autonomy and preference. "A physician should conduct her or his technique as it makes no difference in short-term maternal outcomes," according to the American College of Obstetricians and Gynaecologists (ACOG) and other governing bodies. [110–112]. The choice of individual physician technique is influenced by a variety of factors. The type of practice (private solo or group), faculty group practice, hospital employees, insurance plan (in and out of network), and patient preference are all factors contributing to cost and operating time. Surgical standardisation, while not yet investigated, is most certainly a contributing cause to unanticipated chronic adverse effects following a CD, as it allows some obstetricians to accomplish the surgery in the quickest possible timeframe while others take longer. A call to action is used to standardise the procedures required to achieve the best results. To accomplish change for the benefit of women's





Shaker Yousuf et al.,

health and safety, a challenge to medical autonomy will be essential. It may be necessary to evaluate individual provider and institutional performance across the country, as well as to monitor complications by an independent committee made up of midwives, nurses, and doulas, as well as operating room technicians, doctors, and government agents, in order to implement safety parameters and risk-reduction methods.

The impact of technique on a repeat CS is currently being investigated using video footage of CSs [108]. It's utilised to document and compare surgical techniques performed during a previous caesarean section with intra-abdominal findings during a future CD. It is found to be useful for transparency, education, documentation, and the planning of a subsequent operation, including repeat CS [109], in the same patient. The creation of a common platform for CS videos should be viewed as a collaborative learning experience for all obstetrical surgeons. Video documentation could be incorporated to the CS operative report as an additional source of documentation. The narrative report, as it is currently utilised for documenting in the form of a handwritten, typed, or multiple choice template, frequently overlooks critical finer nuances that could aid in understanding or predicting future pregnancy outcomes.

CONCLUSIONS

The function of caesarean births in obstetrics has been evolving during the past century. CSs are still the most common procedure performed on women of reproductive age worldwide, accounting for one in every three American women, and are the primary cause of maternal mortality and morbidity in the United States. In rare situations, the operation can save the life of both the foetus and the mother. However, before a CS is recommended or performed, the justification, including potential risks and benefits, should be presented to the patient and discussed. Both maternal and foetal risks should be considered when discussing potential damage. Uterine rupture, significant blood loss requiring hysterectomy or transfusion, harm to nearby organs (bladder or intestine), and thromboembolic illness are the most serious maternal concerns. Infant harm is unlikely, but not impossible. With increased awareness of the ultimate goal of returning uterine function to normal physiology during the operation, maternal morbidities can be averted in large part. Obstetricians hold a big part of the solution to reducing cesarean-related complications in their hands. Increasing CS performance should never be considered the easy solution to most obstetrical problems. The link between a previous CS and later problems that are far apart necessitates more research and the use of certain surgical features to improve long-term outcomes.

The majority of research on caesarean morbidity has focused on immediate rather than long-term maternal risks and outcomes. Women who have a caesarean birth are more likely to develop a number of chronic and life-threatening diseases. As the number of CDs grows, these problems worsen. These include discomfort, adhesions, abnormal bleeding, and infertility in the non-pregnant condition. CSP and PAS, the most lethal maternal complications in obstetrics, are among the pregnancy-related dangers. Changes in the baby micro biome caused by CS compared to vaginal birth have recently received increased attention, with long-term implications for obesity and immunological diseases such as asthma, allergy, and atopic dermatitis.

Cesarean techniques have improved over the last century, allowing for a reduction in maternal morbidity and mortality. Despite this improvement, black women continue to have far higher rates of maternal death and morbidity than white women. The health-care system has been challenged by these gaps, which indicate inequality in access to high-quality obstetrical care.

Surgical procedures have been linked to an increased risk of all long-term problems. Recent research suggests that preserving the endometrium after uterine closure may reduce aberrant placentation in later pregnancies. A new study linked the cause of caesarean scar deformity to the uterine closure procedure used after a caesarean birth. The authors emphasised the importance of the endometrium's position during the uterine incision's closure.





Shaker Yousuf et al.,

More research is needed to determine the best surgical approaches for reducing caesarean scar abnormalities, which are thought to be the most common cause of incorrect placental implantation. Surgical procedures are carefully woven to reduce the risk of chronic maternal morbidity. Video documentation of individual physicians' approaches may provide a clear picture of the wide range of surgical techniques in use. This should make subjective evaluation of complications in research trials obsolete. The autonomy of physician for surgical technique selection must also be reassessed in favor of a more structured, standardized optimal cesarean technique to curb these long-term maternal complications. Identification of all patients undergoing a cesarean birth and subsequent follow-up would create a registry and database for tracking and a statistic driven understanding of complications related to CDs. These steps could potentially lead to the discovery of the association between surgical technique and related complications.

Patients must be informed about the dangers of a caesarean delivery as part of their pregnancy education, and doctors must consider long-term risks when deciding whether or not to perform a CD. The success of this goal depends on women's education on the short and long-term risks of a CD to both mother and child. The best caesarean procedure will also allow us to level the playing field so that no one racial or ethnic group suffers from unequal reductions in cesarean-related problems. Our aim has not changed one hundred years later as we seek a twenty-first-century answer to the alarming rates of obstetrical bleeding, peripartum hysterectomy, mother death, and racial disparities in health care.

REFERENCES

1. BE Hamilton, JA Martin, MJ Osterman, AK Driscoll, LM Rossen. Rapid dissemination of vital statistics. Provisional 2017 data on births. CDC, p. 1–10, vol. 2020,
2. M. Nakamura-Pereira, M. do Carmo Leal, A. P. Esteves-Pereira, R. M. Domingues, J. A. Torres, M. A. Dias, The role of the source of payment for childbirth in the use of the Robson classification to measure the caesarean section rate in Brazil. 13:128 in *Reprod Health*.
3. Rucker, MP; Rucker, EM; Rucker, MP; Rucker, EM; Rucker, MP; The caesarean section is examined by a librarian. *Bull Hist Med* 25:132–48, 1951.
4. E. Wyszynski Eduardo Porro's (1842–1902) surgical technique for caesarean section and its relevance for obstetric advancement. In the 150th year since the method's inception. *Ginekol Pol*, vol. 65, no. 2, pp. 196–201, 1994.
5. Hem E, Bergdahl PE. Max Sanger – father of the modern caesarean section. *Gingerol Obstet Invest* 2003; 55:127–9
6. EB C. Obstetric conservatism. 104:1–3 in *New York Medical Journal*, 1916.
7. Schweitzer B. The pathological depthenwachstum of Plazenta and its zervikale implantation. 618–68 in *Arch Gynak*, 1918.
8. Meyer B. Placenta accrete: an investigation based on a unique case. *Acta Obstet Gynecol Scand*, vol. 34, no. 1, pp. 189–201, 1955.
9. JMM Kerr, No. 9. Cesarean section procedure, with emphasis on the incision in the lower uterine segment. 729–34 in *American Journal of Obstetrics and Gynecology*, 1928.
10. D. Peleg, Y. Z. Burke, I. Solt, and M. Fisher. Munro Kerr's crucial role in the history of the low transverse caesarean section. *ISRAEL MEDICAL ASSOCIATION JOURNAL* 2018; 20:316–19.
11. J. On the benefits of a transverse fascia cut above the symphysis for gynaecological laparotomies, as well as surgical methods and indications 68:1–22 in *Samml Klin VortrGynakol*, 1987.
12. Douglas RG, Stromme WB. Cesarean section. *Operative obstetrics*, 3rd ed. New York: Appleton-Century-Crofts; 1976.
13. Taffel SM, Placek PJ. Complications in cesarean and non cesarean deliveries: United States, 1980. *Am J Publ Health* 1983; 73:856–60.
14. S. Joel-Cohen, S. Joel-Cohen, S. Joel-Cohen, S. Joel-Cohen, S. Joel-Cohen, S. Joel-Cohen, S. Joel-Co Time and motion studies have led to the development of new approaches. Heinemann, London, 1972.





Shaker Yousuf et al.,

37. Jauniaux E, Bhide A. Prenatal ultrasound diagnosis and outcome of placenta previa accreta after cesarean delivery: a systematic review and meta-analysis. *Am J Obstet Gynecol* 2017; 217:27–36.
38. Timor-Tritsch IE, Monteagudo A, Bennett TA, Foley C, Ramos J, Kaelin Agten A. A new minimally invasive treatment for cesarean scar pregnancy and cervical pregnancy. *Am J Obstet Gynecol* 2016; 215:351 e351–8.
39. Ouyang Y, Li X, Yi Y, Gong F, Lin G, Lu G. First-trimester diagnosis and management of Cesarean scar pregnancies after in vitro fertilization-embryo transfer: a retrospective clinical analysis of 12 cases. *Reprod Biol Endocrinol* 2015; 13:126.
40. Timor-Tritsch IE, Monteagudo A, Cali G, Palacios-Jaraquemada JM, Maymon R, Arslan AA, et al. Cesarean scar pregnancy and early placenta accreta share common histology. *Ultrasound Obstet Gynecol* 2014; 43:383–95.
41. Flood KM, Said S, Geary M, Robson M, Fitzpatrick C, Malone FD. Changing trends in peripartum hysterectomy over the last 4 decades. *Am J Obstet Gynecol* 2009; 200:632 e631–636.
42. Wright JD, Herzog TJ, Shah M, Bonanno C, Lewin SN, Cleary K, et al. Regionalization of care for obstetric haemorrhage and its effect on maternal mortality. *Obstet Gynecol* 2010; 115:1194–200.
43. Irving FC, Hertig AT. A study of placenta accreta. *Surgery Gynecol Obstet* 1937; 64:178–200.
44. Jauniaux E, Jurkovic D. Placenta accreta: pathogenesis of a 20th century iatrogenic uterine disease. *Placenta* 2012; 33:244–51.
45. Landon MB. Predicting uterine rupture in women undergoing trial of labor after prior cesarean delivery. *Semin Perinatol* 2010;34: 267–71.
46. Tanos V, Toney ZA. Uterine scar rupture - prediction, prevention, diagnosis, and management. *Best Pract Res Clin Obstet Gynaecol* 2019; 59:115–31.
47. Abalos E, Addo V, Brocklehurst P, El Sheikh M, Farrell B, Gray S, et al. Caesarean section surgical techniques (CORONIS): a fractional, factorial, unmasked, randomised controlled trial. *Lancet* 2013;382:234–48.
48. Lyell DJ. Adhesions and perioperative complications of repeat cesarean delivery. *Am J Obstet Gynecol* 2011;205:S11–18
49. McDonald EA, Gartl and D, Small R, Brown SJ. Frequency, severity and persistence of postnatal dyspareunia to 18 months post partum: a cohort study. *Midwifery* 2016;34:15–20.
50. Zhang P, Sun Y, Zhang C, Yang Y, Zhang L, Wang N, et al. Cesarean scar endometriosis: presentation of 198 cases and literature review. *BMC Wom Health* 2019; 19:14.
51. Tower AM, Frishman GN. Cesarean scar defects: an under recognized cause of abnormal uterine bleeding and other gynecologic complications. *J Minim Invasive Gynecol* 2013;20: 562–72.
52. Vervoort A, van der Voet LF, Hehenkamp W, Thurkow AL, van Kesteren PJ, Quartero H, et al. Hysteroscopic resection of a uterine caesarean scar defect (niche) in women with postmenstrual spotting: a randomised controlled trial. *BJOG* 2018;125:326–34.
53. Vervoort A, Vissers J, Hehenkamp W, Brolmann H, Huirne J. The effect of laparoscopic resection of large niches in the uterine caesarean scar on symptoms, ultrasound findings and quality of life: a prospective cohort study. *BJOG* 2018;125:317–25.
54. Sun KW, Pan PH. Persistent pain after cesarean delivery. *Int J Obstet Anesth* 2019;40:78–90.
55. Weibel S, Neubert K, Jelting Y, Meissner W, Woeckel A, Roewer N, et al. Incidence and severity of chronic pain after caesarean section: a systematic review with meta-analysis. *Eur J Anaesthesiol* 2016;33:853–65.
56. Bamigboye AA, Hofmeyr GJ. Closure versus non-closure of the peritoneum at caesarean section: short- and long-term outcomes. *Cochrane Database Syst Rev* 2014:CD000163. <https://doi.org/10.1002/14651858.CD000163.pub2>.
57. Loos MJ, Scheltinga MR, Mulders LG, Roumen RM. The Pfannenstiel incision as a source of chronic pain. *Obstet Gynecol* 2008;111:839–46.
58. Hardy I, Rousseau S. Captive uterus syndrome: an unrecognized complication of cesarean sections?. *Med Hypotheses* 2019;122: 98–102.
59. Silver RM. Delivery after previous cesarean: long-term maternal outcomes. *Semin Perinatol* 2010;34:258–66.
60. Florio P, Filippeschi M, Moncini I, Marra E, Franchini M, Gubbini G. Hysteroscopic treatment of the cesarean-induced isthmocele in restoring infertility. *Curr Opin Obstet Gynecol* 2012;24: 180–6.



**Shaker Yousuf et al.,**

61. Sholapurkar SL. Etiology of cesarean uterine scar defect (niche): detailed critical analysis of hypotheses and prevention strategies and peritoneal closure debate. *J Clin Med Res* 2018; 10:166–73.
62. Stegwee SI, Jordans IPM, van der Voet LF, Bongers MY, De Groot CJ, Lambalk CB, et al. Single- versus double-layer closure of the caesarean (uterine) scar in the prevention of gynaecological symptoms in relation to niche development – the 2Close study: a multicentre randomised controlled trial. *BMC Pregnancy Childbirth* 2019;19:85.
63. Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging. *Am J Obstet Gynecol* 2018;218:75–87.
64. Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: systematic review and meta-analysis. *PLoS Med* 2018;15: e1002494.
65. Kolas T, Saugstad OD, Daltveit AK, Nilsen ST, Oian P. Planned cesarean versus planned vaginal delivery at term: comparison of newborn infant outcomes. *Am J Obstet Gynecol* 2006;195: 1538–43.
66. Fox C, Eichelberger K. Maternal microbiome and pregnancy outcomes. *Fertil Steril* 2015;104:1358–63.
67. Blaser MJ, Dominguez-Bello MG. The human microbiome before birth. *Cell Host Microbe* 2016;20:558–60.
68. Sandall J, Tribe RM, Avery L, Mola G, Visser GH, Homer CS, et al. Short-term and long-term effects of caesarean section on the health of women and children. *Lancet* 2018;392:1349–57.
69. Yasseen AS, III, Bassil K, Sprague A, Urquia M, Maguire JL. Late preterm birth and previous cesarean section: a population-based cohort study. *J Matern Fetal Neonatal Med* 2019;32:2400–7.
70. Williams CM, Asaolu I, Chavan NR, Williamson LH, Lewis AM, Beaven L, et al. Previous cesarean delivery associated with subsequent preterm birth in the United States. *Eur J Obstet Gynecol Reprod Biol* 2018;229:88–93.
71. Sotiriadis A, Makrydimas G, Papatheodorou S, Ioannidis JP, McGoldrick E. Corticosteroids for preventing neonatal respiratory morbidity after elective caesarean section at term. *Cochrane Database Syst Rev* 2018;8:CD006614.
72. 2020 OoDPaHPPH. Maternal, infant and child health objectives. Available from: <https://www.healthypeople.gov/2020/topicsobjectives/topic/maternal-infant-and-child-health/objectives2020>.
73. Walker N. The case for conservatism in management of foetal distress. *Br Med J* 1959;2:1221–6.
74. Benson RC, Shubeck F, Deutschberger J, Weiss W, Berendes H. Fetal heart rate as a predictor of fetal distress. A report from the collaborative project. *Obstet Gynecol* 1968;32:259–66.
75. Lavin JP, Stephens RJ, Miodovnik M, Barden TP. Vaginal delivery in patients with a prior cesarean section. *Obstet Gynecol* 1982; 59:135–48.
76. Flamm BL, Newman LA, Thomas SJ, Fallon D, Yoshida MM. Vaginal birth after cesarean delivery: results of a 5-year multicenter collaborative study. *Obstet Gynecol* 1990;76:750–4.
77. Miller DA, Diaz FG, Paul RH. Vaginal birth after cesarean: a 10-year experience. *Obstet Gynecol* 1994;84:255–8.
78. Rates CDC. Of cesarean delivery—United States, 1991. *MMWR* 1993;42:285–9.
79. MacDorman MF, Menacker F, Declercq E. Cesarean birth in the United States: epidemiology, trends, and outcomes. *Clin Perinatol* 2008;35:293–307.
80. Sachs BP, Kobelin C, Castro MA, Frigoletto F. The risks of lowering the cesarean-delivery rate. *N Engl J Med* 1999;340:54–7.
81. Yang YT, Mello MM, Subramanian SV, Studdert DM. Relationship between malpractice litigation pressure and rates of cesarean section and vaginal birth after cesarean section. *Med Care* 2009; 47:234–42.
82. Hamilton BE, Martin JA, Ventura SJ. Births: preliminary data for 2009. *Natl Vital Stat Rep* 2010;59:1–19.
83. Rosenstein MG, Norrell L, Altshuler A, Grobman WA, Kaimal AJ, Kuppermann M. Hospital bans on trial of labor after cesarean and ante partum transfer of care. *Birth* 2019;46:574–82.
84. Martin JA, Hamilton BE, Osterman MJK, Driscoll AK. Births: final data for 2018. *Natl Vital Stat Rep* 2019; 68:1–47.
85. Tsakiridis I, Mamo Poulos A, Athanasiadis A, Dagklis T. Vaginal birth after previous cesarean birth: a comparison of 3 national guidelines. *Obstet Gynecol Surv* 2018;73:537–43.
86. Chen I, Opiyo N, Tavender E, Mortazhejri S, Rader T, Petkovic J, et al. Non-clinical interventions for reducing unnecessary caesarean section. *Cochrane Database Syst Rev* 2018;9: CD005528.



**Shaker Yousuf et al.,**

87. Crosby DA, Vallejo N, Lachman P, Mullally A, Sheehan S. Reducing the caesarean section rate in nulliparous spontaneous labour: a multidisciplinary institutional approach. *Eur J Obstet Gynecol Reprod Biol* 2020; 244:207–8.
88. Bohren MA, Hofmeyr GJ, Sakala C, Fukuzawa RK, Cuthbert A. Continuous support for women during childbirth. *Cochrane Database Syst Rev* 2017;7:CD003766.
89. Clapp MA, Barth WH. The future of cesarean delivery rates in the United States. *Clin Obstet Gynecol* 2017; 60:829–39.
90. Damiano EA, Auty SG, Von Mertens J, Gerjevic KA. Singleton, term, vertex cesarean delivery on a midwife service compared with an obstetrician service. *Obstet Gynecol* 2020; 135:1353–61.
91. Bardos J, Loudon H, Rekawek P, Friedman F, Brodman M, Fox NS. Association between senior obstetrician supervision of resident deliveries and mode of delivery. *Obstet Gynecol* 2017;129: 486–90.
92. Sentilhes L, Madar H, Ducarme G, Hamel JF, Mattuizzi A, Hanf M. Outcomes of operative vaginal delivery managed by residents under supervision and attending obstetricians: a prospective cross-sectional study. *Am J Obstet Gynecol* 2019;221:59 e51–59 e15.
93. Korb D, Goffinet F, Bretelle F, Parant O, Riethmuller D, Sentilhes L, et al. First twin in breech presentation and neonatal mortality and morbidity according to planned mode of delivery. *Obstet Gynecol* 2020; 135:1015–23.
94. Forde B, DeFranco EA. Association of prior cesarean delivery with early term delivery and neonatal morbidity. *Obstet Gynecol* 2020; 135:1367–76.
95. Molina G, Weiser TG, Lipsitz SR, Esquivel MM, Uribe-Leitz T, Azad T, et al. Relationship between cesarean delivery rate and maternal and neonatal mortality. *J Am Med Assoc* 2015;314: 2263–70.
96. Garbern SC, Mbanjumucyo G, Umuhoza C, Sharma VK, Mackey J, Tang O, et al. Validation of a wearable biosensor device for vital sign monitoring in septic emergency department patients in Rwanda. *Digit Health* 2019;5. <https://doi.org/10.1177/2055207619879349>. 2055207619879349.
97. Clark SL, Belfort MA, Dildy GA, Herbst MA, Meyers JA, Hankins GD. Maternal death in the 21st century: causes, prevention, and relationship to cesarean delivery. *Am J Obstet Gynecol* 2008; 199:36 e31–35. discussion 91–32 e37–11.
98. Troiano NH, Witcher PM. Maternal mortality and morbidity in the United States: classification, causes, preventability, and critical care obstetric implications. *J Perinat Neonatal Nurs* 2018;32: 222–31.
99. Hoyert DL, Minino AM. Maternal mortality in the United States: changes in coding, publication, and data release, 2018. *Natl Vital Stat Rep* 2020; 69:1–18.
100. Prevention CfDCa. Severe maternal morbidity in the United States. In: Health RHMAI, editors. Available from: <https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html> 2014.
101. Leonard SA, Main EK, Scott KA, Profit J, Carmichael SL. Racial and ethnic disparities in severe maternal morbidity prevalence and trends. *Ann Epidemiol* 2019;33:30–6.
102. Creanga AA, Berg CJ, Ko JY, Farr SL, Tong VT, Bruce FC, et al. Maternal mortality and morbidity in the United States: where are we now? *J Womens Health (Larchmt)* 2014;23:3–9.
103. Berg CJ, Mackay AP, Qin C, Callaghan WM. Overview of maternal morbidity during hospitalization for labor and delivery in the United States: 1993–1997 and 2001–2005. *Obstet Gynecol* 2009;113:1075–81.
104. Singh G. Maternal mortality in the United States, 1935–2007: substantial racial/ethnic, socioeconomic and geographic disparities persist. In: Services USDoHaH, editors. A 75th anniversary publication: health resources and services administration. Rockville, Maryland: Maternal and Child Bureau; 2010.
105. Silver RM, Branch DW. Placenta accreta spectrum. *N Engl J Med* 2018; 378:1529–36.
106. Society of Gynecologic, American College of, Gynaecologists, et al. Placenta accreta spectrum. *Am J Obstet Gynecol* 2018;219: B2–16.
107. Rosen T. Placenta accreta and caesarean scar pregnancy: overlooked costs of the rising caesarean section rate. *Clin Perinatol* 2008; 35:519–29. x.
108. Antoine C, Pimentel RN, Reece EA, Oh C. Endometrium-free uterine closure technique and abnormal placental implantation in subsequent pregnancies. *J Matern Fetal Neonatal Med* 2019;1–9. <https://doi.org/10.1080/14767058.2019.1670158>.





Shaker Yousuf et al.,

- 109. Antoine C, Pimentel RN, Timor-Tritsch IE, Mittal K, Bennett TA, Bourroul FM. Origin of a post-cesarean delivery niche: diagnosis, pathophysiologic characteristics, and video documentation. J Ultrasound Med 2020. <https://doi.org/10.1002/jum.15368>.
- 110. Acog. Placenta accreta. Committee Opinion No. 529. American College of obstetricians and gynaecologists. Obstet Gynecol 2012; 120:207–11. 2012.
- 111. Temmerman M. Caesarean section surgical techniques: all equally safe. Lancet 2016; 388:8–9.
- 112. Dodd JM, Anderson ER, Gates S, Grivell RM. Surgical techniques for uterine incision and uterine closure at the time of caesarean section. Cochrane Database Syst Rev 2014. <https://doi.org/10.1002/14651858.cd004732.pub3>



Fig.1. C section in 1950 and silk worm gut sutures and Michel's clips used for skin closure

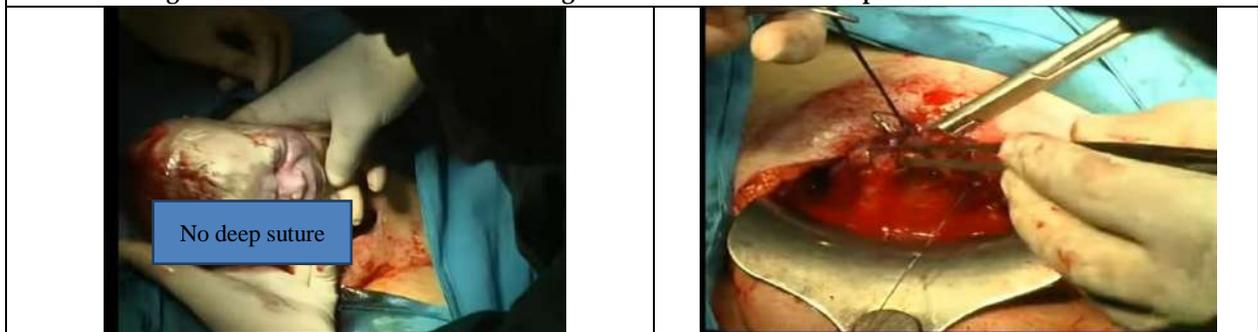


Fig. 2. C section and skin closure in 2021

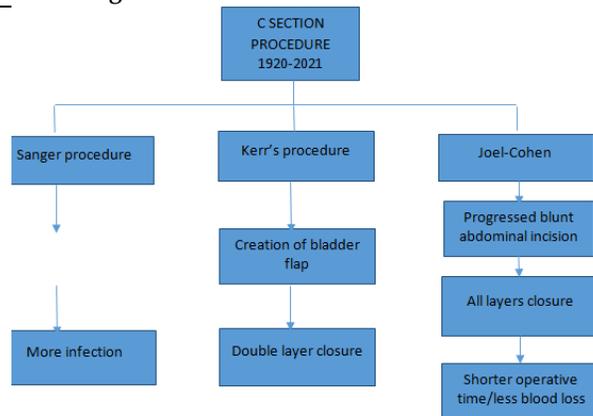


Fig. 3. Long-term obstetrical complications





Scientometric Assessment of the Research Productivity of Calcutta University, West Bengal

Jiaur Rahaman¹ and M Sadik Batcha²

¹Ph.D research scholar, Department of Library and Information Science, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

²Professor and University Librarian, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

Received: 10 May 2022

Revised: 05 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Jiaur Rahaman,

Ph.D research Scholar,

Department of Library and Information Science,

Annamalai University, Annamalai Nagar,

Tamil Nadu, India.

Email: jia.amugeo@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

This paper presents a Scientometric analysis of the publication output of Calcutta University reflected in the Web of Science database from 2002 to 2021 for 20 years. A total of 10856 papers have been retrieved from the database. The paper analyses the growth rate of research publications at West Bengal University in terms of publications, CAI, DCI, subject-wise distribution, and Bradford's law. The findings of the study reveal that the CAI value has increased from 70.45 to 112.17 in more than three authors' patterns. Journal of AUTOPHAGY is the most-cited journal accounting for 3789 of the total journal citations with a 2 h-index. Out of 10856 articles produced by CU, 9115 and 1741 articles were found from domestic and international collaboration. Multi author publications are more compared to single-authored publications therefore there is a growing collaborative trend in research publications.

Keywords: Scientometric; Web of Science; West Bengal University; CAI; Bradford's law

INTRODUCTION

Higher education is crucial in the indigenous systems of science, technology, and innovation. The collaborative work of academia, industry, and the government is critical for the growth of knowledge-based economies. The global formation of new institutional and social structures for knowledge production, transfer, and application is viewed as a strategic action in national science policy agendas around the world. Measures for such connections are still being established, although demands on research systems to accomplish such goals have been presented in evaluation projects developed by both developed and developing countries.



**Jiaur Rahaman and Sadik Batcha**

Essential steps for policy adoption to improve the efficiency and effectiveness of the national higher education system and to implement more accurate systems for evaluating academic research performance. Other factors that influence collaboration between universities, industry, and governments include research budgets, university localization, the intensity of research, level of risk-taking culture, and researcher publication methods. Scientometrics is concerned with the quantitative aspects of science and scientific study. The scientometric analysis is used to objectively map the scientific knowledge field, whereas critical evaluation seeks to identify research themes and associated issues based on scientometric results. Nowadays, scientometrics is one of the interdisciplinary research domains, encompassing nearly all scientific disciplines. There are numerous research studies in which scientometric analyses have been performed utilizing the Web of Science or Scopus databases.

LITERATURE REVIEW

Keshava Sathish Kanth, P.L., Ms. Mamatha, V., and Ms. Shanthakumari, K., (2020) [1] published a paper entitled “Scientometric analysis of publication output of Tumkur University Faculty: A study based on Scopus Data base” from 2005 to 2019. The study revealed that the average Growth Rate was 1.15 years while the mean doubling time was 0.88 years. The study shows that in 2015 the highest output with 116 was published by Tumkur University Faculty. Former Vice-Chancellor Prof. S.C. Sharma has the highest citations among all other faculty members of Tumkur University. The faculty of Tumkur University published their publication in multi-authored rather than single-authored.

Verma, Manoj Kumar, and Das, Saumen (2020) [2] studied the Authorship and Collaboration Pattern of Research Output Published by Researchers of Tripura University. The study was scrutinized by the scientometrics tools and techniques like Degree of collaboration (DC), Collaborative coefficient, modified collaborative coefficient (MCC). The study reveals the highest growth rate in 2013 with 86.95%. According to the study the researchers of Tripura University published theirs in a collaborative way rather than in single publications. The study examined the overall degree of collaboration and it is found to be 0.96. The most productive author was D. Bhattacharjee with 68(13.51%) publications. The study shows that Jadavpur University has the highest collaboration with Tripura University with 48 publications.

Gopikuttan, A., and Aswathy S.,(2014) [3] studied the research productivity of the University of Kerala based on the data collected from the Indian Citation Index for 13 years from 2000 to 2012. The study reveals that the highest research output is 126 articles in 2011. ‘Biology’ is the most productive subject at the University. The most productive author was T.S. Anirudhan, from the department of Chemistry with 114 publications. The highest-ranking publication was ‘Current Science India’ with 25 publications was preferred by University of Kerala researchers. Mulimani, Renuka S., and Hadagali, Gururaj S.,(2018) [4] published a paper entitled Research Productivity of Indian Institute of Toxicology Research (IITR): A Scientometric Analysis. This study focus on national & international collaboration profile, Degree of Collaboration, most productive authors, most preferred journals, citation impact of the publications. The study reveals that the scientists from the IITR preferred to publish their articles in foreign journals rather than in Indian journals. The study indicates the overall predominance of domestic collaboration activity rather than International collaborative activity. The most productive author Alok Dhawan topped the list with 61 (8.36%) of the total research output.

Batcha, Sadik M., (2018) [5] has tried to analyze the development example of the growth of literature, citation, and coordinated effort of different nations distributed in the main six Universities of Tamil Nadu distributed on Web of Science. The study considers data published between 2000-2017. Studies have shown that the growth of literature is inconsistent. The scientific impact of the six universities is linked to science and more than four-fifths of the literature has been cited internationally. Research collaboration with other nations varies among universities. In some of the decided universities, Spectroscopy, Toxicology, and Environmental science, Ecology had been diagnosed as the essential research regions.



**Jiaur Rahaman and Sadik Batcha**

H. Anil Kumar, Mallikarjun Dora, and Asha Desai (2015) [6] studied A Bibliometrics Profile of Gujarat University, based on the data collected from the Scopus for 10 years from 2004 to 2013. Revealed that the impact of studies is an important criterion in the evaluation of any research and counting the citations is one of the critical and not unusual criteria used in calculating the impact of studies.

Vellaichamy,A., and Jeyshankar,R.,(2015) [7] observed the productivity of Pondicherry University based on the Scopus database. The study shows that the majority of the researchers preferred to publish their research papers collaboratively. Physics and Astronomy have published a maximum number of papers rather than other subjects. The most prolific author is S.A. Abbasi with 132 publications. Thirumagal, A., (2012) [8] evaluated the research output of Manonmaniam Sundaranar University as reflected in Web of Science. The study shows the yearly output of research products, types of articles, and institutional collaboration of authors focused on publishing trends, affiliated institutions of authors, countries of contributing authors, and individual authors' research. Sharma, Rakesh Mani,(2009) [9] studied the Research publication trend among scientists of Central Potato Research Institute: A bibliometric study based on the data collected by scanning of annual reports of CPRI and Journal of the Indian Potato Association for 17 years. The study revealed that scientists of the Central Potato Research Institute (CPRI) published their research work mostly collaboratively.

OBJECTIVES OF THE STUDY

The main objective is to analyze the research results of Calcutta University from 2002 to 2021 with the help of Scientometrics indicators.

- To study the pattern of co-authorship and the pattern of domestic as well as an international collaboration of Calcutta University.
- To prepare a ranked list of most-cited journals preferred by Calcutta University researchers.
- To test the applicability of Bradford's Law of scattering.
- To measure subject specialization index and relative priority index of subject-wise and sub-subject publication of Calcutta University with the Nations publication.

RESEARCH METHODOLOGY

Scientific publications are the greatest way to assess an individual scientist's contributions or the evolution of a discipline. The goal of the research is to determine the rate of growth and development of scientific output in the field of Calcutta University. Web of Science was used to obtain bibliographic data for Calcutta University research articles for the study for the period of the last 20 years i.e., 2002 to 2021. In the WoS core collection, found a total of 10856 records as a result of the search query [Affiliation = ("University of Calcutta") Timespan = 2002-01-01 to 2021-06-03, Indexes = SCI, SSCI, and A&HCI. Records of the type article, book review, review, meeting abstract, proceedings paper, editorial material, letter, and so on are included in the data collection. The downloaded records were loaded into Bib excel for the purpose of analysis. The data was also tabulated in MS Excel and tested using scientometric indicators.

DATA ANALYSIS**Co-Authorship Index**

This CAI is calculated using the formula 1. The co-authorship index was developed by Schubert and Braun in 1986 and it is calculated by dividing the number of publications by single, two, multi, and mega-authored articles for different countries. The number of publications corresponds to the average within a Co-authorship pattern when CAI = 100. CAI > 100 indicates that the CAI is higher than the average, while CAI = 100 indicates that the CAI is lower than the average.





Jiaur Rahaman and Sadik Batcha

Table 1 shows the year-wise Co-Authorship Index of C.U publications obtained from Web of Science between 2002 and 2021 shown in table 2. According to the number of authors, the articles have been classified into four categories. Such as single, two, three, and more than three authors. In single author, the CAI value has decreased from 148.55 in the year 2002 to 75.63 in the year 2021, except for some years. In two authors, the CAI value has decreased from 175.28 to 81.08 during the period of the study. In the case of three authors, the CAI value has below average. On the other hand, the CAI value has increased from 70.45 to 112.17 in more than three authors' patterns. The highest CAI value was found in the two author's patterns.

Domestic and International Collaboration

Table 2 indicates the number of collaborative articles produced by academic organizations, research institutes, industrial organizations, and government organizations, indicating that academic organizations have produced the majority of the collaborations. Out of 10856 articles produced by CU, 9115 and 1741 articles were found from domestic and international collaboration. The value of DCI=100 indicates that a country's collaborative effort corresponds to world average. DCI >100 reflects paper collaboration higher than the world average and DCI <100 reflects paper collaboration less than the world average. It is seen above in the table, both Domestic and International collaboration has increased and decreased. Domestic Collaboration, from 2002 to 2009 and 2011 to 2015 was much higher than the world average indicating a good DCI. On the other hand 2010 and 2016 to 2021 had good International collaboration as reflected by the values of ICI.

Most Preferred Journals

Table 3 shows the top fifty journals of the University of Calcutta. After examining the information it is observed that around 143871 citations were scattered in 2367 journals. Journal of Autophagy is the most-cited journal accounting for 3789 of the total journal citations with a 2 h-index followed by Inorganic Chemistry, next with 3416 citations, 40 h-index. Journal Polyhedron with 2802 citations, RSC Advances with 2771 citations and Carbohydrate Polymers with 2028 citations, Tetrahedron Letters with 1992 citations, and 25 h-index and Dalton Transactions with 1938 citations. It is determined that these seven top-ranked journals cover about 13.02% of the entire citations, which may be termed as core journals of Calcutta University preferred by authors.

Bradford Law of Scattering

The number of journals in each Bradford zone can be calculated from the multiplier constant K which is called the Bradford constant using the formulation of Egghe.

Where y is Euler's number having a value 0.57772

y_m Is the number of citations of rank one journal = 3789

p is Bradford group or number of zones, i.e. p=3

$$k = (2.719^{0.57772} \times 3789)^{\frac{1}{3}}$$

$$k = (1.78 \times 3789)^{\frac{1}{3}}$$

$$k = 18.89$$

Using k we can calculate different Bradford groups. The nucleus zone r_0 can be defined as:

$$r_0 = \frac{T(k-1)}{(k^p - 1)}$$

Where, T represents the total number of journals in this study for Calcutta University i.e. 2367

$$r_0 = \frac{2367(18.89 - 1)}{(18.89^3 - 1)}$$





Jiaur Rahaman and Sadik Batcha

$$r_o = \frac{42345.63}{6739.56}$$

$$r_o = 6.28$$

Different Bradford zone can be obtained using the value of k and r0

The k value is found out to be 18.89 and r0 = 6.28

Nucleus zone r0 = r0 x 1 = 6.28

First zone r1 = r0 x k = 6.28 x 18.89 = 118.63

Second zone r2 = r0 x k² = 6.28 x 18.89² = 2240.91

It is in the ratio of **7:119:2241**

Bradford Law of Scattering of Literature

It is observed from Table 4 that there are seven journals in the nuclear zone and these are the most productive journal of University of Calcutta articles published in the Web of Science database with sharing 13.02% (18736) of total cited journals. Autophagy, Inorganic Chemistry, Polyhedron, RSC Advances, CARBOHYD POLYM, TETRAHEDRON LETT, and DALTON These are the journals that belong to the nuclear zone of the Bradford law. The next zone is represented by 119 journals sharing 40.90% (58848) of the total cited journals and the last zone is represented by 2241 journals which share 46.07% (66287) of the total cited journals.

Subject Specialization Index

This SSI⁽¹⁰⁻¹¹⁾ is calculated using the formula 2.

$$SSI = (X_a/X_t) / (Y_a/Y_t)$$

Where,

X_a = number of articles published by group X in discipline α

X_t = Total Number of articles published by reference group X

Y_a = number of articles published by group Y in discipline α

Y_t = Total Number of articles published by reference group Y

In this method, if the value of SI is higher than 1, it indicates that the Country makes a specialty in that particular subject discipline. SI refers to a country that is less than one where discipline is not special. If it is equal to one, then that country shows a neutral situation which means no relative specialization in that particular discipline. In this research, these indicators were used in a double group. One is a publication of Calcutta University which is considered 'X' and the publication of India is considered 'Y'. In the second group publication of India is considered as 'X' and in the same discipline publication of World is considered as 'Y'. 'a' concludes disciplines such as Chemistry, Physics, Biology, and Engineering. Table 5 shows the study compares the research productivity of Calcutta University with the research productivity of four major disciplines in India, namely, Chemistry, Physics, Biology, and Engineering. The study also compares India's research productivity with world productivity.

The highest specialization index value of Calcutta University found in biology is 2.050. This means that biology is the highest research-producing department where research efforts are related to research in India. But compared to the world, India does not represent itself in biological research because it has only 0.546 SI value. In this regard, India has to take a lot of effort to increase productivity. Calcutta University has a SI value of 1.337 in Physics subjects, which is more than 1. This indicates that CU has been in line with its research efforts in India. Research on Physics at the national level is consistent with the world because the SSI value is above 1.





Jiaur Rahaman and Sadik Batcha

Table 5 shows that chemistry and Engineering have values of 0.766 and 0.699 specialization indices, respectively, which are less than 1. This means that the research efforts undertaken by Calcutta University in chemistry and Engineering are not as specialized as the research efforts in the country. The university has to work hard to increase productivity in these branches. Research on Chemistry in India is consistent with the world but Engineering does not represent itself compared to the world. The subject Specialization index speaks about the general development of research in a particular area. A particular area in the Sub-subject matter of research will be considered in the Priority index in Sub-subject. This index helps to realize the strong and weak portions of a particular subject of research.

Distribution of Relative Priority Index found in chemistry sub-subjects

This RPI is calculated using formula 3.

$$RPI = (N_{ij}/N_{io}) / (N_{oj}/N_{oo}) \times 100$$

Where,

“ N_{ij} = the number of publications of the country ‘i’ is subfield j

N_{io} = the number of publications of the country ‘i’ is in all subfields

N_{oj} = the number of publications of all countries (viz., the total world output) is subfield j

N_{oo} = the number of publications of all countries is in all subfields.”

If the value of RPI = 100 indicates that the priority subfield of a given study is exactly consistent with the average of all countries. If RPI > 100 it indicates higher than average priority and RPI < 100 indicates lower than average priority. No country can have high or low priority in all subfields. In this study, the priority index of sub-subjects was studied at the University and National levels. Calcutta University has adopted the most productive subjects for the study of sub-disciplines of Chemistry, Physics, Biology, and Engineering.

Table 6 shows that Calcutta University has the highest research efforts in ‘Inorganic Chemistry’ as its priority index value is 170.135. Followed by ‘Medical Chemistry’ RPI value of 133.698, ‘Physical Chemistry’ RPI value of 131.651, ‘Chemistry Applied’ RPI value of 118.653, and ‘Organic Chemistry’ RPI value of 109.840 and it is more than 100. This means that Calcutta University has made reasonable efforts to align the research productivity of India in these sub-disciplines. But there is some sub-subject of chemistry in which the RPI value has less than 100 and the University has to improve in this sub-subject of chemistry. Table 6 also represents that India has precise research productivity in ‘Analytical Chemistry’ as its RPI value is 128.886, which is more than 100. This indicates that CU has been in line with its sub-subject research efforts in India. Conflicting data is comparing India with the Relative priority index of Calcutta University, the sub-subject of Calcutta University ‘Medical Chemistry’ does not match the productivity of the nation with its research productivity. Similarly, the relative priority index of ‘Analytical Chemistry’ at the university level is low; at the same time, the same sub-subject has India’s highest priority index.

Distribution of Relative Priority Index found in Physics sub-subjects

Table 6 shows the relative priority index values in the sub-subjects of Physics. According to the data, Calcutta University has got the highest priority index in ‘Astronomy and Astrophysics (586.455). This means that Calcutta University is one of the most productive universities in India. Similarly, ‘Nanoscience and Nanotechnology’ is an outstanding subject where Calcutta University has an awesome relative priority index value of 506.703. There is some sub-subject of Physics found in this study Polymer Science (59.303), Physics Multidisciplinary (6.822), Thermodynamics (36.893), Plasma Physics (88.719), Physics Particles Fields (81.733) in which the value of the relative priority index is less than 100 and the Calcutta University has to make sufficient research efforts to align it with the efforts of the country.

Table 6 also reveals that India has the highest relative priority index in ‘Nanoscience and Nanotechnology’ with an RPI value of 161.459. This means that India is one of the leading research effective countries in the world in this ‘Nanoscience and Nanotechnology’. There is some conflicting data shown in the table that University productivity with India’s productivity does not match according to the table. While some sub-subject of Physics is a high RPI value in University, similarly the same sub-subject has India’s low RPI value.



**Jiaur Rahaman and Sadik Batcha****Distribution of Relative Priority Index found in Biology sub-subjects**

According to the data shown in Table 8, Calcutta University has the highest relative priority index in 'Marine & Freshwater Biology' (2171.296) and the lowest in 'Developmental Biology' (6.226). The relative priority index of research efforts of the Calcutta University in 'Mathematical & Computational Biology' (1250.024), 'Biotechnology & Applied Microbiology' (953.671), 'Biochemistry & Molecular Biology' (383.137), 'Biophysics' (360.122), and 'Plant Sciences' (173.566) is more than 100. This means that the University's efforts in these sub-disciplines are consistent with India's productive efforts in the same sub-disciplines. However, Calcutta University needs to focus its efforts on other sub-disciplines like Immunology, Zoology, Reproductive Biology because this sub-subject has an RPI value of less than 100. Table 8 also reveals that India has the highest relative priority index value in Zoology (243.112) and the lowest in Evolutionary Biology (55.242).

Distribution of Relative Priority Index found in engineering sub-subjects

According to the data shown in Table 9, Calcutta University has the highest relative priority index in 'Food Science Technology' (163.868) and the lowest in 'Metallurgy & Metallurgical Engineering' (19.800) in the sub-subject of engineering. The relative priority index of research efforts of Calcutta University in 'Environmental Science' (139.859), 'Chemical Engineering' (119.419), 'Nuclear engineering' (114.759), and 'Electrical Engineering' (105.338) is more than 100. This means that the University's efforts in these sub-disciplines are consistent with India's productive efforts in the same sub-disciplines of engineering. However, Calcutta University needs to focus its efforts on other sub-disciplines like Materials Science, Engineering Multidisciplinary, Instruments Instrumentation, and Metallurgy & Metallurgical Engineering because this sub-subject has an RPI value of less than 100. Table 9 also reveals that India has the highest relative priority index value in Metallurgy & Metallurgical Engineering (232.056) and the lowest in Environmental Science (66.293).

FINDING AND CONCLUSION

The study evaluates the publications published by Calcutta University. It published 10856 documents from 2002 to 2021. It is found from the study that the highest CAI value was found in the two author's patterns. The highest domestic collaboration was found in 2010 with an a110.11 DCI score, and in 2020 highest international collaboration was received with a 167.90ICI value. A total of 143871 citations were received by the Calcutta University publications and Autophagy is the most-cited journal accounting for 3789 of the total journal citations with a 2 h-index. The study reveals that there are seven journals in the nuclear zone and these are the most productive journal of University of Calcutta articles published in the Web of Science database with sharing 13.02% (18736) of total cited journals. Study shows that chemistry and Engineering have values of 0.766 and 0.699 Subject specialization index, respectively, which are less than 1. This means that the research efforts undertaken by Calcutta University in chemistry and Engineering are not as specialized as the research efforts in the country. Calcutta University has the highest research efforts in the Chemistry sub-subject 'Inorganic Chemistry' as its priority index value is 170.135; Physics sub-subject 'Astronomy and Astrophysics' (586.455), Biology sub-subject 'Marine & Freshwater Biology' (2171.296) and Engineering sub-subject 'Food Science Technology' (163.868).

ACKNOWLEDGMENT

The authors are grateful to the editor and the anonymous reviewers for their valuable comments and suggestions, which have substantially improved this manuscript.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.





Jiaur Rahaman and Sadik Batcha

CONTRIBUTORS

Mr. Jiaur Rahaman received his integrated MLIS and PDGLAN from Pondicherry Central University, India. Currently pursuing a Ph.D. at Annamalai University. He has published more than 4 papers in National and International Journals. He collected and analyzed the data and interpretation. Dr. M. SadikBatcha is working as a Librarian and Professor at Annamalai University. He has done his MLIS, M. Phil, and Ph.D. He has put Through 23 years of experience in teaching and research. He has brought out about 129 research articles in National and International Journals.

REFERENCES

1. Keshava, Sathish Kanth P.L, Mamatha V., and Shanthakumari K. (2020), "Scientometric Analysis Of Publication Output Of Tumkur University Faculty : A Study Based On Scopus Database." *Journal Of Indian Library Association* 56 (4): pp. 16–28.
2. Das, Saumen, and Manoj Kumar Verma. (2020), "Authorship and Collaboration Pattern of Research Output Published by Researchers of Tripura University during 2010-2019: A Scientometric." *Library Philosophy and Practice* 2020 (November): 4359.
3. Gopikuttan, A, and S Aswathy. (2014), "Publication Productivity of University of Kerala : A Scientometric View." *DESIDOC Journal of Library & Information Technology* 34 (2): pp.131–39.
4. Rahaman, Jiaur, and M. Sadik Batcha. (2022), "A Scientometric Assessment Of The Research Performance Of Indian Universities" *Shodh Samhita* IX (1): 192–205.
5. Mulimani, Renuka S, and Gururaj S Hadagali. (2018), "Research Productivity of Indian Institute of Toxicology Research (IITR): A Scientometric Analysis." *Library Philosophy & Practice* 2026: pp. 1–16.
6. Sadik Batcha, M. (2018), "Research Output Analysis of Top Six Universities of Tamil Nadu, India: A Scientometric View." *Library Philosophy and Practice* 2018 (December): 1854.
7. Kumar, H. Anil, Mallikarjun Dora, and Asha Desai. (2015), "A Bibliometrics Profile of Gujarat University, Ahmedabad during 2004-2013." *DESIDOC Journal of Library and Information Technology* 35 (1): pp. 9–16.
8. Rahaman, Jiaur, and Sadik Batcha. (2022), "Scientometric Analysis and Collaboration Trends of Published Literature by State Universities from West Bengal Scientometric Analysis and Collaboration Trends of Published Literature by State Universities from West Bengal." *Journal of Social Sciences and Management* 1 (2): 21–33.
9. Vellaichamy, A, and R Jeyshankar. (2015), "Publication Productivity of Pondicherry University Seen through Scopus: A Scientometric Study." *Journal of Advances in Library and Information Science* 4 (2): pp. 113–19.
10. Thirumagal, A. (2012), "Scientific Publications of Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu: Scientometric Analysis." *Library Philosophy and Practice* 2012 (1): 791.
11. Sharma, Rakesh Mani. (2009), "Research Publication Trend among Scientists of Central Potato Research Institute : A Bibliometric Study." *Annals of Library and Information Studies* 56 (March): pp. 29–34.
12. Glänzel, Wolfgang. (2003), "Bibliometrics as a Research Field: A Course on Theory and Application of Bibliometric Indicators." *Researchgate*, no. January 2003: 115.
13. Antony, Jisha, Raja Selvaraju, and Mercy M. Clarence. (2021), "Current Trend of Hydroxychloroquine Research Publications: A Scientometric Analysis." *Journal of Scientometric Research* 10 (2): pp. 195–211.
14. Singha, Sur Chandra and Verma, Manoj Kumar, "Web Content Analysis of Veterinary University Library Websites in India: An Evaluation" (2021). *Library Philosophy and Practice (e-journal)*, Article No. 5967. ISSN-1522-0222
15. Shettar, Iranna M., and Gururaj S. Hadagali. (2020), "Scientometric Analysis of Research Publications of National Institutes of Technology." *SRELS Journal of Information Management* 57 (2): 87.
16. Singh, Rajesh, Avijit Mahala, and Shreya Yadav. (2021), "Science Research Output Pattern of University of Delhi (2015-2019)." *Library Philosophy and Practice* 2021 (June): 1–18.





Jiaur Rahaman and Sadik Batcha

Table No. 1 Co-Authorship Index

| Year | 1 | CAI | 2 | CAI | 3 | CAI | > 4 | CAI | Total |
|--------------------|------------|--------|-------------|--------|-------------|--------|-------------|--------|--------------|
| 2002 | 15 | 148.55 | 79 | 175.28 | 42 | 84.35 | 74 | 70.45 | 210 |
| 2003 | 17 | 159.98 | 72 | 151.79 | 61 | 116.41 | 71 | 64.23 | 221 |
| 2004 | 18 | 152.17 | 61 | 115.53 | 67 | 114.87 | 100 | 81.27 | 246 |
| 2005 | 19 | 159.33 | 54 | 101.45 | 55 | 93.53 | 120 | 96.74 | 248 |
| 2006 | 14 | 102.16 | 77 | 125.88 | 69 | 102.11 | 125 | 87.69 | 285 |
| 2007 | 18 | 109.46 | 97 | 132.15 | 71 | 87.56 | 156 | 91.19 | 342 |
| 2008 | 21 | 118.04 | 101 | 127.18 | 85 | 96.89 | 163 | 88.08 | 370 |
| 2009 | 27 | 121.80 | 112 | 113.20 | 123 | 112.53 | 199 | 86.30 | 461 |
| 2010 | 30 | 137.12 | 99 | 101.38 | 121 | 112.16 | 205 | 90.08 | 455 |
| 2011 | 38 | 135.55 | 138 | 110.29 | 141 | 102.00 | 266 | 91.22 | 583 |
| 2012 | 25 | 82.53 | 140 | 103.54 | 170 | 113.81 | 295 | 93.62 | 630 |
| 2013 | 27 | 78.75 | 187 | 122.20 | 175 | 103.52 | 324 | 90.85 | 713 |
| 2014 | 38 | 102.50 | 169 | 102.13 | 179 | 97.92 | 385 | 99.83 | 771 |
| 2015 | 27 | 72.08 | 161 | 96.29 | 196 | 106.12 | 395 | 101.37 | 779 |
| 2016 | 41 | 108.62 | 143 | 84.88 | 180 | 96.71 | 421 | 107.22 | 785 |
| 2017 | 31 | 78.34 | 159 | 90.01 | 178 | 91.22 | 455 | 110.53 | 823 |
| 2018 | 26 | 69.41 | 137 | 81.94 | 167 | 90.41 | 449 | 115.23 | 779 |
| 2019 | 29 | 73.28 | 128 | 72.46 | 196 | 100.44 | 470 | 114.17 | 823 |
| 2020 | 47 | 103.22 | 149 | 73.31 | 210 | 93.53 | 541 | 114.21 | 947 |
| 2021 | 14 | 75.63 | 67 | 81.08 | 88 | 96.40 | 216 | 112.17 | 385 |
| Grand Total | 522 | | 2330 | | 2574 | | 5430 | - | 10856 |

C.U= University of Calcutta, CAI= Co-Authorship Index

Table No. 2 Year-wise Domestic and International Collaboration

| S. No. | Year | Paper in Domestic Collaboration | DCI | Papers in International Collaboration | ICI | Total Paper |
|--------|------|---------------------------------|--------|---------------------------------------|--------|-------------|
| 1 | 2002 | 189 | 107.19 | 21 | 62.35 | 210 |
| 2 | 2003 | 194 | 104.55 | 27 | 76.18 | 221 |
| 3 | 2004 | 216 | 104.58 | 30 | 76.04 | 246 |
| 4 | 2005 | 226 | 108.54 | 22 | 55.31 | 248 |
| 5 | 2006 | 250 | 104.47 | 35 | 76.58 | 285 |
| 6 | 2007 | 311 | 108.30 | 31 | 56.52 | 342 |
| 7 | 2008 | 315 | 101.40 | 55 | 92.69 | 370 |
| 8 | 2009 | 407 | 105.15 | 54 | 73.04 | 461 |
| 9 | 2010 | 364 | 95.28 | 91 | 124.71 | 455 |
| 10 | 2011 | 539 | 110.11 | 44 | 47.06 | 583 |
| 11 | 2012 | 540 | 102.09 | 90 | 89.08 | 630 |
| 12 | 2013 | 622 | 103.90 | 91 | 79.58 | 713 |
| 13 | 2014 | 688 | 106.28 | 83 | 67.13 | 771 |
| 14 | 2015 | 691 | 105.65 | 88 | 70.44 | 779 |
| 15 | 2016 | 647 | 98.16 | 138 | 109.62 | 785 |
| 16 | 2017 | 647 | 93.63 | 176 | 133.35 | 823 |
| 17 | 2018 | 627 | 95.86 | 152 | 121.67 | 779 |





Jiaur Rahaman and Sadik Batcha

| | | | | | | |
|--------------|------|-------------|-------|-------------|--------|--------------|
| 18 | 2019 | 644 | 93.20 | 179 | 135.62 | 823 |
| 19 | 2020 | 692 | 87.03 | 255 | 167.90 | 947 |
| 20 | 2021 | 306 | 94.66 | 79 | 127.95 | 385 |
| Total | | 9115 | | 1741 | | 10856 |

Table No. 3 Most preferred journals for publishing by authors of Calcutta University from 2002 to 2021

| Rank | Journal Name | Articles | Citations | h-index |
|------|--|----------|-----------|---------|
| 1 | Autophagy | 2 | 3789 | 2 |
| 2 | Inorganic Chemistry | 63 | 3416 | 40 |
| 3 | Polyhedron | 124 | 2802 | 31 |
| 4 | RSC Advances | 194 | 2771 | 28 |
| 5 | Carbohydrate Polymers | 54 | 2028 | 23 |
| 6 | Tetrahedron Letters | 69 | 1992 | 25 |
| 7 | Dalton Transactions | 76 | 1938 | 27 |
| 8 | Inorganica Chimica Acta | 87 | 1750 | 24 |
| 9 | Chemical Engineering Journal | 15 | 1515 | 13 |
| 10 | Journal Of Hazardous Materials | 11 | 1484 | 10 |
| 11 | Physical Review D | 90 | 1429 | 24 |
| 12 | European Journal Of Inorganic Chemistry | 38 | 1357 | 23 |
| 13 | Journal Of Applied Polymer Science | 85 | 1184 | 18 |
| 14 | International Journal Of Biological Macromolecules | 65 | 1175 | 21 |
| 15 | PLOSOne | 68 | 1159 | 20 |
| 16 | Physical Review E | 70 | 1153 | 16 |
| 17 | Journal Of Physical Chemistry B | 30 | 1127 | 19 |
| 18 | IEEE Transactions On Antennas And Propagation | 27 | 858 | 16 |
| 19 | Journal Of Applied Physics | 73 | 855 | 17 |
| 20 | Chemosphere | 25 | 827 | 16 |
| 21 | Journal Of Ethno pharmacology | 21 | 825 | 13 |
| 22 | Indian Journal Of Experimental Biology | 49 | 784 | 16 |
| 23 | Environmental Monitoring And Assessment | 36 | 748 | 17 |
| 24 | Environment International | 7 | 740 | 7 |
| 25 | Scientific Reports | 68 | 736 | 13 |
| 26 | Journal Of Colloid And Interface Science | 19 | 723 | 10 |
| 27 | Environmental Science And Pollution Research | 36 | 718 | 16 |
| 28 | Ceramics International | 35 | 698 | 16 |
| 29 | Ieee Antennas And Wireless Propagation Letters | 28 | 697 | 13 |
| 30 | Marine Pollution Bulletin | 28 | 695 | 16 |
| 31 | Crystengcomm | 27 | 673 | 15 |
| 32 | New Journal Of Chemistry | 73 | 660 | 15 |
| 33 | Food Chemistry | 11 | 650 | 8 |
| 34 | Physical Chemistry Chemical Physics | 43 | 646 | 14 |





Jiaur Rahaman and Sadik Batcha

| | | | | |
|----|---|----|-----|----|
| 35 | Life Sciences | 14 | 645 | 8 |
| 36 | Ieee Transactions On Electron Devices | 30 | 641 | 14 |
| 37 | Physical Review C | 47 | 599 | 15 |
| 38 | Physical Review A | 50 | 586 | 14 |
| 39 | Journal Of Molecular Structure | 53 | 581 | 15 |
| 40 | Food And Chemical Toxicology | 24 | 566 | 15 |
| 41 | IEEE Transactions On Instrumentation And Measurement | 25 | 563 | 12 |
| 42 | Crystal Growth & Design | 19 | 522 | 13 |
| 43 | Nanomedicine-Nanotechnology Biology And Medicine | 10 | 519 | 9 |
| 44 | Journal Of Physical Chemistry A | 31 | 514 | 13 |
| 45 | Journal Of Physical Chemistry C | 22 | 501 | 12 |
| 46 | Journal Of Photochemistry And Photobiology A-Chemistry | 38 | 497 | 13 |
| 47 | Persoonia | 50 | 477 | 13 |
| 48 | Ecotoxicology And Environmental Safety | 4 | 472 | 4 |
| 49 | Spectrochimica Acta Part A-Molecular And Bimolecular Spectroscopy | 29 | 471 | 12 |
| 50 | Progress In Materials Science | 3 | 469 | 3 |

Table No. 4 Bradsford Law of Scattering of Literature

| Zone | 1st | 2nd | 3rd | Total |
|-----------|----------------|----------------|----------------|--------|
| Citations | 18736 (13.02%) | 58848 (40.90%) | 66287 (46.07%) | 143871 |
| Journals | 7 | 119 | 2241 | 2367 |

Table No. 5 Subject Specialization index of four main subjects for Calcutta University

| Name of the main subject | No. of the paper published (2002-2021) | | | | |
|--------------------------|--|--------|----------|----------|-------------|
| | CU | India | SI of CU | World | SI of India |
| Chemistry | 2693 | 266612 | 0.766 | 4340073 | 1.250 |
| Physics | 3291 | 186659 | 1.337 | 3265645 | 1.163 |
| Biology | 2337 | 86422 | 2.050 | 3220669 | 0.546 |
| Engineering | 2794 | 302951 | 0.699 | 6315692 | 0.976 |
| Total | 11115 | 842644 | | 17142079 | |

Note: The total number of CU publications in this table has increased because some research papers cover multiple topics.

Table No. 6 Distribution of Relative Priority Index found in chemistry sub-subjects

| Name of sub-subject in Chemistry | No. of the paper published (2002-2021) | | | | |
|----------------------------------|--|-------|----------|---------|-------------|
| | CU | India | PI of CU | World | PI of India |
| Chemistry Multidisciplinary | 448 | 83662 | 53.014 | 1153787 | 118.037 |
| Inorganic Chemistry | 205 | 11929 | 170.135 | 173852 | 111.697 |
| Organic Chemistry | 428 | 38577 | 109.840 | 560475 | 112.044 |
| Physical Chemistry | 774 | 58205 | 131.651 | 886475 | 106.884 |
| Analytical Chemistry | 110 | 16388 | 66.452 | 206984 | 128.886 |





Jiaur Rahaman and Sadik Batcha

| | | | | | |
|-------------------|-------------|---------------|----------|----------------|----------|
| Chemistry Applied | 420 | 35044 | 118.653 | 707056 | 80.682 |
| Medical Chemistry | 308 | 22807 | 133.698 | 651444 | 56.991 |
| Total | 2693 | 266612 | - | 4340073 | - |

Table No. 7 Distribution of Relative Priority Index found in Physics sub-subjects

| Name of sub-subject in Physics | No. of the paper published (2002-2021) | | | | |
|--------------------------------------|--|---------------|----------|----------------|-------------|
| | CU | India | PI of CU | World | PI of India |
| Physics Applied | 816 | 40766 | 113.531 | 788810 | 90.416 |
| Astronomy and Astrophysics | 286 | 2766 | 586.455 | 54256 | 89.192 |
| Polymer Science | 357 | 34144 | 59.303 | 597015 | 100.057 |
| Physics Multidisciplinary | 53 | 44066 | 6.822 | 683229 | 112.839 |
| Crystallography | 213 | 4421 | 273.263 | 71436 | 108.274 |
| Nano science and Nanotechnology | 341 | 3817 | 506.703 | 41360 | 161.459 |
| Thermodynamics | 38 | 5842 | 36.893 | 95792 | 106.697 |
| Nuclear Physics | 500 | 23603 | 120.150 | 318593 | 129.614 |
| Optics | 428 | 10437 | 232.589 | 328688 | 55.554 |
| Plasma Physics | 171 | 10932 | 88.719 | 192627 | 99.289 |
| Physics Atomic Molecular Chemical | 17 | 938 | 102.794 | 11521 | 142.440 |
| Physics Particles Fields | 71 | 4927 | 81.733 | 82318 | 104.715 |
| Total | 3291 | 186659 | - | 3265645 | - |

Table No. 8 Distribution of Relative Priority Index found in Biology sub-subjects

| Name of sub-subject in Biology | No. of the paper published (2002-2021) | | | | |
|---|--|--------------|----------|----------------|-------------|
| | CU | India | PI of CU | World | PI of India |
| Biochemistry & Molecular Biology | 721 | 6959 | 383.137 | 285554 | 90.820 |
| Biotechnology & Applied Microbiology | 237 | 919 | 953.671 | 16016 | 213.837 |
| Microbiology | 123 | 16357 | 27.808 | 294564 | 206.941 |
| Immunology | 141 | 5306 | 98.269 | 335705 | 58.902 |
| Marine & Freshwater Biology | 128 | 218 | 2171.296 | 13823 | 58.773 |
| Biophysics | 227 | 2331 | 360.122 | 40988 | 211.937 |
| Cell Biology | 184 | 31367 | 21.693 | 1395541 | 83.763 |
| Plant Sciences | 366 | 7798 | 173.566 | 171118 | 169.828 |
| Mathematical & Computational Biology | 96 | 284 | 1250.024 | 11875 | 89.126 |
| Evolutionary Biology | 15 | 2670 | 20.775 | 180120 | 55.242 |
| Developmental Biology | 11 | 6534 | 6.226 | 297746 | 81.781 |
| Zoology | 50 | 2583 | 71.583 | 39595 | 243.112 |
| Reproductive Biology | 38 | 3096 | 45.389 | 138024 | 83.593 |
| Total | 2337 | 86422 | - | 3220669 | - |

Table No. 9 Distribution of Relative Priority Index found in Engineering sub-subjects

| Name of sub-subject in Engineering | No. of the paper published (2002-2021) | | | | |
|---------------------------------------|--|-------|----------|---------|-------------|
| | CU | India | PI of CU | World | PI of India |
| Materials Science | 811 | 90632 | 97.025 | 1854181 | 101.901 |
| Electrical Engineering | 657 | 67628 | 105.338 | 1181330 | 119.345 |



**Jiaur Rahaman and Sadik Batcha**

| | | | | | |
|--|-------------|---------------|----------|----------------|----------|
| Environmental Science | 256 | 19847 | 139.859 | 624127 | 66.293 |
| Instruments Instrumentation | 9 | 4649 | 20.991 | 55720 | 173.939 |
| Chemical Engineering | 444 | 40314 | 119.419 | 836254 | 100.500 |
| Food Science Technology | 166 | 10984 | 163.868 | 205343 | 111.514 |
| Nuclear engineering | 128 | 12094 | 114.759 | 215831 | 116.817 |
| Metallurgy & Metallurgical Engineering | 29 | 15881 | 19.800 | 142670 | 232.056 |
| Engineering Multidisciplinary | 294 | 40922 | 77.900 | 1200236 | 71.079 |
| Total | 2794 | 302951 | - | 6315692 | - |





COVID-19 Prevention: an IoT - Based Solution for Effective Social Distancing and Contact Tracing

Pradeep M^{1*}, P.Kamalakar², V.Ganesh kumar² and Rekharani Maddula³

¹Associate Professor, Department of ECE, Shri Vishnu Engineering College for Women, Bhimavaram, Andhrapradesh, India-534202.

²Associate Professor, Department of EEE, Malla Reddy Engineering College, Maisammaguda, Secunderabad, Telangana, India-500100.

³Assistant Professor, Department of Physics, Gokaraju Lailavathi Womens Engineering College, Hyderabad, Telangana, India-500090.

Received: 18 May 2022

Revised:1 2 June 2022

Accepted: 02 July 2022

*Address for Correspondence

Pradeep M

Associate Professor, Department of ECE,
Shri Vishnu Engineering College for Women,
Bhimavaram, Andhrapradesh, India-534202.

Email: pradeep_ece@svecw.edu.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Corona virus has infected millions of individuals throughout the world, and the number of sick persons continues to rise. Humans get the virus through direct, indirect, or close contact with infected individuals. This proposed work introduces a new feature, an intelligent community distance system, that allows people to maintain community distances among others in both indoor and outdoor locations, therefore avoiding COVID-19 exposure and delaying its spread both locally and internationally. The proposed research aims to monitor an IoT-based portable monitoring device that is designed to measure COVID-19 signals. Furthermore, by monitoring real-time GPS data, the device immediately alerts medical authorities concerned about any confinement violations of patients who may be infected. Also, find out what new tool will be beneficial for tracking and predicting COVID-19 collections. To aid in the analysis of COVID-19, the solution incorporates a mobile system coupled with a portable device that is equipped with clever IoT capabilities (complex data analysis and intelligent data detection) incorporated inside the system. A comparison of several machine learning classifier algorithms such as SVM, Random Forest, KNN, and Decision Tree is presented as the best model for making predictions and determining accuracy. We observed that KNN performs better, with a 95 percent accuracy rate. COVID-19 will be utilized to avoid the transmission of illness in future global health concerns using an automatic social distance monitoring and contact tracking system.

Keywords: Corona virus, COVID-19, community distance system, social distance





Pradeep et al.,

INTRODUCTION

COVID-19 is an extremely severe infectious virus that causes a highly contagious respiratory disease (SARS-CoV-2). SARS-CoV-2 is a virus that targets the respiratory system and causes symptoms including poisoning, fever, nausea, and shortness of breath. Many nations have used Lockdown to avoid the pandemic, in which the government forces inhabitants to stay at home during this vital period. Community health services, such as the Centers for Disease Control and Prevention (CDC), have to make it clear that avoiding close contact with other individuals is the most efficient strategy to prevent the transmission of Covid-19. To keep the turns to the Covid-19 outbreak flat, the earth's population are used to rigorous activity. During incarceration, community activities, team activities, and congregational activities such as travel, meetings, gatherings, workshops, and prayers were prohibited. People are encouraged to coordinate and conduct events as much as possible via phone and email to avoid personal interaction. In order to keep the virus from spreading, individuals are being advised to practice good hygiene, such as hand washing regularly, wearing a mask, and avoiding close contact with ill persons. There is, however, a distinction between knowing what to do to decrease viral spread and actually doing it [1]. Using public broadcasts among persons at least one metre away is one well-known method of preventing the spread of Covid-19. The corona virus is spread from person to person by minute droplets from the nose and mouth, according to WHO. To put it another way, social dispersal is the greatest strategy for minimizing physical contact with probable corona virus carriers by keeping at least a metre between individuals. Covid-19 antiretroviral measures are supported by the planned work. It offers a way to locate individuals in public locations such as retail malls, banks, markets, temples, mosques, public transportation, and government offices [2]. In order to reduce the danger of disease transmission inside congested indoor environments, monitoring and support of social isolation has become more necessary [3].

In public locations, social measures such as contrasting signs on the chairs deter individuals from sitting close to one other (Fig.1). In modern times, the greatest form of prevention is social isolation and wearing a face mask. The World Health Organization (WHO) standards give a full examination of external activities that must be rigorously adhered to: WHO guidelines for follow-up: (1) Prior to exposure, the face mask or cover must be worn. (2) When leaving a private location, a person must maintain a public distance throughout his or her time in public settings. As a result, there is no lasting treatment in the absence of medical assistance. Few initiatives are being done throughout the world to employ IOT data as a preventive or predictive strategy against Covid-19, or as models in epidemiology. With the use of a food security camera that can analyze live or offline to detect social divisions and face mask covering in the official, public, or public area, a vision tool for controlling social distance and face mask at work has been developed. will aid in the monitoring of health policy The Practicing Health regimen helps people live longer and reduce rashes [5].

The COVID-19 outbreak has wreaked havoc on human mobility patterns as well as social behavior connected to everyday mobility. In order to conduct corrective actions at this time, it is necessary to understand illness dissemination patterns and mechanisms among neighbors. Countries throughout the globe are pursuing developments in mobile technology and the Internet of Things (IoT) to help maintain track of common connections to track persons close to identified COVID-19 patients to improve the efficacy of social media tracking. Even once vaccine therapy becomes available in 2021, the COVID-19 management plan will continue to look to the future in terms of digital communication, which is an important aspect of the response, and the adoption of preventative measures like social isolation and masks. In-depth information of the applicability of the various technologies, as well as the usability, privacy, and trade-offs of ethical principles involved, after several months of usage of digital contact monitoring technology. Due to recent developing data on worldwide information for the distribution of digital contact tracking technology, we give a full study of digital communication tracking solutions in terms of their processes and technologies in this proposal. Data collecting and interpretation should be established in contact tracking apps. Figure 2 shows contact tracing zones in public spaces.

Related work





Pradeep *et al.*,

Sengupta *et al* [6] argue that a plan to respond to environmental outbreaks should be developed to aid in the tracking and tracking of safety-related problems in industrial and community settings. Controlling infectious diseases and their spread necessitates comprehensive communication. To track human activity, the framework will incorporate video feeds from surveillance cameras and IoT edge devices located in industrial or public spaces. The architecture suggested here is a hybrid method to integrating feeds from current cameras and IoT devices with cloud-based computer-based edges. S. Srinivasan *et al* provide a comprehensive and successful solution based on the binary category for detecting a person, detecting a breach of social distance, and detecting a face-to-face mask separation utilising object identification, integration, and Convolution Neural Network (CNN). In this scenario, video databases were monitored using YOLOv3, a local collection based on congestion audio applications (DBSCAN), Dual Shot Face Detector (DSFD), and MobileNetV2 based Binary classifier. They did this through comparative study on various facial expressions and face mask classification methods. Finally, a strategy for labelling video databases is proposed. Video data is utilised for system testing and to compensate for public data shortages. System performance is accurately assessed, F1 score as and predictive timing, which should be low enough to be applied in a practical way [7].

A Khanfor *et al.* [8] provide a functional framework for improving pedestrian safety while roaming the real-world map of the smart city using the notion of Social IoT (SIoT). The goal is to limit the danger of infection in highly populated places where social distance may be an issue. While analysing the movement of other devices, the proposed walkway proposes a pedestrian path in real time. First, IoT devices were divided into communities based on two SIoT connections that took into consideration device locations as well as friendship norms among their owners. As a result, the weights on the city map roadways represented their safety requirements. After that, they employ the Dijkstra algorithm, which is a navigation algorithm, to propose the safest path to go. The potential to achieve a trade between the two most secure and quicker routes depending on pedestrian preferences was demonstrated using imitation effects in a real-world IoT data collection. This research [9] proposes a signal processing architecture that enables for combined topic movement analysis and automated temperature testing. The system includes infrared sensors that use temperature data to track subject mobility and health. Existing IoT wireless devices placed according to different structures link the sensors to the network. The goal of the programme is to link the local action of the headers by tracking their equal distance and route of arrival, as well as the remarkable finding of body temperature in individuals near the IR sensors. This article examines acceptable practises as well as proper application implementation employing field standards, with a focus on Bayesian approaches. For privacy neutrality, the suggested framework may be used to both public and private health-care services, as well as intelligent living and shared space circumstances.

W. Lv and colleagues propose chain, an expanded and illegal blockchain protocol. 1) By integrating the anonymous evidence-based protocol with the key security mechanism, the SRC protocol's SRC secrecy and the accompanying block structure are enhanced. As a result, there is no longer any link between personal identify and on-chain location data. The on-chain property owner may still claim ownership at that moment without releasing the secret key to anybody else. 2) Proposed a field-based practise of incentives to encourage IoT witnesses to promote the monitoring industry's oversight. The suggested communication tracking and location verification technique works effectively in the actual world, according to several results. To assure the availability of monitoring of digital communications in the actual world, the suggested contract tracking protocol's power consumption, time delay for each procedure, and BLE performance have been studied [10].

S. Arun Kumar *et al.* present a preventative method in this study, proposing the notion of a smart wrist band with a heat sensor and IoT technology. Blood pressure measures are also taken from time to time with the use of a blood pressure sensor. As a result, once the temperature or blood pressure are determined to be abnormal, this gadget helps to generate an alarm. With the use of IoT technology, faster information is transmitted on to the basic level user and second level relatives. As a result, by monitoring and notifying victims, this joint and active wrist band plays a critical role in saving lives. Because bacterial diseases are linked to a rise in body temperature, our device will be extremely useful in detecting them early. Traditional measurement methods frequently need human participation





Pradeep et al.,

and are not of combined size. These issues are addressed in this architecture, which involves minimum management and sensor configuration for temperature and blood pressure monitoring, data processing, and storage [11]. The goal of this article, by D. Chloros et al [12], is to investigate the developmental obstacles and potential for apps that track transmission, as well as how IoT systems might be used to record symptoms. The benefits and necessity for these apps' development will be highlighted by evaluating their potential. The Fluspot application was created specifically for this investigation. By raising public awareness and providing timely information, Fluspot hopes to help reduce the spread of infections this season. Fluspot uses a wearable IoT device to closely monitor flu flows and collect user inputs for viral propagation to the site. This anonymised and aggregated data is shown on a map to provide a more accurate picture of the situation in each location. Another major element is that the artefact's ability to monitor wearable indications is critical for users in their daily lives. The work by A. Waheed et al. [13] examines a range of technologies utilised in a variety of situations, including social isolation and prevention, isolation and isolation, COVID detection and assessment, therapy and patient care, and hospital administration. This study discusses transparent planning, technical techniques, and digital procedures, as well as the most up-to-date intelligent technologies in a range of disciplines that can aid in overcoming coronavirus intensity. IoT, AI, and machine learning play a significant role in the fight against COVID-19. AI has made a substantial contribution to the resource management pandemic, public awareness, security management, and supporting professionals in implementing stringent standards.

In the COVID-19 era, V. Shubina et al tracking of wearable contact is garnering increasing focus in order to successfully prevent sickness. As a result, identifying viable technologies for tracking wireless communication and their wearability is critical. Existing contact monitoring app trading necessitates a detailed examination of technical skills such as accuracy, power consumption, availability, error sources when dealing with wireless channels, privacy concerns, and hurdles to larger apparel market access. We find, based on considerable literature study, that demarcated buildings, when compared to intermediate techniques, provide a superior location to trade in terms of accuracy and user willingness to utilise them, taking privacy issues into account. This study gives a brief summary of the technological options available for human monitoring services, describes fundamental concepts that influence the efficiency of digital communication tracking, and discusses the effects of wear on coping with viral infection transmission [14]. T. Luo et al. [15] provide a model for infectious, contagious, infectious, asymptomatic disease, Diagnosis, and Death (SEINRHD). The model was created using epidemiological data from COVID-19 in China and the estimation of social network heterogeneity. The original Wuhan public epidemic was recreated and updated with accurate data. We utilised this model to look into strategies to manage the outbreak in instances when three-dimensional signals were not apparent. On the basis of effective replication rates, the occurrence of exceptionally high infections, and the kind and structure of transmission, the impact of undetected cases on the propagation of the epidemic was estimated. Asymptomatic patients can be managed to assist the infection curve shorten. When compared to asymptomatic and non-symptomatic tracking, tracking 75% of non-symptomatic patients results in a total reduction of 32.5 percent in new cases. During the outbreak, emphasis should be placed on illness control and prevention in families.

Proposed Method

System Overview

The following sub-systems make up the proposed system: 1) An Arduino Uno-based temperature measuring device 2) IoT system that measures the Arduino board via social distancing 3) on the server 4) A security guard smartphone application. To begin, everyone attempting to enter the residence must pass an unmodified temperature check. We're utilising an Arduino Uno with an infrared thermometer (e.g., MLX906148) or a hot camera sensor for this (AMG88339 for example). It also employs the ESP8266 Wi-Fi module for MQTT protocol connection with Edge servers. If that person's body temperature is anomalous, the door is locked, and a MQTT message is delivered to the server, providing both the temperature and the location where it was recorded. This message is received by the server, which then transmits it and carries on. with a security guard's smartphone app, so they can arrive and make



Pradeep *et al.*,

sure the individual isn't attempting to enter a work zone. In specific regions, Arduino board devices verify whether public distances are being utilised properly or not. Similarly, when public distances do not operate well in particular rooms, a MQTT message will be sent to alert security personnel. Message processing, event logging, reflection, and message transmission are accomplished on the server side using the MQTT broker and the triple semantic store. Edge servers receive communications, do semantic annotations, and make assumptions to choose the appropriate security guard to notify. Security guards utilise a basic Android mobile app that receives MQTT messages from the server and visualises data about the position. Figure 3 depicts social distancing with a smart device for Covid-19, with the goal of ensuring that COVID-19 safety rules are followed appropriately indoors. The proposed calculation will provide a satisfactory result for physical separation using an ultrasonic sensor. The following is the pseudo-code for the suggested calculation:

IR Sensor

There are two sorts of temperature measurement tools: touch and non-touch. Thermocouples, heat-resistant heat exchangers (RTDs), thermistors, and semiconductor temperature sensors are examples of infrared temperature sensors used in communication equipment. Because contact lenses monitor temperature, they require physical contact with the item being measured to bring the sensor body up to temperature. When a relatively big sensor meets a tiny object and functions as a heat sink, the temperature of the object may be altered. Figure 5: Infrared sensor

Ultrasonic Sensor

Ultrasonic sensors use ultrasonic waves to measure distance. The sensor head sends out an ultrasonic wave that is reflected back to it from the direction. Ultrasonic sensors use the time between output and reception to calculate the distance to the target. The ultrasonic sensor can identify items that are far away from the robot. The ultrasonic sensor, unlike the touch sensor, is not affected by physical contact. The range gives you plenty of room to react. For distances of 10 inches or more, an ultrasonic sensor is often utilised, whereas for shorter distances, a light sensor is typically employed. Ultrasonic sensors detect moving things and measure each object's relative location and movement. The vertical movement of each ultrasonic sensor is measured using a measurement of the measurement range, and the movement in the measuring area is measured using a modified distance data conversion. Figure 6 depicts an ultrasonic sensor.

Social Distancing Algorithm

This is the second step of our framework proposal. The suggested social distance monitoring algorithm serves two purposes. Function 1 aids in the identification of things in the picture. It employs a detection approach to offer human positions as aggregate values like XA (left), YA (top), XB (right), and YB (bottom) (bottom).

$$X = (X_A + X_B) / 2 \quad (1)$$

$$Y = (Y_A + Y_B) / 2 \quad (2)$$

where XA, YA, XB, and YB are the left, top, right, and bottom compound numbers of an object. Coin or centroid values are X and Y. These parameters are also passed on to the next function, which calculates social distance. The distance between the two items is calculated using the Euclidean distance, which indicates their closeness, as indicated in Eq. 3. When comparing this distance vector to the previously indicated threshold value, the choice was taken. If the Euclidean range is less than a specific threshold, it is thought that the two elements did not adhere to the conditions of social reduction or did not generate enough space between them.

$$D = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \quad (3)$$

Where (X1, X2) and (Y1, Y2) are Centroid values of two objects.





Pradeep et al.,

Pseudocode

To distinguish between human and object in the context of physical removal.

1. Human or item in the range of ultrasonic sensors.
2. output: Notifying the client with a sound signal.
3. Uses the ULTRASONIC sensor module to detect the presence of individuals.
4. If a person or moving object is detected, measure the distance between them.
5. If the distance is less than 2 metres, activate the sound directive for that distance alone.
6. Prepare a message and caution for safe separation and disinfection if the distance is similar to 1.5 m.
7. The message will be repeated till the person does not clean. Individuals must push the reset button after disinfection.

Algorithm: Social Distancing Measurement

Input: In: Image I containing N Number of frames of size 225x225x3

Output :D: Distance between two objects

Initialize Parameter:

Threshold = 90.0,

Human_Count= 0;

Cvo = [],

Lcvo = [],

Cen = [],

Center = [],

Function Object_Coordinates(V)

Picks = Human_Detection_Framework (VN)

For (X_A,Y_A,X_B,Y_B) in Pick :

Cvo = [X_A,Y_A,X_B,Y_B]

C1 = ((X_A + X_B) * 0.5)

C2 = ((Y_A+Y_B)*0.5)

Cen = [C1,C2]

Center.append(Cen)

Lcvo.append(Cvo)

Human_Count +=1

End For

Return Human_Count, Lcvo,center,Image

End Function

Temperature Checking

Using a wireless IR sensor, the temperature checking system based on Adriano Uno detects the passenger's temperature. One by one, the passengers pass. If the temperature of the passenger is higher than the average human body temperature (37 °C), the Adriano Uno generates a signal to lock the door to prevent the person from entering the building and sends a MQTT message indicating that a person with a high body temperature has been detected at a specific location. Otherwise, the door to let the individual in is opened.

RESULT AND ANALYSIS

The IoT-based portable monitoring device is meant to measure the signals associated with COVID-19 and uses a machine learning model to anticipate the different machine learning techniques. Machine Learning techniques to increase the model's accuracy and impact, as well as to avoid disease transmission in future global health issues.



**Pradeep et al.,**

Figure 7 shows the various machine learning algorithms. KNN delivers the best set of performance values with a 95 percent accuracy. The performance of two persons was examined in the distant sensing test, and it is projected to decline as the number of people inside the distance view rises. The distance monitor's performance fluctuates with object distance from the camera, as it does with the measurement initially derived between pixels and meters. Figure 8 shows how K-Means algorithms are used to calculate social distance. It is utilized to execute two points on the folks who have been detected. Because social distancing is tested between a minimum of two individuals, the cluster's minimum necessary points are set to two, and the two-person distance parameter is set to two meters. If the space between two people is very small, it is considered risky; if the distance is greater, it is considered safe. The performance of all of the models was evaluated using criteria such as accuracy, specificity, precision, recall/sensitivity, and F1 score, as shown in Table 1. KNN is trustworthy for monitoring IoT-based portable monitoring device is developed to measure the signals connected with COVID-19, according to the accuracy values of four models. With the highest F1 score of the four models, KNN emerges as the best. Although the SVM model is relatively similar to the decision tree, it cannot be regarded a robust model because to its poor recall of 0.83.

CONCLUSION

The proposed technology is based on real-time sensors such as infrared (IR) and ultrasonic sensors for effective social distancing and contact tracing for COVID-19 prevention. Temperature, heart rate, SpO₂, and cough rate are all measured using the wearable sensor layer. It also sends real-time patient GPS position data to medical administrators and notifies family members to alleviate stress. During the epidemic, the app's peripheral interface is in charge of storing, collecting, and analysing data in order to monitor and govern public life and administration. The Android mobile app is quite helpful in informing family responders on patient status and lowering transmission rates. The wearable gadget is totally functional in terms of receiving patient health symptoms both during and after an illness. In order to control, monitor, and control patients who may be infected with COVID-19 in the spread of the disease, this system was tested and verified in real time at the hospital. A wearable gadget might be used as a model, allowing airport travellers to sit alone as they arrive and depart. This work has undergone significant investigation in order to deliver the greatest device performance by comparing current domains. The project's new features are used for a variety of purposes, including measuring health symptoms, tracking and monitoring a patient while detained, storing data to predict the situation, and notifying authorities in a timely manner so that they can be properly monitored and use the Android platform to stay informed. Respondents' family members' patient status. Our suggested technique might potentially be utilised to avoid disease spread in the future in the case of global health issues. Also, take use of this proposed technology, which can assist in diagnosing and treating early symptoms.

REFERENCES

1. Y. C. Hou, M. Z. Baharuddin, S. Yussof and S. Dzulkifly, "Social Distancing Detection with Deep Learning Model," 2020 8th International Conference on Information Technology and Multimedia (ICIMU), 2020, pp. 334-338, doi: 10.1109/ICIMU49871.2020.9243478.
2. A. H. Ahamad, N. Zaini and M. F. A. Latip, "Person Detection for Social Distancing and Safety Violation Alert based on Segmented ROI," 2020 10th IEEE International Conference on Control System, Computing and Engineering (ICCSCE), 2020, pp. 113-118, doi: 10.1109/ICCSCE50387.2020.9204934.
3. N. H. Motlagh *et al.*, "Monitoring Social Distancing in Smart Spaces using Infrastructure-Based Sensors," 2021 IEEE 7th World Forum on Internet of Things (WF-IoT), 2021, pp. 124-129, doi: 10.1109/WF-IoT51360.2021.9595897.
4. <https://binged.it/3rD1btm>
5. B.Sathyabama, A. Devpura, M. Maroti and R. S. Rajput, "Monitoring Pandemic Precautionary Protocols using Real-time Surveillance and Artificial Intelligence," 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), 2020, pp. 1036-1041, doi: 10.1109/ICISS49785.2020.9315934.
6. Sengupta, K., Srivastava, P.R. HRNET: AI-on-Edge for Mask Detection and Social Distancing Calculation. *SN COMPUT. SCI.* 3, 157 (2022). <https://doi.org/10.1007/s42979-022-01023-1>





Pradeep et al.,

7. S. Srinivasan, R. Rujula Singh, R. R. Biradar and S. Revathi, "COVID-19 Monitoring System using Social Distancing and Face Mask Detection on Surveillance video datasets," *2021 International Conference on Emerging Smart Computing and Informatics (ESCI)*, 2021, pp. 449-455, doi: 10.1109/ESCI50559.2021.9396783.
8. A. Khanfor, H. Friji, H. Ghazzai and Y. Massoud, "A Social IoT-Driven Pedestrian Routing Approach During Epidemic Time," *2020 IEEE Global Conference on Artificial Intelligence and Internet of Things (GCAIoT)*, 2020, pp. 1-6, doi: 10.1109/GCAIoT51063.2020.9345900.
9. S. Savazzi, V. Rampa, L. Costa, S. Kianoush and D. Tolochenko, "Processing of Body-Induced Thermal Signatures for Physical Distancing and Temperature Screening," in *IEEE Sensors Journal*, vol. 21, no. 13, pp. 14168-14179, 1 July1, 2021, doi: 10.1109/JSEN.2020.3047143.
10. W.Lv, S. Wu, C. Jiang, Y. Cui, X. Qiu and Y. Zhang, "Towards Large-Scale and Privacy-Preserving Contact Tracing in COVID-19 Pandemic: A Blockchain Perspective," in *IEEE Transactions on Network Science and Engineering*, vol. 9, no. 1, pp. 282-298, 1 Jan.-Feb. 2022, doi: 10.1109/TNSE.2020.3030925.
11. S. Arunkumar, N. Mohana Sundaram and D. Ishvarya, "Temperature Sensing Wrist Band for Covid-19 Crisis," *2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA)*, 2021, pp. 1-5, doi: 10.1109/ICAECA52838.2021.9675689.
12. D. Chloros and D. Ringas, "Fluspot: Seasonal flu tracking app exploiting wearable IoT device for symptoms monitoring," *2020 5th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)*, 2020, pp. 1-7, doi: 10.1109/SEEDA-CECNSM49515.2020.9221843.
13. A. Waheed and J. Shafi, "Successful Role of Smart Technology to Combat COVID-19," *2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, 2020, pp. 772-777, doi: 10.1109/I-SMAC49090.2020.9243444.
14. V. Shubina, A. Ometov and E. Simona Lohan, "Technical Perspectives of Contact-Tracing Applications on Wearables for COVID-19 Control," *2020 12th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT)*, 2020, pp. 229-235, doi: 10.1109/ICUMT51630.2020.9222246.
15. T. Luo, Z. Cao, Y. Wang, D. Zeng and Q. Zhang, "Role of Asymptomatic COVID-19 Cases in Viral Transmission: Findings From a Hierarchical Community Contact Network Model," in *IEEE Transactions on Automation Science and Engineering*, doi: 10.1109/TASE.2021.3106782.

Table 1. Classification result for four models

| Models | Evaluation Metrics | | | | | | | | |
|---------------|--------------------|----|----|----|----------|-------------|-----------|--------|---------|
| | TP | TN | FP | FN | Accuracy | Specificity | Precision | Recall | F1Score |
| SVM | 28 | 6 | 2 | 3 | 0.60 | 0.70 | 0.63 | 0.90 | 0.75 |
| Random Forest | 29 | 6 | 2 | 2 | 0.88 | 0.75 | 0.73 | 0.75 | 0.90 |
| KNN | 29 | 5 | 3 | 2 | 0.95 | 0.89 | 0.90 | 0.93 | 0.92 |
| Decision tree | 26 | 6 | 2 | 5 | 0.65 | 0.75 | 0.69 | 0.73 | 0.72 |





Pradeep et al.,

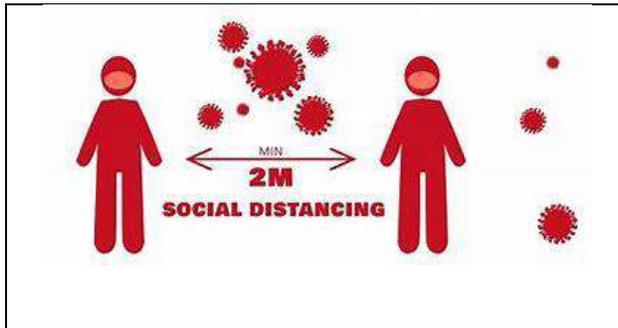


Fig.1.Social distancing [4]

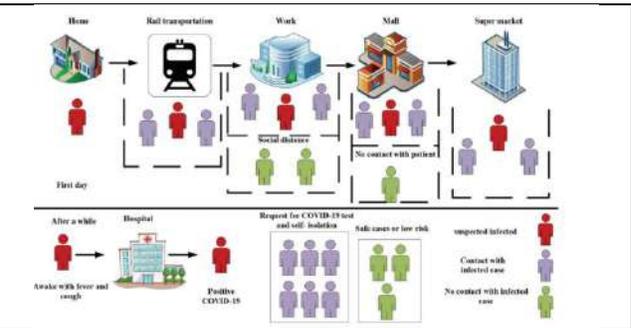


Fig.2. Contact tracing areas in public places

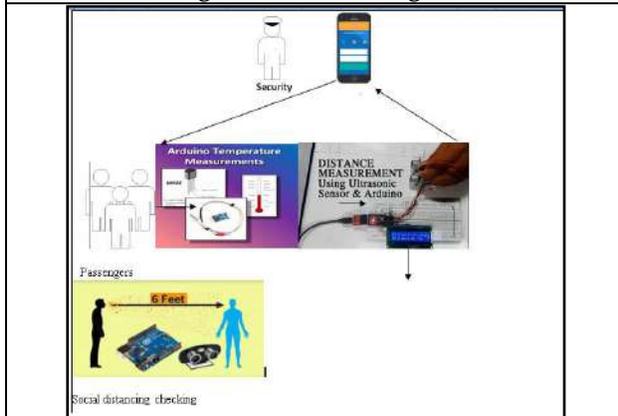


Fig. 3. Overall Architecture of Social Distancing

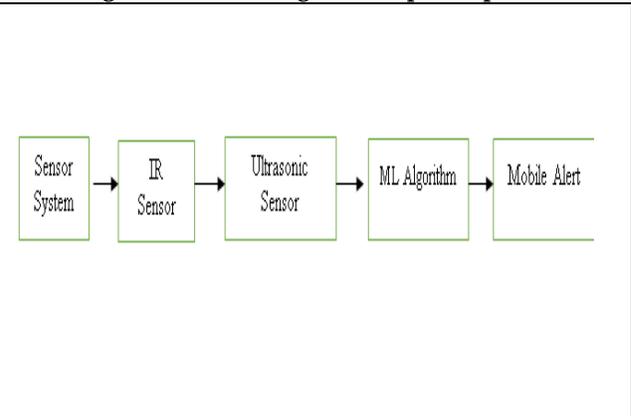


Fig.4.Social Distancing using Smart Device For COVID-19



Fig. 5. IR Sensor

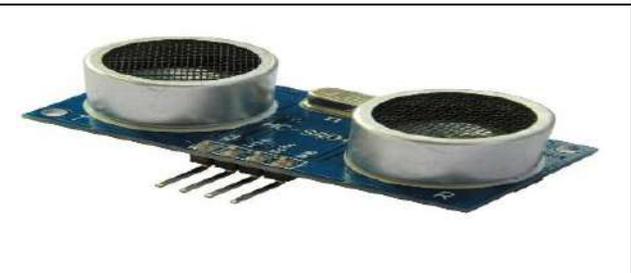


Fig . 6. Ultrasonic Sensor

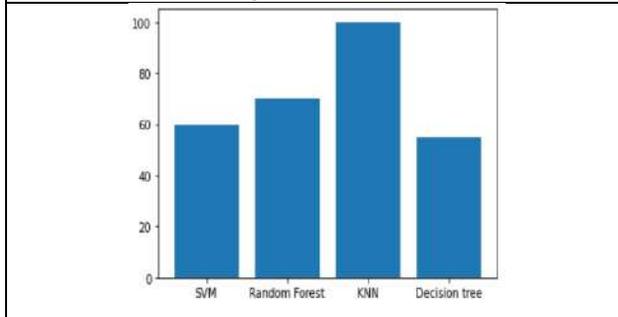


Fig.7. Machine learning's algorithms

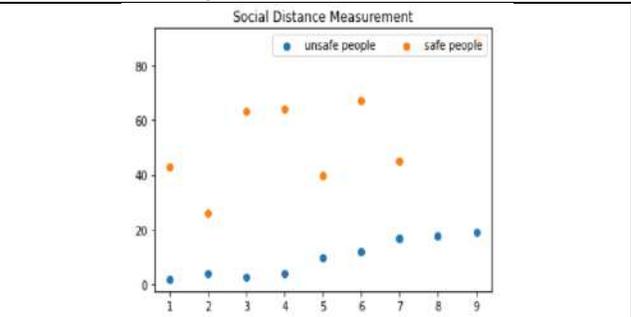


Fig.8. Social Distance Measurement





Analysis of Two Commodity Inventory System with Impatient, Server Interruptions, Compliment Item, Perishable, State-Dependent Arrival and Service Rate

M. Bhuvaneshwari¹, R. Asokan^{2*} and S. Padmasekaran³

¹Research Scholer, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

²Professor, Department of Mathematics, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

³Assistant Professor, Department of Mathematics, Periyar University, Salem, Tamil Nadu, India.

Received: 26 May 2022

Revised: 16 June 2022

Accepted: 04 July 2022

*Address for Correspondence

R. Asokan,

Professor, Department of Mathematics,
Madurai Kamaraj University,
Madurai, Tamilnadu, India.

Email: asokan.maths@mkuniversity.org



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In this paper, we consider the two commodity inventory system with a compliment item. This system admits a stock-dependent arrivals from a finite source and provide a queue-dependent service facility. during the busy period, due to some internal problems the server assumed to be interrupted. This interruption is repaired by the server itself. In addition, the customer impatient, perishable products, (s, Q) ordering principle and instantaneous ordering principle are also to be assumed.

Keywords: Stock dependent arrival rate, Non-stock dependent arrival rate, Two component demand rate, Finite population, (c, C) ordering policy.

INTRODUCTION

In many real-world scenarios, it's important to remember that as the number of customers in the system grows, the pace at which new primary calls are generated drops. This may be accomplished with the use of finite-source technologies. The following works may demonstrate their significance to the reader ([6], [7]). Ponomarov and Lebedev [10] Investigated finite source retrial queues whose service rate varies with queue length. Two- and three-dimensional models describing threshold and hysteresis control strategies are considered. The major results in both cases are explicit vector-matrix representations of stationary distributions. Sztrik et.al. Our idea is primarily inspired by the fast food sector, in which food, such as cakes, hamburger patties, or basic pizza, may be produced ahead of time and heated up, customised to individual customer requirements, and provided to the customer only when they





Bhuvaneshwari et al.,

arrive. Hanukov et. al. [5] explored a two-server service system in which idle servers develop and store preliminary services in order to reduce arriving customers' sojourn time and increase their arrival time. And demonstrated the relationship between the elements in the matrix geometry rate matrix and Catalan numbers, and show that the stability requirement stays the same as in the standard $M/M/2$ queue, despite the lower expected sojourn time of customers.

Sugapriya et. al. [16] Analysed the stock-dependent Markovian demand of a retrial queueing system with a single server and multiple server vacations. Under the (s, Q) ordering policy, the products are refilled. Furthermore, the Matrix geometric method is combined with the Neuts-Rao truncation technique and the waiting time distribution is also studied using the Laplace-Stieltjes transform. Jeganathan et. al. [8] Investigated a single server with queue-dependent service rates in the stochastic queueing-inventory system. Anbazhagan, N. and Arivarignan [2] considered two-commodity inventory system and the arrival was followed by the Poission process. The capacity of both commodities are S_1 and S_2 and order placed $S_i - s$ units of i -th commodity for $i = 1$ and 2 . Sivakumar [12] Analysed two-commodity with the lead time is exponential. Both commodities are considered to be substitutable in the sense that when one commodity runs out of supply, the other is used to satisfy demand. Ozkar and Uzunoglu Kocer [9] Examined two-commodity with two-classes of customers. More two-commodity articles are ([3], [13], [14] and [15]). Sivakumar [11] investigated a perishable inventory system with a finite number of homogeneous demand sources that is subject to continuous review. S is the maximum amount of storage available. Each item's life time is considered to be exponential. (s, S) policy is the operational policy.

In this paper, we consider the two commodity inventory system with a compliment item. This system admits a stock-dependent arrivals from a finite source and provide a queue-dependent service facility. during the busy period, due to some internal problems the server assumed to be interrupted. This interruption is repaired by the server itself. In addition, the customer impatient, perishable products, (s, Q) ordering principle and instantaneous ordering principle are also to be assumed. This paper is organised as follows: section 2 describes the assumption of the model. Section 3 explains the construction of the infinitesimal generator matrix and the stationary probability vector. Some important system performance measures are computed in section 4. Numerical illustrations provided in section 5. Finally, the conclusion is given in section 6.

DESCRIPTION OF THE MODEL

Notations

- 0 : Zero matrix of an appropriate order
- I : Identity matrix of an appropriate order
- I_r : Identity matrix of order r
- e : Column matrix containing all one so fan appropriate order
- δ_{ij} : $\begin{cases} 1, & \text{if } j = i, \\ 0, & \text{otherwise} \end{cases}$
- $\bar{\delta}_{ij}$: $1 - \delta_{ij}$
- $H(x)$: $\begin{cases} 1, & \text{if } x \geq 0, \\ 0, & \text{otherwise} \end{cases}$
- $P_1(t)$: Number of commodity – 1 at any time.
- $P_2(t)$: Server status at any time.
- $P_2(t)$: $\begin{cases} 0, & \text{server is idle} \\ 1, & \text{server is busy} \\ 2, & \text{server is on interruption} \end{cases}$





Bhuvaneshwari et al.,

- $P_3(t)$: Number of commodity – 2 at any time.
 $P_4(t)$: Number of customer in the queue at any time.
 S_1 : $\{(\alpha_1, \alpha_2, \alpha_3, \alpha_4): \alpha_1 = 0, \alpha_2 = 0, \alpha_3 = 1, 2, \dots, C_2, \alpha_4 = 0, 1, \dots, N\}$,
 S_2 : $\{(\alpha_1, \alpha_2, \alpha_3, \alpha_4): \alpha_1 = 1, 2, \dots, C_1, \alpha_2 = 0, \alpha_3 = 1, 2, \dots, C_2, \alpha_4 = 0\}$,
 S_3 : $\{(\alpha_1, \alpha_2, \alpha_3, \alpha_4): \alpha_1 = 1, 2, \dots, C_1, \alpha_2 = 1, 2, \dots, C_2, \alpha_3 = 1, 2, \dots, C_2, \alpha_4 = 1, 2, \dots, N\}$,
 S : $S_1 \cup S_2 \cup S_3$
 a : $C_2(N + 1)$
 b : $C_2(1 + 2N)$

Assumptions

This paper deals a two commodity inventory system in a finite source environment. It stores and sells the commodity-1 of size C_1 and commodity-2 of size C_2 as the major and compliment item respectively. Although he customer who are generated by the finite source comes to the system to buy the major product, he leaves the system with major and compliment items at the end of the service completion. For each service completion there will be one unit of major and minor item will be depleted in the storage place. Here, the complimentary products are used to motivate the customers to make them as loyal customers. When server is doing their service to the customer, they will have the interruption (breakdown) by server internal problems.

However, these problems are rectified by themselves. In such a way, the server will do the three different task as follows: 1) server is idle, 2) server is busy and 3) server is on interruption. These tasks are not possible to do all at a time. Suppose either there is no positive inventory or positive queue, then server becomes free. If the server is on interruption means that it will occur only when server is busy otherwise server will not get interruption. And also there is no one more interruption is allowed to the server. If the interruption duration comes to an end, the interrupted service started immediately with the memory-less property. The demand occurrence times form an output stream which is assumed to be the so called quasi-random output; that is, the probability that any particular source generates a request for demand in any interval $(t, t + dt)$ is $\lambda_{\alpha_1} + o(dt)$ as $dt \rightarrow 0$ where $\alpha_1 = 0, 1, 2, \dots, C_1$ if the source is idle at time t and zero if the source is in orbit at time t , independently of the behavior of any other sources. The arrival rate dependent on current sock level of commodity-1 not on commodity-2. Commodity-2 is just a compliment product only. The arriving customers can join the queue if either the server is busy or on interruption, otherwise they will get service immediately.

The service rate of a customer is assumed to be non-homogeneous. In a restaurant, one can observe that the service provider works fast if there is a congested queue. If not like no congestion, server work in normal speed. The same idea is applied in the model. Therefore, the intensity of the service time is μ_{α_4} where $\alpha_4 = 1, 2, \dots, N$. The average service time is assumed to be exponentially distributed. Whenever the server provides service to the customer, they must have a internal interruption in each service. So the internal interruption are self repaired one. hence the server alone can make the remedy of the interruption. Here, the interruption occurrence is happen according to the Poisson distribution whereas the interruption completion time is obviously exponentially distributed with the parameters η_1 and η_2 respectively. Due to the three different tasks of the server, the customer in the waiting hall will get an impatient and start leaving the system with a parameter, η_3 . Even though the queue-dependent service policy is implemented to reduce the waiting time and customer loss rate, zero stock situation and server interruption tasks are give a way to the customer to leave the system. The duration that a customer can decide to leave the system from he entered into the waiting hall follows exponential distribution. Both commodity-1 and commodity-2 have the perishable products.

When looking into the commodity-1, the perishability is considered except the item which is being serviced to the customer. But commodity-2 has no such restriction. The intensity of perishing commodity-1 and commodity-2 is γ_1





Bhuvaneshwari et al.,

and $\gamma - 2$ respectively. The lead time of both commodities are assumed to be exponentially distributed. Furthermore, the commodity-1 is replenished under the (s, Q) ordering principle. The order of Q items is triggered if commodity-1 drops to reorder level s . Whereas the reorder of C_2 stock of commodity-2 is replaced immediately only the number of commodity-2 down to zero stock. This is called instantaneous ordering principle. The intensity of commodity-1 is β and is assumed to be exponentially distributed.

Construction of Infinitesimal Generator Matrix

Let us consider the collection of continuous time random variables, $\{P(t), t \geq 0\} = \{(P_1(t), P_2(t), P_3(t), P_4(t)), t \geq 0\}$. Since the collection $\{P(t), t \geq 0\}$ is indexed with the time, it can be easily seen that it forms a stochastic process along with the state space S . The process $\{P(t), t \geq 0\}$ holds the Markov property. Thus, the stochastic process is also called continuous time Markov chain. Also, since $\{P(t), t \geq 0\}$ has the finite dimensional state space, it is said to be an irreducible Markov chain.

where

$$D_1 = \beta \times I_b$$

$$D_0 = \begin{cases} D_{01} & \alpha_2' = \alpha_2, \alpha_2 = 0 \\ D_{02} & \alpha_2' = \alpha_2 + 1, \alpha_2 = 0 \\ 0 & \text{Otherwise.} \end{cases}$$

$$D_{01} = \begin{cases} \beta I_1 & \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ 0 & \text{Otherwise.} \end{cases}$$

$$D_{02} = \begin{cases} \beta I_N & \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ 0 & \text{Otherwise.} \end{cases}$$

For $\alpha_1 = 1,$

$$Y_{\alpha_1} = \begin{cases} \gamma_1 & \begin{cases} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 0 \end{cases} \\ \mu_{\alpha_4} & \begin{cases} \alpha_2' = \alpha_2 - 1, \alpha_2 = 1 \\ \alpha_3' = C_2, \alpha_3 = 1 \\ \alpha_4' = \alpha_4 - 1, \alpha_4 = 1, 2, \dots, N \end{cases} \\ \mu_{\alpha_4} & \begin{cases} \alpha_2' = \alpha_2 - 1, \alpha_2 = 1 \\ \alpha_3' = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_4' = \alpha_4 - 1, \alpha_4 = 1, 2, \dots, N \end{cases} \\ 0 & \text{Otherwise.} \end{cases}$$

For $\alpha_1 = 2, 3, \dots, C_1,$





Bhuvaneshwari et al.,

$$Y_{\alpha_1} = \left\{ \begin{array}{l} \alpha_1 \gamma_1 \quad \begin{array}{l} \alpha_{2'} = \alpha_2, \alpha_2 = 0 \\ \alpha_{3'} = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_{4'} = \alpha_4, \alpha_4 = 0 \end{array} \\ (\alpha_1 - 1) \gamma_1 \quad \begin{array}{l} \alpha_{2'} = \alpha_2, \alpha_2 = 1, 2 \\ \alpha_{3'} = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_{4'} = \alpha_4, \alpha_4 = 1, 2, \dots, N \end{array} \\ \mu_{\alpha_4} \quad \begin{array}{l} \alpha_{2'} = \alpha_2, \alpha_2 = 1 \\ \alpha_{3'} = C_2, \alpha_3 = 1 \\ \alpha_{4'} = \alpha_4 - 1, \alpha_4 = 2, 3, \dots, N \end{array} \\ \mu_{\alpha_4} \quad \begin{array}{l} \alpha_{2'} = \alpha_2 - 1, \alpha_2 = 1 \\ \alpha_{3'} = C_2, \alpha_3 = 1 \\ \alpha_{4'} = \alpha_4 - 1, \alpha_4 = 1 \end{array} \\ \mu_{\alpha_4} \quad \begin{array}{l} \alpha_{2'} = \alpha_2 - 1, \alpha_2 = 1 \\ \alpha_{3'} = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_{4'} = \alpha_4 - 1, \alpha_4 = 1 \end{array} \end{array} \right.$$

$$Y_{\alpha_1} = \left\{ \begin{array}{l} \mu_{\alpha_4} \quad \begin{array}{l} \alpha_{2'} = \alpha_2, \alpha_2 = 1 \\ \alpha_{3'} = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_{4'} = \alpha_4 - 1, \alpha_4 = 2, 3, \dots, N \end{array} \\ \mu_{\alpha_4} \quad \begin{array}{l} \alpha_{2'} = \alpha_2, \alpha_2 = 1 \\ \alpha_{3'} = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_{4'} = \alpha_4 - 1, \alpha_4 = 2, 3, \dots, N \end{array} \\ 0 \quad \text{Otherwise.} \end{array} \right.$$

For $\alpha_1 = 0$,





Bhuvaneshwari et al.,

$$X_{\alpha_1} = \begin{cases} (N - \alpha_4)\lambda_0 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4 + 1, \alpha_4 = 0, 1, \dots, N - 1 \end{matrix} \\ \alpha_4\eta_3 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4 - 1, \alpha_4 = 1, 2, \dots, N \end{matrix} \\ \alpha_3\gamma_2 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = C_2, \alpha_3 = 1 \\ \alpha_4' = \alpha_4, \alpha_4 = 0, 1, \dots, N \end{matrix} \\ \alpha_3\gamma_2 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 0, 1, \dots, N \end{matrix} \\ -(\bar{\delta}_{4\alpha_4}(N - \alpha_4)\lambda_0 + \alpha_3\gamma_2 + \bar{\delta}_{0\alpha_4}\alpha_4\eta_3 + \beta) & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 0, 1, \dots, N \end{matrix} \\ 0 & \text{Otherwise.} \end{cases}$$

For $\alpha_1 = 1, 2, \dots, C_1$

$$X_{\alpha_1} = \begin{cases} \alpha_3\gamma_2 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 0 \end{matrix} \\ \alpha_3\gamma_2 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 0 \\ \alpha_3' = C_2, \alpha_3 = 1 \\ \alpha_4' = \alpha_4, \alpha_4 = 0 \end{matrix} \\ (N - \alpha_4)\lambda_{\alpha_1-1} & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 1, 2 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4 + 1, \alpha_4 = 1, 2, \dots, N - 1 \end{matrix} \\ (\alpha_4 - 1)\eta_3 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 1, 2 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4 - 1, \alpha_4 = 2, 3, \dots, N \end{matrix} \\ \eta_1 & \begin{matrix} \alpha_2' = \alpha_2 + 1, \alpha_2 = 1 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 1, 2, \dots, N \end{matrix} \\ \eta_2 & \begin{matrix} \alpha_2' = \alpha_2 - 1, \alpha_2 = 2 \\ \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 1, 2, \dots, N \end{matrix} \\ \alpha_3\gamma_2 & \begin{matrix} \alpha_2' = \alpha_2, \alpha_2 = 1, 2 \\ \alpha_3' = \alpha_3 - 1, \alpha_3 = 2, 3, \dots, C_2 \\ \alpha_4' = \alpha_4, \alpha_4 = 1, 2, \dots, N \end{matrix} \end{cases}$$





Bhuvaneshwari et al.,

$$X_{\alpha_1} = \begin{cases} N\lambda_{\alpha_1} & \alpha_2' = 1, \alpha_2 = 0 \\ & \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ & \alpha_4' = \alpha_4 + 1, \alpha_4 = 0 \\ \alpha_3\gamma_2 & \alpha_2' = \alpha_2, \alpha_2 = 1, 2 \\ & \alpha_3' = C_2, \alpha_3 = 1 \\ & \alpha_4' = \alpha_4, \alpha_4 = 1, 2, \dots, N \end{cases}$$

$$X_{\alpha_1} = \begin{cases} -(\bar{\delta}_{4\alpha_4}N\lambda_{\alpha_1} + \alpha_3\gamma_2 + \bar{\delta}_{0\alpha_4}\alpha_4\eta_3 + \beta + \alpha_1\gamma_1) & \alpha_2' = \alpha_2, \alpha_2 = 0 \\ & \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ & \alpha_4' = \alpha_4, \alpha_4 = 0 \\ -(\bar{\delta}_{4\alpha_4}(N - \alpha_4)\lambda_{\alpha_1-1} + \alpha_3\gamma_2 + \bar{\delta}_{0\alpha_4}\alpha_4\eta_3 + H(s - \alpha_1)\beta + (\alpha_1 - 1)\gamma_1 + \delta_{1\alpha_2}\eta_1 + \delta_{2\alpha_2}\eta_2 + \bar{\delta}_{0\alpha_4}\mu_{\alpha_4}) & \alpha_2' = \alpha_2, \alpha_2 = 1, 2 \\ & \alpha_3' = \alpha_3, \alpha_3 = 1, 2, \dots, C_2 \\ & \alpha_4' = \alpha_4, \alpha_4 = 0, 1, \dots, N \\ 0 & \text{Otherwise.} \end{cases}$$

STEADY-STATE ANALYSIS

It can be seen from the structure of Z that the homogeneous Markov Process $\{P(t), t \geq 0\}$ on the finite state space S is irreducible. Hence the limiting distribution

$$\phi^{(\alpha_1, \alpha_2, \alpha_3, \alpha_4)} = \lim_{t \rightarrow \infty} Pr[P_1(t) = \alpha_1, P_2(t) = \alpha_2, P_3(t) = \alpha_3, P_4(t) = \alpha_4 | P_1(0), P_2(0), P_3(0), P_4(0)],$$

exists.

Let

$$\phi = (\phi^{(0)}, \phi^{(1)}, \dots, \phi^{(C_1)}),$$

$$\phi^{(i,j)} = (\phi^{(i,0)}, \phi^{(i,1)}, \phi^{(i,2)}), \quad i = 0, 1, 2, \dots, C_1$$

$$\phi^{(i,j)} = (\phi^{(i,j,1)}, \phi^{(i,j,2)}, \dots, \phi^{(i,j,C_2)}), \quad i = 0, j = 0,$$

$$\phi^{(i,j,k)} = (\phi^{(i,j,k,1)}, \phi^{(i,j,k,2)}, \dots, \phi^{(i,j,k,N)}), \quad i = 0, j = 0, k = 1, 2, \dots, C_2$$

$$\phi^{(i,j)} = (\phi^{(i,j,1)}, \phi^{(i,j,2)}, \dots, \phi^{(i,j,C_2)}), \quad i = 1, \dots, C_1, j = 0,$$

$$\phi^{(i,j,k)} = (\phi^{(i,j,k,0)}), \quad i = 1, \dots, C_1, j = 0, k = 1, 2, \dots, C_2$$

$$\phi^{(i,j)} = (\phi^{(i,j,1)}, \phi^{(i,j,2)}, \dots, \phi^{(i,j,C_2)}), \quad i = 1, \dots, C_1, j = 1, 2,$$

$$\phi^{(i,j,k)} = (\phi^{(i,j,k,0)}, \phi^{(i,j,k,1)}, \dots, \phi^{(i,j,k,N)}), \quad i = 1, \dots, C_1, j = 1, 2, k = 1, 2, \dots, C_2$$

The vector of limiting probabilities ϕ satisfies

$$\phi Z = \mathbf{0} \text{ and } \phi \mathbf{e} = 1. \tag{3.1}$$

The first equation of the above yields the following set of equations





Bhuvaneshwari et al.,

$$\begin{aligned}
 \phi^{(\alpha_1+1)}Y_{\alpha_1+1} + \phi^{(\alpha_1)}X_{\alpha_1} &= \mathbf{0}, \alpha_1 = 0, 1, \dots, Q - 1, \\
 \phi^{(\alpha_1+1)}Y_{\alpha_1+1} + \phi^{(\alpha_1)}X_{\alpha_1} + \phi^{(\alpha_1-Q)}D_0 &= \mathbf{0}, \alpha_1 = Q, \\
 \phi^{(\alpha_1+1)}Y_{\alpha_1+1} + \phi^{(\alpha_1)}X_{\alpha_1} + \phi^{(\alpha_1-Q)}D &= \mathbf{0}, \alpha_1 = Q_1 + 1, Q + 2, \dots, C_1 - 1, \\
 \phi^{(\alpha_1)}X_{\alpha_1} + \phi^{(\alpha_1-Q)}D &= \mathbf{0}, \alpha_1 = C_1.
 \end{aligned}
 \tag{3.2}$$

The equations (except (3.2)) can be recursively solved to get

$$\phi^{(i_1)} = \phi^{(Q_1)}\Omega_{\alpha_1}, \quad \alpha_1 = 0, 1, \dots, C_1,$$

where

$$\Omega_{\alpha_1} = \begin{cases} (-1)^{Q-\alpha_1}Y_Q X_{Q-1}^{-1}Y_{Q-1} \dots Y_{\alpha_1+1}X_{\alpha_1}^{-1}, & \alpha_1 = 0, 1, \dots, Q - 1, \\ I, & \alpha_1 = Q, \\ (-1)^{2Q-\alpha_1+1} \sum_{i=0}^{C_1-\alpha_1} [(Y_Q X_{Q-1}^{-1}Y_{Q-1} \dots B_{s_1+1-i}A_{s_1-i}^{-1})DX_{C_1-i}^{-1} \\ \times (Y_{C_1-i}X_{C_1-i-1}^{-1}Y_{C_1-i-1} \dots Y_{\alpha_1+1}X_{\alpha_1}^{-1})], & \alpha_1 = Q + 1, \dots, C_1, \end{cases}$$

Substituting the values of Ω_{α_1} in equation (3.2) and in the normalizing condition we get

$$\begin{aligned}
 \phi^{(Q)} [&(-1)^Q \sum_{i=0}^{s-1} [(Y_Q X_{Q-1}^{-1}Y_{Q-1} \dots Y_{s+1-i}X_{s-i}^{-1})DX_{C_1-i}^{-1} \\ &\times (Y_{C_1-i}X_{C_1-i-1}^{-1}Y_{C_1-i-1} \dots Y_{Q+2}X_{Q+1}^{-1})]Y_{Q_1+1} + X_Q \\ &+ (-1)^Q Y_Q X_{Q-1}^{-1}Y_{Q-1} \dots Y_1 X_0^{-1}D_0] = \mathbf{0}
 \end{aligned}$$

and

$$\begin{aligned}
 \phi^{(Q)} [&\sum_{\alpha_1=0}^{Q-1} ((-1)^{Q-\alpha_1}Y_Q X_{Q-1}^{-1}Y_{Q-1} \dots Y_{\alpha_1+1}X_{\alpha_1}^{-1}) + I \\ &+ \sum_{\alpha_1=Q+1}^{C_1} ((-1)^{2Q_1-\alpha_1+1} \sum_{i=0}^{C_1-\alpha_1} [(Y_Q X_{Q-1}^{-1}Y_{Q-1} \dots Y_{s+1-i}X_{s-i}^{-1})CX_{C_1-i}^{-1} \\ &\times (Y_{C_1-i}X_{C_1-i-1}^{-1}Y_{C_1-i-1} \dots Y_{\alpha_1+1}X_{\alpha_1}^{-1})])] \mathbf{e} = 1.
 \end{aligned}$$

Solving the above two equations, we get $\pi^{(Q)}$.

SYSTEM PERFORMANCE

Mean Inventory 1

$$E_1 = \sum_{\alpha_1=1}^{C_1} \alpha_1 \phi^{(\alpha_1)}$$

Mean Inventory 2

$$E_2 = \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=0}^N \alpha_3 \phi^{(0,0,\alpha_3,\alpha_4)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_4=1}^{C_2} \alpha_3 \phi^{(\alpha_1,0,\alpha_3,0)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=0}^N \alpha_3 \phi^{(\alpha_1,\alpha_2,\alpha_3,\alpha_4)}$$

Mean Reorder of Inventory 1

$$\begin{aligned}
 E_{r_1} &= \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=0}^N \mu_k \phi^{(s+1,1,\alpha_3,\alpha_4)} + \sum_{\alpha_2=1}^2 \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=0}^N s \phi^{(s+\alpha_2,\alpha_3,\alpha_4)} \\ &+ \sum_{\alpha_3=1}^{C_2} (s + 1)\gamma_1 \phi^{(s+1,0,\alpha_3,0)}
 \end{aligned}$$

Mean Reorder of Inventory 2

$$E_{r_2} = \sum_{\alpha_4=0}^N \alpha_1 \gamma_2 \phi^{(0,0,1,\alpha_4)} + \sum_{\alpha_1=1}^{C_1} \alpha_1 \gamma_2 \phi^{(\alpha_1,0,1,\alpha_4)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \sum_{\alpha_4=1}^N \alpha_1 \gamma_1 \phi^{(\alpha_1,\alpha_2,\alpha_3,\alpha_4)}$$

Mean Perishable Inventory 1

$$E_{p_1} = \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_3=1}^{C_2} \alpha_1 \phi^{(\alpha_1,0,\alpha_3,0)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \sum_{\alpha_3=1}^{S_2} \sum_{\alpha_4=1}^N (\alpha_1 - 1)\gamma_1 \phi^{(\alpha_1,\alpha_2,\alpha_3,\alpha_4)}$$





Bhuvaneshwari et al.,

Mean Perishable Inventory 2

$$E_{p_2} = \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=1}^N \alpha_3 \gamma_2 \phi^{(0,0,\alpha_3,\alpha_4)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \alpha_3 \gamma_2 \phi^{(\alpha_1,0,\alpha_3,0)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \sum_{\alpha_3=1}^{S_2} \sum_{\alpha_4=1}^N (\alpha_1 - 1) \gamma_1 \phi^{(\alpha_1,\alpha_2,\alpha_3,\alpha_4)}$$

Mean Number of Customer in Waiting Hall

$$E_{wh} = \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=1}^N \alpha_4 \phi^{(0,0,\alpha_3,\alpha_4)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \sum_{\alpha_3=1}^{S_2} \sum_{\alpha_4=1}^N \alpha_4 \phi^{(\alpha_1,\alpha_2,\alpha_3,\alpha_4)}$$

Mean Customer lost

$$E_{cl} = \sum_{\alpha_3=1}^{C_1} \sum_{\alpha_4=1}^N \alpha_4 \eta_3 \phi^{(0,0,\alpha_3,\alpha_4)} + \sum_{\alpha_1=1}^{C_1} \sum_{\alpha_2=1}^2 \sum_{\alpha_3=1}^{S_2} \sum_{\alpha_4=1}^N (\alpha_4 - 1) \eta_3 \phi^{(\alpha_1,\alpha_2,\alpha_3,\alpha_4)}$$

Mean Time Server Interruption Occurs

$$\sum_{\alpha_1=1}^{C_1} \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=1}^N \eta_1 \phi^{(\alpha_1,1,\alpha_3,\alpha_4)}$$

Mean Time Server Interruption Completed

$$\sum_{\alpha_1=1}^{C_1} \sum_{\alpha_3=1}^{C_2} \sum_{\alpha_4=1}^N \eta_2 \phi^{(\alpha_1,2,\alpha_3,\alpha_4)}$$

Optimum Total Cost

$$OTC = ch_1 \times E_1 + ch_2 \times E_2 + cs_1 \times E_{r_1} + cs_2 \times E_{r_2} + cp_1 \times E_{p_1} + cp_2 \times E_{p_2} + cw \times E_{wh} + cl \times E_{cl},$$

where,

- ch_1 : Holding cost of commodity – 1 per unit
- ch_2 : Holding cost of commodity – 2 per unit
- cr_1 : Setup cost of commodity – 1 per order
- cr_2 : Setup cost of commodity – 2 per order
- cp_1 : Deteriorating cost of commodity – 1 per unit
- cp_2 : Deteriorating cost of commodity – 2 per unit
- cw : Waiting cost per customer
- cl : Lost cost per customer.

NUMERICAL ILLUSTRATION

This section explores the features of the propose model numerically. Numerical illustration is the only way to explain the application the mathematical modeling. So that the justification of the model is to be predicted easily. Whatever the assumptions made in the description of the model, one may verify that the characteristics of all the parameters are satisfied or not. Hence, before we start the such illustrations first assume the fixed parameters and cost values as follows: $\lambda = 3.5, \gamma_1 = 0.5, \gamma_2 = 1.8, \lambda_0 = 1.1, s = 3; \eta_1 = 0.06, \eta_2 = 0.4, \eta_3 = 0.2, \beta = 0.3, \mu = 7.3, Q = C_1 - s; N = 25; p = S_2 * (N + 1); q = S_2 * (1 + 2 * N); x = 0.5, y = 0.5, ch_1 = 0.1, ch_2 = 0.1, cr_1 = 10, cr_2 = 5, cp_1 = 0.1, cp_2 = 0.33, cw = 0.5, cl = 0.3.$

Example 1 (Investigation on Optimum values) This example demonstrates the local convex of the proposed model under the three categories of which are classified as purely not dependent, partially dependent and purely dependent for both arrival and service rates. These classifications of the proposed model is controlled by scaling factors x and y. Here, x = 0 and y = 0 represents purely not dependent, x = 0.5 and y = 0.5 represents partially dependent and x = 1 and y = 1 is purely dependent rates. When observing Figures [1-3] they are illustrated using x is fixed and y is varied and obtained the convex for each cases. All the three are obtained for varying C₁ and C₂. Each figure holds a three classification of convex curves and each of which are varied only for the scaling factor y. This concentrates on queue-dependent service rate and give result for homogeneous and non-homogeneous cases.





Bhuvaneshwari et al.,

Generally the increase of scaling factor will reduce the total cost. As of that the non-homogeneous case will produce the optimum result as shown in Figure 1. Figure 2 is demonstrated for $x = 0.5$ and Figure 3 represents $x = 1$. The optimum values are given as below:

1. If $x = 0$ and $y = 0$, then $OTC = 18.157343, C_1 = 13, C_2 = 9$.
2. If $x = 0$ and $y = 0.5$, then $OTC = 17.702360, C_1 = 11, C_2 = 13$.
3. If $x = 0$ and $y = 1$, then $OTC = 17.373205, C_1 = 12, C_2 = 13$.
4. If $x = 0.5$ and $y = 0$, then $OTC = 18.353363, C_1 = 11, C_2 = 9$.
5. If $x = 0.5$ and $y = 0.5$, then $OTC = 17.772847, C_1 = 11, C_2 = 11$.
6. If $x = 0.5$ and $y = 1$, then $OTC = 17.476128, C_1 = 12, C_2 = 13$.
7. If $x = 1$ and $y = 0$, then $OTC = 18.255812, C_1 = 11, C_2 = 9$.
8. If $x = 1$ and $y = 0.5$, then $OTC = 17.743643, C_1 = 9, C_2 = 13$.
9. If $x = 1$ and $y = 1$, then $OTC = 17.566045, C_1 = 12, C_2 = 13$.

CONCLUSION

The investigation of stock-dependent arrival and queue-dependent service rates are discussed in the finite source. By looking into the commodities assumed in this model, the optimum cost value is determined and obtained for both commodities. Interestingly, the scaling factors will have the major contribution in the numerical section. Because these factors produced the generalized results for homogeneous and non-homogeneous arrival and service rates which are assumed in the system. In all the way, the non-homogeneous case produce the expected optimum result. The discussion in the total cost, convex and customer lost cases, the non-homogeneous cases gave the better solution. That is if $x, y \in (0,1]$, the considered model performs better. In the steady-state part, the joint probability distribution of the number of commodity-1 and commodity-2, customer in queue and the server status are computed. Using this probability distribution, the sufficient system performance measures are discussed. In future, we will extend this model into a multi server environment.

REFERENCES

1. Almási, B., Roszik, J. and Sztrik, J., 2005. Homogeneous finite-source retrial queues with server subject to breakdowns and repairs. *Mathematical and Computer Modelling*, 42(5-6), pp.673-682.
2. Anbazhagan, N. and Arivarignan, G., 2001. Analysis of two commodity Markovian inventory system with lead time. *Korean Journal of Computational and Applied Mathematics*, 8(2), pp.427-438.
3. Anbazhagan, N. and Arivarignan, G., 2003. Two-commodity inventory system with individual and joint ordering policies.
4. Falin, G.I. and Artalejo, J.R., 1998. A finite source retrial queue. *European Journal of Operational Research*, 108(2), pp.409-424.
5. Hanukov, G., Avinadav, T., Chernonog, T. and Yechiali, U., 2019. A multi-server queueing-inventory system with stock-dependent demand. *IFAC-PapersOnLine*, 52(13), pp.671-676.
6. Jeganathan, K., 2015. A stochastic inventory system with two types of services and a finite populations. *Int. J. Math. Appl*, 3(1), pp.73-81.
7. Jeganathan, K., 2016. Analysis of two queues in parallel with mixed priority service and a finite population. *International Journal of Operational Research/Nepal*, 5(1), pp.15-43.
8. Jeganathan, K., Selvakumar, S., Anbazhagan, N., Amutha, S. and Hammachukiattikul, P., 2021. Stochastic modeling on M/M/1/N inventory system with queue-dependent service rate and retrial facility. *AIMS Mathematics*, 6(7), pp.7386-7420.
9. Ozkar, S. and Uzunoglu Kocer, U., 2021. Two-commodity queueing-inventory system with two classes of customers. *Opsearch*, 58(1), pp.234-256.





Bhuvaneshwari et al.,

10. Ponomarov, V. and Lebedev, E., 2013, January. Finite source retrial queues with state-dependent service rate. In Belarusian Workshop on Queueing Theory (pp. 140-146). Springer, Berlin, Heidelberg.
11. Sivakumar, B., 2009. A perishable inventory system with retrial demands and a finite population. Journal of Computational and Applied Mathematics, 224(1), pp.29-38.
12. Sivakumar, B., 2008. Two-commodity inventory system with retrial demand. European Journal of Operational Research, 187(1), pp.70-83.
13. Sivakumar, B., Anbazhagan, N. and Arivarignan, G., 2007. Two-commodity inventory system with individual and joint ordering policies and renewal demands. Stochastic analysis and applications, 25(6), pp.1217-1241.
14. Sivakumar, B., Anbazhagan, N. and Arivarignan, G., 2005. A two-commodity perishable inventory system. ORiON, 21(2), pp.157-172.
15. Sivakumar, B., Anbazhagan, N. and Arivarignan, G., 2006. Two commodity continuous review perishable inventory system. International journal of information and management sciences, 17(3), p.47.
16. Sugapriya, C., Nithya, M., Jeganathan, K., Anbazhagan, N., Joshi, G.P., Yang, E. and Seo, S., 2022. Analysis of Stock-Dependent Arrival Process in a Retrial Stochastic Inventory System with Server Vacation. Processes, 10(1), p.176.

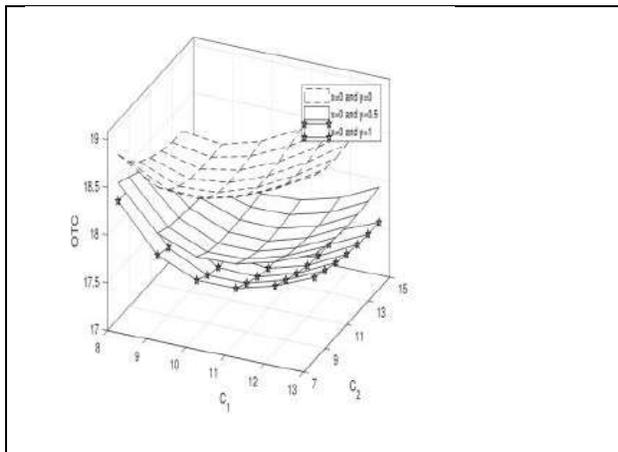


Figure 1: Impact OTC C_1 and C_2 and $x = 0$

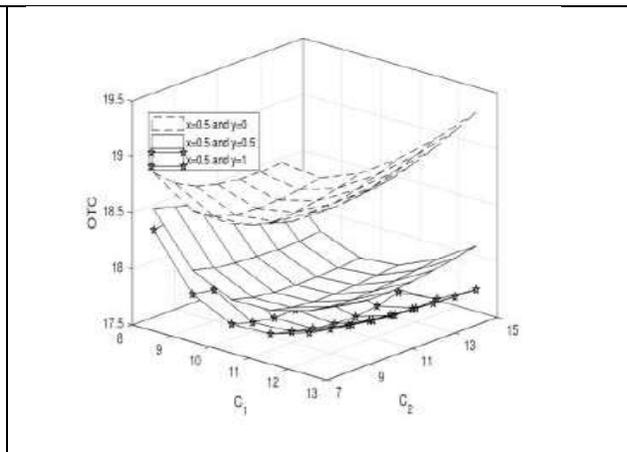


Figure 2: Impact OTC C_1 and C_2 and $x = 0.5$

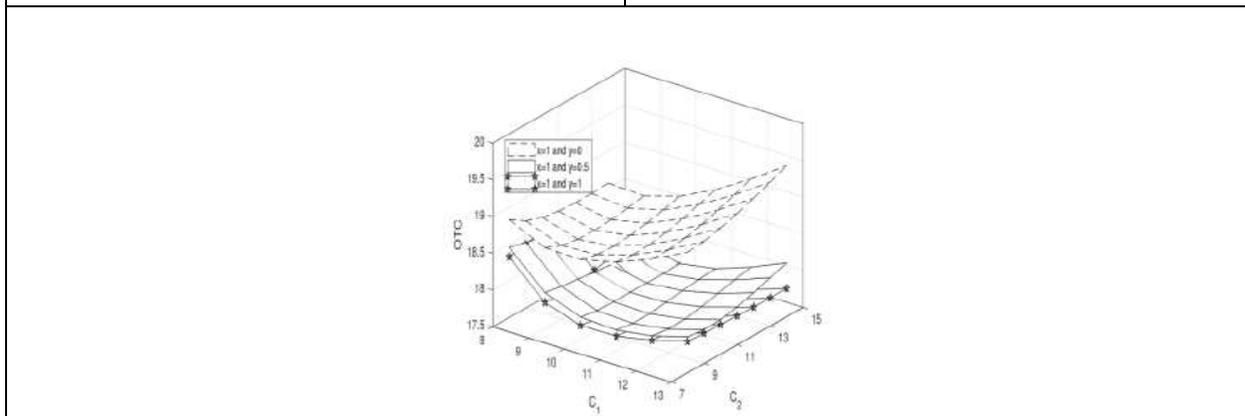


Figure 3: Impact OTC C_1 and C_2 and $x = 1$





Application of Chemical Agents as Inducers of Diabetes in the Screening of Anti-Diabetic Drugs

R. Jothi Lakshmi^{1*}, R. Srinivasan², R. Devi¹ and S.Kalaivanan¹

¹Assistant Professor, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

²Dean and Professor, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

Received: 26 May 2022

Revised: 05 June 2022

Accepted: 08 July 2022

*Address for Correspondence

R. Jothi Lakshmi

Assistant Professor,
Faculty of Pharmacy,
Bharath Institute of Higher Education and Research,
Chennai, Tamil Nadu, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Despite their extensive use as diabetic therapies in traditional medicine across the world, few secondary metabolites have been proved to fulfil the standards of scientific study. Because of the enormous hikes in the occurrence of DM-2 in our culture, there is a growing demand for alternative diabetes preventive and treatment methods. The creation and study of newer bioactive anti-diabetic substances is underway. In this review, we have attempted to bring together all of the previously described in vivo and in vitro models for antidiabetic medication testing, as well as the numerous in vitro testing methods, such as inhibiting alpha-amylase and beta-glucosidase activities, as well as the glucose absorption assay. The induction of diabetes mellitus through study utilising animal models and in vitro approaches is critical for expanding our knowledge, gaining a better understanding of diabetogenic pathways, and developing new therapies. The utilisation of animal models and in vitro processes are both critical components in developing a new diabetic therapy. The goal of this article is to provide an overview of the relevance of the animal models that are presently accessible for antidiabetic activity screening.

Keywords: diabetes, chemicals, induction agents, screening of diabetes.

INTRODUCTION

Diabetes mellitus is the most prevalent endocrine disorders that affect the quality of life of people, health status of individuals and the expectancy of life. This was characterized by symptoms involving hyperglycaemia, irregularities in the metabolism of carbohydrates, lipid and proteins thus resulting in the hormonal deficiency (Vijaya raj and Sri



**Jothi Lakshmi et al.,**

Kumar an, 2018). Diabetes type 1 and 2 are commonest types of diabetes based on the insulin secretion and utilization. Diabetes affects around 12% of the population, with Type 2 accounting for 90% of cases. Hyperglycemia, hypercholesterolemia, and hypertriglyceridemia are symptoms of the condition, which are caused by abnormalities in insulin production, decreased tissue sensitivity to secreted insulin often termed as insulin resistance. Often types the disorder is characterised due to the combination of both. It is a significant endocrine condition characterised by very discrete regulation and is linked to a huge cardiovascular risk such as angiopathy, nephropathy, retinopathy, neuropathy, or diabetic cataract (Vijaya raj et al., 2016).

According to the WHO forecasts, the occurrence of diabetes is expected to rise by 36%. There are currently over 160 million diabetics globally, with this number expected to rise to 310 million or more by 2025. According to statistical projections, the number of diabetes in India would increase from 15.5 million in 1998 to 57.5 million in 2028, making it the country with the largest affected countries on the planet. Despite the intense interest in developing novel medications to alleviate the burden of this condition, the researchers around the globe has focused on evaluating either raw or separated natural compounds in experimental research; few have been evaluated therapeutically in humans. Diabetes experimental investigations in animal models and improved in vitro techniques are critical for improving the knowledge base and also mechanisms of the pathology and possible etiology as well as finding novel therapies. All the available animal models of DM are very important in the pharmacological research as they attain the possibility of newer views in the disease. As the animals were tiny in size, short regeneration cycles, less cost of study and accommodation of animals, rats are selected as reasonable models to study anti-diabetic drugs effectively. Diabetes mellitus was researched experimentally using a variety of approaches, including pharmacological, interventional, and mutational modifications (Kumar et al., 2012). It is now critical to pick a suitable animal model for the screening of newly designed anti-diabetic drugs (NDD) and all the other therapeutic modes of the diabetes therapy (Chattopadhyay et al., 1997).

Chemical agents' as Diabetes Inducers

The major goal of this work is to gather and comprehend the available in vitro and in vivo methods of assessing the anti-diabetic drugs, using the chemical induction in rats and other models. Diabetes-causing chemical compounds (diabetogenic agents) are categorised into three types, which include that: specifically,

1. Cause damage to β -cell,
2. Causing inhibition of the production of insulin temporarily
3. Diminishing the secretion and metabolic utilization efficacy of insulin in the target tissue.

Advantages of the animal models with chemical induction of DM

1. The methods are selective to incur loss to the pancreatic cells and leave those cells other than beta cells.
2. Left over insulin in the body allows the experimental animals to live longer utilizing the available insulin which enables no need for insulin treatment
3. The mortality of the animal and chances of resultant diseases like ketosis is significantly less
4. The methods are restively cheaper and since the dose regulation is under control and so the induction of Diabetes.

Disadvantages of the animal models with chemical induction of DM

1. In the chemical methods, DM is induced due to the deficiency of insulin in the body rather than inducing resistance to insulin thus there can be a bias in the study where the drug mechanism is based on treating the insulin resistance.
2. Inducers used for DM are notorious to cause cytotoxicity to other organs of the body along with the pancreatic cells.
3. As mentioned earlier the fluctuations in the results and the degree of bias are very high compared to other methods of induction of DM.
4. Chemically induced DM is often reversible even without the intervention of the drug therapy. This also interferes with the results making them inconclusive of whether the activity is due to the drug of the general healing and reproductive mechanisms of the pancreas.





Jothi Lakshmi *et al.*,

Alloxan

Alloxan is most commonly utilised in diabetes studies. Alloxan induces the necrosis of pancreatic cells selectively and is usually delivered via IV, IM and SC methods using syringes. This method is effective to induce diabetes in lab animals like the rats and mice, rabbits and dogs. Depending on the animal type, the methods and doses of alloxan required may differ (Iranloye *et al.*, 2011). In the case of alloxan, the hypoglycaemia phase lasts 30 minutes after injection. The hypoglycaemia state might be caused by insulin release stimulation and high plasma insulin levels. These mechanisms underlying in the hyper secretion of insulin is often related to the short-term spike in the ATP generation and the inhibition of glucokinases (Federiuk *et al.*, 2004). Next stage involves in the elevation of blood glucose levels within 1hr of the injection of alloxan that is followed by a lowering of concentration of insulin in the plasma. The significant elevation of blood glucose that lasts for up to 3 hours because plasma insulin concentrations are low. This might be related to insulin secretion suppression and beta cell damage (Kliber *et al.*, 1996). The last stage is the hypoglycaemia phase, which lasts 4-8 hours following alloxan administration (Tasaka *et al.*, 1988).

Situations with the presence or absence of the glucose, the therapy causes a rapid increase in insulin secretion. Insulin is released until the islet response to glucose is completely suppressed. In the glucokinase, alloxan reacts with two sulfhydryls, resulting in a disulfide bond and enzyme deactivation. GSH decreases the amount of alloxan. Ferric ions are liberated from ferritin by superoxide radicals and reduced to ferrous ions. Alloxan radicals can also be used to decrease Fe³⁺ (Malaisse *et al.*, 1982). The mechanism, according to Szkudelski T (2001), involves DNA fragmentation in b-cells that are exposed to alloxan. The alteration of calcium levels inside the cells also contributes to alloxan's diabetogenic activity.

Streptozotocin

Streptozotocin (STZ) is a naturally obtained substance which is highly toxic to pancreatic beta islet cells. This is used in the research involving the use of animal models for testing for anti-hyperglycaemic drugs and chemotherapeutic agents. STZ destroys the pancreatic islet cells selectively with the release of the nitric oxide that also responsible for generation of superoxide dismutases which regularly interact with the cellular functions of mitochondria that is resulting in the diabetes and often its complications (Papaccio *et al.*, 2000; Szkudelski, 2001).

The main process driving the elevation in the blood sugar in type 1 or 2 diabetes is the excessive production and poor use of glucose. The STZ changes the levels of insulin and glucose in the blood. Hyperglycaemia occurs 2 hours after administration which is due to low insulin in the blood. Hypoglycaemia develops 6 hours later as a result of elevated blood insulin levels. Finally, hyperglycaemia occurs, and blood insulin levels fall. STZ inhibits oxidation of glucose and lowers insulin production and release (Bedoya *et al.*, 1996). STZ was shown to initially suppress the B cell response to glucose. STZ inhibits the expression of GLUT2. STZ causes DNA alterations in pancreatic cells (Morgan *et al.*, 1994). STZ alkylation of DNA causes B cell death (Turk *et al.*, 1993). Poly ADP ribosylation is activated by STZ-induced DNA damage (Nukatsuka *et al.*, 1990). The poly ADP-ribosylation activation is most important for the induction of diabetes with STZ that the production of free radicals or the damage of DNA.

Nicotinamide-Streptozotocin

This model has advantages of the protection by nicotinamide partially against the cellular damage caused due to the STZ. This also creates a newer experimental syndrome with diabetes in the rodents which appears to be the most similar syndrome to NIDDM in terms of the responsiveness to the insulin to the available glucose and also sulfonyleureas than other available animal models. Among the various nicotinamide dose tested in young and adult Wistar rats (100-350 mg/kg body weight), 230 mg/kg given via the IP route 15 mins before the administration STZ (65 mg/kg I.V.) produced moderate to the non-fasted hyperglycaemia (155.3 vs. 121.3 mg/dl in controls; P 0.05).

Sucrose-challenged Streptozotocin

This paradigm was used to test the anti-diabetic efficacy of sucrose loaded model (SLM) male albino rats in vivo. Charles Foster/Wistar strain rats weighing 160-200 g on average were utilised. STZ was dissolved in a 100 mM citrate buffer at a pH of 4.5, and a determined quantity of the fresh solution was administered intraperitoneally (60 mg/kg)



**Jothi Lakshmi et al.,**

into overnight starved rats. Glucostrips was used to monitor blood glucose levels 48 hours later, and animals with blood glucose levels between 144 and 270 mg/dl (8–15 mM) were declared diabetic. After 30 minutes, a sucrose load of 2.5 g/kg body weight was administered. Thirty minutes after sucrose loading, blood glucose levels were measured again using glucostrips at 30, 60, 90, 120, 180, 240, 300, and 24 h.

Monosodium Glutamate

MSG (monosodium glutamate) raises plasma glutamate content. MSG increases insulin release. MSG administration resulted in obesity and hyperinsulinemia in mice. Blood glucose, total cholesterol, and triglyceride levels had all increased after 29 weeks (Kim et al., 1997; Jin et al., 2010).

Dithizone

Dithizone is an organosulfur molecule that is chelating. Dithizone is utilised in the production of diabetes in animals. Zinc, iron, and potassium levels in the blood of dithizonised diabetic animals were found to be greater than usual (Graham et al., 2000). Dithizone enters membranes and compounds zinc inside liposomes, causing protons to be released, which increases diabetogenicity (Nakajima et al., 1985).

Atypical antipsychotic agents

Aside from the therapeutic advantage over first-generation antipsychotics, the fact that the use of atypical medicines is connected with the appearance of severe metabolic derangement in patients is no longer a secret. These includes the dysregulation of the glucose, resistance of the insulin in the body, dyslipidemia, weight gain and the hypertension, all of which raise the risk of cardio metabolic illnesses in patients. The interaction between diabetes and antipsychotic medications needs cautious consideration.

One research in this series looked at the diabetogenic effects of a variety of antipsychotics, both atypical and typical. Healthy mice were given acute doses of clozapine (10 mg/kg), olanzapine (3 mg/kg), risperidone (1 mg/kg), ziprasidone (3 mg/kg), or haloperidol (0.25 mg/kg) and then assessed utilising hyperinsulinemic-euglycemic and hyperglycemic clamp methods. Clozapine and olanzapine increased insulin sensitivity by decreasing the rate of infusion of glucose and boosting the production of glucose in the liver.

Goldthioglucose

GTG (gold thioglucose) is a diabetogenic substance that causes obesity-induced Type 2 diabetes. For a period of 16-20 weeks, intraperitoneal treatment of GTG causes obesity, hyperinsulinemia, hyperglycemia, and insulin resistance in experimental animals. The GTG is delivered specifically to the cells, causing necrotic lesions that contribute to the development of hyperphagia and obesity. It also raises body lipid, hepatic lipogenesis, and triglyceride production, lowers glucose metabolism, and increases adipose tissue lipogenesis (Szopa et al., 1993).

Ferric nitrilotriacetate

Parenteral treatment of a significant daily dosage of ferric nitrilotriacetate to experimental rats for 60 days causes diabetic symptoms such as elevation of glucose in blood, glycosuria, excessive ketones in the blood and ketonuria (Le Marchand, 1999)

Other chemical agents

Another research looked at how sirolimus affected cyclosporine-induced pancreatic islet dysfunction in rats. Sirolimus medication raised glucose levels in the blood in a dose-based manner. In comparison to rats treated with cyclosporine A, combined sirolimus and cyclosporine treatment elevated concentration of blood glucose, haemoglobin A1c level, HOMA-R [fasting insulin (mU/mL) fasting glucose (mmol/L) /22.5] index and lowering of insulin in the plasma, and induction of mass in the pancreatic beta islet cells. The study's findings showed that sirolimus is diabetogenic and worsens cyclosporine A-induced pancreatic islet dysfunction. A cyclophosphamide-accelerated diabetes model has also been reported. Cailleau et colleagues investigated the effect of IL-1 in the cyclophosphamide-accelerated diabetes paradigm. Male non-diabetic mice were given 200 mg/kg cyclophosphamide



**Jothi Lakshmi et al.,**

and then given anti-IL-1 Ab twice a week. In comparison, only 34% of mice given 0.25 mg of anti-IL-1 Ab developed diabetes.

Chemical mediators for *In vitro* evaluation

α - Amylase

The test was carried out with a minor changes in the afore described technique (Sangeetha et al., 2012). The testing samples were produced in DMSO from a 1 g/mL-1 stock solution, then mixed with a 0.5 mg/mL amylase solution and incubated for 10 minutes at room temperature. A 1.0 percent starch solution (500L) was added and incubated for 10 minutes at room temperature. After that, 1 mL of dinitrosalicylic acid was added to the reaction mixture and cooked for 5 minutes in a boiling water bath. At 540nm, the absorbance was measured. The usual formula was used to calculate the % inhibition of the activity of the enzyme in the bioactive fractions.

α -Glucosidase

The test was carried out with a minor modification of a previously described technique (Ramachandran et al., 2013). Various concentrations of the test samples were designed in DMSO from a 1 g/mL-1 stock solution, and the test sample was added to a 1 g/mL-1 of glucosidase and is incubated in the normal temperature for 5mins. Then 500uL of 37 mM maltose solution was added and incubated at room temperature for 30 minutes. After that, 1 mL of GPX reagent was mixed to the above mixture and is allowed in the normal temperature for about 15 mins. The combination was then treated with 1 mL of Tris buffer. At 540 nm, the optical density was evaluated in comparison to the blank reagent.

CONCLUSION

We reviewed *in vitro* and *in vivo* models utilised in diabetes research in this study. Each model is an important tool for studying the metabolic mechanisms, endocrine stimulations and other genetic based mechanisms of diabetes in human beings. Animal models and *in vitro* procedures are required for the development of a novel medication for the treatment of diabetes. Huge volume of experimental animal models, computer simulation software, and sophisticated methodologies must be created for advanced diabetes research, and it is believed that future developments in diabetes research will result in more therapy options.

REFERENCES

1. Bedoya FJ, Solano F, Lucas M (1996) N-monomethyl- arginine and nicotinamide prevent streptozotocin- induced double strand DNA break formation in pancreatic rat islets. *Experientia* 52: 344-347.
2. Brentjens R, Saltz L (2001) Islet cell tumors of the pancreas: the medical oncologist's perspective. *SurgClin North Am* 81: 527-542.
3. Chattopadhyay S, Ramanathan M, Das J, Bhattacharya SK (1997) Animal models in experimental diabetes mellitus. *Indian J ExpBiol* 35: 1141-1145.
4. Federiuk IF, Casey HM, Quinn MJ, Wood MD, Ward WK (2004) Induction of type-1 diabetes mellitus in laboratory rats by use of alloxan: route of administration, pitfalls, and insulin treatment. *Comp Med* 54: 252-257.
5. Graham TE, Sgro V, Friars D, Gibala MJ (2000) Glutamate ingestion: the plasma and muscle free amino acid pools of resting humans. *Am J PhysiolEndocrinolMetab* 278: E83-89.
6. Iranloye BO, Arikawe AP, Rotimi G, Sogbade AO (2011) Anti-diabetic and anti-oxidant effects of Zingiberofficinaleon alloxan-induced and insulin- resistant diabetic male rats. *Nigerian journal of physiological sciences: official publication of the Physiological Society of Nigeria* 26: 89-96.
7. Jarvill-Taylor KJ, Anderson RA, and Graves DJ (2001) Ahydroxychalcone derived from cinnamon functions as a mimetic for insulin in 3T3-L1 adipocytes. *J Am CollNutr* 20: 327-336.
8. Jin OC, Dong HC, Chung DJ, Chung MY (2010) Spontaneous hypoglycemia due to Insulin antibody after Insulin treatment of Diabetic Ketoacidosis. *Endocrinol Metab* 25: 217-220.



**Jothi Lakshmi et al.,**

9. Kim MR, Sheeler LR, Mansharamani N, Haug MT, Faiman C, et al. (1997) Insulin antibodies and hypoglycemia in diabetic patients. Can a quantitative analysis of antibody binding predict the risk of hypoglycemia? *Endocrine* 6: 285-291.
10. Kliber A, Szkudelski T, Chichlowska J (1996) Alloxan stimulation and subsequent inhibition of insulin release from in situ perfused rat pancreas. *Journal of physiology and pharmacology: an official journal of the Polish Physiological Society* 47: 321-328.
11. Kumar S, Singh R, Vasudeva N, Sharma S (2012) Acute and chronic animal models for the evaluation of anti-diabetic agents. *CardiovascDiabetol* 11: 9.
12. Le Marchand-Brustel Y (1999) Molecular mechanisms of insulin action in normal and insulin-resistant states. *Exp Clin Endocrinol Diabetes* 107: 126-132.
13. Malaisse WJ, Malaisse-Lagae F, Sener A, Pipeleers DG (1982) Determinants of the selective toxicity of alloxan to the pancreatic B cell. *ProcNatlAcadSci USA* 79: 927-930.
14. Morgan NG, Cable HC, Newcombe NR, Williams GT (1994) Treatment of cultured pancreatic B-cells with streptozotocin induces cell death by apoptosis. *Biosci Rep* 14: 243-250.
15. Nakajima H, Tochino Y, Fujino-Kurihara H, Yamada K, Gomi M, et al. (1985) Decreased incidence of diabetes mellitus by monosodium glutamate in the non-obese diabetic (NOD) mouse. *Res Commun Chem PatholPharmacol* 50: 251-257.
16. Nukatsuka M, Yoshimura Y, Nishida M, Kawada J (1990) Importance of the concentration of ATP in rat pancreatic beta cells in the mechanism of streptozotocin-induced cytotoxicity. *J Endocrinol* 127: 161-165.
17. Ramachandran S, Rajasekaran A, Adhirajan N (2013) In Vivo and In Vitro Antidiabetic Activity of Terminaliapaniculata Bark: An Evaluation of Possible Phytoconstituents and Mechanisms for Blood Glucose Control in Diabetes. *ISRN Pharmacol* 2013: 484675.
18. Sangeetha R, Vedaşree N (2012) In Vitro Amylase Inhibitory Activity of the Leaves of Thespesiapopulnea. See comment in PubMed Commons below *ISRN Pharmacol* 2012: 515634.
19. Szkudelski T (2001) The mechanism of alloxan and streptozotocin action in B cells of the rat pancreas. *Physiol Res* 50: 537-546.
20. Szkudelski T (2001) The mechanism of alloxan and streptozotocin action in B cells of the rat pancreas. *Physiol Res* 50: 537-546.
21. Szopa TM, Titchener PA, Portwood ND, Taylor KW (1993) Diabetes mellitus due to viruses--some recent developments. *Diabetologia* 36: 687-695.
22. Tasaka Y, Inoue Y, Matsumoto H, Hirata Y (1988) Changes in plasma glucagon, pancreatic polypeptide and insulin during development of alloxan diabetes mellitus in dog. *EndocrinolJpn* 35: 399-404.
23. Turk J, Corbett JA, Ramanadham S, Bohrer A, McDaniel ML (1993) Biochemical evidence for nitric oxide formation from streptozotocin in isolated pancreatic islets. *BiochemBiophys Res Commun* 197: 1458-1464.
24. Vijayaraj R and Sri Kumara N (2018); Evaluation of in vivo antidiabetic and antioxidant activity of *Achyranthes aspera* Linn. Seeds by streptozotocin induced diabetic rats; *International Journal of Green Pharmacy*, 12 (1), 29-36.
25. Vijayaraj R, Kumar KN, Mani P, Senthil J, Jayaseelan T, Kumar GD (2016). Hypoglycemic and antioxidant activity of *Achyranthes aspera* seed extract and its effect on streptozotocin induced diabetic rats. *International Journal of Biological and Pharmaceutical Research*, 7:23-28.





MEMS Based Automatic Fall Detection for Aged People

M.Jagadeesh Chandra Prasad¹ and Telugu Maddileti^{2*}

¹Professor, Department of ECE, Malla Reddy Engineering College [A], Hyderabad, Telangana, India.

²Associate Professor, Department of ECE, Malla Reddy Engineering College [A], Hyderabad, India.

Received: 28 May 2022

Revised: 03 June 2022

Accepted: 08 July 2022

*Address for Correspondence

Telugu Maddileti

Associate Professor,

Department of ECE,

Malla Reddy Engineering College [A],

Hyderabad, India.

Email: madhu14283@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Body Falls in older adults are the significant cause of injury. Falls incorporate dropping from a standing position or from uncovered positions, for example, those on stepping stools or stepladders. The seriousness of damage is commonly identified with the height of fall often leading to disability or death. In this research generally we use wearable sensor and vision based technique that is automatically detect body fall as early as possible. Accelerometer is used for measuring or maintaining orientation and angular velocity. In vision based procedure first we procure casings or video arrangements from the camera. The division module separates the body outline from the foundation. For Feature Extraction GLCM method is used. SVM method is used for classification. By using those methods we can surely detect the human body fall and can take the preventive measures.

Keywords: Accelerometer, SENSOR, SVM method, GLCM etc.

INTRODUCTION

The primary worry in the recent decades is with the senior or the old age population of the nation [1]. These older population experience variety of a illnesses and diseases condition at very uncertain time. Most of the time injuries are due to the falling on the ground, unconscious and hurting themselves. It will cause serious injury or sometimes death [2]. Therefore, they should be urgently transported to the emergency clinic, where they will be watched and gave medicinal assistance if wellbeing condition is indanger. Simultaneously, the measure of old peoples keeping up their independent life is developing quickly. Be that as it may, remote checking can help to prevent depicted situation, essentially diminish healthcare costs and simultaneously keep up patient's independent way of life [3]. Consequently, there is a reasonable interest in solid multi-useful remote observing frameworks for old individuals,



**Jagadeesh Chandra Prasad and Telugu Maddileti**

which gather and join various sources of medical information relating to ordinary daily routine of the monitored patient. As a response to the maturity masses, present day social medicinal services market gives a wide extent of restorative therapeutic gadgets for remote evaluating of basic wellbeing parameters. Most of the supplies is adjusted and maltreatment for spot checking and can't give a constant review of the patient's prosperity conditions. In addition, various parameters are estimated independently and checking procedure isn't synchronized. Simultaneously fall incident are viewed as one of the most widely recognized and most dangers among older populace, with about portion of nursing home occupants and 30% of freely living individuals falling every year. Along these lines, present day social healthcare will in general incorporate solid fall identification usefulness into general observing system. As a response to the maturity masses, present day social medicinal services market gives a wide extent of restorative therapeutic gadgets for remote evaluating of basic wellbeing parameters. Most of the supplies is adjusted and maltreatment for spot checking and can't give a constant review of the patient's prosperity conditions. In addition, various parameters are estimated independently and checking procedure isn't synchronized. Simultaneously fall incident are viewed as one of the most widely recognized and most dangers among older populace, with about portion of nursing home occupants and 30% of freely living individuals falling every year. The system consists of following parts.

- i) Image Acquisition
- ii) Segmentation
- iii) Feature Extraction
- iv) Classification.

As a rule, various parts involving the frameworks are crumbled and working independently from one another. Be that as it may, if we combine monitoring component (for example sensors, video camera, Smartphone's) into smart situations, we will almost certainly do overlook for elder individuals with different endless situation at home. With the ongoing advancement on ICT showcase wearable sensors and image processing are regularly conveyed related to environmental devices to improve fall discovery rates and limit false cautions.

LITERATURE SURVREY

Shery Oliver et.al [1] proposed to identify falls by handling with a few component extraction and grouping method for typical just as debilitated individuals. The feature extraction algorithm picked is equipped for detecting, preparing and imparting the fall event under genuine conditions. The blend of numerical information is utilized so as to identify fall with high exactness and dependability. Fouzi Harrou et.al [2] proposed Acknowledgment of human developments is exceptionally helpful for a few applications, for example, brilliant rooms, intelligent augmented experience frameworks, human detection and condition displaying. The goal of this work centers around the identification and order of falls dependent on varieties fit as a fiddle, a key test in PC vision .the recognition is accomplished with multivariate exponentially weighted moving normal (MEWMA) checking plan, which is viable in identifying falls since it is touchy to little changes. Shockingly, a MEWMA measurement neglects to separate genuine tumbles from some like-fall motions. To cure this restriction, an arrangement stage dependent on help vector machine is connected on distinguished successions. To approve this approach, two fall recognition datasets have been tried: the University of Rzeszow fall identification dataset (URFD) and the fall discovery dataset (FDD).Yoosuf Nizamet.al [3] proposed fall location for older is a noteworthy subject the extent that assistive advancements are concerned. This paper gives a survey of past chips away at human fall identification gadgets and a primer outcomes from a creating profundity sensor based gadget. The three primary methodologies utilized in fall identification gadgets, for example, wearable based gadgets, encompassing based gadgets and vision based gadgets are distinguished alongside the sensors utilized. The structures and calculations connected in every one of the methodologies and their uniqueness is additionally represented. Pooja Shukla et.al [4] proposed that the population of old people are living alone at home is more. Fall is one of the real hazards for old individuals. In some cases more seasoned individuals may quit fooling around damage to their spine (spinal rope) and that may prompt passing. Once in a while fallen harmed older might lie on the ground surface for a few times after a fall episode has happened. This makes it imperative to have a fall location framework. In this paper, she proposes a novel and powerful fall location framework. Their methodology depends on movement history. Their calculation gives promising outcomes





Jagadeesh Chandra Prasad and Telugu Maddileti

on video successions of everyday exercises and mimicked falls. Wang, J.et.al [5] proposed, an upgraded fall recognition framework is proposed for old individual checking that depends on savvy sensors worn on the body which recognized the unplanned falls in the home medicinal services condition. By using data assembled from an accelerometer, cardio tachometer and savvy sensors, the effects of falls can be minimized and recognized from typical every day exercises. The proposed framework has been sent in a model framework as point by point in this research.

RESULTS

Finally it is concluded that by using this method lifetime of a person can be saved and this is useful for the elderly people so they can live their life independently, Automatic falls can be easily detected through this technology. Block diagram used for the implementation of the proposed method is shown in fig.1. Prototype is constructed and tested for results and is shown in fig.2

CONCLUSION

We have reviewed different techniques for the detection of a fall event using wearable sensors. Gyroscope sensor is mandatory to detect fall. From study of computerized image processing technique we come up with a following conclusion. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. The SVM method is used for classification

REFERENCES

1. Sheryl Oliver A, Anuradha M, Jean Justus J, Maheshwari N, "Optimized low computational algorithm for elderly fall detection based on machine learning techniques", Biomedical Research, Volume 29, Issue 20, 2018, pp. 3715- 3722.
2. Harrou F, Zerrouki N, Sun Y, Houacine A, "Vision-based fall detection system for improving safety of elderly people". IEEE Instrumentation & Measurement Magazine 20, 2017, pp. 49– 55.
3. Yoosuf Nizam, Mohd Norzali Haji Mohd, M. Mahadi Abdul Jamil, " A Study on Human Fall Detection Systems: Daily Activity Classification and Sensing Techniques", International Journal of Integrated Engineering, Vol.8 No. 1 ,2016, pp. 35-43.
4. Integrated Engineering, Vol. 8 No. 1 ,2016, pp. 35-43.
5. Pooja Shukla, Arti Tiwari, "Vision based approach to human fall detection", International Journal of Engineering Research and General Science Volume 3, Issue 6, November- December, 2015, pp. 944-949.
6. Wang, J., Zhang, Z., Bin, L., Lee, S. and Sherratt, S., "An Enhanced Fall Detection System for Elderly Person Monitoring using Consumer Home Networks", IEEE Transactions on Consumer Electronics Volume 60, 2014, pp. 23-29
7. Quoc T. Huynh et al. "Optimization of an Accelerometer
8. Gregory Koshmak, Maria Linden, Amy Loutfi. "Evaluation of the Android-Based Fall Detection System with Physiological Data Monitoring". 35th Annual International Conference of the IEEE EMBS Osaka, Japan, 3 - 7 July, 2013.
9. Diana Yacchiremaa,b, JaraSuárez de Pugaa, Carlos Palaua, Manuel Esteve .Fall detection system for elderly people using IoT and Big Data "Procedia Computer Science 130, 2018,pp.603–610.
10. Liang, Shengyun, et al. "Pre-impact alarm system for fall detection using MEMS sensors and HMM- based SVM classifier." 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). IEEE, 2018.
11. Nyan, M. N., et al. "Garment-based detection of falls and activities of daily living using 3-axis MEMS accelerometer." Journal of Physics: Conference Series. Vol. 34. No. 1. IOP Publishing, 2006.





Jagadeesh Chandra Prasad and Telugu Maddileti

12. Yu, Xinguo. "Approaches and principles of fall detection for elderly and patient." Health Com 2008- 10th International Conference on e-health Networking, Applications and Services. IEEE, 2008.
13. Gupta, Piyush, et al. "MEMS-based sensing and algorithm development for fall detection and gaitanalysis." Microfluidics, BioMEMS, and Medical Microsystems VIII. Vol. 7593. SPIE, 2010.
14. Hu, Xinyao, and Xingda Qu. "Pre-impact fall detection." Biomedical engineering online 15.1 (2016): 1-16.
15. Gong, Shulan, et al. "Design of remote elderly health monitoring system based on MEMS sensors." 2017 IEEE International Conference on Information and Automation (ICIA). IEEE, 2017.

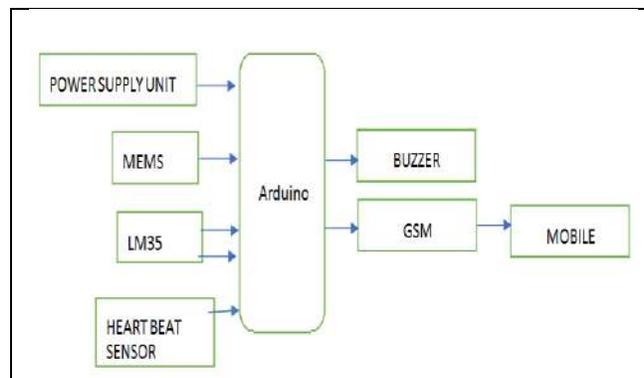


Fig 1: Block Diagram

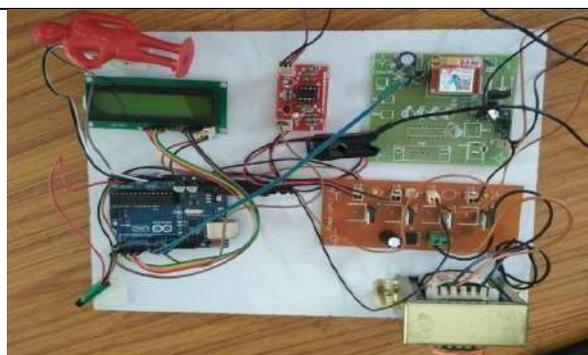


Fig 2. Prototype





Screening of Phytochemicals and Evaluation of Antimicrobial Activity of *Azadirachta indica* (Neem) Against Different Microbes Involved in Skin Infections

Indrani Barman¹, Apurba Talukdar², Herusikha Hatimuria³, Karabi Das³ and Nayan Talukdar^{4*}

¹Assistant Professor, Programme of Biochemistry, Faculty of Science, Assam down town University, Assam India.

²Associate Professor, NETES Institute of Pharmaceutical Science, Santipur, Mirza, Assam, India.

³Student, Faculty of Science, Assam down town University, Assam, India.

⁴Associate Professor, Programme of Biotechnology, Faculty of Science, Assam down town University, Assam, India.

Received: 30 Apr 2022

Revised: 29 May 2022

Accepted: 07 July 2022

*Address for Correspondence

Nayan Talukdar

Associate Professor,

Programme of Biotechnology,

Faculty of Science,

Assam down town University,

Assam, India.

Email: nayan.talukdar@adtu.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Herbal remedies have been widely used for treatment of many skin infections since ages. The superficial layer of the skin are quite often found to be infected with problems such as burns, acne, scars, urticaria, erythema, etc. Cutaneous infections are most frequently caused by bacteria such as *S. aureus*, streptococcus and some gram negative bacteria such as *E. coli*. The present study was conducted to evaluate the antibacterial activity of the leaf extracts of *A. indica* against *S. aureus* and *E. coli* along with the screening of its phytochemical constituents. The leaves of *A. indica* were dried and extracted in soxhlet apparatus. The extracts showed the presence of various phytochemicals such as saponins, glycosides, phenols, flavonoids, steroids and alkaloids. The anti-bacterial activity of the ethanolic extracts were performed by well diffusion method. 200µl/ml of the ethanolic extract showed considerable zone of inhibition (in mm) i.e. 3±0.65 against *S. aureus* and 2±0.38 against *E. coli* while 400µl/ml of the extracts showed 6±0.28 against *S. aureus* and 4±0.29 against *E. coli*. The study supports the medicinal values of the plant to be cheaper substitute for conventional drugs since the plant is easily available.

Keywords: Cutaneous infections, Neem, anti-bacterial, phytochemical.





INTRODUCTION

Skin, the largest organ of the body is the outer covering which constitutes the first line of defence[1]. The skin guards the underlying bones, muscles, ligaments and our internal organs[2]. The superficial layer of the skin are quite often found to be infected with problems such as burns, acne, scars, urticaria, erythema, etc. Some of the causative agents for skin diseases are fungal, bacterial, parasitic infestations, etc. Cutaneous infections are most frequently caused by bacteria such as *S. aureus*, *streptococcus* and some gram negative bacteria such as *E. coli*[3]. Herbal remedies are widely used for treatment of many of these infections. Herbs are found to have least side effects as well as proven to be efficiently effective against skin diseases and infections [4].

The neem tree is well known as a medicinal herb since centuries for treating various acute as well as chronic ailments. It is found to be attributed with anti-oxidant, anti-microbial, anti-cancerous, anti-inflammatory activity, anti-ulcer, anti-malarial, etc. The medicinal properties of the neem tree have been especially ascribed to the leaves, fruit, and bark. Neem and its ingredients play role in the inhibition of growth of numerous microbes such as viruses, bacteria, and pathogenic fungi[5]. It is distributed in the areas of India, Bhutan, Indonesia, Nepal, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam; Tropical Australia, Pacific islands (Solomon Islands), Myanmar, China. Neem is an evergreen tree that is cultivated in various parts of India. It is cultivated and frequently naturalized throughout the drier regions of tropical and sub-tropical India[6].

Neem has high rate of photosynthesis and liberate more oxygen than many other tree species, thus purify the atmosphere. The leaf of *Azadirachta indica* is effective in many skin problems as treating eczema, ringworm, acne, anti-inflammatory, antihyper glycaemic properties and it is also used to heal chronic wounds, diabetic foot and gangrene developing conditions[7]. Neem tree is a rich source of flavonoids, terpenoids, tannins, saponins, anthraquinones, sterols and alkaloids[8]. In the present study, the antibacterial activity of the leaf extracts of *A. indica* is observed against two potent skin infection causing microbes – *S. aureus* and *E. coli* along with the screening of its phytochemical constituents.

MATERIALS AND METHODS

Collection and preparation of plant sample[9], [10]

The plant sample was collected from Guwahati, Assam. The leaves thus taken were dried in sterile conditions (shade) for seven days. The dried leaves were grinded and further used for extraction. Ethanol was used as a solvent for the extraction of the sample in Soxhlet apparatus.

Phytochemical screening of the extracts

The test sample was screened for the presence of various phytochemicals.

Test for alkaloids: 0.5 g of sample was dissolved in hydrochloric acid and filtered using filter paper to the 2 ml of filtrate was treated with Dragendroff's reagent (solution of potassium Bismuth iodide) formation of red precipitate confirmed indicating the presence of alkaloid the test is called Dragendroff's test. To 2 ml of filtrates was treated with Hager's reagent, formation of yellow colour confirmed the presence of alkaloid.

Test for saponin: 0.5 g of sample was boiled with 50 ml of distilled water and filtered. To 5 ml of each filtrate, 3 ml of distilled water was added and shaken vigorously for about 5 minutes. Formation of frothing was confirmed showing the presence of saponins.





Indrani Barman et al.,

Test for glycosides: 0.5 g of sample was dissolved in ethanol for about 10 minutes for proper extraction and filtered. To 5 ml of each filtrate, 0.3 ml of Fehling's solution A and B was added until it turn to alkaline indicating the presence of glycoside.

Test for flavonoids: 0.5 g of the sample dissolve in distilled water and filtered to 5 ml of filtration, 3 ml of lead ethanoate solution was added. Appearance of pale yellow-brown confirmed the presence of flavonoid.

Test for steroids: 0.5 g of the sample dissolved in distilled water and filtered to 4 ml of the filtrate, 2 ml of acetic acid was added and allowed the solution to cool well in refrigerator followed by the addition of concentrated H_2SO_4 carefully. Colour change from violet to bluish green indicated the presence of steroidal ring.

Test for phenol: 0.5 g of the sample was boiled with 15 ml of distilled water and filtered. To 2 ml of the filtrate, few drops of 10% ferric chloride solution were then added. Formation of violet colour was confirmed indicating the presence of phenolic hydroxyl group.

Evaluation of anti-microbial activity of the extract by well diffusion method

In the well diffusion method, nutrient agar plates are prepared and the surface of the plate is inoculated by spreading a volume of the microbial inoculums over the entire agar surface. Then, a hole with a diameter of 6 to 8 mm is punched aseptically with a sterile cork borer or a tip, and a volume (20–100 μ l/ml) of the antimicrobial agent or extract solution at desired concentration is introduced into the well. Then, agar plates are incubated under suitable conditions depending upon the test microorganism. The antimicrobial agent diffuses in the agar medium and inhibits the growth of the microbial strain tested[11]. For the above study, two different concentrations (200 μ l/ml and 400 μ l/ml) of the sample dissolved in distilled water were taken. Triplicate plates of each concentration were prepared and used for screening the antimicrobial activity of the given test extract against *Escherichia coli* and *Staphylococcus aureus*. The agar plates were incubated at 37°C for 48 hours and further observed for growth inhibition.

RESULT AND DISCUSSION

Phytochemical screening

The Phytochemical test was done to find out the presence of active chemical constituents such as saponins, tannins, phenols, glycoside, flavonoids and alkaloids. Steroids and saponin were highly found, while glycosides and flavonoids were moderately found in the ethanolic extracts. Phenol and alkaloids were least found in the extracts. Table 1 shows the result of qualitative analysis of different phytochemicals in the ethanolic leaf extract of *A. Indica*. Presence of these phytochemicals verifies the potentiality of *A. indica* to be used traditionally in medicines since centuries. Studies have been reported stating the potentiality of these phytochemicals towards their anti-cancer, anti-inflammatory, anti-fungal, anti-viral, anti-mycobacterial activities[12].

Anti-bacterial activity

The ethanolic extracts of *A. indica* were observed for their anti-bacterial properties against *S. aureus* and *E. coli*. 200 μ l/ml extract showed considerable zone of inhibition i.e. 3 ± 0.65 against *S. aureus* and 2 ± 0.38 against *E. coli* while 400 μ l/ml extracts showed 6 ± 0.28 against *S. aureus* and 4 ± 0.29 against *E. coli*. Increasing the strength of the extract resulted in increase inhibition of bacterial growth under same growth conditions (37°C for 48 hours). Table 2 shows zone of inhibition in mm against *S. aureus* and *E. coli* respectively. Studies stating the anti-bacterial activity of the leaf bark and stem extracts of *A. indica* are also reported. Both water and ethanolic extracts are active against the selected pathogens [13].



**Indrani Barman et al.,**

CONCLUSION

Synthetic medicines are not only expensive but yet loaded with side effects. Inclining towards herbal medicines has now become a necessity to cure various ailments may it be acute or chronic as these herbs are also competent and have the ability to fight diseases. However, in recent studies, it is seen that the day by day requirement of medicine is leading towards the exploitation of medicinal plants. Hence, it is required to develop ideas for smart use of such resources. In the present study, the plant extract showed various degrees of the inhibition at different concentrations, against bacterial strains of *S. aureus* and *E. coli* by using agar well diffusion method. The observations confirm the anti-bacterial activity of ethanolic extract of *A.indica* tree leaves against human skin infection causing bacteria viz. *S.aureus* and *E. coli*. The study on the *A.indica* extract revealed that the extract is potentially rich in antimicrobial compounds and suggests that they represent an economic and safe alternative for treatment of skin infections. Moreover, the presence of active phytochemicals such as saponin, glycosides, flavonoids, etc. contributes towards its medicinal values. It is therefore believed that this study will serve as a better alternative of the traditional methods and in the same time save the present quantity of resources.

ACKNOWLEDGEMENTS

The author acknowledges the help and support by the members' and management of Assam down town University for providing the laboratory facilities.

REFERENCES

1. N. Tabassum and M. Hamdani, "Plants used to treat skin diseases," *Pharmacogn. Rev.*, vol. 8, no. 15, p. 52, 2014.
2. J. G. Marks, J. J. Miller, and D. P. Lookingbill, "Principles of dermatology," *Lookingbill Marks. Princ. dermatology (4 th ed.)*. Philadelphia, PA Saunders Elsevier, pp. 3–50, 2006.
3. K. Samraj, S. Thillaivanan, P. Parthiban, and K. Samraj, "A review of beneficial effects of medicinal plants on skin and skin diseases," *Int J Pharm Res Bio Sci*, vol. 3, no. 1, pp. 93–106, 2014.
4. R. P. Giri, A. K. Gangawane, and S. G. Giri, "Neem the wonder herb: a short review," *Int. J. Trend Sci. Res. Dev.*, vol. 3, no. 3, pp. 962–966, 2019.
5. R. K. Bijauliya, S. Alok, D. K. Chanchal, M. Sabharwal, and R. D. Yadav, "An updated review of pharmacological studies on *Azadirachta indica* (neem)," *Int. J. Pharm. Sci. Res.*, vol. 9, no. 7, pp. 2645–2655, 2018.
6. M. B. Yerima *et al.*, "Effect of neem extracts (*Azadirachta indica*) on bacteria isolated from adult mouth," *Niger. J. Basic Appl. Sci.*, vol. 20, no. 1, pp. 64–67, 2012.
7. A. Sahrawat, J. Sharma, S. N. Rahul, S. Tiwari, M. D. Joshi, and A. Pundhir, "Phytochemical analysis and Antibacterial properties of *Azadirachta indica* (Neem) leaves extract against *E. coli*," *J. Pharmacogn. Phytochem.*, vol. 7, no. 4, pp. 1368–1371, 2018.
8. S. Maji, "Neem: Treasure of Natural Phytochemicals."
9. I. I. Ujah, C. A. Nsude, O. N. Ani, U. B. Alozieuwa, I. O. Okpako, and A. E. Okwor, "Phytochemicals of neem plant (*Azadirachta indica*) explains its use in traditional medicine and pest control," *GSC Biol. Pharm. Sci.*, vol. 14, no. 2, pp. 165–171, 2021.
10. N. Talukdar, A. M. Dutta, C. Raja, and D. Karabi, "Screening of phytochemicals, antioxidant and inhibitory effect on alpha-amylase by ethanolic extract of *Elaeocarpus Ganitrus* (Bark)," *Int. J. Pharm. Sci. Res.*, vol. 8, no. 12, pp. 5270–5275, 2017.
11. M. Balouiri, M. Sadiki, and S. K. Ibnsouda, "Methods for in vitro evaluating antimicrobial activity: A review," *J. Pharm. Anal.*, vol. 6, no. 2, pp. 71–79, 2016.
12. S. K. Srivastava, B. Agrawal, A. Kumar, and A. Pandey, "Phytochemicals of *Azadirachta indica* source of active medicinal constituent used for cure of various diseases: A Review," *J. Sci. Res.*, vol. 64, no. 1, pp. 385–390, 2020.





Indrani Barman *et al.*,

13. U. Francine, U. Jeannette, and R. J. Pierre, "Assessment of antibacterial activity of neem plant (*Azadirachta indica*) on *Staphylococcus aureus* and *Escherichia coli*," *J Med Plants Stud*, vol. 3, no. 4, pp. 85–91, 2015.

Table1: Test for phytochemicals

| Test | Result |
|------------|--------|
| Alkaloids | + |
| Steroids | +++ |
| Saponin | +++ |
| Glycosides | ++ |
| Flavonoids | ++ |
| Phenol | + |

(+++ highly found, ++ moderately found, +least found)

Table 2: Zone of inhibition against selected microbes

| Concentration of extract | Zone of inhibition against <i>S. aureus</i> (in mm) | Zone of inhibition against <i>E. coli</i> (in mm) |
|--------------------------|---|---|
| 200µl/ml | 3±0.65 | 2±0.38 |
| 400 µl/ml | 6±0.28 | 4±0.29 |

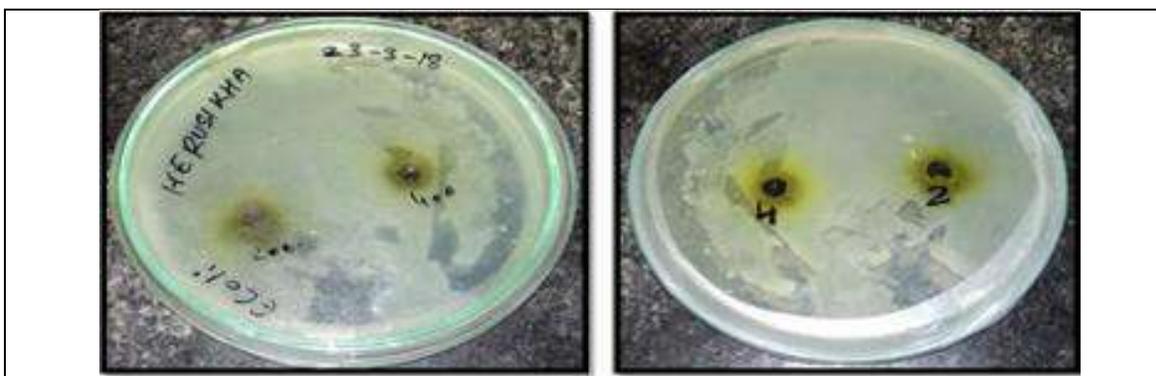


Figure 1: Zone of inhibition against *E. coli*

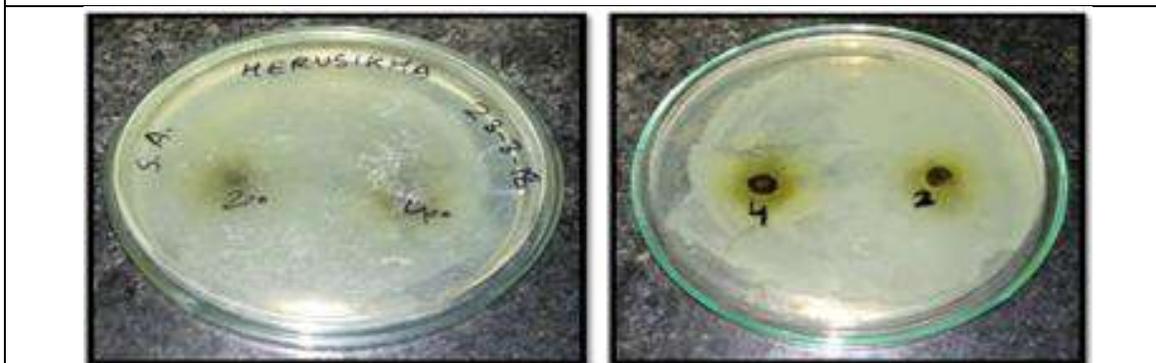


Figure 2. Zone of inhibition against *S. aureus*





A Study and Analysis of E-Commerce Factors Influencing Consumer's Online Shopping Buying Psychology among Biology Science Students

S. Saguber Ali^{1*} and J. Prabakaran²

¹Research Scholar, Department of Business Administration, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India.

²Research Supervisor and Assistant Professor (Deputed), Department of Business Administration, Annamalai University, Chidambaram, Tamil Nadu, India.

Received: 25 Mar 2022

Revised: 05 June 2022

Accepted: 07 July 2022

*Address for Correspondence

S. Saguber Ali,

Research Scholar,

Department of Business Administration,

Annamalai University, Annamalai Nagar,

Chidambaram, Tamil Nadu, India.

Email: saguber.phd2020@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Online shopping has expanded essentially worldwide over the most recent couple of years. Chennai city, India is no special case, however albeit this city has encountered an expansion in internet shopping, it appears to fall behind the remainder of the reality where this improvement is concerned. Investigation into the elements which impact consumer online shopping psychology is consequently basic for Indian retailers to foster the right techniques for online deals. With this data, they can change over likely clients into genuine clients and hold them. This examination explores the variables which impact consumer online purchasing Psychology among Biology Science Students in Chennai city, India. The specialist utilized optional exploration to develop a model of elements affecting web-based consumer loyalty and afterward tried the model among PG Science Students living in the Chennai city. An example of 400 UG and PG Biology Science Students was utilized and quantitative exploration was directed through an organized survey. It was tracked down that comfort, conveyance, and efficient were seen by clients as the main explanations behind purchasing on the web, while marking was considered to be the most un-significant element. The study results affirmed the model created by the analyst. Based on the review, as well as suggestions for future exploration, are introduced.

Keywords: Online shopping, e-commerce factors, biology students, Chennai city, India, consumers buying Psychology.





INTRODUCTION

According to Dot Knowledge – UK, the psychology of shopping is a magnetic field of study and very well understood today, actually by marketing-savvy laypersons – at least as far as standard real-world retail sales are concerned. Using psychological principles and consumer behaviourism to online retail sales, on the other hand, has only really formed to take off in a significant way over the earlier decade. Learning how online buyers search, browse and select the products they want to buy and knowing what it takes to clinch the sale and avoid renounced carts can help consumers present offerings and approaches in the right way to win business and recount sales. In order to do this, consumers must know the basics of the psychology of online shopping and how this varies from retail local store customer decision making.

The Internet plays had a critical impact in our regular routine in that individuals can talk through the web to one who is really on the opposite side of the Earth, can send email nonstop, can look through data, can play game with others, and even can purchase things on the web. In the mean time, Internet shopping has been generally acknowledged as an approach to buying items and administrations It has turned into a more famous method in the Internet world (Loekamto, 2012). It likewise gives customer more data and decisions to look at item and cost, more decision, comfort, simpler to find anything on the web (Shanthi and Desti, 2015). Web based online shopping has been displayed to give more fulfillment to current customers looking for comfort and speed (Close and Kukar-Kinney, 2010). Then again, a few customers actually feel awkward to purchase on the web. Absence of trust, for example, is by all accounts the significant explanation that blocks customers to purchase on the web. Likewise, buyers might have a need to test and feel the items and to meet companions and get a few additional remarks about the items prior to buying. Such factors might have negative impact on purchaser choice to shop on the web.

The method involved with settling on choice are fundamentally the same as whether the shopper is disconnected or on the web. Yet, one a few significant contrasts are shopping climate and promoting correspondence. As indicated by conventional shopper choice model, Consumer buy choice normally begins with need mindfulness, then data search, elective assessments, choosing to buy lastly, post-buying conduct (Katawetawarak and Wang, 2011). Exact examination has featured the advantages of internet business. Dependence on the web assists with eliminating existence hindrances confronting organizations and shoppers. It can likewise encourage upgrades in item assortment, subsequently advancing quality and consumer loyalty, working with authoritative cycles, further developing work and the board efficiency and decreasing expenses (Hansen and Deimler, 2001). Rustic organizations are embracing internet business to increase the value of their products and furthermore further develop client connections (Chen et al., 2020). At long last, online business can add to the reshaping of client provider connections and the smoothing bankrupt cycles (Rita et al., 2019).

As far as online correspondence, when clients see flag promotions or online advancement, these commercials might stand out for clients and animate their intriguing specific items. Before they choose to buy, they will require extra data to take care of them. On the off chance that they need more data, they will look through web-based channels, e.g., online inventories, sites, or web search tools (Izogo and Jayawardhena, 2018). Whenever clients have sufficient data, they should analyze those selections of items or administrations. In the pursuit stage, they could search for the item audits or client remarks. They will figure out which brand or organization offers them the best fit to their assumption. During this stage, efficient site structure and the alluring plan are significant things to convince buyers to be keen on purchasing item and administration (Rahman et al., 2018).

Also, the data sources' inclination might impact purchaser conduct (De Mooij, 2019). The most valuable quality of web is that it upholds the pre-buy stage (Abbasi, 2021.) as it assists clients with looking at changed choices (Alhaimer, 2022). During the buying stage, item arrangement, deal administrations and data quality appear to be the main highlight assist purchasers with concluding what item they ought to choose, for sure dealer they should purchase from (Tseng and Wei, 2020). Post-buy conduct will turn out to be more significant after their internet based



**Saguber Ali and Prabakaran**

buy. Customers once in a while have an issue or worry about the item, or they should change or return the item that they have purchased. Accordingly, return and trade administrations become more significant at this stage (Javed and Wu, 2020).

Literature review

According to Li et al. (2020), experimentally judging and contrasting different versatile internet business retailing (applications) are crucial for increment web-based shopping productivity and upgrade plan for framework improvement. In this examination, versatile applications in internet business retailing are considered a data activity interaction. The distance of data state progress hypothesis is acquainted with measuring the "accommodation" of portable applications to get administration data. In this way, an original DIT-based assessment strategy for the convenience of portable applications in internet business retailing is proposed according to customer web-based shopping behaviours. Three agent Chinese undertakings, to be specific, Tianmao Mall, Jingdong Mall and Suning Easy-to-purchase, are picked as study objects. Also, the usability marks of three portable applications under regular internet shopping ways of behaving are assessed quantitatively. Results show that this examination has significant ramifications for online buyers and creators of internet shopping frameworks.

According to Octaviani and Gunawan (2018), This study means to decide the impact of perceived risk on buyer web-based shopping conduct of design item. The vast contrast introduced is the item class, involving the classification of design products as the most exciting class by buyers. Tests utilized are understudies in the field of bookkeeping at colleges. The consequence of this exploration is a negative impact of the impression of product chance to consumer loyalty and yet again bought expectation. The perceived cost risk has no adverse consequence on fulfilment and yet again bought goal. View of an individual gamble do not negatively affect consumer loyalty and once again bought aim.

According to Daroch et al. (2021), this study expects to research buyer conduct towards web-based shopping, looking at different elements restricting customers for web-based shopping conduct. The examination was to figure out the issues that purchasers face during their shopping through web-based stores. A quantitative exploration strategy was embraced for this examination, where an overview was led among the clients of internet shopping locales. According to the outcomes, absolute six elements emerged from the review that controls customers to purchase from online destinations - anxiety toward bank exchange and confidence, conventional shopping more helpful than web-based shopping, notoriety and administrations given, insight, frailty and secondary item data and absence of trust. This study is helpful for e-shopping associated with web-based business exercises that might be consumer to consumer or consumer to the business. Administrative ramifications are proposed for further developing showcasing methodologies for creating shopper trust in internet shopping. As opposed to past research, this study expects to zero in on distinguishing those factors that confine buyers from web-based shopping.

According to Tham et al. (2019), the review analyzes the effect of a monetary gamble, accommodation risk, non-conveyance risk: merchandise exchange chance and item risk on web-based purchaser conduct of Malaysian customers. The study utilized a self-controlled overview to gather practical information from 245 Malaysian internet-based customers through accommodation testing. Cronbach alpha was determined to affirm the unwavering quality of the information, and afterwards, ordinariness was surveyed. Corroborative Factor Analysis was then led to testing the model utilizing the integrity tests. Lastly, underlying condition displaying is utilized to test the theories and make inferences. IBM SPSS AMOS adaptation 22.0 was used for information examination. The exploration demonstrates that item risk, accommodation hazard, and merchandise exchange risk emphatically affect web-based shopping conduct. Monetary gamble is found to have few adverse consequences on customer conduct greetings expansion; the non-conveyance risk is found to affect internet shopping conduct contrarily. The discoveries give a helpful model for estimating and overseeing apparent risks in web-based shopping, which might increase the interest of Malaysian customers and decrease their mental lacks in the online business climate. A few administrative ramifications are examined alongside the extension for future exploration.



**Saguber Ali and Prabakaran**

According to Vinerean (2020), The COVID-19 pandemic has affected our everyday behaviour, from connections with companions, partners, and family to safety measures and working somewhere. Furthermore, this pandemic has drastically changed purchasers' shopping conduct. This exploration paper aims to analyze the effect of the Covid-19 pandemic on shopper conduct. Accordingly, this paper proposes another model that joins three factors: mentality for internet shopping during the COVID-19 pandemic, financial plan contemplations during the COVID-19 pandemic, and future social aim after the COVID-19 pandemic. This study's primary research approach is a quantitative review and assessment utilizing an example of Romanian purchasers. Furthermore, the proposed speculations were inspected in an SEM model, and every one of the theories was upheld given the meticulous investigation. This study adds hypothetical commitments by surveying the progressions of buyers' web-based shopping conduct during the COVID-19 pandemic. Administrative ramifications concentrate on restrictions, and future research roads are likewise discussed.

According to Rehman et al. (2019), the reason for this exploration is to decide the connection between Theory planned Behaviour (TPB) and Technological acceptance model (TAB) components and customer buy goal. Customer buy goal intervenes the connection among TPB and TAM components and internet shopping conduct. The directing job of trust is not set in stone between purchaser buy goal and internet shopping conduct. The PLS-SEM procedure was utilized to examine information gathered from understudies and speakers of the higher education commission (HEC) perceived colleges in Punjab, Pakistan. The flow research endeavours to analyze the job of seen handiness, saw usability, demeanour, emotional standards, conduct control, trust, responsibility, and shopper buy expectation in foreseeing the natural way of behaving of customers by incorporating three pre-laid out structures of TAM and TPB hypothesis. Discoveries uncover that apparent handiness, convenience, disposition, abstract standards, and conduct control affect buyer buy expectations. Consumer Purchasing Intention (CPI) intervenes between the five free develops and online shopping behaviour (OSB). Responsibility and trust fundamentally moderate the connection between buyer buy goal and web shopping conduct, affecting web-based shopping conduct.

RESEARCH METHODOLOGY

Respondents were chosen from UG and PG Biology Science Students in Chennai city because it had suitable for the researcher. The sample selected had at least a one-time online shopping understanding. The size of the sample selected was 400, and stratified random sampling was used for this study. Selected UG and PG biology department students from the colleges and Universities in Chennai district. Biology is a subdivision of science that deals with living organisms and their essential processes. Biology encompasses various fields, together with botany, conservation, ecology, evolution, genetics, marine biology, medicine, microbiology, molecular biology, physiology, and zoology. The first set of respondents was selected based on assessment. Thereupon, additional units were conveyed based on data given by initial sample units, and then further referrals were accepted from those fixed in the sample. Total 535 questionnaires were distributed out of that 413 was received, and 13 questionnaires were found incomplete. So only 400 questionnaires were assigned finally for further analysis of data. The structured questionnaire includes Yes or No questions, multiple-choice, and semantic differential questions. All the differential questions are thought to be based on an interval scale. The arithmetic mean standard deviation, reliability test based on Cronbach's Alpha value, factorial analysis were the statistical measures and tests used for data analysis.

Both primary and secondary research was performed for this study. Secondary data are information gathered for other research projects or problems, and primary data are mainly collected to address the research objective (Greenhoot and Dowsett, 2012). The study involved quantitative research, which typically involves collecting primary data from large numbers of people to launch the results to a broader population. The aim is to generalise the exact population founded on the results of a usual sample of that population (Kersting et al., 2011). The target population contained all biology students in Chennai, India. The survey area of the research contained Colleges and Universities in Chennai City and semi-urban Colleges of Chennai.





To ensure content validity, a structured questionnaire was completed by a research team, including a statistician, and examined by the research team members to assess whether each measurement question in the questionnaire was necessary. Respondents were confirmed their anonymity and confidentiality, and all details provided was treated as confidential and used exclusively for the study. Categories covered in the questionnaire contained frequency of online buying, type of products filtered and purchased, motivations for buying online, period of buying online, references and reviews for buying online, fulfilment with online shopping and demographic information.

Data Analysis and Interpretation

From the above table 1, it is observed that majority 58.75% (235) of the Science students are in the age group of below 17-20, 28.25% (113) of Science students are in the age group of 21-24, 13.00% (52) of respondents are in the age group of Above 25. From the above table 2, it is observed that majority 72.75% (293) of the Science students are in the male category, 27.25 % (109) of Science students are in the female category. From the above table 3, it is observed that majority 65.25% (261) of the Parent's monthly income of Science students are in the 10000-20000 INR income category, 18.00% (72) of Parent's monthly income of Science students are in the 21000-40000 INR income category and above 41000 INR income category for Parent's monthly income of Science students frequency is 16.75%(67).

From the above table 4, it is observed that majority 60.25% (241) of the science students are in the UG category, 38.25% (153) of science students are in the PG category and 1.5 % (6) science students are in M.Phil or Ph.D. category. Mean values between 5 - 7 are product information, filters, availability, UI website quality, product worth and information, delivery charges or free. Median values between 5-7 are from product feature, convenience, product information, filters, availability, UI website quality, product worth and information, delivery charges or free. Moreover, price offers, corporate brands' payment modes, worth of products, and product features are small important.

As the mean and median values are moderately close to each other, it indicates that the distribution of the values are relatively symmetric, except for UI website quality, product worth and information, and delivery charges and free, where the median values were higher than the mean values, signifying that a few lower scores have impacted the mean. Subsequently, the factors determined in the framework (see Figure 1) were subjected to an exploratory factor analysis to resolve if any explicit constructs emerged.

Factor Analysis

An explorative factor analysis was executed, using principal component extraction and varimax rotation. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (0.693) and the Bartlett's Test of Sphericity, which was significant ($p = 0.000$), both reveal that a factor analysis is suitable. The research identified six factors (final factor loadings are shown in Table 5), established on the eigenvalue criterion, which present 64.3% of the variance.

Factor loadings

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. All the six factors were labelled as Privacy and security, delivery and services, convenience, price experience and price offer and product variety, technological factor, respectively. Using Cronbach alpha, the internal consistency (reliability) for the six factors was 0.812, 0.712, 0.599 and 0.513, respectively. Although loadings for the second and third factors were below the verge of 0.7, they were considered satisfactory due to the exploratory nature of this analysis.

Factor-based scores were subsequently figured as the mean score of the variables in each factor for each respondent.

In order to specify the extent to which these factors have an effect on science student's online buying satisfaction of online customers, a multiple regression analysis was accomplished with the three declarations that were used as representatives for online shopping and customer satisfaction, respectively:

- Biology Science students ranking of overall online shopping buying experience
- Biology Science students purchasing Intention and visiting the online website again
- Referral programs, testimonials and product feedbacks





Saguber Ali and Prabakaran

Regression analysis

- a Predictors: (Constant), Biology Science students ranking of overall online shopping buying experience
- a Predictors: (Constant), Biology Science students purchasing Intention and visiting the online website again
- a Predictors: (Constant), Referral programs, testimonials and product feedbacks

The above table 6 displays are R, R², adjusted R² and standard error R (.493) denotes the multiple correlation coefficient .i.e. it is the correlation between the observed and predicted values of the dependent variable. R² (.227) is the proposition of variation in the dependent variable explained by the regression model. Sample R² tends to optimistically estimates how well the model fits the population. Adjusted R² (.182) attempts to correct R² to more closely reflect the goodness of fit of the model in the population.

The above table 7 displays are R, R², adjusted R² and standard error R (.423) denotes the multiple correlation coefficient .i.e. it is the correlation between the observed and predicted values of the dependent variable. R² (.218) is the proposition of variation in the dependent variable explained by the regression model. Sample R² tends to optimistically estimates how well the model fits the population. Adjusted R² (.197) attempts to correct R² to more closely reflect the goodness of fit of the model in the population.

The above table 8 displays are R, R², adjusted R² and standard error R (.451) denotes the multiple correlation coefficient .i.e. it is the correlation between the observed and predicted values of the dependent variable. R² (.201) is the proposition of variation in the dependent variable explained by the regression model. Sample R² tends to optimistically estimates how well the model fits the population. Adjusted R² (.165) attempts to correct R² to more closely reflect the goodness of fit of the model in the population.

a Predictors: (Constant), E-Commerce Factors Influencing Biology Science student's Online Shopping Buying Psychology.

b Dependent Variable: [Overall, E-Commerce Factors Influencing Biology Science students Online Shopping Buying Psychology in Chennai City, India] The above table 14 summarizes the results of the analysis of variance. The sum of squares, degrees of freedom, mean square are displayed for two sources of variations, regression and residual. The above output for regression displays information about the variations accounted for by the model. The output for a total (386.769) is the sum of information for regression (82.017) and residual (304.752). A model with the large regression sum of squares compared with the residual sum of squares indicates that the model accounts for most of the variation in the dependent variable. F statistics (91.635) are the regression mean square dividend residual mean squared. Regression degree of freedom is the numerated degree of freedom, and the residual degree of freedom is the denominator degree of freedom for the 'F' statistics. The total number degree of freedom is the number of cases minus 1. If the significance of 'F' statistics is small (0.05), then the independent variable does good work in explaining the variation in the dependent variable. a Dependent Variable: [Overall, E-Commerce Factors Influencing Biology Science student's Online Shopping Buying Psychology among Chennai City, India]

From the above table 10 Significance value .000 and beta value .461 and Overall, E-Commerce Factors Influencing Biology Science student's Online Shopping Buying Psychology among Chennai City, India is the significant variables.

The results revealed that, for each statement, the factors did not result in a declaration model that can be used for predictive objectives, as seen from the low R² values. However, it indicated that:

- ✓Security and Price experience affect the overall online buying experience among UG and PG Biology science students
- ✓Price experience affects buying online again in the future
- ✓Product Variety affects referring someone to an online shopping website.

Thus, to make the online buying knowledge as positive as possible, online retailers should pay explicit awareness to security and price when developing their market offerings. Online shoppers are exposed to fraud and theft where



**Saguber Ali and Prabakaran**

credit card purchases are affected. These issues should be managed in market offerings, especially on the shopping websites of online retailers. Adequate privacy and security, the reliability of the information, and privacy should be highlighted in all promotions and shopping websites.

The price knowledge of online shoppers, when buying from an online retailer, can exploit them to either buy from the retailer again in the future or to ignore the retailer in future online shopping. Ease of payment, low prices, and value for money are key factors that online retailers should consider when developing their market offerings. These factors can help online retailers to build long-term relationships with their consumers. Presenting a wide variety of products and delivering sufficient information about these products will ultimately influence word of mouth references and online reviews. It is thus imperative that online merchants do not simply stock and advertise a narrow range of products. Online retailers' information includes product types and definitions, instructions, demonstrations, filter facility and product reviews. A comprehensive variety of products and sufficient information will confirm positive word-of-mouth references.

CONCLUSION

Online shopping has grown tremendously in the last few years, but India seems to lag after most other countries where this type of shopping is unbalanced. Therefore, this research aimed to analyse the e-commerce factors influencing Biology Science student's online shopping satisfaction and online buying psychology in India. The researcher thus developed a declaration model that contains factors that could influence Science student's online buying satisfaction and investigated whether the factors in the model influence shoppers' online shopping satisfaction among UG and PG Science students in Chennai city, India. The results also indicate that product variety influences referring someone to an online shopping website. These findings offer practical insight for online retailers to design adequate market offerings that will convert probable customers into actual Science students and maintain them. In order to close the gap between online shopping in India and online shopping in the rest of the cities, Indian retailers should pay attention to the e-commerce factors identified in the declaration model. They could use these factors in the design of their shopping websites, advertisements, product descriptions, coupon codes, pricing policies, and delivery methods, resulting in increased online sales, online buying, and online customer satisfaction.

REFERENCES

1. Abbasi, G. A. (2021). Attributes tempting students' online purchase intention; the mediating role of pre-purchase Searching. *International Journal of Electronic Commerce Studies*, 12(2), 159-176.
2. Alhaimer, R. (2022). Fluctuating attitudes and behaviors of customers toward online shopping in times of emergency: The case of Kuwait during the COVID-19 pandemic. *Journal of Internet Commerce*, 21(1), 26-50.
3. Chen, X., Sun, X., Yan, D., & Wen, D. (2020). Perceived sustainability and customer engagement in the online shopping environment: The rational and emotional perspectives. *Sustainability*, 12(7), 2674.
4. Close, A. G., & Kukar-Kinney, M. (2010). Beyond buying: Motivations behind consumers' online shopping cart use. *Journal of Business Research*, 63(9-10), 986-992.
5. Daroch, B., Nagrath, G., & Gupta, A. (2021). A study on factors limiting online shopping behaviour of consumers. *Rajagiri Management Journal*. <https://doi.org/10.1108/ramj-07-2020-0038>
6. De Mooij, M. (2019). *Consumer behavior and culture: Consequences for global marketing and advertising*. Sage.
7. <https://dotknowledge.uk/articles/view-article/understanding-the-psychology-of-shopping-to-increase-sales>
8. Greenhoot, A. F., & Dowsett, C. J. (2012). Secondary data analysis: An important tool for addressing developmental questions. *Journal of Cognition and Development*, 13(1), 2-18.
9. Hansen, M. T., & Deimler, M. S. (2001). Cutting costs while improving morale with B2E management. *MIT Sloan Management Review*, 43(1), 96-96.





Saguber Ali and Prabakaran

10. Izogo, E. E., & Jayawardhena, C. (2018). Online shopping experience in an emerging e-retailing market. *Journal of Research in Interactive Marketing*.
11. Javed, M. K., & Wu, M. (2020). Effects of online retailer after delivery services on repurchase intention: An empirical analysis of customers' past experience and future confidence with the retailer. *Journal of Retailing and Consumer Services*, 54, 101942.
12. Kersting, A., Brähler, E., Glaesmer, H., & Wagner, B. (2011). Prevalence of complicated grief in a representative population-based sample. *Journal of affective disorders*, 131(1-3), 339-343.
13. Katawetawaraks, C., & Wang, C. (2011). Online shopper behavior: Influences of online shopping decision. *Asian journal of business research*, 1(2).
14. Li, X., Zhao, X., Xu, W. (Ato), & Pu, W. (2020). Measuring ease of use of mobile applications in e-commerce retailing from the perspective of consumer online shopping behaviour patterns. *Journal of Retailing and Consumer Services*. <https://doi.org/10.1016/j.jretconser.2020.102093>
15. Loekamto, A. (2012). Implementasi technology acceptance model (TAM) dalam online shopping. *Kajian Ilmiah Mahasiswa Manajemen*, 1(3).
16. Octaviani, E. S., & Gunawan, H. (2018). Perceived Risk on Consumer Online Shopping Behaviour. *Journal of Applied Accounting and Taxation*. <https://doi.org/10.30871/jaat.v3i2.876>
17. Rita, P., Oliveira, T., & Farisa, A. (2019). The impact of e-service quality and customer satisfaction on customer behavior in online shopping. *Heliyon*, 5(10), e02690.
18. Rehman, S. U., Bhatti, A., Mohamed, R., & Ayoup, H. (2019). The moderating role of trust and commitment between consumer purchase intention and online shopping behavior in the context of Pakistan. *Journal of Global Entrepreneurship Research*. <https://doi.org/10.1186/s40497-019-0166-2>
19. Rahman, M. A., Islam, M. A., Esha, B. H., Sultana, N., & Chakravorty, S. (2018). Consumer buying behavior towards online shopping: An empirical study on Dhaka city, Bangladesh. *Cogent Business & Management*, 5(1), 1514940.
20. Shanthi, R., & Desti, K. (2015). Consumers' perception on online shopping. *Journal of Marketing and Consumer Research*, 13, 14-21.
21. Tham, K. W., Dastane, O., Johari, Z., & Ismail, N. B. (2019). Perceived risk factors affecting consumers' online shopping behaviour. *Journal of Asian Finance, Economics and Business*. <https://doi.org/10.13106/jafeb.2019.vol6.no4.246>
22. Tseng, C. H., & Wei, L. F. (2020). The efficiency of mobile media richness across different stages of online consumer behavior. *International Journal of Information Management*, 50, 353-364.
23. Vinerean, S. (2020). Understanding Consumers' Online Shopping Behavior during the Covid-19 Pandemic – Empirical Research. *Expert Journal of Marketing*.

Table 1 Age of the Science students

| S.NO | AGE (in years) | FREQUENCY | PERCENT |
|------|----------------|-----------|---------|
| 1 | 17-20 | 235 | 58.75 |
| 2 | 21-24 | 113 | 28.25 |
| 3 | Above 25 | 52 | 13.00 |
| | Total | 400 | 100 |

Table 2 Gender of the Science students

| S.NO | Gender | FREQUENCY | PERCENT |
|------|--------|-----------|---------|
| 1 | Male | 291 | 72.75 |
| 2 | Female | 109 | 27.25 |
| | Total | 400 | 100 |





Saguber Ali and Prabakaran

Table 3 Parent’s Monthly Income of the Science students

| S.NO | Parent’s Monthly Income (INR) | FREQUENCY | PERCENT |
|------|-------------------------------|-----------|---------|
| 1 | 10000-20000 | 261 | 65.25 |
| 2 | 21000- 40000 | 72 | 18.00 |
| 3 | Above 41000 | 67 | 16.75 |
| | Total | 400 | 100 |

Table 4 Educational Status of the Science Students

| S.NO | Educational Status | FREQUENCY | PERCENT |
|------|--------------------|-----------|---------|
| 1 | UG | 241 | 60.25 |
| 2 | PG | 153 | 38.25 |
| 3 | M.Phil or Ph.D. | 6 | 1.5 |
| | Total | 400 | 100 |

Table 5 : Factor Loadings

| | Loading Factors | | | | | |
|---|-----------------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Price normal offers | | | | | .631 | |
| Festival offers | | | | | .712 | |
| Traditional shopping online feedback | | | | | | .671 |
| Corporate brands | | | | | .679 | |
| Payment modes | | | | .612 | | |
| Worth of products | | | .513 | | | |
| Product features | | | .671 | | | |
| Convenience | | | | | .738 | |
| Privacy and Security | | | | .712 | | |
| Product information | .747 | | . | | | |
| Product filters | .812 | | | | | |
| Product and company research | | | .702 | | | |
| Availability | .618 | | . | | | |
| UI Website quality | | | | | | .707 |
| Product worth and information (online data) | | | | | | .618 |
| Delivery charges or free | | .703 | | | | |
| Return Policy of the products | | .599 | | | | |
| Money back guarantee | | .616 | | | | |

Table 6 Model Summary of Biology Science students ranking of overall online shopping buying experience

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|---------|----------|-------------------|----------------------------|
| 1 | .493(a) | .227 | .182 | .917 |

Table 7 Model Summary of Biology Science students purchasing Intention and visiting the online website again

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|---------|----------|-------------------|----------------------------|
| 1 | .423(a) | .218 | .197 | .930 |





Saguber Ali and Prabakaran

Table 8 Model Summary of Referral programs, testimonials and product feedbacks

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|---------|----------|-------------------|----------------------------|
| 1 | .451(a) | .201 | .165 | .873 |

Table 9 ANOVA(b)

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|-------|------------|----------------|-----|-------------|--------|---------|
| 1 | Regression | 82.017 | 1 | 69.023 | 91.635 | .000(a) |
| | Residual | 304.752 | 396 | .751 | | |
| | Total | 386.769 | 397 | | | |

Table 10 Coefficients (a)

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------|---|-----------------------------|------------|---------------------------|--------|------|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 3.123 | .164 | | 12.659 | .000 |
| | E-Commerce Factors Influencing Biology Science Students Online Shopping Buying Psychology | .383 | .037 | .461 | 9.627 | .000 |

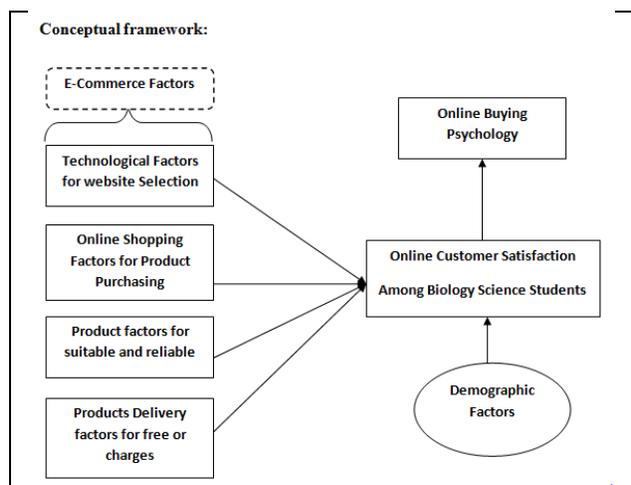


Figure 1: Conceptual framework

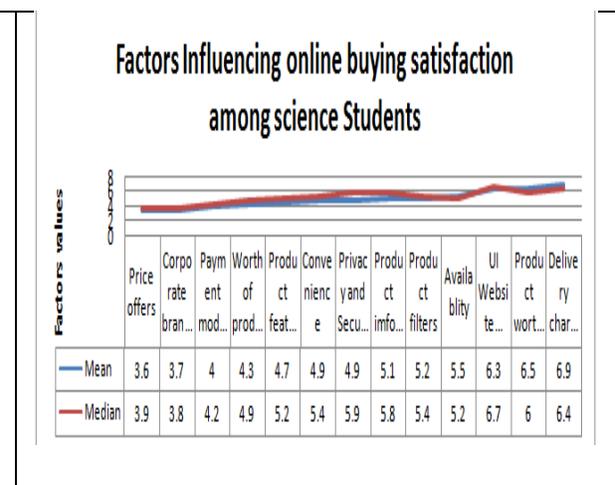


Figure 2: Factors influencing online buying satisfaction





Inclusion and Histopathological Bodies: Guide to Diagnosis

Saveetha Thakkanvar¹, Neeta Padmawar^{2*}, Vinayakumar Kulkarni³ and Minal Patil⁴

¹Reader, Department of Oral Pathology and Microbiology, Tatyasaheb Kore Dental College and Research Centre, Kolhapur, Maharashtra, India.

²Sr.Lecturer, Department of Paediatric and Preventive Dentistry, Rural Dental College, Pravara Institute of Medical Sciences (Deemed to be University), Loni (BK), Maharashtra India.

³Professor and HoD, Department of Pediatric and Preventive Dentistry, SMBT Dental College and Hospital and Post Graduate Research Center, Ghulewadi, Sangamner, Maharashtra, India.

⁴Sr.Lecturer, Dept. of Paediatric and Preventive Dentistry, Saraswati Dhanwantari Dental College and Hospital and Post-Graduate Research Institute, Dr Prafulla Patil Educational and Hospital Campus, Parbhani - 431401, Maharashtra, India.

Received: 21 Apr 2022

Revised: 13 June 2022

Accepted: 02 July 2022

*Address for Correspondence

Neeta Padmawar

Sr.Lecturer,

Department of Paediatric and Preventive Dentistry,

Rural Dental College, Pravara Institute of Medical Sciences (Deemed to be University),

Loni (BK), Maharashtra India..



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The histopathology marks a strong base for diagnosis. It broadly deals with many cellular and nuclear altered structures. One of the interesting and key features is the observation of various histopathological and inclusion bodies. The names of these inclusion bodies are usually associated with the name of the scientist who first described them. They may be seen within the nucleus, the cytoplasm or both. These are either intracellular or extracellular bodies, some may require special stains to demonstrate. These typical bodies are unique and an important diagnostic-aid in identifying the underlying disease Therefore this article presents compilation and description of various histopathological bodies characteristic of various diseases with their morphological features and staining reactions.

Keywords: Diagnosis, Histopathology, Inclusions, Stains.

INTRODUCTION

Histopathologic or inclusion bodies are nuclear or cytoplasmic aggregates of stainable substances, usually proteins. These usually show characteristic presentation which signifies the morphologic alterations in a highly specific pattern. Inclusion bodies can also be hallmarks of diseases[1]. These structures appear within the cell nucleus or the cytoplasm or both, and exhibit characteristic staining properties[2].





Mechanism of formation

Basically there are two broad descriptions for inclusion body formation. Firstly, the overproduction of certain proteins results in concentrations that exceed the solubility limit for the cytoplasm. Excess protein thus precipitates from solution, leaving a constant maximum concentration of protein in the cytoplasm; this model adopts equilibrium between both soluble and insoluble forms of the proteins. A mutation in single amino acid creates a hydrophobic surface patch that acts as a site for molecular contact, resulting in a fiber. The mechanism that best fits the available data requires at least two alternative protein folding pathways one which leads to a soluble native form of protein and the other to an inactive precipitated form[1,3].

Classification

- I. Physiological bodies.
 1. Odland bodies
 2. Weibel-palade bodies.
- II. Pathological bodies.
 1. Infections
 - Negri bodies
 - Henderson-Peterson bodies
 - Lipschutz bodies
 - Cowdry A
 - Cowdry B
 - Owl's eye bodies
 - Asteroid bodies
 - Councilman bodies
 2. Blood dyscrasias
 - Howell-jolly bodies
 - Heinz bodies
 3. Autoimmune disease
 - Civatte bodies
 - Schaumann bodies
 4. Neoplasm
 - Verocay bodies
 - Wagner- meissner bodies
 - Psammoma bodies
 5. Inflammatory conditions
 - Russell bodies
 - Rushton bodies

Physiological bodies

Odland Bodies Odland (lamellar) bodies were first described by Odland in 1960 as a distinctive submicroscopic granular component of size 200-300nm, seen in the upper spinous and granular cell layers. The small granules were probably attenuated mitochondria occurring due to fragmentation of the normal filamentous mitochondria [4]. They contain proteases, cathepsin D, kallikrein and other proteins including corneo-desmosins. Odland bodies are involved in desquamation of keratinocytes, formation of the cornified envelope and in local anti-microbial immunity and also important for maintaining homeostasis of the epidermis and are involved in epidermal permeability barrier function [5].

Weibel-palade bodies Ewald Weibel and George Palade first described these bodies in 1964[6]. Weibel-Palade bodies (WPBs) are elongated secretory organelles specific to endothelial cells that contain von Willebrand factor (VWF) and a variety of proteins that contribute to angiogenesis, inflammation and tissue repair. The remarkable architecture of WPBs is due to distinctive properties of their major constituent VWF[7].





Pathological bodies

Bodies seen in viral infections

Henderson-peterson bodies.

These are large bodies, measuring up to 35 microns in diameter. They are the result of a virally induced transformation process. Initially, the small virion particles are formed in the cytoplasm of the supra basal layer. These eosinophilic particles grow in size as they progress towards the granular cell layer, causing compression of the nucleus to the periphery of the infected epithelial cells [8]. (Fig 1). Wright's Giemsa stain, toluidine blue, Haematoxylin& eosin staining can be done to demonstrate these bodies [8,9].

Lipschutz bodies

These are eosinophilic, ovoid, homogenous structures within the nucleus, which tends to displace nucleolus and nuclear chromatin peripherally. The displacement of chromatin produces perinuclear halo. Commonly seen associated with herpes virus infections [10].

Cowdry bodies

Cowdry in 1934 described these inclusion bodies. Cowdry A type These are intranucleareosinophilic droplet-like bodies surrounded by a clear halo, with margination of chromatin on the nuclear membrane. They occur in diseases as herpes simplex infection or yellow fever. Hemorrhagic necrosis with intranuclear aggregates of herpes simplex viruses, apparently of nonspecific protein, are responsible for the granular appearance. Cowdry B type: Intranucleareosinophilicdroplet-like bodies surrounded by a clear halo, without any nuclear changes during early stages of development of the inclusion [11, 12].

Owl's eye inclusion bodies

Presents with characteristic intranuclear glassy-appearing basophilic inclusions with surrounding halo (owl's eye-type inclusion) and marked increase in the size of the cell (cytomegaly), particularly in tubular epithelial cells and in endothelial cells. The pathologic hallmark of cytomegalo virus infection is an enlarged cell with viral inclusion bodies [13,14, 15]. (Fig 2).

Negri bodies

Negri bodies are the characteristic histopathologic feature of rabies. They are sharply defined, eosinophilic inclusions present in the neuronal perikarya and proximal dendrites. These are spherical, and display a range of sizes and shape. Negri bodies are most common in the hippocampal pyramidal cells, cerebellar Purkinje cells, and brainstem nuclei. They are composed of granular and filamentous material, which signifies viral ribonucleoprotein, and peripheral, fully formed virions budding into the surrounding endoplasmic reticulum [16,17].Negri bodies can be stained by modified Heidenhain's iron haematoxylin [18].

Warthin- Finkeldey bodies

First noted by Warthin in 1931, later described by Finkeldey. These bodies are found in lymph nodes or throughout the reticuloendothelial system and are considered to be specific for, and in fact diagnostic of, measles. The cells contain anywhere from a few to many small nuclei arranged in small morules or in a "grape-like" cluster, surrounded by a small amount of eosinophilic or basophilic cytoplasm. The nuclei often resemble those of lymphocytes [19,20].

Dolhe bodies First reported by Dolhe in 1911. Döhle bodies are small, round or oval, pale blue-grey structures usually found at the periphery of the neutrophil. They consist of ribosomes and endoplasmic reticulum. They are seen in bacterial infections like scarlet fever, typhus, dyptheria, tuberculosis, but also following tissue damage including burns, in inflammation, following administration of G-CSF, in neutrophilic leukaemoid reactions [21,22].





Saveetha Thakkanvar *et al.*,

Bodies in blood dyscrasias

Howell-Jolly bodies William Henry Howell and Justin Marie Jolly described these structures. Howell-Jolly bodies are basophilic nuclear remnants (clusters of DNA) present in circulating erythrocyte. They are normally pitted out by the spleen during erythrocyte circulation, but will persist in individuals with functional hyposplenism or asplenia. Also seen in coeliac disease, radiation therapy, myelodysplastic syndrome [23, 24, 25].

Heinz bodies

First described by Robert Heinz in 1890 [26]. These are round, oval or serrated granules which are eccentrically placed and are very refractile. Sometimes they appear to protrude from a cell, as if hanging by a stalk, and frequently they can be observed outside the cells in the plasma [26, 27]. Commonly seen in hemolytic anemia, thalassemia, and Glucose 6-phosphate dehydrogenase deficiency. Heinz bodies are formed due to damaged DNA component, usually through oxidation or due to change in the internal morphology of amino acid residue within red blood cells. They are demonstrated with crystal violet and wright's stain [28].

Pappenheimer bodies Dr A. M. Pappenheimer described these structures in 1945. These are iron inclusions which appear as red–purple, usually coccoid, and seen adjacent to the cell membrane. They are demonstrated by Prussian blue stain, wright stain [29,30]. Pappenheimer bodies are seen in sideroblastic anemia, hemolytic anemias, and sickle cell disease [31].

Bodies seen in neoplasms

Verocay bodies

First described by Jose Juan Verocay in 1910. Verocay bodies are considered diagnostic of a schwannoma. These consist of a stacked arrangement of two rows of elongated palisading nuclei that alternates with acellular zones made up of cytoplasmic processes of the Schwann cells [32],(Fig 3). Such an arrangement of nuclei may be the result of an adaptive response to maintain cell-cell interaction which may otherwise be disrupted due to increased matrix deposition of laminin and phospholipids like lysophosphatidic acid (LPA) [33,34].

Wagner Meissner bodies

Whorled structures seen in typical Neurofibromatosis, particularly in diffuse histological type[35]. Meissner bodies are sensitive, tactile receptors concerted in the dermal papillae of the digital tips, palms, and soles. Meissner bodies are present at the apex of the gingival connective tissue papillae and function chiefly as sensitive receptors for touch stimuli. They appear as pale eosinophilic globules containing parallel slits within the cellular sheets. The globules composed of narrow elongated cells stacked in a lamellar arrangement. Meissner bodies are immunopositive for S-100 protein, neuron-specific enolase, and vimentin [36].

Psammoma bodies

The word “psammoma” is derived from a Greek word “psammos” meaning “sand.” These unique spherical structures were termed as “psammoma-like bodies” Golg. Ultrastructurally, psammoma-like bodies possess a dark rim of crystals from which small needle-like crystalloids project toward the periphery. Characteristically present in psammomatoid juvenile ossifying fibroma [37,38].

Dutcher bodies

Dutcher bodies are first described by Dutcher and Fahey (1959) [39]. These are PAS-positive, diastase-resistant nuclear pseudoinclusions of eosinophilic cytoplasm found in plasma cells. Ultrastructurally, these pseudoinclusions are formed by a cytoplasmic invagination into the nucleus. They are smooth, membrane-bound, and surrounded by clumped chromatin. The pseudo inclusions are thought to result from the accumulation of immunoglobulin in the perinuclearcisterna. Seen in patients with Waldenstrom macroglobulinaemia, myeloma, and lymphomas [40].

Russell bodies

First described by William Russell, in 1890 [41]. Russell bodies are considered to be aggregated unreleased immunoglobulin components, as a result of a block in the normal secretion pathway of immunoglobulins. They are





Saveetha Thakkanvar *et al.*,

stored within the rough endoplasmic reticulum of plasma cells and may totally fill up the cytoplasm and compress the nuclei. They mainly accumulate in plasma cells but may exist as smaller particles in extracellular locations as well [42]. (Fig 4)

Rushton bodies

These hyaline bodies were first noted by Dewey in 1918 but described by Martin A Rushton in 1955[43]. These structures measure about 0.1cm in length which are eosinophilic, peculiar, linear, curved or straight, polycyclic, glassy, occurring with variable frequency in the epithelial lining of odontogenic cysts [44] (Fig 5). They give positive reaction with orcein, Prussian blue, Aldehyde fuchsin, Congo red, Masson's trichrome stain.[43].

Civette bodies

known as Colloid bodies, hyaline bodies, cytoid bodies, apoptotic bodies. Civatte bodies are necrotic keratinocytes [45]. They are 10-25 µm in diameter, seen as rounded, homogenous, eosinophilic masses seen in the deeper parts of epidermis/epithelium and more frequently in connective tissue situated mostly within or above the inflammatory cell infiltrate. They are associated with Lichen planus, actinic cheilitis, and acute generalized exanthematouspustulosis, drug reaction with eosinophilia and systemic symptoms, granulomatous rosacea, dermatitis herpetiformis, keratosis follicularis, Darier's disease, familial benign chronic pemphigus [46].

CONCLUSION

Histopathological / inclusion bodies represent peculiar cytoplasmic or nuclear alterations. They also exhibit characteristic staining properties. As these are pathognomonic for certain diseases, knowledge about the morphology and the occurrence of these bodies provides an excellent clue to the diagnosis of the disease.

REFERENCES

1. Kruger. JK, Kulke. MH, Schutt.C, Stock J. Protein inclusion body formation and purification. Biofarm; 1989:40-45.
2. Naziya NJ, Jayanthi P, Harish RK, Rathy R, Sunil S. Histopathological bodies in oral pathology. Oral MaxillofacPathol J. 2017;8(2):114-117
3. Surinder. MS, Amulya.KP. Solubilization and refolding of bacterial inclusion body protein. Journal of bioscience and engineering.2005.99(4):303-310
4. Odland GF. A submicroscopic granular component in human epidermis. J Invest Dermatol 1960;34:11-5
5. Joshi R. Learning from eponyms: George F. Odland and Odland bodies. 2014; 5(3):334-338.
6. Weibel ER, Palade GE. New cytoplasmic components in arterial endothelia. J. Cell Biol. 1964; 23(1):101-112.
7. Valentijn KM, Sadler JE, Valentijn JA, Voorberg J, Eikenboom J. Functional architecture of Weibel-Palade bodies. Blood. 2011; 117(19): 5033-5043.
8. Rao K, Priya NS, Umadevi HS, Smitha T. Molluscumcontagiosum. J Oral MaxillofacPathol 2013 Jan-Apr; 17(1): 146-147.
9. Basak S, Rajurkar MN. Molluscumcontagiosum an update. Indian medical gazette.2013; 276-278.
10. Rajendran R, Shivapathsundharam B. Shafer's Textbook of Oral Pathology. 7th ed. viral infections of Oral Cavity. p. 343.
11. Eyons AS, Kaslow RA. Viral infections of humans: Epidemiology and control. B J biomed sci. 1998; 1029:813.
12. Margolis G, Kilham L, Baringer R. Identity of cowdry type B inclusions and nuclear bodies: observations in reovirus encephalitis. Experimental and molecular pathology.1975; 23(2):228-244.
13. Mattes F, Emery V, Clark D, Griffiths C.Histopathological detection of owl's eye inclusions is still specific for cytomegalovirus in the era of human herpesvirus and &. ClinPathol .2000; 53(8): 612-614.
14. Agnes B. Fogo, Mark A. Lusco, BehzadNajafian, Charles E. Alpers. AJKD Atlas of Renal Pathology: Cytomegalovirus Infection. Am J Kidney Dis. 2016; 68(6):e35-e36





Saveetha Thakkanvar et al.,

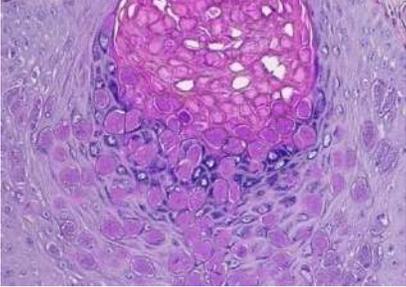
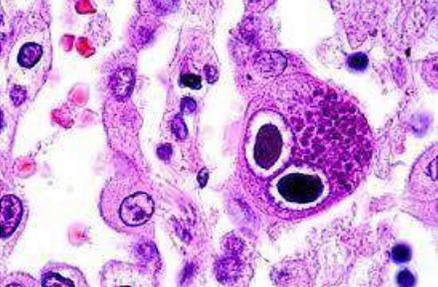
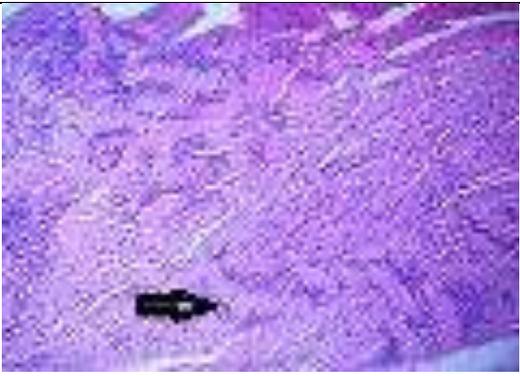
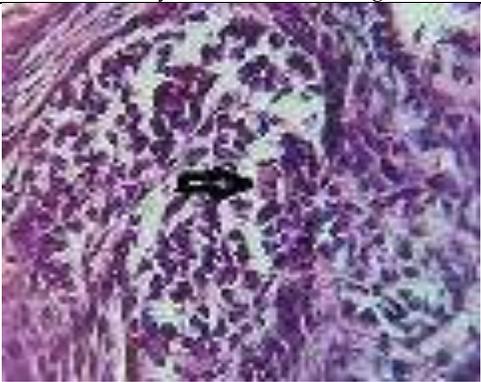
15. Goodman AL, Murray CD, Watkins J, Griffiths PD, Webster DP. CMV in the gut: a critical review of CMV detection in the immunocompetent host with colitis. *Eur J Clin Microbiol Infect Dis*. 2015; 34(1): 13–18.
16. Kimmo J, Hatanpaa, Jung H, Kim. Handbook of clinical neurology. Neuropathology of viral infections. 2014; 123: 193-214
17. Jack E. Moulton. A Histochemical Study of the Negri Bodies of Rabies. *Am J Pathol*. 1954 Jun; 30(3): 533–543.
18. Zlotnik I. A Selective Method for the Staining of Negri Bodies in Histological Brain Sections. *Nature* 1953; 172:962.
19. Janigan DT. Giant cell pneumonia and measles: An analytical review. *Canad. M. A. J*; 1961(85):741-749.
20. Robert M. Kliegman, Richard E, Behrman, Hal B. Jenson. Nelson textbook of paediatrics E book. Infectious diseases. P.1332
21. Bain BJ, Dacie and Lewis Practical Haematology. 12th ed. Blood Cell Morphology in Health and Disease. p.84.
22. J. A. Easton, Ch. Fessasthe Incidence of Döhle Bodies in Various Diseases and their Association with Thrombocytopenia. *Br J Haematol* 1966; 12:54-60.
23. Hutchison HE, Ferguson-smith MA. The significance of howell-jolly bodies in red cell precursors. *J. clin. Pathol*. 1959; 12: 451-453.
24. Dawson DW, Bury HP. The significance of Howell-Jolly bodies and giant metamyelocytes in marrow smears. *J Clin Pathol*. 1961 Jul; 14(4): 374–380.
25. Available from <https://www.humpath.com/Howell-jolly-bodies>.
26. Webster SH. Heinz body phenomenon in erythrocytes. *Blood* 1949 4:479-497.
27. Jacob HS, Winterhalter KH. The Role of Hemoglobin Heme Loss in Heinz Body Formation: Studies with Partially Heme-Deficient Hemoglobin and with Genetically Unstable Hemoglobins. *The Journal of Clinical Investigation* 1970; 49:2008-16.
28. Kulkarni M, Agrawal T, Dias V. Histopathological bodies: an insight. *J Int Clin Dent Tes Organ* 2011; 3(1):43-47.
29. Anthony A M, Ermens, Otten R. Pappenheimer bodies in a splenectomized patient with alcohol abuse. *Blood* 2012; 119:3878.
30. David A. Sears* and Mark M. Udden. Pappenheimer Bodies: A Brief Historical Review. *American Journal of Hematology* 2004; 75:249–250.
31. Wilson EC, Geddie AA, Orringer EP. Pappenheimer Bodies and Spuriously Elevated Platelet Counts. *JAMA* 1981; 246(9):938
32. Joshi R. Learning from eponyms: Jose Verocay and Verocay bodies, Antoni A and B areas, Nils Antoni and Schwannomas. *Indian dermatology online journal*. 2012; 3(3):215-219.
33. Reibel J, Wewer U, Albrechtsen R. The pattern of distribution of laminin in neurogenic tumors, granular cell tumors and nevi of the oral mucosa. *Acta Pathol Microbiol Immunol Scand* 1985; 93:41-7.
34. Weiner JA, Fukushima N, Contos JJ, Scherer SS, Chun J. Regulation of Schwann cell morphology and adhesion by receptor mediated lysophosphatidic acid signaling. *J Neurosci* 2001; 21:7069-78.
35. Nair PA, Kota RK. Solitary neurofibroma over cheek showing Wagner–Meissner bodies. *The Egypt J dermatol venereal* 2017; 37:26-27.
36. Ohno J, Iwahashi T, Ozasa R, Okamura K, Taniguchi K. Solitary neurofibroma of the gingiva with prominent differentiation of Meissner bodies: a case report. *Diagnostic Pathology* 2010, 5:61-67.
37. Tamgadge SA, Tamgadge AP, Bhatt DM, Bhalerao S, Periera T, Gotmare S. Juvenile ossifying fibroma (Psammomatoid Type) of the maxilla. *Scientific Journal*. 2009; 3:14–16.
38. Malathi N, Radhika T, Thamizhchelvan H, Ravindran R, Ramkumar S, Giri GVV, Deepika Gopal. Psammomatoid juvenile ossifying fibroma of the jaws. *J Oral Maxillofac Pathol*. 2011; 15(3): 326–329.
39. Eyre TA, Littlewood TJ, Bain BJ. Dutcher bodies: cytoplasmic inclusions within the nucleus. *British Journal of Haematology* 2014; 166: 946–957.
40. Gray Y, Schwartz S. Dutcher Bodies in Chronic Synovitis. *Arch Pathol Lab Med*. 2002; 126:199-201.
41. A. G. Everson Pearse. The nature of Russell bodies and kurloff bodies. *I. clin. Pathol*. 1949; 2: 81-88.
42. Verheij J, Jaspars EH, Paul van der Valk, Rozendaal L. Russell bodies in a skin biopsy: a case report. *Journal of Medical Case Reports* 2009; 3:108





Saveetha Thakkanvar et al.,

- 43. Babburi S, Rudraraju AR, Aparna V, Sowjanya P. Rushton Bodies: An Update. J ClinDiagn Res. 2015 Feb; 9(2): 1–3.
- 44. Rushton Martin A. Hyaline bodies in the epithelium of dental cysts. Proceedings of the Royal Society of Medicine. 1955; 48:407–09.
- 45. Weyers, Wolfgang. Civette bodies. Dermatopathology: Practical and conceptual.1998; 4(2):1-10.
- 46. Tanwar P, Arora SK, Chhabra S. Civatte Bodies: A Diagnostic Clue. Indian J Dermatol. 2013; 58(4): 327.

| | |
|---|---|
|  |  |
| <p>Figure 1: Shows Molluscum bodies. Large eosinophilic cells with cytoplasmic inclusions that displace nuclei and contain viral particles. (Courtesy: Jerad M Gardener, MD, University of Arkansas for Medical Sciences, USA.)</p> | <p>Figure 2: Owl's eye inclusion bodies: Enlarged cell with nuclear and cytoplasmic inclusions. Nuclear inclusions appear as owl's eye and cytoplasmic inclusions appear basophilic and granular. Courtesy: Danny L Wiedbrauk, PhD, Scientific Director, Virology & Molecular Biology, Warde Medical Laboratory, Ann Arbor, Michigan.</p> |
|  |  |
| <p>Figure 3: Verocay bodies: Elongated two rows of palisaded nuclei with a acellular zone</p> | <p>Figure 4: Shows Russell bodies. Round eosinophilic, refractile bodies devoid of nuclei.</p> |





Saveetha Thakkanvar *et al.*,

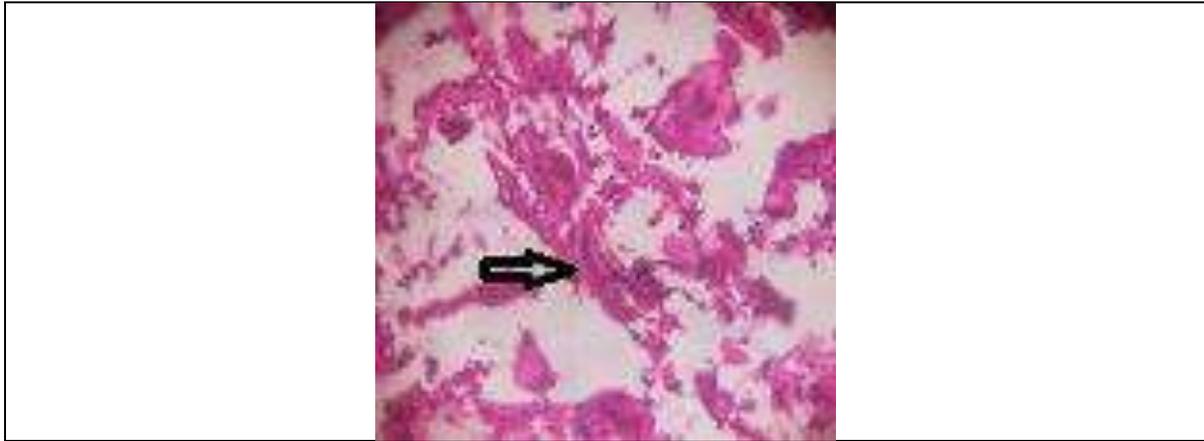


Figure 5: Shows Rushton bodies. Eosinophilic, hyaline, linear and curved structures.





Larvicidal Activity of Leaf Extracts of *Nicotiana rustica* and *Cedrus deodara* against Dengue Vector *aedes*

Rajesh Kumar Shah¹, Tamanna Begum², Mousumi Rai^{2*} and Parinita Devi Nath³

¹Assistant Professor, Dept. of Zoology, DHSK College, Dibrugarh, Assam, India

²Student, Dept. of Zoology, DHSK College, Dibrugarh, Assam, India

³Student, Dept. of Botany, Dibru College, Dibrugarh, Assam, India.

Received: 17 Apr 2022

Revised: 05 June 2022

Accepted: 07 July 2022

*Address for Correspondence

Mousumi Rai,

Student, Dept. of Zoology,

DHSK College, Dibrugarh, Assam, India.

Email: mousumirai3096@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The present study was undertaken to evaluate the larvicidal activity of two plant extracts *Nicotiana rustica* and *Cedrus deodara* against dengue vector *Aedes*. The methanolic and ethanolic extract of the plants were prepared and larvicidal activity was tested against third and fourth instar larvae of *Aedes* at different concentrations. The percent mortality of the larvae was recorded after 24 and 48 hours and LC₅₀ and LC₉₀ values were calculated. Both the plants showed significant larvicidal activity. From the present study it can be concluded that the tested medicinal plants can be used as potential larvicidal agent against mosquito vector *Aedes*.

Keywords: Larvicidal activity, *Nicotiana rustica*, *Cedrus deodara*, *Aedes*.

INTRODUCTION

Mosquitoes are a group of vectors that have important role in the transmission of various diseases such as malaria, chikungunya, Japanese encephalitis (JE), dengue and many more [1] and have been considered as “public enemy number one” by the WHO [2]. Dengue is a mosquito-borne infectious disease caused by one of the four serotypes of dengue virus DENVs 1-4 belonging to the family Flaviviridae. Dengue virus is transmitted by the bite of the female *Aedes* mosquitoes, mainly by *Aedes aegypti* [3]. Dengue has emerged as one of the fastest spreading mosquito-borne infectious diseases across the world and is endemic to many tropical and sub-tropical countries [4]. Its prevalence is seen across 129 countries and is estimated that about 3.9 billion people are at a high risk of infection. Studies have shown that about 390 million dengue cases are reported globally every year, out of which 96 million cases are clearly evident and around 40,000 deaths are reported every year [5]. Dengue is also a major health concern in India and it alone contributes about 33 million cases of the total global burden [6]. The outbreak of such infectious disease





Rajesh Kumar Shah *et al.*,

accompanied with high prevalence puts strain on the country's economy and health services [7] and therefore, there is an immediate need to control such disease causing vectors.

Chemical insecticides such as organophosphate and organochlorine compounds are extensively used to control mosquito vectors. However, mosquitoes have developed resistance to these insecticides due to their overuse and as a result it has become difficult in controlling them. Other problems of using such chemicals are that they are costly, have unfavourable effect on the environment, contaminate the soil, water and air. Also, they are non-biodegradable and have adverse effect on human health and on untargeted organisms as well. Therefore, alternative approaches or agents are being searched for that have promising insecticidal activities and highly effective in controlling mosquito vectors [8]. Medicinal plants are considered as potential alternative against synthetic insecticides. Plants contain different naturally occurring substances or chemicals known as phytochemicals like alkaloids, tannins, steroids, isoflavonoids, tannins and many others that have various medicinal as well as insecticidal properties [8][1]. Medicinal plants have been utilized in treating diseases as well as insecticides from the ancient past. Therefore, the use of plant and plant based products are becoming increasingly popular across the world. Also, the plant products are far better than synthetic insecticides as they are environment-friendly, less costly, easily degradable and acts on specific targets [9].

The present study was undertaken to evaluate the larvicidal activity of leaf extracts of the medicinal plants *Nicotiana rustica* and *Cedrus deodara* against dengue vector *Aedes*. There have been various reports of usage of these plants as traditional medicines and are known to have various medicinal properties. *Nicotiana rustica* is used as traditional medicines to treat ailments like skin problems, intestinal parasites, mental illness and many more [10]. Certain compounds like nicotine, pyridine, indole and d-limonene are reported in the leaves of the plant; thereby the leaves can be used as pesticides and mosquito repellents [11]. *Cedrus deodara* is also traditionally used in the treatment of skin diseases, asthma, microbial infections and many other diseases [12] and also as insecticides, pest deterrent against houseflies and storage pests [13].

MATERIALS AND METHODS

Collection of plant samples

Fresh leaves of *Nicotiana rustica* and *Cedrus deodara* were collected from different areas of Dibrugarh district during 2017 and were identified.

Preparation of the extract

Collected leaves were then washed under tap water and air-dried for 7 to 8 days in the shade at normal environmental temperature. The dried samples were then grounded into a fine powder using kitchen blender and stored in an air-tight container. 10 gm of the powdered samples were taken and soaked in two different solvents – methanol and ethanol for 48 hours. After 48 hours, solutions were filtered using a filter paper. Filtrates obtained were then evaporated until it completely dried and the extracts obtained were stored at a low temperature (4°C) until use.

Larvicidal Bioassay

Larvicidal bioassay was performed according to WHO guidelines with minimum modifications. 20 healthy larvae of late third and early fourth instar were selected and introduced in plastic cups with 99 ml of their natural growth medium (Tap water – untreated – dog biscuits and yeast added in the ratio 3:1). To this solution, 1 ml of different concentrations of plant extracts in DMSO (0.25, 0.5, 1 and 2 mg/ml) were added. The experiment was carried out in triplicates under appropriate control and the mortality of the larvae was recorded after 24 and 48 hours of their exposure.

The percent mortality was calculated using the formulae –

Percentage mortality = (Number of dead larvae / Number of larvae introduced) × 100.





Rajesh Kumar Shah *et al.*,

LC₅₀ (Lethal concentration that kills 50 percent of the exposed larvae) and LC₉₀ (Lethal concentration that kills 90 percent of the exposed larvae) were also calculated after 24 hours and 48 hours after treatment [14][15][16].

RESULTS

The result of larvicidal activity indicated that both plants, *Cedrus deodara* and *Nicotiana rustica* exhibited significant larvicidal activity. The larvicidal activity of ethanolic extract of *Nicotiana rustica* and *Cedrus deodara* is shown in Table 1. LC₅₀ and LC₉₀ for *Nicotiana rustica* were found to be 0.14 mg/ml and 1.89 mg/ml respectively. Similarly, LC₅₀ and LC₉₀ for *Cedrus deodara* were found to be 0.05 mg/ml and 1.92 mg/ml respectively. Results of larvicidal activity of methanolic extract of *Nicotiana rustica* and *Cedrus deodara* is shown in table 2. LC₅₀ and LC₉₀ for *Nicotiana rustica* were found to be 0.96 mg/ml and 1.37 mg/ml respectively. Likewise, LC₅₀ and LC₉₀ for *Cedrus deodara* were found to be 0.13 mg/ml and 1.67 mg/ml respectively.

DISCUSSION

Plants are a storehouse of various naturally occurring phytochemicals and many bioactive compounds. These compounds produced by the plants are known to possess medicinal and pesticidal properties [8] and can be used as insecticides, antifeedants, repellents and so on [1]. Several studies have also shown that plants have larvicidal properties that are effective in controlling mosquito vectors [17]. Larvicidal assay of medicinal plants has also been performed by many workers [1][18][19].

In the present study the alcoholic extracts of two medicinal plants *Nicotiana rustica* and *Cedrus deodara* were evaluated against *Aedes* mosquito. The results indicated that both the plants showed significant larvicidal activity. Both the plants are effective against *Aedes* mosquito and can be used as anti mosquito agents. Medicinal plants are viewed as potential alternative against the available chemical insecticides as they are cheaper, environment friendly, degradable and are easily available anywhere on Earth [8]. However, due to lack of information about the compounds present on the plants, there has not been any significant work carried on the plant-derived compounds against mosquito larvae. Further research for isolation of bioactive compounds that can be used as effective control against mosquito vectors is under progress.

INTEREST CONFLICT

There is no interest conflict.

REFERENCES

1. Shivakumar M S, Srinivasan, R, Natarajan, D. Larvicidal Potential of some Indian Medicinal Plant Extracts against *Aedes aegypti* (L.). Asian Journal of Pharmaceutical and Clinical Research 2013; 6(3):75–78.
2. Anonymous. Report of the WHO Informal Consultation on the evaluation and testing of insecticides, CTD/WHO PES/IC/96.1. World Health Organization, Geneva 1996; 69.
3. Anonymous. Dengue and severe dengue. World Health Organization 2022.
4. Khetarpal, N, Khanna, I. Dengue Fever : Causes, Complications, and Vaccine Strategies. Journal of Immunology Research 2016.
5. Anonymous. Vector-borne diseases. World Health Organization 2022.
6. Shet, Anita, Kang, Gagandeep. Dengue in India: Towards a better understanding of priorities and progress. International Journal of Infectious Diseases 2019; S1-S3.
7. Ganeshkumar, P, Murhekar, MV, Poornima, V, Saravanakumar, V, Sukumaran, K, Anandaselvasankar, A, *et al.* Dengue infection in India: A systematic review and meta-analysis. PLOS Neglected Tropical Diseases 2018; 12(7).
8. Ghosh, Anupam, Chowdhury, Nandita, Chandra, Goutam. Plant extracts as potential mosquito larvicides. The Indian Journal of Medical Research 2012; 135(5): 581-598.





Rajesh Kumar Shah *et al.*,

9. Rodrigues, AMS, Paula, JE De, Degallier, N, Molez, JF, Espindola, LS. Larvicidal Activity of some Cerrado Plant Extracts against *Aedes aegypti*. Journal of the American Mosquito Control Association 2006; 22(2): 314–317.
10. Berlowitz, I, Torres, EG, Walt, H, Wolf, U, Maake, C, Martin-Soelch, C. “Tobacco is the Chief Medicinal Plant in My Work”: Therapeutic Uses of Tobacco in Peruvian Amazonian Medicine Exemplified by the Work of a *Maestro Tabaquero*. Frontiers in Pharmacology 2020.
11. Lamria, G, Gozan, M, Fauzantoro, A, Virgine, KA. Utilization of *Nicotianatobacum*'s extract for mosquito extermination with fogging method. The 4th Biomedical Engineering's Recent Progress in Biomaterials, Drugs Development, Health, and Medical Devices 2019.
12. Bisht, A, Jain, S, Misra, A, Dwivedi, J, Paliwal, S, Sharma, S. Cedrus deodara (Roxb. ex D.Don) G.Don: A review of traditional use, phytochemical composition and pharmacology. Journal of Ethno pharmacology 2021; 279.
13. Buner, ID, Yousuf, M, Attaullah, M, Afridi, S, Anjum, SI, Rana, H, *et al.* A comparative toxic effect of *Cedrus deodara* oil on larval protein contents and its behavioral effect on larvae of mealworm beetle (*Tenebrio molitor*) (Coleoptera: Tenebrionidae). Saudi Journal of Biological Sciences 2017; 26: 281-285.
14. Anonymous. Instructions for determining the susceptibility for resistance of mosquito larvae to insecticides. World Health Organization/VBC 1981; 81: 807-962.
15. Rathy, MC, Sajith, U, Harilal, CC. Larvicidal efficacy of medicinal plant extracts against the vector mosquito *Aedes albopictus*. International Journal of Mosquito Research 2012; 2(2): 80-82.
16. Rajasekaran, A, Duraikannan, G. Larvicidal activity of plant extracts on *Aedes Aegypti* L. Asian Pacific Journal of Tropical Biomedicine 2012; 2(3): S1578-S1582.
17. Yang, Y-C, Park, I-K, Kim, E-H, Lee, H-S, Ahn, Y-J. Larvicidal Activity of Medicinal Plant Extracts Against *Aedes aegypti* , *Ochlerotatus togoi* , and *Culex pipiens pallens* (Diptera : Culicidae). Journal of Asia-Pacific Entomology 2004; 7(2): 227–232. [https://doi.org/10.1016/S1226-8615\(08\)60220-4](https://doi.org/10.1016/S1226-8615(08)60220-4).
18. Raveen, R, Kumar, L, Sugirtha, A, Karthikeyan, N, Tennyson, S, Arivoli, S *et al.* Efficacy of Tobacco Leaf Extracts on the Larva of the Dengue Vector Mosquito. Global Journal of Science Frontier Research 2019; 19(1).
19. Govindarajan, M, Sivakumar, R, Amsath, A, Niraimathi, S. Larvicidal efficacy of botanical extracts against two important vector mosquitoes. European Review for Medical and Pharmacological Sciences 2012; 16: 386-392.

Table 1: Larvicidal activity of ethanolic extract of *Nicotiana rustica* and *Cedrus deodara*.

| Plants | Concentrations (mg/ml) | Percentage mortality | Mean ± S.D. |
|--------------------------|-------------------------|----------------------|-------------|
| <i>Nicotiana rustica</i> | 0.25 | 50 | 50±0 |
| | 0.5 | 70 | 70±14.14 |
| | 1 | 75 | 75±7.07 |
| | 2 | 90 | 90±0 |
| <i>Cedrus deodara</i> | 0.25 | 55 | 55±7.07 |
| | 0.5 | 60 | 60±0 |
| | 1 | 75 | 75±7.07 |
| | 2 | 90 | 90±0 |

Table 2: Larvicidal activity of methanolic extract of *Nicotiana rustica* and *Cedrus deodara*.

| Plants used | Concentrations (in mg/ml) | Percentage mortality | Mean ± S.D. |
|--------------------------|---------------------------|----------------------|-------------|
| <i>Nicotiana rustica</i> | 0.25 | 70 | 70±14.14 |
| | 0.5 | 75 | 75±7.07 |
| | 1 | 85 | 85±7.07 |
| | 2 | 100 | 100±0 |
| <i>Cedrus deodara</i> | 0.25 | 55 | 55±7.07 |
| | 0.5 | 65 | 65±7.07 |
| | 1 | 80 | 80±14.14 |
| | 2 | 95 | 95±7.07 |





A Comparison on GLCM and Gabor Filter for Fabric Defect Detection

S.Valarmathi* and R.Nithya

Assistant Professor, School of Computing Science, KPR College of Arts Science and Research, Coimbatore, Tamil Nadu, India.

Received: 26 May 2022

Revised: 28 June 2022

Accepted: 09 July 2022

*Address for Correspondence

S.Valarmathi

Assistant Professor,
School of Computing Science,
KPR College of Arts Science and Research,
Coimbatore, Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In the textile production, defect detection acts an integral part since defects in a fabric may drastically reduces the profit which also leads to the deviation in the quality control. Due to the inattentiveness and various factors, human experts cannot able to detect defects accurately. So, an automatic robust fabric defect detection system can be built which would produce more accurate defects at a faster rate. This automatic system can be built using several approaches but to maintain robustness and to produce accurate results statistical based approach Gray-Level Co-occurrence Matrix (GLCM) is used and it is compared with Gabor filter approach. In this system, GLCM texture statistics such as Contrast, Energy, Homogeneity and Correlation are extracted for the fabric samples. In Gabor filter based approach, Gabor filter bank is generated with different levels of scale and orientation degrees and with the convolution mask, the fabric samples are filtered. The energy responses can be compared to find the defect decision. The comparative analysis shows that GLCM approach produces more accurate results than Gabor filter approach and the results are summarized.

Keywords: Defect Detection, Quality Control, Gray-Level Co-occurrence Matrix (GLCM), Gabor filter, Gabor filter bank, Convolution mask.

INTRODUCTION

In common, the woven fabric image is considered to be a real textured image. Detecting fabric defects in a fabric is one of the most fascinating processes in computer vision which grabbed many researchers attention over the years. As fabric defects reduces the manufacturers profit by 50-60% [1], careful inspections must be carried out in the textile industry in order to maintain high quality standards and to increase the financial graph of the company. The defects must be detected and reported earlier before raw fabrics are sent to the garment manufacturing unit in order to prevent huge loss as it is considered to be the key issue.





Valarmathi and Nithya

Ideally, web fabric is 1-4m wide and it is processed at a speed of 25-250m/min. The contemporary system is very manual and it is performed by the human experts. Moreover, they can only predict 50% defects in a fabric running at a speed of 35m/min. So, in order to increase the quality and defect detection ratio, an automated robust fabric defect detection system can be built which can be so consistent and more reliable in quality [2]. However, due to distinct features, the automated fabric defect detection system becomes reasonably challenging. Some of the features are listed below.

- a. Different and huge variety of fabric textures has to be inspected.
- b. Fabric defects may take more than one form and it's difficult to classify.

In this paper, GLCM and Gabor filter based approach is followed to detect fabric defects the results are compared with the Gabor filter based approach. In section II, few related works have been discussed while in section III, fabric defects are discussed. In section IV, GLCM based approach and Gabor filter based approach are discussed and implemented. The performance evaluation and comparison is done in section V and finally the conclusion is drawn in section VI.

RELATED WORK

Most commonly used approaches for fabric defect identification is GLCM which is statistical based approach and the other is Gabor filter which is spectral based approach. However, it can also be achieved through various different models. Karayiannis [3] proposed a defect detection system using multi-resolution decomposition technique. Cohen [4] proposed a Gauss Markov Random Field model in which hypothesis testing was used for the inspection purpose where the statistics are derived from the random field model and for defect classification, Back propagation Neural network with power spectrum was used. Zuo [5] used GLCM along with Euclidean distance and for texture enhancement, NL-means filtering technique was used to find defects which achieved an accuracy of 88.79%. Siew [6] used Spatial Grey Level Dependence Matrix for carpet wears and other GLCM based techniques were also discussed for the fabric defect detection. Tsai [7] used only two fabric features for the defect detection and achieved a classification accuracy of 96%. Connors [8] used six different GLCM fabric features to detect nine different wood surface defects. Connors also deployed GLCM-based strategy on DSP kit. The second-order statistics are most commonly used reliable features derived from the Spatial Gray-Level Co-occurrence Matrices. Fourier-based methods are used since the fabric texture shows high periodicity which distinguish the spatial-frequency distribution, but the spatial domain information was not considered [9].

Shu [10] discussed Gabor filters as a combination of both spatial and spatial-frequency representation which contains high-specific frequency and orientation features for textured image analysis. Alimohamadi [11] produced 3.2% of false rate on 71 images where 39 images were flawless. Runping [12] achieved an accuracy of 95.24% while using 42 images.

FABRIC DEFECTS

A Fabric defect is any irregularity or flaws in the fabric which leads to a deviation in the quality control. Nowadays, consumers are well aware of fabric quality, so delivering quality fabrics are important to satisfy customer requirements as well as to increase company's profit. Based on the acceptance level, the defects are classified into three types, Critical, Major and Minor. Some of the major defects are holes, stitches, knots, oil stains and marks, double pick, crack and so on. Few defects are shown below in Figure 1.

FABRIC DEFECT DETECTION

Many automated fabric defect detection systems were developed in recent times employing different strategies, as detailed in the preceding section. Two different methods for identifying fabric flaws are carried out in this study. A statistical method called Gray-level co-occurrence Matrix (GLCM) and a linear filter-based approach called Gabor filter are used to identify fabric flaws. The performance of two defect detection approaches is tested and compared in this experiment. The techniques and their implementations are discussed in the sections that follow.





Valarmathi and Nithya

GLCM based approach

A statistical way of inspecting textures which determines the spatial relationship of pixels is the Gray-Level Co-occurrence Matrix (GLCM). The co-occurrence probabilities give a second order technique for creating texture characteristics. According to Haralick [13], the matrix includes the conditional joint probability of all pair-wise possibilities of grey levels provided with two parameters: inter-pixel distance (d) and inter-pixel orientation (θ). According to Barber [14], the probability measure is defined as follows:

$$P_r(x) = \{C_{ij} | (d, \theta)\} \quad (1)$$

Where C_{ij} is described as:
$$C_{ij} = \frac{P_{ij}}{\sum_{i,j=1}^G P_{i,j}} \quad (2)$$

The number of occurrences of grey levels g_i, g_j is represented by P_{ij} , while the total number of grey levels is represented by G . The total number of grey level pairings within a window with a specific (d, θ) is represented by the denominator sum. Normally, the distance between pixels is less than ten, and only four orientations are used: 0, 45, 90, and 135 degrees. As a result, 180 degrees is equivalent to 0 degrees while 225 degrees is equivalent to 5 degrees. The four most widely used GLCM texture statistics are as follows:

$$\text{Contrast} = \sum_{i,j=1}^G C_{ij} (i-j)^2 \quad (3)$$

$$\text{Homogeneity} = \sum_{i,j=1}^G \frac{1}{1+|i-j|} C_{ij} \quad (4)$$

$$\text{Correlation} = \sum_{i,j=1}^G \frac{(i-\mu_i)(j-\mu_j)}{\sigma_i \sigma_j} C_{ij} \quad (5)$$

$$\text{Energy} = \sum_{i,j=1}^G C^2_{i,j} \quad (6)$$

The average of the four orientations can be utilised, and various statistical information for each GLCM can be discovered in addition to the ones described above.

GLCM and Gabor filter process flow was shown in Figure 2. In this subsection, GLCM based defect detection approach is described. The process is carried out on considering two important parameters such as distance between the pixel pair (d) and θ which is their angular relation. Normally, the GLCM is processed in a small window that scans the full sample. Before processing GLCM, the defect-free image and the defected image samples are converted to gray scale image. The produced GLCM are calculated for various displacements from which the distances may vary. The GLCM is normalized before texture computation and it is represented in probability.

In this work, the basic GLCM features such as: Contrast, Homogeneity, Energy and correlation are considered to produce effective results. The defect detection can be done by extracting the statistical information of the defected and defect-free fabric samples by varying d values using four GLCM features and it is compared. When both outcomes are the same, the cloth is defect-free; otherwise, it is defective.





Valarmathi and Nithya

Gabor filter based approach

Gabor filter performs well in both spatial and spatial frequency domain. On using different scales and orientations, the Gabor filter decomposes the image into various components. In two-dimensional plane, the impulse response can take the below form [15, 16].

$$h(x, y) = \frac{1}{2\pi\sigma_x\sigma_y} \exp\left\{-0.5\left[\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right]\right\} \exp\{j2\pi Fx\} \quad (7)$$

Where F is a radial frequency and σ_x , σ_y are the space constants along x and y axes.

The Gabor filter with orientation and frequency by co-ordinate rotation can be expressed as,

$$h'(x, y) = \frac{1}{2\pi\sigma_x\sigma_y} \exp\left\{-0.5\left[\frac{x'^2}{\sigma_x^2} + \frac{y'^2}{\sigma_y^2}\right]\right\} \exp\{j2\pi Fx'\} \quad (8)$$

Where $x' = \beta^{-p}(x \cdot \cos\theta_q + y \cdot \sin\theta_q)$, $y' = \beta^{-p}(-x \cdot \sin\theta_q + y \cdot \cos\theta_q)$

x and y are initial co-ordinates and x' and y' are co-ordinates after rotation.

A bank of Gabor filters are formed by changing different scales and orientations. Each Gabor filter contains both real and imaginary parts processed as spatial mask of N*N sizes. The impulse response of the real and imaginary parts of the Gabor filter in spatial domain can be calculated.

In common, Gabor filter works well in both spatial and frequency domain. In this approach, both odd and even symmetric Gabor filters are used for better results as odd symmetric filter detects edge defects and even symmetric filters detects blobs. The dimension of the filter mask is N*N and the parameters considered here are number of orientations, number of scales and size of filter mask for texture extraction. Alternatively the parameters are changed and kept constant for several instants. As a result, here it cannot able to capture similar images when using different filters and also it is so expensive to implement.

EXPERIMENTAL RESULTS

The experimental findings of the GLCM and Gabor filter are detailed in this section. The GLCM statistical features included in this study are investigated based on feature values, and both defective and defect-free fabric samples are shown for visibility in Figure 3. The GLCM statistical features such as contrast, homogeneity, correlation and energy and its difference values taken from the fabric samples are described. The feature values are as follows: contrast difference = 0.0059, homogeneity difference = 0.0065, correlation difference = 0.0136 and energy difference = 0.0018.

Performance evaluation of GLCM approach

The effectiveness of the GLCM is evaluated by using database containing 50 fabric samples of which 25 are defective and other 25 are defect-free. The materials in the database are mostly regular, plain, and jeans woven fabrics, however other patterns are also included. The fabric samples used in this test are 512 x 512 pixels and have an 8 bit grey level. The three primary factors investigated were $d = 1$, $\theta = 0^\circ$ and various window values. The size of the window is to be defined by two contrasting elements: the amount of operations and the precision of fault detection. Table 1 shows the performance evaluation of GLCM based on True Detection (TD), False Detection (FD), and Missed Detection (MD) T1 is the sum of TD, FD and MD. The GLCM-based approach has achieved 98% of true detection, 2% of false detection and no missed detections were found.

Performance evaluation of Gabor filter approach

The effectiveness of the Gabor filter is evaluated using the same set of fabric samples which was considered for GLCM experiment. Each filter in the filter bank is deployed as three mask sizes; 8 x 8, 16 x 16, and 32 x 32 with three possible scale and orientation combinations. The best results were obtained using 32 x 32 masks, while the 8 x 8 mask does not provide the best defect information. As a consequence, the results for 32 x 32 masks with scale 5 and



**Valarmathi and Nithya**

orientation 8 are presented. Table 2 shows the performance evaluation of Gabor filter. Figures 4 demonstrate a bank of 40 even and odd symmetric Gabor filters, respectively. The Gabor filter-based approach has achieved 94% of true detection, 4% of false detection and 2% of missed detection were found. The comparative analysis of two techniques shows that GLCM based approach outperformed the Gabor filter based approach in terms of true positive detection accuracy. The Gabor filter may achieve good results when the filter bank parameters are well tuned and optimized. The GLCM based approach achieved greater defect detection rate as 98% whereas Gabor filter based approach achieved 94% of defect detection as the results are summarized.

CONCLUSION

Defect detection techniques are often divided into two groups. They are Supervised and Unsupervised, where the supervised technique may not be applicable to all fault types and the unsupervised approach is more sophisticated. In this research, two unsupervised approaches for defect identification are applied and compared concurrently. Initially, pre-processing techniques like as segmentation, noise reduction, and so forth are used. The output is then transferred to the feature extraction process through the GLCM and Gabor filter bank. The system's performance is assessed using a range of fabric datasets. When compared to the Gabor filter, the output reveals that the GLCM detects the majority of the faults correctly.

REFERENCES

1. K. Srinivasan, P.H. Dastoor, P. Radhakrishnaiah, S. Jayaraman, FDAS: A knowledge-based framework for analysis of defects in woven textile structures, *J. Textile Inst.* 83 (3 (pt. 1)) (1992) 431–448.
2. C. Cho, B. hung, M. Park, Development of Real-Time Vision-Based Fabric Inspection System, *IEEE Trans. Ind. Electron.* 52 (4 (August)) (2005) 1073–1079.
3. Y.A Karayiannis, R. Stojanovic, P. Mitropoulos, C. Koulamas, T. Stouraitis, S. Koubias, G. Papadopoulos, Defect Detection and Classification on web textile fabric using multiresolution decomposition and neural networks, in: *Proceedings of 6th IEEE International Conference on Electronics, Circuits and Systems*, 5-8 September, 1999, pp. 765-768.
4. F.S. Cohen, Z. Fan, S. Auali, Automated Inspection of textile fabrics using textural models, *IEEE Trans. Pattern Anal. Mach. Intell.* 13 (8) (1991) 803-808.
5. H. Zuo, Y. Wang, X. Yang, X. Wang, Fabric defect detection based on texture enhancement, in: *Image and Signal Processing (CISP)*, 2012 5th International Congress on, 16-18 October, 2012, pp. 876-880.
6. L.H. Siew, R.M. Rodgson, E.J. Wood, Texture measures for carpet wear assessment, *IEEE Trans. Pattern Anal. Mach. Intell.* 10 (1) (1988) 92-105.
7. Tsai, C. Lin, J.I. Lin, Applying an artificial neural network to pattern recognition in fabric defects, *Text. Res. J.* 65 (1995) 123-130.
8. R.W. Connors, C.A. Harlow, A theoretical comparison of texture algorithms, *IEEE Trans. Pattern Anal. Mach. Intell. PAMI-2* (3) (1980) 204-222.
9. J.L. Raheja, B. Ajay, A. Chaudhary, Real time fabric defect detection system on an embedded DSP platform, *Optik* (2013).
10. Shu, Z. Tan, Fabric defects automatic detection using Gabor filters, in: *Intelligent Control and Automation, 2004. WCICA, 2004, Fifth World Congress on*, vol.4, 15-19 June, 2004, pp. 3378-3380.
11. Kumar, G. Pang, Defect detection in textured materials using Gabor filters, in: *Industry Applications Conference, 2000. Conference Record of the 2000 IEEE*, vol. 2, 2000, pp. 1041-1047.
12. R. Han, L. Zhang, Fabric defect detection method based on Gabor filter mask, in: *Intelligent Systems 2009. GCIS'09. WRI Global Congress on* vol. 3, 19-21 May, 2009, pp. 184-188.
13. R.M. Haralick, Statistical and structural approaches to texture, in: *Proceedings of the IEEE*, vol. 67, 1979, pp. 786-804.





Valarmathi and Nithya

14. D.G. Barber, E.F. LeDrew, SAR sea ice discrimination using texture statistics: a multivariate approach, Photogrammetric Engineering and Remote Sensing 57 (4(April)) (1991) 385-395.
 15. B.S. Manjunath, W.Y. Ma, Texture features for browsing and retrieval of image data, IEEE Trans. Pattern Anal. Machine Intell. 18 (8 (August)) (1996) 837-842.
 16. H.W. Tang, V. Srinivasan, S.H. Ong, Texture segmentation via nonlinear interactions among Gabor feature pairs, Opt. Eng. 34 (1995) 125-134.

Table 1. Performance evaluation of GLCM technique

| Performance evaluation | True Detection (TD) | False Detection (FD) | Missed Detection (MD) | T1=TD+FD+MD |
|------------------------|---------------------|----------------------|-----------------------|-------------|
| No. of samples | 49 | 1 | 0 | 50 |
| Defect detection in % | 98 | 2 | 0 | 100 |

Table 2. Performance evaluation of Gabor filter technique

| Performance evaluation | True Detection (TD) | False Detection (FD) | Missed Detection (MD) | T1=TD+FD+MD |
|------------------------|---------------------|----------------------|-----------------------|-------------|
| No. of samples | 47 | 2 | 1 | 50 |
| Defect detection in % | 94 | 4 | 2 | 100 |

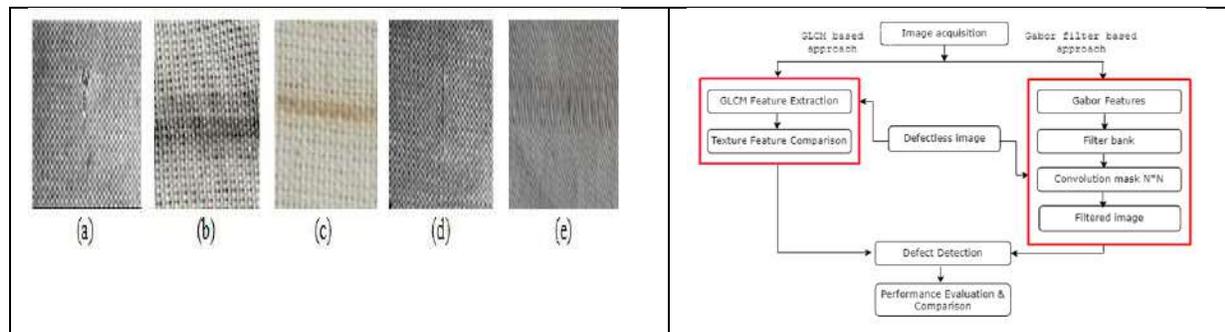


Figure 1. Defected fabric samples. (a) Holes (b) Oil mark (c) Oil stain (d) Stitches (e) Weft crack

Figure 2. GLCM and Gabor filter process flow for detecting fabric flaws

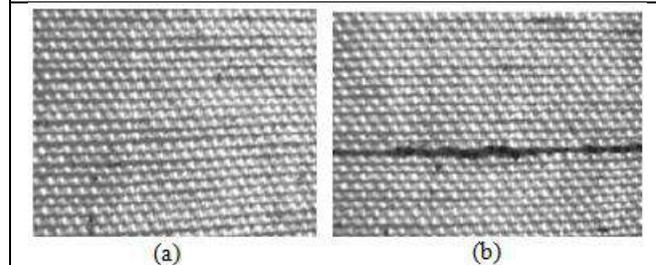


Figure 3. (a) Defect-free fabric (b) Defective fabric

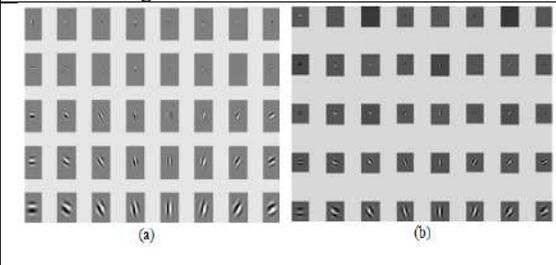


Figure 4. Gabor filter bank. (a) Odd symmetric (b) Even symmetric





Adsorption and Removal Pollutants from Aqueous Solution using Low Cost Adsorbent

R.Sivakumar^{1*}, P.Jegajeevanram¹ and M.K.Murali²

¹Assistant Professor, Department of Chemistry, J.J College of Arts and Science (Autonomous), (Affiliated to Bharathidasan University, Tiruchirappalli), Pudukkottai, Tamil Nadu, India.

²Assistant Professor, Department of Physics, J.J College of Arts and Science (Autonomous), (Affiliated to Bharathidasan University, Tiruchirappalli), Pudukkottai, Tamil Nadu, India.

Received: 01 June 2022

Revised: 16 June 2022

Accepted: 08 July 2022

*Address for Correspondence

R.Sivakumar

Assistant Professor,
Department of Chemistry,
J.J College of Arts and Science (Autonomous),
(Affiliated to Bharathidasan University,
Tiruchirappalli), Pudukkottai,
Tamil Nadu, India.
Email: sivachemjj86@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The work ambitions at adsorption studies of Rhoda mine-B Dye (Rh-B) from aqueous solution onto activated nano carbon prepared from *Senna alata* Bark by way of acid remedy was tested for its efficiency in casting off Rh-B dyes. The process parameters studied consist of agitation time, initial Rh-B dyes concentration, adsorbent dose, pH and temperature. The adsorption facts had been correlated with Langmuir, Freundlich isotherm models. The adsorption accompanied second order response equation and the rate is mainly controlled by means of intra-particle diffusion. The Activated *Senna alata* Bark nano carbon has high adsorption capacity and adsorption rate for the elimination of Rh-B dyes from aqueous solution.

Keywords: Adsorption, Rhodamine-B dyes, Kinetics, Activated *Senna alata* Bark Nano Carbon (SABC).

INTRODUCTION

One of the most essential environmental issues confronted the human in closing century and current century are the treatment of waste water due to growing in industrial chemical effluents generated from rubber, plastic, leather-based and textile processing flora comprise unique styles of synthetic dyes, which include malachite green, methyl violet, indigo carmine and Rhodamine B [1]. The discharge of these dyes into the receiving waters produce



**Sivakumar et al.,**

negative biological and ecological results, which have the propensity of inhibiting aquatic boom and therefore ensuing in the loss of life of aquatic species. Synthetic dyes are complicated in nature due to their fragrant structures, which are no biodegradable as a result of their optical, thermal and physic chemical balance [2, 3]. Due to the complexity of the shape and thermal balance of artificial dyes in water, organic methods of treatment were less successful [4]. To reduce the dyes in industrial water effluents physical, chemical, bio- chemical and organic strategies consisting of photocatalytic degradation, extraction, chemical oxidation, microbiological decomposition, ion change, adsorption on activated carbon, combined of adsorption and degradation and ultrasonic decomposition have been applied with particularly value [5]. The adsorption on agriculture waste has benefit of low fee and high efficiency compared to different techniques. The activated carbon derived from agriculture waste along with Jackfruit peel [6], walnut shell [7], palm shell [8] extensively utilized to removal the Rh-B with nicely percent elimination but the activation procedure and carbonization manner extra cost make the activated carbon now not economic as compared to direct use of low fee agriculture waste.

The aim of currently article is to introduce the novel low value adsorbent for removal of Rh-B from aqueous solution and get the most appropriate situation of adsorption such as preliminary awareness, pH, touch time and adsorbent dose. The adsorption isotherm includes Langmuir and Freundlich have been used to test the adsorption statistics. The kinetic information analysis with the aid of rate equation to reap the order of adsorption reaction.

MATERIALS AND METHODS

Chemicals

All the chemical compounds hired in the present look at have been commercially available high purity Analar grade (Merck India or SRL India) and have been used as obtained. Double distilled water became used in the course of the work.

Preparations of dye solutions

The dyes hired for the adsorption research inside the present work is Rhodamine-B. Dyes for the study had been commercially available high purity Analar grade (Merck India) and used without similarly purification. Stock solution (1000 Rh-B/L) of the dyes was prepared via dissolving required amount of the Rh-B dye in one liter of distilled water.

Preparation of Adsorbent

The herbal plant cloth *Senna alata* Bark become accrued from nearby Thiruvarur district, Tamilnadu, India the leaves had been washed with distilled water numerous instances to eliminate the dirt and dirt and become Carbonized with concentrated Sulphuric acid (w/v) and washed with water. Afterward, the primary carbon became activated at 1100°C for 8 hrs in a muffle furnace to reap activated carbon. The activated carbon became there after kept at room temperature in an inert surroundings of nitrogen and washed with warm distilled water and 0.5 N Hydrochloric and till the pH of the fabric reached 7.0 the activated carbon turned into also dried in a hot air oven at a 110°C, ground properly and sieved to achieve the preferred unique size and stored in desiccators for similarly use.

Characterization of SABC adsorbent

The extensive usefulness of *Senna alata* bark nano carbon (SABC) is a result of its unique surface area, high chemical and mechanical balance. The chemical nature and pore structure typically determine the sorption activity [9]. The SABC applied within the studies characterized [10-12] as follows





METHODOLOGY

Concentration of the Rh-B dyes earlier than and after adsorption become measured the usage of a UV-Visible double beam spectrophotometer (Systronics 2203). Standards for the established order of calibration treatment for UV-Visible spectrophotometer analysis become prepared by way of diluting the inventory solutions if you want to have 25 to 125 Rh-B/L of the Rh-B dyes and the absorbance of the solution on the respective wave length changed into recorded. The wave duration of most absorbance for Rhodamine-B is 554 nm.

Adsorption Study

To take a look at the impact of critical parameters like the pH, contact time and quantity of adsorbent at the adsorptive removal of Rhodamine-B dye batch experiments had been carried out. For each experimental run, 50 ml of various concentrations of the dye solution (25-125 Rh-B/L) become agitated with 0.025 g of the adsorbent at 120 rpm till the equilibrium become carried out. Samples were withdrawn at different time durations (15, 30, 45 and 60 mins) and kinetics, isotherm and other parameters of adsorption was determined by reading the remaining dye concentration from aqueous solution. In order to evaluate the effect of the preliminary pH on (Rh-B) adsorption, the equilibrium observe turned into performed at exclusive pH levels 3,4, 5, 6, 7, 8 and 9 and other equilibrium studies have been endured on the greatest pH 6.5. The pH of the answers becomes adjusted through including 0.01 N aqueous solutions of NaOH and HCl.

The percentage removal of dye became calculated the usage of the subsequent equation

$$\% \text{ (Rh - B) Removal} = \frac{C_0 - C_t}{C_0} \times 100 \dots \dots \dots (1)$$

Where, C_0 (Rh-B/L) and C_t (Rh-B/L) are the initial dye concentration and dye concentration at time t , respectively. When the system reached the equilibrium concentration, the equilibrium adsorption capacity was calculated through the following equation

$$q_e = \frac{v(C_0 - C_e)}{w} \dots \dots \dots (2)$$

In this equation, q_e (Rh-B/g) represents the rate of the adsorbed dye per mass unit of the adsorbent, C_0 (Rh-B/L) and C_e (Rh-B/L) are initial and equilibrium dye concentrations, respectively, and v (L) and w (g) are the volume of the dye solution and the weight of the adsorbent, respectively.

RESULT AND DISCUSSION

ADSORPTION STUDIES OF RHODAMINE-B DYE

Effect of contact time and initial Rh-B dye concentration

The experimental results for the adsorption at numerous concentrations (50 to 250 Rh-B L-1) with touch time are shown in Figure 3.1. The respective information's are provided in table 3.1, revealing that, percent adsorption reduced with growth in initial dye concentration, but the actual amount of dye adsorbed per unit mass of SABC improved with an increase in dye concentration. It way that the adsorption is tremendously dependent on initial concentration of dye. It is because of the reason that at lower attention, the ratio of the initial wide variety of dye molecules to be had floor place is low. Subsequently the fractional adsorption will become impartial of initial attention [13].



Sivakumar *et al.*,

Effect of Dosage of SABC

The adsorption of Rh-B on SABC was studied by using various the concentration (50-250 Rh-B/50ml) for 50 Rh-B L-1 of dye concentration. The percentage adsorption accelerated with an boom inside the SABC concentration (Figure 3.2). This is probably because of the accelerated SABC floor area and availability of greater adsorption sites [14]. Hence, the remaining elements of the experiments were carried out with an ultimate dose of the adsorbent (50 Rh-B/50 ml).

Effect of pH

One of the maximum essential parameters controlling the adsorption manner is pH. The impact of pH of the answer on the adsorption of Rh-B dye on SABC became decided. The end result is shown in Figure 3.3. The pH of the answer turned into managed by means of the addition of HCl or NaOH. The uptake of Rh-B dye at pH 7.5 changed into the minimal and a most uptake became acquired at pH 3.0-6.7. However, while the pH of the solution changed into expanded (greater than pH 7.5), the uptake of Rh-B become elevated. It seems that a alternate in pH of the solution consequences in the formation of various ionic species, and distinct SABC surface rate. At pH values lower than 6.7, the Rh-B dye can enter the pore shape. As a pH values are higher than 6.7, the zwitterions form of Rh-B in water may additionally increase the aggregation of Rh-B to form a bigger molecular form (dimer) and come to be not able to go into the pore shape of the SABC surface [15].

THEORY OF ADSORPTION ISOTHERM

Adsorption isotherm describes the relation between the quantity or concentration of adsorbate that accumulates at the adsorbent and the equilibrium attention of the dissolved adsorbate. Equilibrium studies have been finished with the aid of agitating a series of beakers containing 50 mL of Rh-B initial concentration 50 Rh-B/L with 0.025 g of activated nano carbon at 30°C with a regular agitation. Agitation turned into furnished for 1.0 hour, that's extra than enough time to reach equilibrium.

Freundlich isotherm

The Freundlich adsorption isotherm is based totally at the equilibrium sorption on heterogeneous surfaces. This isotherm is derived from the belief that the adsorption websites are dispensed exponentially with respect to heat of adsorption. The adsorption isotherm is expressed by using the following equation

$$q_e = K_F C_e^{1/n_F} \dots \dots \dots (3)$$

Which, can be linearized as

$$\ln q_e = \ln K_F + \frac{1}{n_F} \ln C_e \dots \dots \dots (4)$$

Where, q_e is the quantity of Rh-B adsorbed at equilibrium (Rh-B/g) and C_e is the concentration of Rh-B dye inside the aqueous phase at equilibrium (ppm). K_F (L/g) and $1/n_F$ are the Freundlich constants associated with adsorption potential and sorption intensity, respectively. The value of K_f and 'n' are calculated from the intercept and slope of the plot of $\log q_e$ Vs $\log C_e$ respectively. The regular K_f and 'n' values are given in table 3.2. In preferred K_f value increases the adsorption capability for a given adsorbate will increase [16]. The magnitude of the exponent $1/n$ gives an indication of the favorability of adsorption. The value of $n > 1$ represents favorable adsorption condition. The received value of $1/n$ lying inside the variety of 1 to 10 confirms the favorable situation for Rh-B dye adsorption by using SABC. This was further supported by Langmuir isotherm.

Langmuir isotherm

The Langmuir isotherm model [17] is based on the assumption that most adsorption corresponds to a saturated monolayer of solute molecules on the adsorbent surface. The Langmuir isotherm in a linear form can be represented as:





Sivakumar *et al.*,

$$\frac{C_e}{q_e} = \frac{1}{q_m K_L} + \frac{C_e}{q_m} \dots \dots \dots (5)$$

Where q_e is the amount of Rh-B adsorbed at equilibrium (Rh-B/g), C_e is the concentration of Rh-B in the aqueous phase at equilibrium (ppm), q_m is the maximum Rh-B uptake (Rh-B/g), and K_L is the Langmuir constant related to adsorption capacity and the energy of adsorption (g/Rh-B). q_m and 'b' are Langmuir constants related to adsorption capability and rate of adsorption respectively. q_m is the quantity of adsorbate at complete monolayer insurance (Rh-B/g) which gives the maximum adsorption efficiency of the adsorbent and 'b' (L/Rh-B) is the Langmuir isotherm consistent that relates to the energy of adsorption (or rate of adsorption). The linear plot of specific adsorption capability C_e/q_e against the equilibrium concentration (C_e) shows that the adsorption obeys the Langmuir model. The Langmuir consistent q_m and 'b' have been decided from the slope and intercept of the plot and are offered in table 3.2 suggests better affinity of SABC toward Rh-B dye. In order to discover the feasibility of the isotherm, the essential characteristics of the Langmuir isotherm may be expressed in terms of dimensionless regular separation component R_L . A high K_L value shows a high adsorption affinity Weber and Chakraborti expressed the Langmuir isotherm in term of dimensionless constant separation thing or equilibrium parameter (R_L) defined inside the following equation

$$R_L = \frac{1}{1 + K_L C_0} \dots \dots \dots (6)$$

Where, C_0 is the initial Rh-B concentration (ppm). Four eventualities may be distinguished: The sorption isotherm is negative while $R_L > 1$, the isotherm is linear while $R_L = 1$, the isotherm is favorable while $0 < R_L < 1$ and the isotherm is irreversible when $R_L = 0$. The values of dimensionless separation factor (R_L) for Rh-B elimination have been calculated at extraordinary concentrations and temperatures. As shown in Table 3.3, at all concentrations and temperatures examined the values of R_L for Rh-B adsorptions at the SABC have been less than 1 and greater than zero, indicating favorable adsorption. The received R_L values were in among 0 to 1 indicates favorable adsorption of Rh-B dye for all initial concentration (C_0) and temperatures studied.

ADSORPTION KINETICS

The rate and mechanism of the adsorption process may be elucidated based totally on kinetic studies. Dye adsorption on solid surface can be explained through two wonderful mechanisms: (1) An initial rapid binding of dye molecules at the adsorbent surface; (2) incredibly slow intra-particle diffusion. To analyze the adsorption kinetics of the dye, the pseudo-first-order, the pseudo-second-order, and intra-particle diffusion fashions have been implemented [18]. Each of these models and their linear modes of them equations supplied in under.

Where, q_e and q_t confer with the quantity of (Rh-B) dye adsorbed (Rh-B/g) at equilibrium and at any time, t (min), respectively and k_1 (1/min), k_2 (g/Rh-B min) are the equilibrium rate constants of pseudo-first order and pseudo-second order models, respectively. Pseudo-first order model is a easy kinetic model and used for estimation of the surface adsorption reaction rate. The values of $\ln(q_e - q_t)$ had been linearly correlated with t . The plot of $\ln(q_e - q_t)$ vs. t must give a linear relationship from which the values of k_1 have been determined from the slope of the plot. In many cases, the primary-order equation of Lagergren [19] does now not in shapes nicely with the entire range of touch time and is normally applicable over the initial level of the adsorption processes [20].

In the pseudo-second order model [16], the slope and intercept of the t/q_t Vs t plot have been used to calculate the second-order rate constant k_2 . The values of equilibrium rate constant (k_2) are provided in Table 3.4. According to Table 3.4, the value of R^2 (0.999) associated with the pseudo-second order model found out that (Rh-B) dye adsorption followed this model, Nevertheless, pseudo-first order and pseudo-second order kinetic models cannot discover the mechanism of diffusion of dye into the adsorbent pores.

Simple Elovich model

The simple Elovich model is expressed in the form [21],

$$q_t = \alpha + \beta \ln t \dots \dots \dots (9)$$





Sivakumar et al.,

Where, q_t is the amount adsorbed at time t , α and β are the constants obtained from the experiment. A plot of q_t towards $\ln t$ should provide a linear relationship for the applicability of the easy Elovich kinetic. The following shows the simple Elovich kinetics of (Rh-B) dye on to SABC for various initial concentrations (25, 50, 75, 100 and 125 Rh-B/L) of volume 50 mL (each), adsorbent dose 0.025g, temperature 28°C and pH 6.5

Intra-Particle diffusion version

The adsorption technique on a porous adsorbent is typically a multi-step technique. In order to examine the mechanism of the adsorption of (Rh-B) dye with the aid of SABC, the experimental information has been tested in opposition to the intra-particle diffusion model. The adsorption mechanism of the adsorbate on to the adsorbent follows three consecutive steps: mass transfer throughout the external film of liquid surrounding the particle, adsorption at the floor of pores and the intra-particle diffusion. The slowest of those steps determines the general rate of the process. The possibility of intraparticle diffusion resistance which can have an effect on the adsorption is explored by means of the use of the intra-particle diffusion model given within the equation

$$q_t = K_{id} t^{1/2} + I \dots \dots \dots (10)$$

Where, K is the intra-particle diffusion rate constant and I is the intercept. A plot of q_t against $t^{1/2}$ is drawn to analyse the possibility of intra-particle diffusion because the rate determining step. A two stage adsorption mechanism with first changed into rapid and second became gradual has been determined from the experimental facts. The plot of q_t towards $t^{1/2}$ is multi-linear and deviating from the starting place, indicating a couple of procedure has affected the adsorption [22]. Hence, the primary part of the plot shows the external mass transfer and the second component is due to intra-particle or pore diffusion.

THERMODYNAMIC REMEDY OF THE ADSORPTION PROCEDURE

In order to study the feasibility of the adsorption method, the thermodynamic parameters inclusive of free energy, enthalpy and entropy modifications may be expected from the subsequent equations.

$$K_c = C_{Ae} / C_e \dots \dots \dots (11)$$

$$\Delta G^0 = -RT \ln K_c \dots \dots \dots (12)$$

$$\text{Log} K_c = \Delta S^0 / 2.303R - \Delta H^0 / 2.303RT \dots \dots \dots (13)$$

Where C_e is the equilibrium concentration in answer in Rh-B/L and C_{Ae} is the equilibrium attention on the sorbent in Rh-B/L and K_c is the equilibrium constant. The Gibbs free energy (ΔG^0) for the adsorption of Rhodamine-B onto biomass in any respect temperatures became obtained from Eq.12 and is supplied in Table 3.5. The values of ΔH^0 and ΔS^0 had been calculated from the slope and intercept of the plot $\log K_c$ towards $1/T$ and also are indexed in Table 3.5. In order to aid that physical adsorption is the foremost mechanism, the values of activation strength (E_a) and sticking opportunity (S^*) had been calculated from the experimental facts. They were calculated the use of changed Arrhenius type equation related to surface coverage (θ) as follows [23]

$$\theta = \left(1 - \frac{C_e}{C_i} \right) \dots \dots \dots (14)$$

$$S^* = (1 - \theta) e^{-\frac{E_a}{RT}} \dots \dots \dots (15)$$

The sticking opportunity, S^* , is a feature of the adsorbate/adsorbent system underneath attention but need to fulfill the situation $0 < S^* < 1$ and is depending on the temperature of the system. The values of E_a and S^* can be calculated from slope and intercept of the plot of $\ln(1-\theta)$ versus $1/T$ respectively and are indexed in Table 3.5. Thermodynamic





Sivakumar et al.,

parameters associated with the adsorption, via standard free energy change (ΔG^0), standard enthalpy change (ΔH^0) and standard entropy change (ΔS^0) and those have been calculated. The thermodynamic treatment of the sorption data suggests that ΔG^0 values negative at all temperatures. From the results, it is able to be made out that physisorption changed into a good deal greater favorable for the adsorption of Rh-B dye. The positive values of ΔH^0 display the endothermic nature of adsorption and that they govern the possibility of physical adsorption. In the case of physical adsorption, while increasing the temperature of the device, the quantity of dye adsorption will increase, this rules out the possibility of chemisorptions. The low ΔH^0 fee that depicts Rh-B dye is physisorbed onto adsorbent SABC. The poor values of ΔG^0 (Table 3.5) display the adsorption is fantastically favorable and spontaneous. The positive value of ΔS^0 (Table 3.5) display the increased disorder and randomness on the solid solution interface of Rh-B dyes with SABC adsorbent [9].

CONCLUSION

The present have a look at investigated the performance of *Senna alata* bark nano carbon (SABC) as a reasonably-priced adsorbent and the consequences discovered that SABC turned into the right adsorbent for removal of Rhodamine-B from the aquatic environments. pH additionally plays a major function in removing the Rhodamine-B. The findings of the present have a look at also confirmed that as the contact time elevated, the dye's number one attention as well as the dose of the intended adsorbate of the adsorption efficiency increased, as nicely. Adsorption equilibrium data follows Langmuir, Freundlich isotherm models. The kinetic observe of Rhodamine-B directly to SABC became accomplished based on pseudo-first-order, pseudo-second-order and intra-particle diffusion equations. The data suggest that the adsorption kinetics follow the pseudo-second-order rate. This take a look at concludes that the SABC could be employed as a suitable, inexpensive, on hand and low-price adsorbent for the removal of Rhodamine-B from aquatic environments.

REFERENCES

1. Shen K, Gondal MA., Removal of hazardous Rhodamine dye from water by adsorption onto exhausted coffee ground. *J Saudi Chem Soc* 21: S120–S12, (2017)
2. Al-Ghouti MA, Khraish MAM, Allen SJ, Ahmad MN The removal of dyes from textile wastewater: A study of the physical characteristics and adsorption mechanisms of diatomaceous earth. *J Environ Manage* 69: 229–238, (2003).
3. Ahmad A, Mohd-Setapar SH, Chuong CS, Khatoon A, Wani WA, Kumar R, et. al. Recent advances in new generation dye removal technologies: novel search for approaches to reprocess wastewater. *RSC Adv* 5: 30801–818, (2015).
4. Ahmad T, Danish M, Rafatullah M, Ghazali A, Sulaiman O, Hashim R, et. al. The use of date palm as a potential adsorbent for wastewater treatment: a review. *Environ Sci Pollut Res* 19: 1464–84, (2012).
5. Ahmed R. and Kumar R., "Adsorption studies of hazardous malachite green onto treated ginger waste" *Environmental mangement. J*, 91, 1032-1038, (2010).
6. Inbaraj B.S. and Sulochana, N., "Use of jackfruit peel carbon for adsorption of Rhodamine B a basic dye from aqueous solution" *Indian journal of chemical Technology*, 13,17-23, (2006).
7. Sumanjit J, Walia T.P. and Kansal I, "Removal of Rhodamine B by adsorption on walnut shell charcoal" *Surface. Sci. Technol. J*, 24(3), 179-193, (2008).
8. Mohammadi M., Hassani A.J., Mohamed A.R and Najafpour, G., "Removal of Rhodamine B from aqueous solution using palm shell-based activated carbon: adsorption and kinetic studies" *Chem. Eng. Data. J*, 55, 5777-5785, (2010)
9. Ahmedna, M., Marshall, W.E., Husseiny, A.A., Rao, R.M and Goktepe, I. "The use of nutshell carbons in drinking water filters for removal of trace metals", *Water Res.*, 38, 1062-1068,(2004).
10. Hema, M and Arivoli, S. "Rhodamine B adsorption by activated carbon: Kinetic and equilibrium studies" *Indian*





Sivakumar et al.,

- J. of Chem. Technol.*, 16(1), 38-45,(2009)
11. Vijayakumaran, V., Arivoli, S and Ramuthai, S. "Adsorption of Nickel Ion by Low Cost Carbon Kinetic, Thermodynamic and Equilibrium Studies", *E. J. Chem.*, 6 (S1), S347-S357, (2009)
 12. Andersen, W.C and Bruno, T.J. "Application of a gas-liquid entraining rotor to supercritical fluid extraction: Removal of iron(III) from water", *Anal. Chim. Acta*, 485, 1-8, (2003).
 13. World Health Organization (WHO), Guidelines for Drinking Water Quality: Recommendations. Geneva, Switzerland, 1:79, (1984).
 14. Suresh Gupta, and Babu, B.V. Available: www.discovery.bits-pilani.ac.in/~bvbabu/SG_BVB_EF (2013).
 15. Ngah, W.S.W., Endud, C.S and Mayanar, R. "Removal of Copper(II) Ions from Aqueous Solution onto Chitosan and Cross-Linked Chitosan Beads Reactive and Functional Polymers", 50(2), 181-190, (2002)
 16. Freundlich H. Uber die adsorption in lösungen. Engelmann, Leipzig. *Z Phys, Chem.*, 57(A): 385-470, (1906).
 17. Langmuir, I. The adsorption of gases plane surfaces of glass, mica and platinum. *J. Am. Soc.*, 579, 1361-1403, (1918).
 18. Altenor S, Carene B, Emmanuel E, Lambert J, Ehrhardt JJ, Gaspard S. "Adsorption studies of Malachite Green and phenol onto vetiver roots activated carbon prepared by chemical activation", *J Hazard Mater.*; 165(1-3): 1029-1039,(2009)
 19. Colak F, Atar N, Olgun A. "Biosorption of acidic dyes from aqueous solution by Paenibacillus macerans: Kinetic, thermodynamic and equilibrium studies", *Chem Eng J.* 150(1), 122-1230,(2009).
 20. Murugan T, Ganapathi A, Valliappan R. "Removal of dyes from aqueous solution by adsorption on biomass of mango (*Mangifera indica*) leaves", *J.Chem* 7(3), 669-676. (2010).
 21. Freundlich H. Uber die adsorption in lösungen. Engelmann, Leipzig. *Z Phys, Chem.*, 57(A): 385-470, (1906).
 22. Lagergren S. Zur theorie der sogenannten adsorption gelöster stoffe. *Kungliga Svenska Vetenskapsakademiens. Handlingar.* 24, 1-39, (1898).
 23. Ahmad AA, Hameed BH, Aziz N. "Adsorption of direct dye on Palm Ash: Kinetic and Equilibrium Modeling", *J Hazard Mater.* 141(1), 70-86, (2007).
 24. Ho Y, McKay G. "Pseudo-second order Model for Sorption Processes", *Proc Biochem.* 34(5), 451-465, (1999).

Table 1 Characterization of the adsorbent (SABC)

| Analysis | Value |
|--------------------------------------|-------|
| pH _{zpc} | 6.701 |
| Specific gravity | 0.112 |
| Moisture content, % | 0.181 |
| Bulk density, g cm ⁻³ | 0.020 |
| Particle density, g cm ⁻³ | 0.031 |

Table 2 Adsorption Kinetics

| Kinetic Models and Their Linear Forms | | | |
|---------------------------------------|----------------------------|------------------------------------|-----------------|
| Model | Nonlinear Form | Linear Form | No. of Equation |
| Pseudo-first-order | $dq/dt = k_1(q_e - q_t)$ | $\ln(q_e - q_t) = \ln q_e - k_1 t$ | (7) |
| Pseudo-second-order | $dq/dt = k_2(q_e - q_t)^2$ | $t/q_t = 1/k_2 q_e^2 + (1/q_e)t$ | (8) |

Table 3. Equilibrium Parameters for the Adsorption of Rh-B dye onto SABC

| M ₀ | Ce (Rh-B / L) | | | | Qe (Rh-B / L) | | | | Removal % | | | |
|----------------|---------------|--------|---------|--------|---------------|--------|--------|--------|-----------|--------|--------|--------|
| | 30°C | 40°C | 50°C | 60°C | 30°C | 40°C | 50°C | 60°C | 30°C | 40°C | 50°C | 60°C |
| 50 | 0.5362 | 0.4384 | 0.3461 | 0.2713 | 48.926 | 49.123 | 49.307 | 49.457 | 97.855 | 98.246 | 98.615 | 98.914 |
| 100 | 2.4810 | 2.0411 | 1.7470 | 1.3514 | 95.037 | 95.917 | 96.505 | 97.297 | 95.038 | 95.918 | 96.505 | 97.297 |
| 150 | 5.9146 | 5.4175 | 4.9575 | 4.4553 | 138.18 | 139.15 | 140.08 | 141.08 | 92.113 | 92.776 | 93.389 | 94.059 |
| 200 | 12.643 | 11.693 | 10.8306 | 9.8385 | 174.72 | 177.66 | 176.33 | 180.35 | 87.355 | 88.302 | 89.169 | 90.161 |
| 250 | 21.130 | 19.051 | 17.3857 | 15.544 | 207.72 | 211.87 | 215.22 | 218.90 | 83.095 | 84.754 | 86.091 | 87.563 |





Sivakumar et al.,

Table 4. Isotherms Parameter for the Adsorption of (Rh-B) dye onto SABC

| Model | Constant | Temperature (°C) | | | |
|------------|---|------------------|--------|--------|--------|
| | | 30 | 40 | 50 | 60 |
| Freundlich | $K_f(\text{Rh-B/g})(\text{L/Rh-B})^{1/n}$ | 64.696 | 69.885 | 75.311 | 81.948 |
| | N | 2.5297 | 2.5976 | 2.6875 | 2.7866 |
| Langmuir | $Q_m(\text{Rh-B/g})$ | 232.14 | 233.66 | 234.53 | 234.84 |
| | b (L/Rh-B) | 0.3076 | 0.3574 | 0.4127 | 0.5003 |

Table 5. Dimensionless separation factor (R_L) for the adsorption of Rh-B onto SABC

| (C _i) | Temperature °C | | | |
|-------------------|----------------|--------|--------|--------|
| | 30°C | 40°C | 50°C | 60°C |
| 50 | 0.1150 | 0.1007 | 0.0882 | 0.0741 |
| 100 | 0.0610 | 0.0531 | 0.0462 | 0.0382 |
| 150 | 0.0413 | 0.0357 | 0.0312 | 0.0257 |
| 200 | 0.0316 | 0.0273 | 0.0236 | 0.0194 |
| 250 | 0.0253 | 0.0216 | 0.0191 | 0.0155 |

Table 6. The Kinetic Parameters for the adsorption of Rh-B onto SABC

| C ₀ | Temp °C | Pseudo second order | | | | Elovich model | | | Intraparticle diffusion | | |
|----------------|---------|---------------------|----------------|--------|--------|---------------|--------|-------|-------------------------|--------|--------|
| | | q _e | k ₂ | γ | H | α | β | γ | K _{id} | γ | C |
| 50 | 30 | 50.980 | 0.0071 | 0.9954 | 18.488 | 19.263 | 0.2565 | 0.991 | 0.0846 | 0.9986 | 1.8409 |
| | 40 | 50.370 | 0.0103 | 0.9991 | 26.202 | 289.38 | 0.4144 | 0.993 | 0.0510 | 0.9968 | 1.8989 |
| | 50 | 50.583 | 0.0101 | 0.9986 | 25.999 | 263.33 | 0.4143 | 0.991 | 0.0508 | 0.9985 | 1.9006 |
| | 60 | 50.665 | 0.0105 | 0.9968 | 27.213 | 800.22 | 0.4336 | 0.992 | 0.0483 | 0.9944 | 1.9064 |
| 100 | 30 | 98.410 | 0.0041 | 0.9962 | 40.530 | 449.13 | 0.1557 | 0.994 | 0.0711 | 0.9983 | 1.8507 |
| | 40 | 98.527 | 0.0050 | 0.9983 | 49.266 | 294.44 | 0.2029 | 0.991 | 0.0534 | 0.9973 | 1.8843 |
| | 50 | 99.088 | 0.0051 | 0.9976 | 50.085 | 190.20 | 0.2050 | 0.992 | 0.0525 | 0.9968 | 1.8884 |
| | 60 | 99.791 | 0.0052 | 0.9969 | 52.344 | 665.65 | 0.2101 | 0.994 | 0.0508 | 0.9982 | 1.8951 |
| 150 | 30 | 142.08 | 0.0033 | 0.9976 | 68.473 | 334.12 | 0.1368 | 0.995 | 0.0550 | 0.9947 | 1.8637 |
| | 40 | 142.97 | 0.0034 | 0.9989 | 70.388 | 142.57 | 0.1375 | 0.997 | 0.0544 | 0.9995 | 1.8680 |
| | 50 | 144.04 | 0.0033 | 0.9929 | 69.931 | 458.75 | 0.1354 | 0.999 | 0.0549 | 0.9973 | 1.8700 |
| | 60 | 144.93 | 0.0034 | 0.9954 | 72.567 | 737.97 | 0.1394 | 0.998 | 0.0528 | 0.9964 | 1.8767 |
| 200 | 30 | 179.91 | 0.0025 | 0.9984 | 81.744 | 131.28 | 0.1032 | 0.997 | 0.0578 | 0.9985 | 1.8354 |
| | 40 | 181.82 | 0.0025 | 0.9960 | 83.618 | 104.47 | 0.1019 | 0.998 | 0.0576 | 0.9957 | 1.8402 |
| | 50 | 183.44 | 0.0025 | 0.9940 | 86.410 | 214.72 | 0.1036 | 0.992 | 0.0564 | 0.9969 | 1.8470 |
| | 60 | 185.46 | 0.0025 | 0.9945 | 87.783 | 175.92 | 0.1038 | 0.994 | 0.0556 | 0.9982 | 1.8530 |
| 250 | 30 | 211.71 | 0.0029 | 0.9987 | 134.38 | 132.85 | 0.1175 | 0.991 | 0.0423 | 0.9945 | 1.8412 |
| | 40 | 217.66 | 0.0022 | 0.9955 | 106.72 | 160.76 | 0.0900 | 0.992 | 0.0546 | 0.9963 | 1.8282 |
| | 50 | 221.60 | 0.0020 | 0.9953 | 101.54 | 143.77 | 0.0836 | 0.994 | 0.0579 | 0.9986 | 1.8290 |
| | 60 | 225.20 | 0.0020 | 0.9984 | 105.02 | 130.54 | 0.0846 | 0.995 | 0.0562 | 0.9965 | 1.8392 |

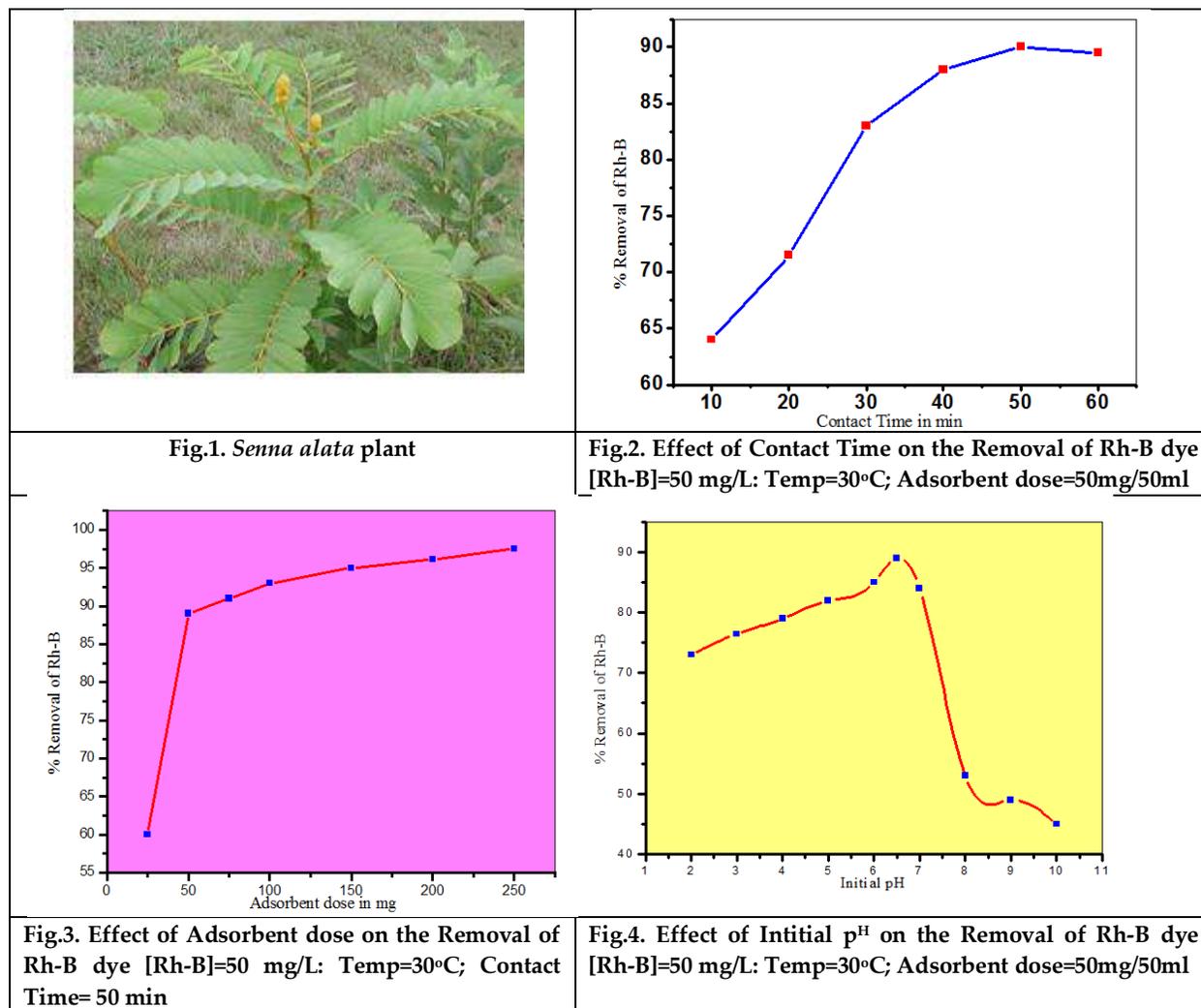




Sivakumar et al.,

Table 7. Thermodynamic Parameters for the adsorption of Rh-B onto SABC

| (C ₀) | ΔG° | | | | ΔH° | ΔS° |
|-------------------|----------|----------|----------|----------|---------|--------|
| | 30°C | 40°C | 50°C | 60°C | | |
| 50 | -9624.28 | -10475.8 | -11455.9 | -12491.8 | -19.386 | 95.593 |
| 100 | -7437.74 | -8215.22 | -8911.65 | -9921.03 | -17.193 | 81.178 |
| 150 | -6191.82 | -6643.40 | -7111.52 | -7647.23 | -8.441 | 48.238 |
| 200 | -4869.28 | -5261.05 | -5661.23 | -6133.08 | -7.816 | 41.816 |
| 250 | -4011.50 | -4464.14 | -4895.27 | -5403.58 | -9.936 | 46.005 |





Periodic, Rational and Exact Solitary Wave Solutions for (2+1) and (3+1) Dimensional MEW Equation by Tanh-Coth Method

K. Azhagu Raja¹ and R. Asokan^{2*}

¹Research Scholar, Department of Mathematics, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

²Professor, Department of Mathematics, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

Received: 12 May 2022

Revised: 16 June 2022

Accepted: 05 July 2022

*Address for Correspondence

R. Asokan,

Professor,

Department of Mathematics,

Madurai Kamaraj University,

Madurai, Tamil Nadu, India.

Email: asokan.maths@mkuniversity.org



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In this work, we study the (2+1) dimensional modified equal width Wave equation, which can describe analytically and deal significant relation between nonlinear phenomena and dispersion. The effective tanh - coth method is a direct algebraic approach for a given nonlinear partial differential equations, constructing explicit exact rational, periodic and solitary wave solutions.

Keywords: (2+1) and (3+1) dimensional modified equal width wave equation, tanh-coth method, periodic solution, rational solution and exact solitary wave solutions.

AMS Subject Classification: 35C08, 35Q51.

INTRODUCTION

Many real life situation and natural phenomenon involving nonlinearity. Most of the physical and engineering nonlinear models described Mathematically and solved by various regular methods such as Hirita bilinear form [6], Inverse scattering transformation method [2], Painlevé analysis [4], Homoclinic test approach method [34], Transformed rational function method [31], Similarity transformation method [10] and so on. The Modified Equal Width (MEW) wave equation is one of the nonlinear physical model equation, which describes the shallow water wave, fluid dynamics and plasma physics. The analytic and numerical approach of MEW equation, (2+1) and (3+1) dimensional MEW equations are extensively studied by various methods such as the extended tanh method [13, 15], sine-cosine method [15], Lie symmetry method [33, 36], Integral bifurcation Method [16], Auxiliary equation method [17], Extended auxiliary equation mapping method [33] and so on.





Azhagu Raja and Asokan

The equal width wave equation

$$u_t - u_{xxt} - uu_x = 0, \quad (1)$$

introduced by Morrison et al. [1]. The approximation and numerical simulations of inelastic collisions of solitary waves derived by split-step fast Fourier transform method and also the same type of equation investigated by Galerkin's method [3, 12], Petrov-Galerkin method [7] and reduced differential transform method [20] to obtain abundant exact solitary wave solutions.

Zaki [8] considered the normalized form of MEW equation is

$$u_t + 3u^2u_x - \mu u_{xxt} = 0, \quad (2)$$

this equation numerically solved by finite element method and found soliton and exact solutions.

The MEW equation, variant of MEW equation with positive and negative exponents

$$u_t + a(u^3)_x + bu_{xxt} = 0, \quad (3)$$

$$u_t + a(u^n)_x - b(u^n)_{xxt} = 0, \quad (4)$$

$$u_t + a(u^{-n})_x - b(u^{-n})_{xxt} = 0, \quad (5)$$

are extensively studied in [9, 22] and derive variety of solitary wave solutions like compactons, periodic, travelling wave solution and numerical solutions.

The nonlinear two dimensional ZK-MEW equation and its generalizations are as follows,

$$u_t + a(u^3)_x + (bu_{xt} + \gamma u_{yy})_x = 0, \quad (6)$$

$$u_t + a(u^n)_x + (bu_{xt} + \gamma u_{yy})_x = 0, \quad (7)$$

where a, b and γ are constants. In [11], equation (6) and (7) employed by extended tanh method and sine-cosine method to obtain solitary wave and periodic wave solutions. In [19], equation (6) solved by extended Jacobi-Elliptic function expansion method to revealed periodic and travelling wave solution. In [24], equation (6) explored by (G'/G) -expansion method to find periodic wave and soliton solution. In [32], equation (6) examined by new mathematical method and obtain bright and dark solution, periodic and travelling wave solution. The extended trial equal method [21] has been applied in equation (7) to find soliton, rational and elliptic solution. The $\exp(-\phi n)$ expansion method [23] has been used in equation (7) to obtain soliton and kink solution.

The fractional order of EW, MEW and coupled MEW are handled by variety of methods like Extended Fan Sub-equation method [26], Kuderyshov method [37], Ansatz method [35] and Lie group analysis method [30] to obtain bright, dark and singular soliton solution.

In [28, 29], the authors has consider a new class of (2+1) dim MEW wave equation

$$u_t + u^3u_x - u_{xxt} - u_{yyt} = 0, \quad (8)$$

to employed similarity reduction by Lie Classical method.

Here, we using tanh-coth method [14, 18, 25] for the nonlinear partial differential equations of (2+1) and (3+1) dimensional MEW equations, which is a direct algebraic approach to establish exact solitary wave solutions. The





Azhagu Raja and Asokan

complicated and tedious algebraic calculations made by the availability of computer symbolic system like Mathematica. The organize of the work is as follows: chapter (2) gives the methodology of tanh-coth method, chapter (3) and (4) applying the proposed method to obtain exact and solitary wave solutions of (2+1) and (3+1) dimensional MEW equation chapter (5) deals with the discussion, finally, chapter (6) conclude the entire work.

The tanh-coth Method

Wazwaz [14] discovered the tanh-coth method. A wave variable $\xi = x - ct$ converts any Partial Differential Equation (PDE)

$$P(u, u_t, u_x, u_{xx}, u_{xxx}, \dots) = 0, \quad (9)$$

to an Ordinary Differential Equation (ODE)

$$Q(u, u', u'', u''', \dots) = 0. \quad (10)$$

Eq. (10) is then integrated as long as all terms contains derivatives, where the integration constants are considered as zero. The standard tanh method is developed by Malfliet [5], where the tanh is used as a new variable, since all derivatives of a tanh are represented by tanh itself. Introducing a new independent variable,

$$Y = \tanh(\mu\xi) \quad \text{and} \quad Y = \tan(\mu\xi), \quad \xi = x - ct, \quad (11)$$

where, μ is the wave number, leads to the change of derivatives:

$$\begin{aligned} \frac{d}{d\xi} &= \mu(1 - Y^2) \frac{d}{dY}, \\ \frac{d^2}{d\xi^2} &= -2\mu^2 Y(1 - Y^2) \frac{d}{dY} + \mu^2(1 - Y^2)^2 \frac{d^2}{dY^2}. \end{aligned} \quad (12)$$

and

$$\begin{aligned} \frac{d}{d\xi} &= \mu(1 + Y^2) \frac{d}{dY}, \\ \frac{d^2}{d\xi^2} &= 2\mu^2 Y(1 + Y^2) \frac{d}{dY} + \mu^2(1 + Y^2)^2 \frac{d^2}{dY^2}. \end{aligned} \quad (13)$$

The tanh – coth method admits the use of the finite expansion

$$u(\mu\xi) = s(Y) = \sum_{k=0}^M a_k Y^k + \sum_{k=1}^M b_k Y^{-k}, \quad (14)$$

and

$$Y' = \mu(1 - Y^2) \quad \text{and} \quad Y' = \mu(1 + Y^2), \quad (15)$$

where M is a positive integer, in most cases, that will be determined by Homogeneous Balance Method. Substituting (14) and (15) into the reduced ODE, we obtain an algebraic equation in powers of Y . Balancing the highest order of the linear term with the highest order of nonlinear term to determine the parameter M . Then collect all coefficients of powers of Y in the resulting equation, where these coefficients have to vanish. This will give a system of algebraic equations involving the parameters a_k , b_k , μ , and c . Having determined these parameters, we obtain an analytic solution $u(x,t)$ in a closed form. The obtained solutions are may be solitons, kink, compacton, peakon, cuspon, travelling wave and periodic solutions as well.





Azhagu Raja and Asokan

(2+1) dimensional MEW wave equation

The (2+1) dimensional MEW wave equation is

$$u_t + u^2 u_x - u_{xxt} - u_{yyt} = 0, \tag{16}$$

$$u(x, t) = u(\xi), \quad \xi = x + y - ct. \tag{17}$$

Using (17) into (16) and integrating to get an ODE

$$-cu - \frac{1}{3}u^3 + 2cu'' = 0. \tag{18}$$

From Eq. (18) balancing the nonlinear term u^3 with the higher order derivative u'' to get the value $M = 1$ and hence,

$$u(x, y, z, t) = S(Y) = a_0 + a_1 Y + \frac{b_1}{Y}. \tag{19}$$

Substituting (19) into (18), collecting the coefficients of each power of Y^i , setting each coefficient to zero, where $Y = \tanh(\mu\xi)$

$$2a_1 a_0 b_1 - a_0 c + \frac{a_0^3}{3} = 0, \tag{20}$$

$$a_1^2 b_1 - 4a_1 c \mu^2 - a_1 c + a_0^2 a_1 = 0, \tag{21}$$

$$a_0 a_1^2 = 0, \tag{22}$$

$$4a_1 c \mu^2 + \frac{a_1^3}{3} = 0, \tag{23}$$

$$a_1 b_1^2 + a_0^2 b_1 - 4b_1 c \mu^2 - b_1 c = 0, \tag{24}$$

$$a_0 b_1^2 = 0, \tag{25}$$

$$4b_1 c \mu^2 + \frac{b_1^3}{3} = 0. \tag{26}$$

Solving the resulting algebraic system with computer algebra software such as Mathematica, we obtain the following sets:

$$a_0 = 0, a_1 = \mp \sqrt{-\frac{3c}{2}}, b_1 = \pm \sqrt{-\frac{3c}{2}}, \mu = -\frac{1}{2\sqrt{2}} \tag{27}$$

$$a_0 = 0, a_1 = \mp \sqrt{-\frac{3c}{2}}, b_1 = \pm \sqrt{-\frac{3c}{2}}, \mu = \frac{1}{2\sqrt{2}} \tag{28}$$

Substituting Eqs. (11) and (27-28) into Eq. (19), we obtain the following rational and exact solitary wave solutions:

$$u_1 = \mp \sqrt{-\frac{3c}{2}} \left(\tanh \left[-\frac{1}{2\sqrt{2}}(x + y - ct) \right] - \coth \left[-\frac{1}{2\sqrt{2}}(x + y - ct) \right] \right), \tag{29}$$

$$u_2 = \mp \sqrt{-\frac{3c}{2}} \left(\tanh \left[\frac{1}{2\sqrt{2}}(x + y - ct) \right] - \coth \left[\frac{1}{2\sqrt{2}}(x + y - ct) \right] \right). \tag{30}$$

Substituting (19) into (18), collecting the coefficients of each power of Y^i , setting each coefficient to zero, where $Y = \tan(\mu\xi)$

$$2a_1 a_0 b_1 - a_0 c + \frac{a_0^3}{3} = 0, \tag{31}$$

$$a_1^2 b_1 + 4a_1 c \mu^2 - a_1 c + a_0^2 a_1 = 0, \tag{32}$$

$$a_0 a_1^2 = 0, \tag{33}$$

$$4a_1 c \mu^2 + \frac{a_1^3}{3} = 0, \tag{34}$$





Azhagu Raja and Asokan

$$a_1 b_1^2 + a_0^2 b_1 + 4b_1 c \mu^2 - b_1 c = 0, \tag{35}$$

$$a_0 b_1^2 = 0, \tag{36}$$

$$4b_1 c \mu^2 + \frac{b_1^3}{3} = 0. \tag{37}$$

Solving the resulting algebraic system with computer algebra software such as Mathematica, we obtain the following sets:

$$a_0 = 0, a_1 = \mp\sqrt{-3c}, b_1 = 0, \mu = -\frac{1}{2}, \tag{38}$$

$$a_0 = 0, a_1 = 0, b_1 = \mp\sqrt{-3c}, \mu = -\frac{1}{2}, \tag{39}$$

$$a_0 = 0, a_1 = \mp\sqrt{-3c}, b_1 = 0, \mu = \frac{1}{2}, \tag{40}$$

$$a_0 = 0, a_1 = 0, b_1 = \mp\sqrt{-3c}, \mu = \frac{1}{2}, \tag{41}$$

$$a_0 = 0, a_1 = \mp\frac{\sqrt{-3c}}{2}, b_1 = \pm\frac{\sqrt{-3c}}{2}, \mu = -\frac{1}{4}, \tag{42}$$

$$a_0 = 0, a_1 = \mp\frac{\sqrt{-3c}}{2}, b_1 = \pm\frac{\sqrt{-3c}}{2}, \mu = \frac{1}{4}. \tag{43}$$

Substituting Eqs. (11) and (38-43) into Eq. (19), we obtain the following periodic and exact solitary wave solutions:

$$u_3 = \mp\sqrt{-3c} \tan \left[-\frac{1}{2}(x + y - ct) \right], \tag{44}$$

$$u_4 = \mp\sqrt{-3c} \cot \left[-\frac{1}{2}(x + y - ct) \right], \tag{45}$$

$$u_5 = \mp\sqrt{-3c} \tan \left[\frac{1}{2}(x + y - ct) \right], \tag{46}$$

$$u_6 = \mp\sqrt{-3c} \cot \left[\frac{1}{2}(x + y - ct) \right], \tag{47}$$

$$u_7 = \mp -\frac{\sqrt{-3c}}{2} \left(\tan \left[-\frac{1}{4}(x + y - ct) \right] - \cot \left[-\frac{1}{4}(x + y - ct) \right] \right), \tag{48}$$

$$u_8 = \mp -\frac{\sqrt{-3c}}{2} \left(\tan \left[\frac{1}{4}(x + y - ct) \right] - \cot \left[\frac{1}{4}(x + y - ct) \right] \right). \tag{49}$$

(3+1) dimensional MEW wave equation

The (3+1) dimensional MEW wave equation is

$$u_t + u^2 u_x - u_{xxt} - u_{yyt} - u_{zzt} = 0, \tag{50}$$

$$u(x, y, z, t) = u(\xi), \quad \xi = x + y + z - ct. \tag{51}$$

Using (51) into (50) and integrating we get an ODE

$$-cu + \frac{1}{3}u^3 + 3cu'' = 0. \tag{52}$$

From Eq. (52) balancing the nonlinear term u^3 with the higher order derivative u'' , we get the value $M = 1$ and hence,

$$u(x, y, z, t) = S(Y) = a_0 + a_1 Y + \frac{b_1}{Y}. \tag{53}$$

Substituting (53) into (52), collecting the coefficients of each power of Y^i , setting each coefficient to zero, where $Y = \tanh(\mu\xi)$

$$2a_1 a_0 b_1 - a_0 c + \frac{a_0^3}{3} = 0, \tag{54}$$





Azhagu Raja and Asokan

$$a_1^2 b_1 - 6a_1 c \mu^2 - a_1 c + a_0^2 a_1 = 0, \tag{55}$$

$$a_0 a_1^2 = 0, \tag{56}$$

$$6a_1 c \mu^2 + \frac{a_1^3}{3} = 0, \tag{57}$$

$$a_1 b_1^2 + a_0^2 b_1 - 6b_1 c \mu^2 - b_1 c = 0, \tag{58}$$

$$a_0 b_1^2 = 0, \tag{59}$$

$$6b_1 c \mu^2 + \frac{b_1^3}{3} = 0. \tag{60}$$

Solving the resulting algebraic system with computer algebra software such as Mathematica, we obtain the following sets:

$$a_0 = 0, a_1 = \mp \sqrt{-\frac{3c}{2}}, b_1 = \pm \sqrt{-\frac{3c}{2}}, \mu = -\frac{1}{2\sqrt{2}} \tag{61}$$

$$a_0 = 0, a_1 = \mp \sqrt{-\frac{3c}{2}}, b_1 = \pm \sqrt{-\frac{3c}{2}}, \mu = \frac{1}{2\sqrt{2}} \tag{62}$$

Substituting Eqs. (11) and (61-62) into Eq. (53), we obtain the following rational and exact solitary wave solutions:

$$u_9 = \mp \sqrt{-\frac{3c}{2}} \left(\tanh \left[-\frac{1}{2\sqrt{2}}(x + y - ct) \right] - \coth \left[-\frac{1}{2\sqrt{2}}(x + y - ct) \right] \right), \tag{63}$$

$$u_{10} = \mp \sqrt{-\frac{3c}{2}} \left(\tanh \left[\frac{1}{2\sqrt{2}}(x + y - ct) \right] - \coth \left[\frac{1}{2\sqrt{2}}(x + y - ct) \right] \right). \tag{64}$$

Substituting (53) into (52), collecting the coefficients of each power of Y^i , setting each coefficient to zero, where $Y = \tan(\mu\xi)$

$$2a_1 a_0 b_1 - a_0 c + \frac{a_0^3}{3} = 0, \tag{65}$$

$$a_1^2 b_1 + 6a_1 c \mu^2 - a_1 c + a_0^2 a_1 = 0, \tag{66}$$

$$a_0 a_1^2 = 0, \tag{67}$$

$$6a_1 c \mu^2 + \frac{a_1^3}{3} = 0, \tag{68}$$

$$a_1 b_1^2 + a_0^2 b_1 + 6b_1 c \mu^2 - b_1 c = 0, \tag{69}$$

$$a_0 b_1^2 = 0, \tag{70}$$

$$6b_1 c \mu^2 + \frac{b_1^3}{3} = 0. \tag{71}$$

Solving the resulting algebraic system with computer algebra software such as Mathematica, we obtain the following sets:

$$a_0 = 0, a_1 = \mp \sqrt{-3c}, b_1 = 0, \mu = -\frac{1}{\sqrt{6}} \tag{72}$$

$$a_0 = 0, a_1 = 0, b_1 = \mp \sqrt{-3c}, \mu = -\frac{1}{\sqrt{6}} \tag{73}$$

$$a_0 = 0, a_1 = \mp \sqrt{-3c}, b_1 = 0, \mu = \frac{1}{\sqrt{6}} \tag{74}$$

$$a_0 = 0, a_1 = 0, b_1 = \mp \sqrt{-3c}, \mu = \frac{1}{\sqrt{6}} \tag{75}$$

$$a_0 = 0, a_1 = \mp \frac{\sqrt{-3c}}{2}, b_1 = \pm \frac{\sqrt{-3c}}{2}, \mu = -\frac{1}{2\sqrt{6}} \tag{76}$$

$$a_0 = 0, a_1 = \mp \frac{\sqrt{-3c}}{2}, b_1 = \pm \frac{\sqrt{-3c}}{2}, \mu = \frac{1}{2\sqrt{6}} \tag{77}$$

Substituting Eqs. (11) and (72-77) into Eq. (53), we obtain the following periodic and exact solitary wave solutions:

$$u_{11} = \mp \sqrt{-3c} \tan \left[-\frac{1}{\sqrt{6}}(x + y - ct) \right], \tag{78}$$





Azhagu Raja and Asokan

$$u_{12} = \mp \sqrt{-3c} \cot \left[-\frac{1}{\sqrt{6}}(x + y - ct) \right], \quad (79)$$

$$u_{13} = \mp \sqrt{-3c} \tan \left[\frac{1}{\sqrt{6}}(x + y - ct) \right], \quad (80)$$

$$u_{14} = \mp \sqrt{-3c} \cot \left[\frac{1}{\sqrt{6}}(x + y - ct) \right], \quad (81)$$

$$u_{15} = \mp -\frac{\sqrt{-3c}}{2} \left(\tan \left[-\frac{1}{2\sqrt{6}}(x + y - ct) \right] - \cot \left[-\frac{1}{2\sqrt{6}}(x + y - ct) \right] \right), \quad (82)$$

$$u_{16} = \mp -\frac{\sqrt{-3c}}{2} \left(\tan \left[\frac{1}{2\sqrt{6}}(x + y - ct) \right] - \cot \left[\frac{1}{2\sqrt{6}}(x + y - ct) \right] \right). \quad (83)$$

CONCLUSION

The Eqs. (29) and (30) are the rational and exact solitary wave solutions of Eq. (16). The rational solution of u_1 graphically represents in Fig1 and Fig2. Eqs. (44-49) are the periodic and exact solitary wave solutions of Eq. (16). u_3 and u_4 are periodic wave solutions and its corresponding graphical illustrations in Fig3 and Fig4. Eqs. (63) and (64) are the rational and exact solitary wave solutions of Eq. (50). The 2D, 3D and contour plots of u_9 explored in Fig5 and Fig6. Eqs. (78-83) are the periodic and exact solitary wave solutions of Eq. (50). Fig7 and Fig8 shows that the graphical representation of periodic wave solutions of u_{13} .

The (2+1) and (3+1) dimensional MEW equations solved by tanh - coth method with the help of Mathematica. The direct effective tanh - coth method produced different physical structured solitary wave solutions such as rational solutions and periodic solutions. The hyperbolic and trigonometric function solutions are represent graphically in 2D, 3D and Contour plots.

REFERENCES

- Morrison, P. J., J. D. Meiss, and J. R. Cary. "Scattering of regularized-long-wave solitary waves." *Physica D: nonlinear phenomena* 11.3 (1984): 324-336.
- Arkadiev, V. A., A. K. Pogrebkov, and M. C. Polivanov. "Inverse scattering transform method and soliton solutions for Davey-Stewartson II equation." *Physica D: Nonlinear Phenomena* 36.1-2 (1989): 189-197.
- Gardner, L. R. T., and G. A. Gardner. "Solitary waves of the equal width wave equation." *Journal of Computational Physics* 101.1 (1992): 218-223.
- Lakshmanan, Muthuswamy, and Ramajayam Sahadevan. "Painlevé analysis, Lie symmetries, and integrability of coupled nonlinear oscillators of polynomial type." *Physics Reports* 224.1-2 (1993): 1-93.
- W. Malfliet and W. Hereman, The tanh method: I. Exact solutions of nonlinear evolution and wave equations, *Physica Scripta* 54.6 (1996), 563.
- Tsujimoto, Satoshi, and Ryogo Hirota. "Pfaffian representation of solutions to the discrete BKP hierarchy in bilinear form." *Journal of the Physical Society of Japan* 65.9 (1996): 2797-2806.
- Gardner, L. R. T., et al. "Simulations of the EW undular bore." *Communications in Numerical Methods in Engineering* 13.7 (1997): 583-592.
- Zaki, S. I. "Solitary wave interactions for the modified equal width equation." *Computer Physics Communications* 126.3 (2000): 219-231.
- Wazwaz, Abdul-Majid. "The tanh and the sine-cosine methods for a reliable treatment of the modified equal width equation and its variants." *Communications in Nonlinear Science and Numerical Simulation* 11.2 (2006): 148-160.
- Vaganan, B. Mayil, and M. Senthil Kumaran. "Similarity solutions of the Burgers equation with linear damping." *Applied mathematics letters* 17.10 (2004): 1191-1196.
- Wazwaz, Abdul-majid. "Exact solutions for the ZK-MEW equation by using the tanh and sine-cosine methods." *International Journal of Computer Mathematics* 82.6 (2005): 699-708.





Azhagu Raja and Asokan

12. Dogan, Abdulkadir. "Application of Galerkin's method to equal width wave equation." *Applied Mathematics and Computation* 160.1 (2005): 65-76.
13. Wazwaz, Abdul-Majid. "The extended tanh method for the Zakharov–Kuznetsov (ZK) equation, the modified ZK equation, and its generalized forms." *Communications in Nonlinear Science and Numerical Simulation* 13.6 (2008): 1039-1047.
14. A. M. Wazwaz, The extended tanh method for new solitons solutions for many forms of the fifth-order KdV equations, *Appl. Math. and Comp.* 184.2 (2007), 1002-1014.
15. Wazwaz, Abdul-Majid. "The tanh method and the sine–cosine method for solving the KP-MEW equation." *International Journal of Computer Mathematics* 82.2 (2005): 235-246.
16. Rui, Weiguo, et al. "Integral bifurcation method and its application for solving the modified equal width wave equation and its variants." *Rostocker Mathematisches Kolloquium*. Vol. 62. 2007.
17. Esen, Alaattin, and Selçuk Kutluay. "Travelling wave Solutions for the generalized (2+ 1)-dimensional ZK-MEW Equation." *International Journal of Nonlinear Science* 8.4 (2009): 428-434.
18. A. M. Wazwaz, *Partial differential equations and solitary waves theory*, Springer Science & Business Media, 2010.
19. Zhang, Weimin. "Extended Jacobi elliptic function expansion method to the ZK-Mew equation." *International Journal of Differential Equations* 2011 (2011).
20. Arora, Rajan, Md Junaid Siddiqui, and V. P. Singh. "Solutions of Inviscid Burgers' and Equal Width Wave Equations by RDTM." *International Journal of Applied Physics and Mathematics* 2.3 (2012): 212.
21. Pandir, Yusuf. "New exact solutions of the generalized Zakharov–Kuznetsov modified equal-width equation." *Pramana* 82.6 (2014): 949-964.
22. Taha, Wafaa M., and M. S. M. Noorani. "Application of the G' G-expansion method for the generalized Fisher's equation and modified equal width equation." *Journal of the Association of Arab Universities for Basic and Applied Sciences* 15 (2014): 82-89.
23. Mohyud-Din, Syed Tauseef, Ayyaz Ali, and Muhammad Asad Iqbal. "Traveling wave solutions of Zakharov–Kuznetsov-modified equal-width and Burger's equations via $\exp(-\varphi(\eta))$ -expansion method." *Asia Pacific Journal on Computational Engineering* 2.1 (2015): 1-10.
24. Khan, Kamruzzaman, M. Ali Akbar, and Ahmet Bekir. "Solitary wave solutions of the (2+ 1)-dimensional Zakharov-Kuznetsevmodified equal-width equation." *Journal of Information and Optimization Sciences* 37.4 (2016): 569-589.
25. Asokan, R., and D. Vinodh. "The tanh-coth method for soliton and exact solutions of the Sawada–Kotera equation." *International Journal of Pure and Applied Mathematics* 117.13 (2017): 19-27.
26. Tariq, Kalim U., et al. "Dispersive traveling wave solutions to the space–time fractional equal-width dynamical equation and its applications." *Optical and Quantum Electronics* 50.3 (2018): 1-16.
27. Khalique, Chaudry Masood, and Innocent Simbanefayi. "Exact solutions and conservation laws for the modified equal width-Burgers equation." *Open Physics* 16.1 (2018): 795-800.
28. Padmasekaran, S., R. Asokan, and K. Kannagidevi. "Lie symmetries of (2+ 1)-dimensional modified equal width wave equation." *Int. J. Math. Trends Technol* 56 (2018): 2231-5373.
29. Alaguraja, K., R. Asokan, and S. Padmasekaran. "Symmetry Reductions of (2+ 1)-dimensional Modified Equal Width Wave Equation with Damping Term by Lie Classical Method." *rn* 55: 7.
30. Ray, S. Saha. "Invariant analysis and conservation laws for the time fractional (2+ 1)-dimensional Zakharov–Kuznetsov modified equal width equation using Lie group analysis." *Computers & Mathematics with Applications* 76.9 (2018): 2110-2118.
31. Asokan, R., and D. Vinodh. "Soliton and Exact Solutions for the KdV–BBM Type Equations by tanh–coth and Transformed Rational Function Methods." *International Journal of Applied and Computational Mathematics* 4.4 (2018): 1-20.
32. Iqbal, Mujahid, et al. "Construction of a weakly nonlinear dispersion solitary wave solution for the Zakharov–Kuznetsov-modified equal width dynamical equation." *Indian Journal of Physics* 94.9 (2020): 1465-1474.
33. Bruzon, M. S., et al. "On a family of (2+ 1)-dimensional Zakharov-Kuznetsov modified equal width equations." *AIP Conference Proceedings*. Vol. 2293. No. 1. AIP Publishing LLC, 2020.
34. Vinodh, D., and R. Asokan. "Multi-soliton, Rogue Wave and Periodic Wave Solutions of Generalized (2+ 12+ 1) Dimensional Boussinesq Equation." *International Journal of Applied and Computational Mathematics* 6.1 (2020): 1-16.





Azhagu Raja and Asokan

35. Ali, Khalid K., and J. F. Gómez-Aguilar. "New Solitary Wave Solutions of the Space–time Fractional Coupled Equal Width Wave Equation (CEWE) and Coupled Modified Equal Width Wave Equation (CMEWE)." *International Journal of Applied and Computational Mathematics* 7.4 (2021): 1-19.
36. Munir, Mobeen, et al. "Lie symmetries of Generalized Equal Width wave equations." *AIMS Mathematics* 6.11 (2021): 12148-12165.
37. Zafar, A., et al. "Different soliton solutions to the modified equal-width wave equation with Beta-time fractional derivative via two different methods." *REVISTA MEXICANA DE FISICA* 68.1 (2022): 1-14.

| | |
|---|---|
| <p>a) $t = -0.05, c = -1, y = -0.4$ b) $t = -0.05, c = -1$ c) $t = -0.05, c = -1$</p> | <p>a) $t = -0.05, c = -1, y = -0.4$ b) $t = -0.05, c = -1$ c) $t = -0.05, c = -1$</p> |
| <p>Fig. 1: Rational solution of u_1 with negative sign</p> | <p>Fig. 2: Rational solution of u_1 with positive sign.</p> |
| <p>a) $t = -0.4, c = -0.05, y = -1$ b) $t = -0.4, c = -0.05$ c) $t = -0.4, c = -0.05$</p> | <p>a) $t = -0.4, c = -0.05, y = -1$ b) $t = -0.4, c = -0.05$ c) $t = -0.4, c = -0.05$</p> |
| <p>Fig. 3: Periodic wave solution of u_3 with negative sign</p> | <p>Fig. 4: Periodic wave solution of u_4 with positive sign.</p> |
| <p>a) $x = -1.5, t = 4, c = -0.3, v = 0.3$ b) $x = -1.5, t = 4, c = -0.3$ c) $x = -1.5, t = 4, c = -0.3$</p> | <p>a) $x = -1.5, t = 4, c = -0.3, v = 0.3$ b) $x = -1.5, t = 4, c = -0.3$ c) $x = -1.5, t = 4, c = -0.3$</p> |
| <p>Fig. 5: Rational solution of u_9 with negative sign.</p> | <p>Fig. 6: Rational solution of u_9 with positive sign.</p> |
| <p>a) $x = -2.5, t = 3.3, c = -1.2, y = -5.25$ b) $x = -2.5, t = 3.3, c = -1.2$ c) $x = -2.5, t = 3.3, c = -1.2$</p> | <p>a) $x = -2.5, t = 3.3, c = -1.2, y = -5.25$ b) $x = -2.5, t = 3.3, c = -1.2$ c) $x = -2.5, t = 3.3, c = -1.2$</p> |
| <p>Fig. 7: Periodic wave solution of u_{13} with negative sign</p> | <p>Fig. 8: Periodic wave solution of u_{13} with positive sign.</p> |





A Literature Review on Reckless and Hazardous Contraceptive Practices used since Primeval Times

Bhumika Chauhan and Monica Misra*

Department of Zoology, Acharya Narendra Dev College, University of Delhi, Delhi-110009

Received: 10 May 2022

Revised: 03 Jun 2022

Accepted: 04 July 2022

*Address for Correspondence

Monica Misra

Department of Zoology,
Acharya Narendra Dev College,
University of Delhi, Delhi-110009,
Email: monicamisra@andc.du.ac.in.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Historians have extrapolated that primitive society used a diversity of methods to restrain populations such as physical segregation of men and women, infanticide and rallying of practices that would prevent pregnancies. The lack of education, perceived stigma from friends, alienation from parents and stringent financial implication were some of the utmost reasons considered as major drawback that leads to unplanned pregnancies and turning out with severe deadly consequences. The authors in the present communication accentuates the usage of harmful elements like lead, arsenic, plastic bags, oils, honey, etc as method of contraception in ancient times that was absolutely not only myths but also hazardous. The utility of few herbal plants had already proved to have 100% effectiveness on birth control in distinct animal groups but still their usage remains unseasoned in humans. The authors also spotlights on the fact that certain authentic research is still needed to substantiate the use of herbs as natural mode of birth control as the present day practices of oral contraceptives (OC) retain hormonal imbalances and side effects.

Keywords: Contraceptive, women, fertility, birth control, sperm, human.

INTRODUCTION

In spite of the accessibility of secure and potent forms of contraception till today, societies in both developing as well as the developed world endure from unsatisfactory elevated rates of coincidental and nasty pregnancies. Though much progress has been made in recent decades in fertility abstraction in developing countries but still around 120 million (10–12%) married women in many regions and also more than 24% in sub-Saharan Africa, persevere to report an envious demand for contraception (Sirtuk Ware *et al.*, 2013). The expeditious hike in the population growth has remarkably expanded the number of individuals per family and many cases of serious shortage of food and shelter have been reported that eventually leads to high maternal and infant mortality.



**Bhumika Chauhan and Monica Misra**

Use of the contraceptive methods has long way back history around thousands of years since the beginning of the time when humans engaged themselves in sexual activity for impetus rather than reproduction. Women employed homemade contraceptive methods like herbs, spices, heavy metals, barrier methods made from animal guts and various other sperm blocking ingredients. These ingredients were directly placed into the genitals to prevent pregnancy. Contraception is a encyclopedic term including devices, drugs and various other practices for birth control.

The method of action of contraceptives is broadly categorized into three broad ways i.e. (i) preventing the female gamete (ova) and male gamete (sperm) from congregation that would further prevent fertilization and formation of a zygote (ii) Halting egg production (ovulation) in females (iii) Preventing the zygote from adhering to the lining of endometrium for implantation. Contraceptive methods, based on a elemental understanding of the processes of successful reproduction, helps in population-regulation with an important place in the science of reproductive medicine (Giudice *et al.*,2011).

Now a days, oral hormonal contraceptives has been widely accepted as potent method of birth control. But the adverse effects and discussions on the usage of hormonal contraceptives still into needs lot of talk as it has revealed to influence a wide range of metabolic factors including hemostatic variables, carbohydrate metabolism and lipid profile for e.g. the OCs(Oral Contraception) have been shown to induce rare cardiovascular events mainly Venous Thrombo Embolism (VTE) (Lidegaard *et al.*,2009 , Dinger *et al.*, 2007 and Lidegaard *et al.*,2001) .Thus, diverse approaches have been accomplished in order to upgrade the safety of hormonal contraceptives such as lowering the estrogen dose, altering the estrogen type, selecting newer progestins, new administration schedules and alternative routes of delivery.

The aim of the present communication is to elucidate the practices used by women in ancient times in different parts of the world until the late 1800s and explicate the today's commonly used birth control methods. The authors also highlights upon the successful usage of traditional herbs in several animal groups for birth control and its unavailable research and testing on humans and also upon the scientific aspect whether the ancient practices had a justification for the birth control methods or it was just a myth.

ANCIENT METHODS OF CONTRACEPTION

Various factors like social, research and religious beliefs have been often considered as basis of .prohibition of contraception since ancient times. Only by early 20th century that birth control methods became accessible for married couples (Quarini *et al.*,2005). But prior to 20th century women used to depend upon natural methods for controlling pregnancy. Some of the known popular methods are listed below as-

USE OF SILPHIUM

Ancient Minoans, Egyptians, Romans, and Greeks used silphium for many purposes like the ancient Mediterranean for trading economy. Silphium is a fennel-like plant with heart-shaped seeds, employed for a variety of grounds including inflated stomachs, flavoring food, to fragrance body and to prevent pregnancy. Women utilized silphium plant's seeds for more than six centuries in the following ways to retard pregnancy-

- a) Swallowing its juice once a month.
- b) Placing wool soaked in silphium juice into vagina.

USE OF OLIVE OIL

According to many Greek, Roman and Soranus (practised medicine in Rome)women who didn't wish to conceive should smear an ointment of old olive oil on the orifice of the uterus (i.e. the cervix). Soranus and Aristotle were of the opinion that women should use olive oil , honey, cedar resin, balsam tree juice with or without white lead. These ingredients used to serve as primitive spermicide and slows sperms motility.



**Bhumika Chauhan and Monica Misra****USE OF GHEE AND SALT**

In Ancient times Indian women used to insert cotton dipped in a blend of ghee (clarified butter), honey, rock salt and tree seeds into their vaginas to prevent unwanted and unplanned pregnancy. This might sound excruciatingly uncomfortable but such practises were used by females and no other mode of birth control was known at that point of time and if any was known then and even family mindset didn't allow.

USE OF JUNIPER BERRIES

Pedanius Dioscorides, a physician hypothesized the usage of medicinal herb i.e Juniper Berries in crushed forms for both men and women and used to smear them on their genitals. He was of belief that these berries might obstruct with conception by reducing the possibility of implantation.

SNEEZING AS METHOD OF CONTRACEPTION

Soranus, a Greek gynaecologist postulated a natural method i.e sneezing as method of contraception. He was of opinion that after man had ejaculated his semen into the vagina of female, the female partner "must detain her breath and draw herself away a little, so that the sperm may not be hurled too deep into the cavity of the uterus. And after that female partner must immediately get up and should induce sneezing and wipe the vagina all round."

USE OF LIQUID LEAD AND MERCURY

During ancient times Chinese women consumed lead, mercury, and arsenic, and possibly all three mixed together. Despite the potential serious side effects, that cause kidney failure to brain damage and even death, women aimed to drink just enough of these substances in order to prevent conception, but not enough to get poisoned.

CROCODILE EXCREMENT

Ancient Egyptian women used an uncommon component—crocodile excrement—for preventing pregnancies. They used to mingle up the reptile's and elephant feces with fermented dough, and sprinkle the concoction on their vulvas or inside their vaginas to block sperm from reaching the uteri. Some researchers have postulated that the alkaline nature of the feces could have the ability to destroy the sperm, while others assume that it might increase the naturally acidic pH of the vagina's that was indeed making pregnancy more likely, as greater alkalinity is beneficial for sperm.

USE OF ALCOHOL AND COCA COLA

In regions of Bosnia and Herzegovina, during 1950s and 1960sa type of fruit brandy called Rakija was used as a vaginal wash .Its enormous alcohol content causes vaginal dryness and dyspareunia [painful intercourse]. In some areas like Angola, Coca-Cola is believed to have contraceptive properties. Young people consumed Coca-Cola with two or more aspirin after intercourse. A statement of an old women to UNFPA (United Nations Population Fund) stating that- "I tried this a long time ago, when I was a teenager," proves its wide range of usage . Still the idea that Rakhija and coca cola effects on pregnancy is a myth or it has some scientific fact behind is under consideration and yet a topic of debate.

USE OF MILK AND IODINE

In Kyrgyzstan, women have been known to drink milk and iodine after sex to prevent pregnancy. While mainly observed in the 1980s and 1990s, this method may still be used in remote areas. Iodine solution is toxic and can cause inflammation, burns to the esophagus and stomach tissue, and hormonal imbalances.

USE OF ALUM

Reproductive health experts reported the use of alum as a vaginal suppository to prevent pregnancy in diverse countries. Post usage of causes irritation, dysbacteriosis – or harmful microbial imbalance – and elevated risk of infections.





Bhumika Chauhan and Monica Misra

SCIENTIFIC CLAIMS BEHIND ANCIENT PRACTICES

USE OF FLOWERS AND FENNEL FOR FAMILY PLANNING

Silphium, a type of “giant funnel” which is now extinct, whose juice was evidently used as a contraceptive, through the ancient world to prevent pregnancies and induce abortions. Silphium belonged to the ferula genus, whose plants contain a substance, ferujol, that in low doses is nearly 100 percent effective in preventing pregnancy in rats (Kolata, Gina., 1994). Another plant that the ancients used was Queen Anne’s lace, or wild carrot. Hippocrates wrote that its seeds are contraceptives and that they also induce abortions and this was studied on rodents. Hippocrates have been right as these seeds blocks the production of progesterone, a hormone that is important for maintaining pregnancy. Queen Anne’s lace is still used as a folk medicine. Some women in Appalachia, still drink a glass of water containing a teaspoonful of the seeds immediately after sexual intercourse, to prevent pregnancy. This was also observed in women in Rajasthan, India, as they chew the plants seeds for the same reason. Another ancient contraceptive is pennyroyal, as mentioned in Aristophanes’s comedy “Peace” written back in 421 BC. Men used to worry about their female companion might become pregnant, so a dose of pennyroyal was recommended as this contained pulegone, a chemical that terminates pregnancy.

USE OF OIL / SALTS AND THEIR COMBINATIONS WITH OTHER MATERIALS AS CONTRACEPTIVES In a research conducted by Ajayi *et al.*, 2016 “concoction”-a mixture of oil/water, salt, soft drinks, lime, potash and alabukun were used as method of emergency contraception after unsafe sex. Till date no proven efficiency of these hazardous practices are reported.

USE OF TOXIC CHEMICALS/ELEMENTS AS CONTRACEPTION

Lead, a known potent element that has hazardous effects on the health of individuals was earlier used by Chinese women to prevent unwanted pregnancy. Since long the toxic potent effects of lead on individual health is known but despite its known effects like kidney failure, heart, brain damage etc., several reports of Chinese women using it for have been reported. The hazardous role of lead is known in miscarriage, early or too small and it even causes the child to have learning or behaviour problems (Shannon, M., 2003).

EMERGING SCIENCE AND FUTURE OF CONTRACEPTION

CONCLUSION

Fifty years ago, family planning was acknowledged as a human right. Yet safe and reliable forms of contraception are still out of reach for hundreds of millions of people. In desperation, many resort to ineffective or even dangerous methods, often based on myth and rumour. Lack of sex knowledge, perceived stigma from friends, alienation from parents, and perceived stringent financial implication are main reason for following these ancient dangerous practices till date in many parts of the world. It was also found that young couples in schools and colleges followed these myths at a higher rate. The authors through this text highlights the fact that majority of the contraception method are not only dangerous but also can cause severe complications upon consumption and have no scientific reason on the mode of action of the above mentioned methods. Educating young generation at school levels and adults remote areas by shortening the communication gap and being helpful rather than judgmental can be of a great help in controlling this trends.

REFERENCES

1. Ajayi I.A., Nwokocha E.E., Akpan, W and Adeniyi V.O .2016. Use of non-emergency contraceptive pills and concoctions as emergency contraception among Nigerian University students: results of a qualitative study. *BMC Public health*.16.pp.1046-1050.





Bhumika Chauhan and Monica Misra

2. Dinger JC, Heinemann LA, Kühl-Habich D. 2007. The safety of a drospirenone-containing oral contraceptive: final results from the European Active Surveillance Study on oral contraceptives based on 142,475 women-years of observation. *Contraception*. 75.pp.344–354.
3. Giudice, LC.; Sitruk-Ware, R.; Bremner, WJ.; Hillard, P. 2011. Eunice Kennedy Shriver National Institute of Child Health and Human Development. Bethesda, Maryland: 2011 Jan 25–26. Scientific Vision Workshop on Reproduction, Workshop White Paper. http://www.nichd.nih.gov/vision/comments/whitepapers/NICHD_Reproduction_Vision_White_paper_030511.pdf
4. Lidegaard O, Nielsen LH, Skovlund CW, Løkkegaard E. 2001. Venous thrombosis in users of non-oral hormonal contraception: follow-up study, Denmark 2001-10. *BMJ*. 201210. 344:e2990.
5. Lidegaard O, Løkkegaard E, Svendsen AL, Agger C. 2009. Hormonal contraception and risk of venous thromboembolism: national follow-up study. *BMJ*. 2339:b2890. [PubMed: 19679613]
6. Shannon ,M. 2003. Severe lead poisoning in pregnancy. *Ambul Pediatr*. Jan-Feb;37(9). doi:10.1367/1539-4409(2003)003<0037.slpip>2.0.co;2.





Survival Analysis of Type I Diabetes Patients using a Length Biased Weighted Devya Distribution

Arulmozhi.V^{1*} and Arumugam.P²

¹Ph.D Research Scholar, Department of Statistics, Annamalai University, Annamalai Nagar, Tamil nadu, India

²Associate Professor, Department of Statistics, Annamalai University, Annamalai Nagar, Tamil nadu, India

Received: 13 May 2022

Revised: 14 June 2022

Accepted: 18 July 2022

*Address for Correspondence

Arulmozhi.V

Research Scholar,

Department of statistics,

Annamalai University,

Annamalai Nagar, Tamil Nadu, India

Email: arulmozhi16@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In this study, we proposed new two-parameter distribution namely; Length Biased Weighted Devya (LBWD) distribution. The structural properties include the moment, survival analysis, hazard rate function, reverse hazard rate, order statistics and entropy. To estimate parameters for the given distribution, the approach of maximum likelihood estimation is utilized. The proposed distributions flexibility in type I diabetes patients data is illustrated. Finally, the diabetic data set is fitted to this new distribution, and the fit is good.

Keywords: Length Biased Weighted Devya Distribution, Maximum likelihood estimation, Survival analysis, Hazard function, Order statistics and Entropies.

INTRODUCTION

Fisher (1934) was the first to propose the use of weighted distributions to model ascertainment bias. Weighted distributions are commonly used in research involving dependability, survival analysis, family data analysis, biomedicine, ecology, and a variety of other topics (see Stene (1981) and Oluyede and George (2002)). When standard distributions were not suited to record observations with equal probabilities, Rao (1965) established this concept in a unified approach while modelling statistical data. As a result, weighted models were developed to record data based on a weighted function in such scenarios. Because the weight function only considers the unit length, the weighted distribution becomes a length biased weighted distribution. Cox and Zelen (1969) was the first to propose the idea of





Arulmozhi and Arumugam

length biased sampling (1974). Size-biased distribution theory was independently developed by Van-Deusen (1986) and applied to the distributions of breast diameter and height (DBH). Tallis et al. (1995) used weights to model fish population densities in fisheries. Gupta and Tripathi (1996) used statistical methods to investigate the weighted version of the bivariate logarithmic series distribution, which has applications in a variety of domains including ecology, social, and behavioural sciences. Size biased sampling and invariant weighted distributions were addressed by Patil and Ord (1976). Shanker (2016) introduced the devya distribution with many statistical properties, which can be found in Patil and Rao for modeling real weighted distributions linked to human population and ecosystem (1978). Weighted distributions are used in biomedicine, reliability, ecology, and branching processes, among other fields. Para and Jan (2018) examined the statistical characteristics and applicability of the Weighted Pareto type-II distribution as a new model for processing medical science data. The characterization and estimate of length biased weighted generalised uniform distributions was studied by Rather and Subramanian (2018). The weighted sushila distribution was studied by Rather and Subramanian (2019), along with its many statistical properties and applications. Mariyam mohiud din et al. (2020) a new generalization of devya distribution with application to using a real life data. Manoj et al. (2019) presented weighted Odoma distribution, its statistical properties, and how to estimate its parameter. The proposed distributions flexibility in type I diabetes patient’s dataset is illustrated. The Devya distribution is superior to the two parameter Akash, Lindley, distributions in terms of fit.

Length biased weighted devya Distribution

The probability density function of weighted devya distribution is given by.....(1)

$$f(x, \theta, c) = \frac{\theta^{c+5} x^c (1 + x + x^2 + x^3 + x^4) e^{-\theta x}}{\theta^4 c! + (c+1)! \theta^3 + (c+2)! \theta^2 + (c+3)! \theta + (c+4)!} \quad x > 0, \theta > 0$$

And its cumulative distribution function (cdf) is defined by

$$f(x, \theta, c) = \frac{\theta^4 \gamma(c+2, \theta x) + \theta^3 \gamma(c+3, \theta x) + \theta^2 \gamma(c+4, \theta x) + \theta \gamma(c+5, \theta x) + \gamma(c+6, \theta x)}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \dots (2)$$

Suppose X is a random variable with probability density function f(x). Let w(x) is the weight function then the probability density function of the weighted random variable is given by

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

Where (w(x)) is a non-negative weight function and

$$E(w(x)) = \int w(x)f(x), dx > 0$$

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

Where

$$E(x^c) = \int_0^\infty x^c f(x) dx$$

For different weighted models, we can have different choices of the weight function w(x) on the study we will develop the new version of devya distribution by taking w(x)=x, c=1 to get the length biased weighted devya distribution, the probability density function (pdf) of length biased weighted devya distribution is given by

$$f_L(x) = \frac{xf(x)}{E(x)} \quad x > 0$$





Arulmozhi and Arumugam

$$E(x) = \int_0^{\infty} xf(x)dx$$

$$E(x) = \int_0^{\infty} \frac{x\theta^{c+5}x^c(1+x+x^2+x^3+x^4)e^{-\theta x}}{\theta^4c!+(c+1)!\theta^3+(c+2)!\theta^2+(c+3)!\theta+(c+4)!} \dots\dots\dots (4)$$

Substituting the values of equation (1) and equation (4) in equation (3) we get the probability density function (pdf) of length biased weighted devya distribution.

$$E(x) = \int_0^{\infty} \frac{\theta^{c+5}}{\theta^4c!+(c+1)!\theta^3+(c+2)!\theta^2+(c+3)!\theta+(c+4)!} \int_0^{\infty} x^{c+1}(1+x+x_2+x_3+x_4)e^{-\theta x} dx$$

$$E(x) = \left(\frac{\theta^{c+5}}{\theta^4c!+(c+1)!\theta^3+(c+2)!\theta^2+(c+3)!\theta+(c+4)!} \right)$$

$$\int_0^{\infty} x^{c+1}e^{-\theta x} dx + \int_0^{\infty} x^{c+2}e^{-\theta x} dx + \int_0^{\infty} x^{c+3}e^{-\theta x} dx + \int_0^{\infty} x^{c+4}e^{-\theta x} dx + \int_0^{\infty} x^{c+5}e^{-\theta x} dx$$

$$E(x) = \left(\frac{\theta^{c+5}}{\theta^4c!+(c+1)!\theta^3+(c+2)!\theta^2+(c+3)!\theta+(c+4)!} \right)$$

$$\left[\frac{(\Gamma c + 2)}{\theta^{c+2}} + \frac{(\Gamma c + 3)}{\theta^{c+3}} + \frac{(\Gamma c + 4)}{\theta^{c+4}} + \frac{(\Gamma c + 4)}{\theta^{c+5}} \right]$$

$$E(x) = \left(\frac{\theta^{c+5}}{\theta^4c!+(c+1)!\theta^3+(c+2)!\theta^2+(c+3)!\theta+(c+4)!} \right)$$

$$[\theta^4(\Gamma c + 2) + \theta^3(\Gamma c + 3) + \theta^2(\Gamma c + 4) + \theta(\Gamma c + 5)]$$

Now,

$$f_l(x, c, \theta) = \frac{x^{c+1}\theta^{c+6}(1+x+x^2+x^3+x^4)e^{-\theta x}}{\theta^4(c+1)!\theta^3(c+2)!\theta^2(c+3)!\theta(c+4)!} \quad x > 0, c > 0, \theta > 0 \dots\dots\dots(5)$$

The cumulative distribution function (cdf) of the length biased weighted devya distribution is obtained as

$$F_l(x, c, \theta) = \int_0^x f_L(x, \theta, c)dx$$

$$= \theta^{c+6} \int_0^x \frac{x^{c+1}(1+x+x^2+x^3+x^4)e^{-\theta x}}{\theta^4(c+1)!\theta^3(c+2)!\theta^2(c+3)!\theta(c+4)!} dx$$

$$= \frac{\theta^{c+6}}{\theta^4(c+1)!\theta^3(c+2)!\theta^2(c+3)!\theta(c+4)!}$$

$$\int_0^x x^{c+1}e^{-\theta x} dx + \int_0^x x^{c+2}e^{-\theta x} dx + \int_0^x x^{c+3}e^{-\theta x} dx + \int_0^x x^{c+4}e^{-\theta x} dx + \int_0^x x^{c+5}e^{-\theta x} dx \dots\dots\dots(6)$$





Arulmozhi and Arumugam

After simplification, using an incomplete gamma function $\gamma(s, x) = \int_0^x t^{s-1} e^{-t} dt$ to an equation (6).we get the cumulative function of length biased weighted devya distribution.

$$\begin{aligned}
 &\theta x = z, x = \frac{z}{\theta}, \theta dx = dz, \\
 \text{Put} \\
 &= \frac{1}{\theta} \int_0^{\theta x} \left(\frac{z}{\theta}\right)^{c+1} e^{-z} dz + \frac{1}{\theta} \int_0^{\theta x} \left(\frac{z}{\theta}\right)^{c+2} e^{-z} dz + \frac{1}{\theta} \int_0^{\theta x} \left(\frac{z}{\theta}\right)^{c+3} e^{-z} dz + \frac{1}{\theta} \int_0^{\theta x} \left(\frac{z}{\theta}\right)^{c+4} e^{-z} dz + \frac{1}{\theta} \int_0^{\theta x} \left(\frac{z}{\theta}\right)^{c+5} e^{-z} dz \\
 &= \frac{\theta^{c+6}}{\theta^4(c+1)! + \theta^3(c+2)! + \theta^2(c+3)! + \theta(c+4)!} \left(\left(\frac{1}{\theta}\right)^{c+2} \int_0^{\theta x} z^{c+2-1} e^{-z} dz + \left(\frac{1}{\theta}\right)^{c+3} \int_0^{\theta x} z^{c+3-1} e^{-z} dz \right. \\
 &+ \left. \left(\frac{1}{\theta}\right)^{c+4} \int_0^{\theta x} z^{c+4-1} e^{-z} dz + \left(\frac{1}{\theta}\right)^{c+5} \int_0^{\theta x} z^{c+5-1} e^{-z} dz + \left(\frac{1}{\theta}\right)^{c+6} \int_0^{\theta x} z^{c+6-1} e^{-z} dz \right) \\
 &F_L(x, \theta, c) = \left(\frac{1}{\theta}\right)^{c+2} \gamma(c+2; \theta x) + \left(\frac{1}{\theta}\right)^{c+3} \gamma(c+3; \theta x) + \left(\frac{1}{\theta}\right)^{c+4} \gamma(c+4; \theta x) + \left(\frac{1}{\theta}\right)^{c+5} \gamma(c+5; \theta x) \\
 &+ \left(\frac{1}{\theta}\right)^{c+6} \gamma(c+6; \theta x) \times \left(\frac{\theta^{c+6}}{\theta^4(c+1)! + \theta^3(c+2)! + \theta^2(c+3)! + \theta(c+4)!} \right).
 \end{aligned}$$

.....(7)

Where $\gamma(s, x) = \int_0^x t^{s-1} e^{-t} dt$ incomplete gamma function.

Plot of pdf and cdf for different values of c and θ are given in figure 1 and figure 2.

Survival Analysis

In this section, we have obtained the survival function; failure rate of the length biased weighed devya distribution. The survival function of the (LBWD) distribution is given by

$$s_L(x; c, \theta) = 1 - F_L(x; c, \theta)$$

$$s_L(x; c, \theta) = \left(\begin{aligned} &1 - \left(\frac{\theta^{c+6}}{\theta^4(c+1)! + \theta^3(c+2)! + \theta^2(c+3)! + \theta(c+4)!} \right) \\ &\times \frac{1}{\theta^{c+6}} \left(\theta^4 \gamma(c+2, \theta x) + \theta^3 \gamma(c+3, \theta x) + \theta^2 \gamma(c+4, \theta x) + \theta \gamma(c+5, \theta x) \right) \\ &+ \gamma(c+6, \theta x) \end{aligned} \right) ; x > 0, \theta > 0, c > 0$$





Arulmozhi and Arumugam

$$S_l(x; c, \theta) = 1 - \left\{ \frac{\theta^4 \gamma(c + 2, \theta x) + \theta^3 \gamma(c + 3, \theta x) + \theta^2 \gamma(c + 4, \theta x) + \theta \gamma(c + 5, \theta x) + \gamma(c + 6, \theta x)}{\theta^4 (c + 1)! + \theta^3 (c + 2)! + \theta^2 (c + 3)! + \theta (c + 4)!} \right\}$$

Hazard function

The hazard function is also known rate, instantaneous force of mortality and is given by

$$h_l(x) = \frac{f_l(x, \theta, c)}{S_l(x, 0, \theta)}$$

$$h_l(x) = \frac{x^{c+1} \theta^{c+6} (1 + x + x^2 + x^3 + x^4) e^{-\theta x}}{\left(\frac{\theta^4 (c + 1)! + \theta^3 (c + 2)! + \theta^2 (c + 3)! + \theta (c + 4)!}{\theta^4 \gamma(c + 2, \theta x) + \theta^3 \gamma(c + 3, \theta x) + \theta^2 \gamma(c + 4, \theta x) + \theta \gamma(c + 5, \theta x) + \gamma(c + 6, \theta x)} \right)}$$

The reverse hazard rate is given by

$$h_l^r(x : c, \theta) = \frac{f_L(x, c, \theta)}{F_L(x, c \theta)}$$

$$h_l^r(x : c, \theta) = \frac{x^{c+1} \theta^{c+6} (1 + x + x^2 + x^3 + x^4) e^{-\theta x}}{\left(\theta^4 \gamma(c + 2, \theta x) + \theta^3 \gamma(c + 3, \theta x) + \theta^2 \gamma(c + 4, \theta x) + \theta \gamma(c + 5, \theta x) + \gamma(c + 6, \theta x) \right)}$$

Mills ratio of length biased weighted devya function is written as

$$\begin{aligned} \text{millsratio} &= \frac{1}{h_l^s(x)} \\ &= \frac{\left(\theta^4 \gamma(c + 2, \theta x) + \theta^3 \gamma(c + 3, \theta x) + \theta^2 \gamma(c + 4, \theta x) + \theta \gamma(c + 5, \theta x) + \gamma(c + 6, \theta x) \right)}{x^{c+1} \theta^{c+6} (1 + x + x^2 + x^3 + x^4) e^{-\theta x}} \end{aligned}$$

Plots of survival function are displayed in figure 3.

Moments and associated measures

Let x_n denote the random variable following length biased devya distribution then r^{th} order moment, that is, $E(X_x^r)$ is obtained by

$$\mu_r^1 = E(X)^r = \int_0^\infty x^r f(x) dx$$

$$E(X)^r = \int_0^\infty x^{c+r+1} e^{-\theta x} dx + \int_0^\infty x^{c+r+2} e^{-\theta x} dx + \int_0^\infty x^{c+r+3} e^{-\theta x} dx + \int_0^\infty x^{c+r+4} e^{-\theta x} dx + \int_0^\infty x^{c+r+5} e^{-\theta x} dx$$





Arulmozhi and Arumugam

$$E(X)^r = \int_0^\infty x^{c+r+2-1} e^{-\theta x} dx + \int_0^\infty x^{c+r+3-1} e^{-\theta x} dx + \int_0^\infty x^{c+r+4-1} e^{-\theta x} dx + \int_0^\infty x^{c+r+5-1} e^{-\theta x} dx + \int_0^\infty x^{c+r+6-1} e^{-\theta x} dx$$

$$E(X)^r = \frac{1}{\theta^{c+6+r}} \{ (r+c+1)! \theta^4 + \theta^3 (r+c+2)! + (r+c+3)! \theta^2 + \theta (r+c+4)! \}$$

$$E(X_l^r) = \left(\frac{\theta^{c+6}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right) \times \left(\frac{(r+c+1)! \theta^4 + \theta^3 (r+c+2)! + (r+c+3)! \theta^2 + \theta (r+c+4)!}{\theta^{r+c+6}} \right)$$

$$E(X_l^r) = \left(\frac{(r+c+1)! \theta^4 + \theta^3 (r+c+2)! + (r+c+3)! \theta^2 + \theta (r+c+4)!}{\theta} \right)$$

Setting r=1, 2, 3,.. in equation (8), the moments of length biased weighted devya distribution is

$$\mu_1' = \left(\frac{(c+2)! \theta^4 + \theta^3 (c+3)! + (c+4)! \theta^2 + \theta (c+5)! + \theta (c+6)!}{\theta} \right)$$

$$\mu_2' = \left(\frac{(c+3)! \theta^4 + \theta^3 (c+4)! + (c+5)! \theta^2 + \theta (c+6)! + (c+7)!}{\theta^2} \right)$$

$$\mu_3' = \left(\frac{(c+4)! \theta^4 + \theta^3 (c+5)! + (c+6)! \theta^2 + \theta (c+7)! + (c+8)!}{\theta^3} \right)$$

variance = $\mu_2' - (\mu_1')^2$

$$\mu_2 = \left(\frac{(c+3)! \theta^4 + \theta^3 (c+4)! + (c+5)! \theta^2 + \theta (c+6)! + (c+7)!}{\theta^2} \right) - \left(\frac{(c+2)! \theta^4 + \theta^3 (c+3)! + (c+4)! \theta^2 + \theta (c+5)! + \theta (c+6)!}{\theta} \right)^2$$





Arulmozhi and Arumugam

$$\mu_2 = \left(\left(\frac{(c+3)! \theta^4 + \theta^3 (c+4)! + (c+5)! \theta^2 + \theta (c+6)! + (c+7)!}{\theta^2} \right) \right. \\ \left. - \left(\frac{(c+2)! \theta^4 + \theta^3 (c+3)! + (c+4)! \theta^2 + \theta (c+5)! + \theta (c+6)!}{(\theta)^2} \right) \right)$$

$$S.D(\sigma) = \sqrt{\left(\left(\frac{(c+3)! \theta^4 + \theta^3 (c+4)! + (c+5)! \theta^2 + \theta (c+6)! + (c+7)!}{\theta^2} \right) \right. \\ \left. - \left(\frac{(c+2)! \theta^4 + \theta^3 (c+3)! + (c+4)! \theta^2 + \theta (c+5)! + \theta (c+6)!}{\theta^2} \right) \right)^2}$$

Harmonic mean

Harmonic mean of the length biased weighted devya distribution model can be obtained as

$$H.M = E\left(\frac{1}{X_N}\right)$$

$$= \int_0^\infty \frac{1}{x} f_l(x; c, \theta) dx$$

$$= \int_0^\infty \frac{1}{x} \left(\frac{x^{c+6} \theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\theta x}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right) dx$$

$$= \left(\frac{x^{c+6} \theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\theta x}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right) \int_0^\infty (1+x+x^2+x^3+x^4) x^{c-1} e^{-\theta x} dx$$

$$= \left(\frac{x^{c+6} \theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\theta x}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)$$

$$\times \int_0^\infty x^{c-1} e^{-\theta x} dx + \int_0^\infty x^c e^{-\theta x} dx + \int_0^\infty x^{c+1} e^{-\theta x} dx + \int_0^\infty x^{c+2} e^{-\theta x} dx + \int_0^\infty x^{c+3} e^{-\theta x} dx$$

On simplification we get

$$H.M = \frac{\theta^6 (\theta^5 \Gamma(c) + \theta^5 \Gamma(c+1) + \theta^5 \Gamma(c+2) + \theta^5 \Gamma(c+3) + \theta^5 \Gamma(c+4))}{\theta^4 (c+1) + \theta^3 (c+2) + \theta^2 (c+3) + \theta (c+4)}$$

Moment generating function and characteristic function





Arulmozhi and Arumugam

Let X_n follows length biased weighted devya distribution, and then the moment generating function (mgf) of X is obtained as

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

Using Taylor's series expansion for e^{tx}

$$M_X(t) = \left(1 + tx + \frac{(tx)^2}{2!} + \frac{(tx)^3}{3!} + \frac{(tx)^4}{4!} + \dots \right)$$

$$M_X(t) = \sum_{r=0}^\infty \frac{t^r}{r!} \int_0^\infty f(x) dx$$

$$M_X(t) = \sum_{r=0}^\infty \frac{t^r}{r!} \mu_r^1$$

This gives that

$$M_X(t) = \sum_{r=0}^\infty \left(\frac{t^r}{r!} \right) \left\{ \frac{(r+c+1)! \theta^4 + \theta^3 (r+c+2)! + (r+c+3)! \theta^2 + \theta (r+c+4)! + (r+c+5)!}{\theta^r} \right\}$$

Similarly we can get the characteristic function of length biased weighted devya distribution

$$\phi_x(t) = M_X(it) = \int_0^\infty e^{-itx} f(x) dx$$

$$\phi_x(t) = \sum_{r=0}^\infty \frac{(it)^r}{r!} \left(\frac{(r+c+1)! \theta^4 + \theta^3 (r+c+2)! + (r+c+3)! \theta^2 + \theta (r+c+4)! + (r+c+5)!}{\theta^r} \right)$$

Order statistics

Let $x_{(1)}, x_{(2)}, x_{(3)}, x_{(4)}, \dots, x_{(n)}$, be the order statistics of a random variable $x_1, x_2, x_3, \dots, x_n$ drawn from the continuous population $f(x)$ is the probability density function while $F(x)$ is the cumulative distribution function of the distribution then the p.d.f of r^{th} order statistics $x(r)$ is given by

$$f_{X(r)}(x) = \frac{n!}{(r-n)!(n-r)!} f_X(x) [F_X(x)]^{r-1} [1-F_X(x)]^{n-r}$$

Using equation (5) and (7) in equation (9), the probability density function of r^{th} order statistics $X_{(r)}$ of length biased weighted devya distribution is given by





Arulmozhi and Arumugam

$$f_{X(l)(r)}(x) = \frac{n!}{(r-n)!(n-r)!} \times \frac{x^{c+1} \theta^{c+6} (1+x+x^2+x^3+x^4)e^{-\theta x}}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!}$$

$$\times \left[\left(\frac{1}{\theta}\right)^{c+2} \gamma(c+2; \theta x) + \left(\frac{1}{\theta}\right)^{c+3} \gamma(c+3; \theta x) + \left(\frac{1}{\theta}\right)^{c+4} \gamma(c+4; \theta x) + \left(\frac{1}{\theta}\right)^{c+5} \gamma(c+5; \theta x) \right]$$

$$\times \left[\frac{\theta^{c+6}}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!} \right]^{r-1}$$

$$\times \left[1 - \left\{ \frac{\theta^4 \gamma(c+2, \theta x) + \theta^3 \gamma(c+3, \theta x) + \theta^2 \gamma(c+4, \theta x) + \theta \gamma(c+5, \theta x) + \gamma(c+6, \theta x)}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!} \right\} \right]^{n-1}$$

Therefore, the probability density function of highest order statistics $X_{l(n)}$ can be obtained as

$$f_{X(l)(n)}(x) = \frac{nx^{c+1} \theta^{c+6} (1+x+x^2+x^3+x^4)e^{-\theta x}}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!}$$

$$\times \left[\left(\frac{1}{\theta}\right)^{c+2} \gamma(c+2; \theta x) + \left(\frac{1}{\theta}\right)^{c+3} \gamma(c+3; \theta x) + \left(\frac{1}{\theta}\right)^{c+4} \gamma(c+4; \theta x) + \left(\frac{1}{\theta}\right)^{c+5} \gamma(c+5; \theta x) \right]$$

$$\times \left[\frac{\theta^{c+6}}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!} \right]^{n-1}$$

And pdf of first order statistic $X_{l(1)}$ can be obtained as

$$f_{X(l)(r)}(x) = \frac{x^{c+1} \theta^{c+6} (1+x+x^2+x^3+x^4)e^{-\theta x}}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!}$$

$$\times 1 - \left\{ \frac{\theta^4 \gamma(c+2, \theta x) + \theta^3 \gamma(c+3, \theta x) + \theta^2 \gamma(c+4, \theta x) + \theta \gamma(c+5, \theta x) + \gamma(c+6, \theta x)}{\theta^4(c+1)!+\theta^3(c+2)!+\theta^2(c+3)!+\theta(c+4)!} \right\}$$

Entropies

The concept of entropy is important in different areas such as probability, statistics, physics, communication theory and economics. Entropies quantify the diversity, uncertainty of a system. Entropy of a random variable X is a measure of variation of the uncertainty.

Renyi Entropy

The Renyi Entropy is important in ecology and statistics as an index of diversity it is also important in quantum information, where it can be used as a measure of entanglement. For a given probability distribution, Renyi Entropy is given by

$$e(\gamma) = \frac{1}{1-\gamma} \log \left(\int f_i^\gamma(x; c, \theta) dx \right)$$





Arulmozhi and Arumugam

$$\begin{aligned}
 &= \frac{1}{1-\gamma} \left(\int_0^\infty \left(\frac{x^{c+1} \theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\theta x}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\gamma dx \right) \\
 &= \frac{1}{1-\gamma} \left(\left(\frac{\theta^{c+6}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\gamma \left(\int_0^\infty x^{\gamma c+1} (1+x+x^2+x^3+x^4) e^{-\gamma \theta x} dx \right) \right)
 \end{aligned}$$

Using binomial expansion

$$\begin{aligned}
 &= \frac{1}{1-\gamma} \log \left(\frac{\theta^{c+6}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\gamma \\
 &\sum_{i=0}^{\gamma} \sum_{j=0}^i \sum_{k=0}^j \sum_{l=0}^k \binom{r}{i} \binom{i}{j} \binom{i}{k} \binom{k}{l} \left(\int_0^\infty x^{(\gamma(c+1)+i+j+k+l+1)-1} e^{-\gamma \theta x} dx \right) \\
 &= \frac{1}{1-\gamma} \log \left(\frac{\theta^{c+6}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\gamma \\
 &\sum_{i=0}^{\gamma} \sum_{j=0}^i \sum_{k=0}^j \sum_{l=0}^k \binom{r}{i} \binom{i}{j} \binom{i}{k} \binom{k}{l} \frac{\Gamma(\gamma c+1+i+j+k+l+1)}{(\theta \gamma)^{(\gamma c+1+i+j+k+l+1)}}
 \end{aligned}$$

Tsallis Entropy

$$\begin{aligned}
 s_\lambda &= \frac{1}{1-\lambda} \left(1 - \left(\int f_l(x; c, \theta) dx \right)^\lambda \right) \\
 s_\lambda &= \frac{1}{1-\lambda} \left(1 - \int_0^\infty \left(\frac{x^{c+1} \theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\theta x}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\lambda dx \right) \\
 s_\lambda &= \frac{1}{1-\lambda} \left(1 - \left(\frac{x^{c+1} \theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\theta x}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\lambda \left(\int (\theta^{c+6} (1+x+x^2+x^3+x^4) e^{-\lambda \theta x}) dx \right) \right)
 \end{aligned}$$

Using binomial expansion

$$\begin{aligned}
 &= \frac{1}{1-\lambda} \left(1 - \frac{\theta^{c+6}}{\theta^4 (c+1)! + \theta^3 (c+2)! + \theta^2 (c+3)! + \theta (c+4)!} \right)^\lambda \\
 &\sum_{i=0}^{\lambda} \sum_{j=0}^i \sum_{k=0}^j \sum_{l=0}^k \binom{r}{i} \binom{i}{j} \binom{i}{k} \binom{k}{l} \left(\int_0^\infty x^{((\lambda c+1)+i+j+k+l+1)-1} e^{-\lambda \theta x} dx \right)
 \end{aligned}$$





Arulmozhi and Arumugam

Maximum Likelihood Estimator (MLE)

In this section, we will discuss the maximum likelihood of the parameters of length biased weighted devya distribution. Let $(x_1, x_2, x_3, \dots, x_n)$ to be a random sample of size n from length biased weighted devya distribution then the likelihood function, is given by

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

$$L = \left(\frac{\theta^{c+6}}{\theta^4(c+1)! + \theta^3(c+2)! + \theta^2(c+3)! + \theta(c+4)!} \right) \prod_{i=1}^n (1 + x + x^2 + x^3 + x^4)^{-\theta x_i} \dots(10)$$

The log likelihood function is given by

$$n \log \left(\frac{\theta^{c+6}}{\theta^4(c+1)! + \theta^3(c+2)! + \theta^2(c+3)! + \theta(c+4)!} \right) + \sum_{i=1}^n \log(1 + x_i + x_i^2 + x_i^3 + x_i^4) - \theta \sum x_i = \log L$$

Differentiating above equation with respect with respect to c and θ as follows

$$\log l = n \left\{ \log \theta^{c+6} - (\log \theta^4(c+1)! + \theta^3(c+2)! + \theta^2(c+3)! + \theta(c+4)!) \right\} - \theta \sum x_i = \log l$$

$$\log l = n \left\{ (c+6) \log \theta - \log \left(\theta^4(c+1)! - \log \theta^3(c+2)! - \log \theta^2(c+3)! - \log(c+4)! + \log(c+5)! \right) + \sum_{i=1}^n \log(1 + x_i + x_i^2 + x_i^3 + x_i^4) - \theta \sum x_i = 0 \right\} \dots(12)$$

$$\frac{\partial \ell}{\partial c} = n \log \theta - \frac{\psi(c+1)!}{(c+1)!} - \frac{\psi(c+2)!}{(c+2)!} - \frac{\psi(c+3)!}{(c+3)!} - \frac{1}{(c+4)!} \psi(c+4)! - \frac{1}{(c+5)!} \psi(c+5) = 0 \dots (13)$$

Because of the complicated from of likelihood equation (12) and (13), it is very difficult to solve the system of nonlinear equations. Therefore, we use R software application for estimating the required parameters.

Application and goodness of fit

The two-parameter length biased weighted devya distribution can be used to analyse a wide range of type I diabetes data, including medical, biosciences, and so on. The application of the two parameter length biased weighted devya distribution to a diabetes dataset of HbA1c blood sugar (glucose) is presented in this section. If your HbA1c level is high, it may be a sign of diabetes, a chronic disease that causes serious health problems such as heart disease, kidney disease, and nerve damage. It was compared to two-parameter Lindley and two-parameter akash distributions for goodness of fit.





Arulmozhi and Arumugam

Data set

The data set represents the type I diabetes patients HbA1c blood sugar (glucose) data relating to times (in months from 11th march 2021 to march 16th 2022) of 150 diabetes patients blood sugar data set analyzed by RMMCH hospital.

The data are as follows:

6.1,6.6,9.2,8.4,8.8,7.8,8.3,8.4,8.5,8.2,7.8,8.7,7.2,7.9,8.6,9.2,8.4,8.6,6.9,8.8,7.9,6.6,7.8,7.1,7.8,6.8,8.1,8.3,7.8,6.8,8.1,8.3,7.8,8.3,7.2,8.4,8.9,8.1,7.4,8.6,6.9,8.3,7.9,6.6,7.7,8.6,7.9,7.8,7.9,7.7,6.8,1.6,9.8,6.7,8.9,7.9,7.6,8.9,7.8,8.3,7.9,8.8,8.2,8.5,6.9,6.4,8.4,7.8,7.7,7.1,9.2,8.1,7.8,9.1,7.8,7.9,8.1,8.5,7.9,8.2,7.2,10.1,6.6,7.6,9.9,8.2,8.9,7.1,7.4,8.5,8.7,9.1,7.4,8.8,7.1,7.8,7.4,6.7,7.7,7.8,8.9,7.1,7.4,6.1,6.6,9.2,8.4,8.8,7.8,8.3,8.4,8.5,8.2,8.8,8.4,7.8,8.7,7.2,7.9,8.6,9.2,8.4,8.6,6.9,8.8,7.9,6.6,7.8,7.1,7.8,6.8,8.1,8.3,7.8,8.3,7.2,8.4,8.9,8.1,7.4,8.6,6.9,8.3,7.9.

To compare these distributions, minimum AIC (Akaike Information Criteria), BIC (Bayesian information criterion), AICC (Akaike Information Criterion corrected), $-2\log L$ for the diabetes patients HbA1c blood sugar (glucose) have been computed. The formulae for computing AIC, BIC, AICC and $-2\log L$ are as follows:

$$AIC = -2\ln l + 2k, BIC = -2\ln l + k \ln n \text{ and } AICC = AIC + \frac{2k(k+1)}{n-k-1}$$

Where k is the number of parameters and n is the sample size.

RESULTS

The new proposed distribution was compared with two parameter length biased weighted devya, two parameter Lindley, two parameter Akash. These distributions were applied to diabetes patients HbA1c blood sugar (glucose) data to determine the most efficient distribution. The results in table two clearly show that the length biased weighted devya distribution has lower AIC, BIC, and $-2\log L$ values than the Lindley and akash distributions, implying that the length biased weighted devya distribution provides a better fit than the Lindley and akash distributions.

CONCLUSION

In this study, a novel weighted devya distribution model called the Length biased weighted devya distribution with two parameters is implemented, and its various statistical and mathematical aspects are examined and calculated. The weighted approach was used to create the subject distribution, and the maximum likelihood estimator was used to acquire the parameters. The major goal of this manuscript complication is to make one aware of the importance of novel extensions in some random processes, despite the fact that we already have a number of conventional distributions. It's also worth noting that the considered data sets fit better in the newly introduced model than the baseline distribution, namely the length biased weighted devya distribution. Finally, the importance of the newly presented distribution is established using HbA1c blood sugar (glucose) data sets, which show that the length biased weighted devya distribution fits better than the two parameter lindley and akash distributions.

REFERENCES

1. A. Rather;C.Subramanian;On Weighted Sushila Distribution with Propertis, International Journal of Scientific Research in Mathematical and Statistical Sciences, 6(1) 105- 117(2019).
2. A.K.Gupta;R.C.Tripathi; Weighted bivariate logarithmic series distributions, Common Stat Theory Methods 25 1099–1117(1996).
3. O.Oluyede;E.O.George; on stochastic inequalities and comparisons of reliability measures for weighted distributions, Math Probl Eng 8 1–13 (2002).





Arulmozhi and Arumugam

4. C.E.Bonferroni;Elmenti di statistica generale. Libreria Seber, Firenze Sciences and Applications. 12(4) 62–67(1930).
5. C.Tsallis; Possible generalization of boltzmann-gibbs statistics. Journal of Statistical Physics, 5252 479-48 (1988).
6. G. P. Patil; Pergamum Press and Statistical publishing Society, Calcutta 320-332(1965).
7. G. P.Patil;J.K.Ord;On size biased sampling and related form invariant weighted distribution, Indian J Stat, 39 48–61(1976).
8. Ganaie et al, Weighted Aradhana distribution, properties and applications, journal of information technology research, IX (8) 392-406 (2019).
9. H.Anwar;M.A.Dar; et.al.;A New Generalization of Pranav Distribution Using Weighting Technique, International Journal of Scientific Research Paper Mathematical and Statistical Sciences. 6(1) 25-32 (2019).
10. H.Zakerzadeh;A.Dolati Generalized Lindley distribution, Journal of Mathematical extension 3(2) 13–25 (2009).
11. K. I.Alsairan; I.A.Amer; Weighted Suja Distribution with Application to ball bearing data, Life Cycle Reliability and Safety Engineering, 9195– 211(2020).
12. Mariyam mohiud din, Shabir A. Dar; a new generalization of devya distribution with application to real life data 7(3),pp.313-325,(2020)
13. M.K.Shakhatreh; A two parameter of weighted exponential distributions. Statistics and Probability Letters, 82(2) 252-261 (2012).
14. Obubu Maxwell,samuel Oluwafemi Oyamakin; new generalization of length biased exponential distribution with application sawka, Nigeria, (2019).
15. R.Shanker; Devya Distribution and its Applications, International Journal of Statistics and Applications, 6(4) 189-202 (2016).
16. R.Shanker; Akash Distribution and its Applications, International Journal of Probability and Statistics. 4(3) 65-75(2015).
17. R.Shanker; Amarendra distribution and Its Applications. American Journal of Mathematics and Statistics, 6(1) 44 – 56 (2016).
18. R.Shanker; K. K. Shukla; Weighted Akash Distribution and Its Application to model lifetime data, International Journal of Statistics, 39(2) 1138- 1147(2016).
19. R.Shanker;Shanker Distribution and its applications. Int J Stat Appl. 5(6) 338-48 (2015).

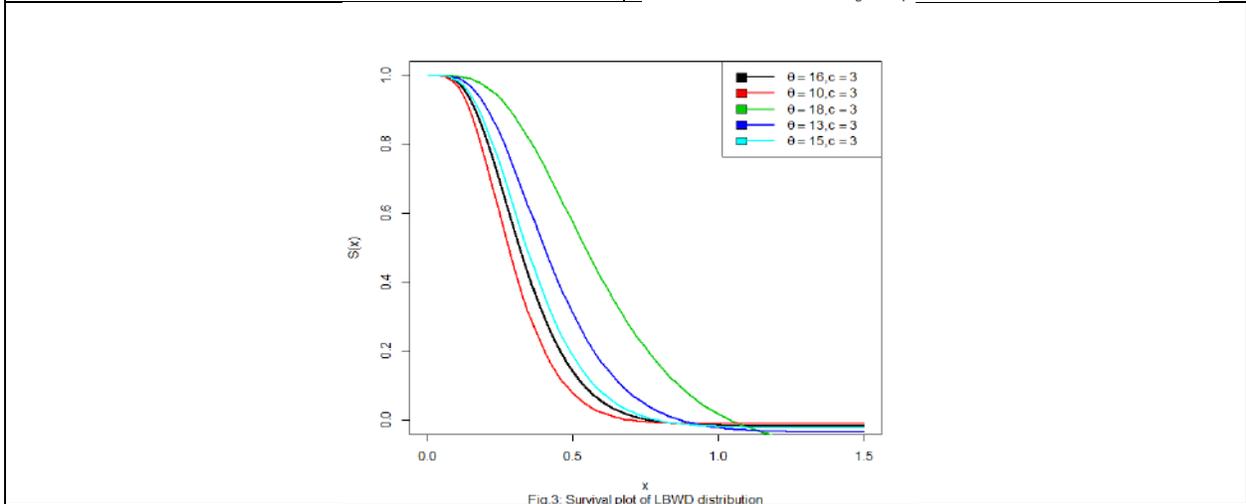
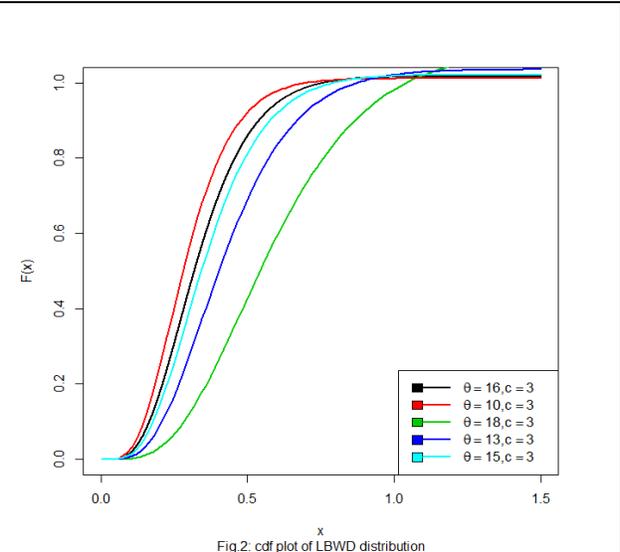
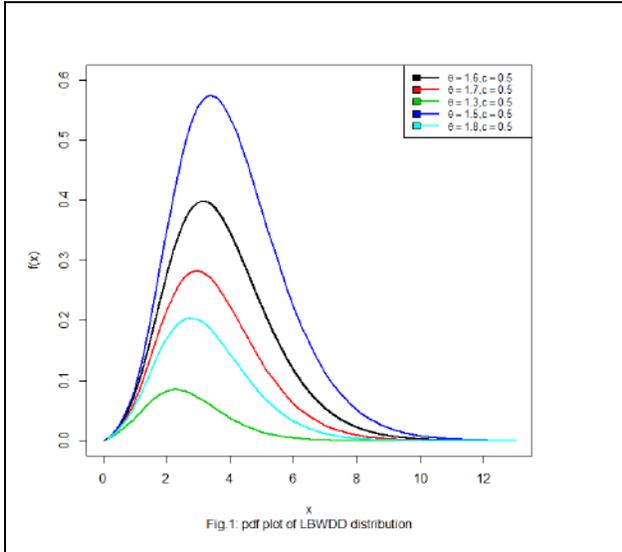
Table 1. Diabetes Patients HbA1c blood sugar (glucose) data to determine the most efficient distribution

| Distribution | MLE'S | -2 log L | AIC | BIC | AICC |
|------------------------------|-----------------------------|----------|----------|----------|----------|
| Length biased Weighted Devya | $\hat{\theta} = 0.5836994$ | 472.4523 | 487.1956 | 493.1935 | 487.2772 |
| Two-parameter Lindley | $\hat{\theta} = 0.6470174$ | 483.3459 | 497.6055 | 503.5923 | 497.7825 |
| Two parameter Akash | $\hat{\theta} = 0.74021667$ | 616.0854 | 623.0854 | 629.9297 | 623.1482 |





Arulmozhi and Arumugam





A Study to Assess the Effectiveness of Video Assisted Teaching Programme on Knowledge Regarding Basic Life Support among Caregivers of Cardiac Patients

Ravivarman D^{1*} and K.Kamala²

¹Assistant Professor, Vinayaka Mission's College of Nursing, Karaikal, Pudhucherry (UT) India.

²Principal, Vinayaka Mission's College of Nursing, Karaikal, Pudhucherry (UT), India.

Received: 01 June 2022

Revised: 15 June 2022

Accepted: 14 July 2022

*Address for Correspondence

Ravivarman D

Assistant Professor,

Vinayaka Mission's College of Nursing,

Karaikal, Pudhucherry (UT), India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Basic life support (CPR) is a critical and vital part of the management of cardiac arrest and prevention of sudden cardiac death. It should be started as soon as possible. Family members, caregivers and relatives had patient at risk of sudden cardiac death they must know the knowledge regarding how to perform BLS. To assess the effectiveness of Video Assisted Teaching Programme on Knowledge regarding Basic Life Support among Caregivers of Cardiac Patients. Quantitative pre experimental research design was adopted for this present study. 50 caregivers of cardiac patient were chosen by non-probability convenience sampling technique. The data were collected by using demographic and 30 pretested self-structured (Investigator made) knowledge questionnaire. Pre-test and post-test knowledge scores revealed that during pre-test, the mean score 17.4 ± 4.56 (SD) which is 58% of the total mean score, whereas in post-test, the mean score was 26.4 ± 3.82 (SD) which is 78% of the total mean score depicting difference of 30% increase in mean percentage of score. The calculated 't' value 19.76 which is higher than the $P < 0.05$, states that highly significant difference between the pre-test and post-test. It proved that the Video assisted teaching programme was highly effective to improve the knowledge of caregivers of cardiac patients.

Keywords: Effectiveness, Video assisted Teaching programme, Knowledge, Basic Life support, caregivers and cardiac patients.



**Ravivarman and Kamala**

INTRODUCTION

Sudden cardiac arrest (SCA) is a leading cause of death. Basic life support (BLS) dramatically increases the chance of survival for a victim suffering from SCA. BLS provides critical blood flow and oxygen to the heart and brain. BLS is started within three to five minutes of collapse, it increases a victim's chance of survival and reduces the chance of permanent damage [1]. Basic life support is important for saving life demands only two hands and some basic knowledge. A qualified staff nurse can open airways, resuscitate, massage a heart and call for help. A person with cardiopulmonary resuscitation training can sustain an ailing person's heart and brain for a short time. Resuscitation is an important activity performed to save lives. It is used to assist people who have suffered with cardiac arrest and suddenly stopped breathing in order to supply sufficient oxygen to the vital tissues of their body [2,3]. Knowledge of BLS and practice of simple CPR techniques ensures the survival of the patient till experienced medical help arrives and in most cases that itself is sufficient for survival [4].

Early bystander initiated CPR would improve the survival rate of out-of-hospital sudden cardiac arrests. Caregivers play an important role as bystanders on and off campus (home) both now and in the future [5]. Studies have shown that, in case of out-of-home cardiac arrest, bystanders, lay persons or family members attempt CPR in 14% to 45% of the time, and only half of bystanders perform CPR effectively. Only a minority of bystanders will initiate CPR when a family member collapses in the home. The main reason for not performing CPR was fear of failing. The study highlighted that CPR courses are not reaching to those most likely to be called upon to use this skill [6]. Comprehensive arrest identification, encouragement and empowering of bystanders are needed to improve the out-of-hospital cardiac arrest survival. Arrest identification can be simplified so that bystanders can start CPR when a person is unconscious and not breathing normally.

Bystanders should initiate CPR with compressions and consider the addition of rescue breathing based on their CPR training and skills as well as special circumstances of the victim [7]. The American heart association strongly encourages the people, companies and organization to implement CPR programs to increase the chances of survival for people who have heart-related emergencies [8]. The video provides a unique resource to enrich the knowledge on BLS. Caregivers of cardiac patients require skills of assessment for cardiac arrest and need to initiate BLS, involving maintaining respiration and circulation for the casualty until emergency services, or advanced life support services, arrive. Video-assisted Teaching Program was effective in enhancing the knowledge and skills regarding BLS. [9,10]

STATEMENT OF THE PROBLEM

A Study to assess the effectiveness of Video Assisted Teaching Program on Knowledge regarding Basic Life Support among Caregivers of Cardiac Patients

OBJECTIVES OF THE STUDY

- To assess the knowledge regarding Basic life support among care givers of cardiac patients
- To determine the effectiveness of Video assisted teaching program on knowledge regarding Basic life support among care givers of cardiac patients
- To find out the association of pretest level of knowledge regarding Basic life support among care givers of cardiac patients with their demographic variables.

•

HYPOTHESES

- **H₁:** There will be a significant difference between pre test, post test knowledge regarding Basic life support among care givers of cardiac patients
- **H₂:** There will be an association between pretest level of knowledge regarding Basic life support among care givers of cardiac patients with their demographic variables.





MATERIAL AND METHODS

The Quantitative pre experimental Research design was adopted for this present study to found the effectiveness of Video assisted program me on knowledge regarding Basic life support among care givers of cardiac patients. 50 caregivers of cardiac patient were chosen by non-probability convenience sampling technique. The data were collected by using demographic and 30 pretested self-structured (Investigator made) knowledge questionnaire. The reliability of the tool was tested by test retest method and the score was $r=0.73$. The informed written consent had obtained from the study samples.

RESULTS

Table.1 showed that in pre-test 7 (14 %) of care givers had adequate knowledge, 12(24%) of care givers had moderately adequate knowledge and 31(62%) of care givers had inadequate knowledge whereas, in post-test 16(32%) of care givers had moderately adequate knowledge and 34(68%) of care givers had adequate knowledge and none of them had inadequate knowledge. Table.2. showed that the comparison of overall mean, SD and mean percentage of pre-test and post- test knowledge scores reveals that during pre-test, the mean score 17.4 ± 4.56 (SD) which is 58% of the total mean score, whereas in post-test, the mean score was 26.4 ± 3.82 (SD) which is 78% of the total mean score depicting difference of 30% increase in mean percentage of score. The calculated 't' value 19.76 which is higher than the $P < 0.05$, states that highly significant difference between the pre-test and post-test. It proved that the teaching program me was highly effective in improving the knowledge regarding Basic life support among caregivers. So H_1 was accepted. The table 3 revealed that there was a significant association with the pre test level of knowledge regarding BLS among caregivers with their selected demographic variables like age, Education and Previous source of information regarding BLS and not found statistically significant with other variables like gender and Relationship to patients. So H_1 was partially accepted.

DISCUSSION

The present study result showed that in pretest majority of the care givers had inadequate knowledge and after the teaching program me the knowledge was improved among them. So this study proved that significant difference was there between pre test, post test knowledge and also found that video assisted teaching program me was effective in improving the knowledge regarding Basic life support among care givers of cardiac patients. Arpana Acharya (2021) conducted study and revealed that mean knowledge score percentage in posttest is higher than pre-test. Overall findings shows that video assisted teaching program me was effective in improving their level of knowledge regarding BLS [11]. Ruchir Joshi et al., (2018) reported that the mean score of post-test knowledge 22.68(75.62 %) was apparently higher than the mean score of pre-test knowledge 16.35 (54.50) %, suggesting that the video assisted teaching was effective in increasing the knowledge regarding cardio-pulmonary resuscitation [12]. Aliyu I et al., (2018) reported that there was poor awareness of CPR among respondents, furthermore there was lack of willingness to perform CPR by most respondents on children.[13] Karthiga (2018) revealed that Emergency Preparedness Protocol was effective in improving knowledge and skill regarding pre hospital management of cardiac emergencies among patients with chronic illness and their caregivers.[14] Levy M (2015) found that CPR done by bystanders doubled the survival rate (6.2%) and CPR administered by health care professionals tripled the survival rate (10.8%) when compared to no bystander CPR (3.1%). The study concluded that victims of cardiac arrest have a higher chance of survival with bystander CPR [15].





CONCLUSION

Most of the care givers knowledge was not up to the mark before the teaching program me. The teaching program me among care givers facilitated them to learn more about BLS. Health education is an integral part of making awareness among public regarding health consciousness, prevention of fatal and it emphasis a scientific attitude towards health, which is very important to modern healthy living.

ACKNOWLEDGEMENT

The author has grateful for the management, colleagues and study participants for their support and cooperation.

Financial support and sponsorship: Nil

Conflicts of interest: There are no conflicts of interest

REFERENCES

1. American healthcare academy. CPR-Introduction Updated May 2015
2. Krucik G. Health line. First aid CPR. c2014.
3. Ounprasertsuk et al. /The Effectiveness of Basic Life Support Activities in Lower Secondary School Children WatLatPeng School, SamutSongkhram Province. Vol 11, Issue 10, Oct-Nov 2020
4. Steen PA, Johansen K J. Improving cardiopulmonary resuscitation quality to ensure survival. 2015; 14:299-304
5. Chen ZQ, Zhao Y, Lu ZH, Li XY, Shi HJ, Sun J, et.al. Awareness and attitudes of chinese students towards cardiopulmonary resuscitation. Emergency medicine journal. 2014; 27: 907-910.
6. Gallagher EJ, Lombardi G, Gennis P. Effectiveness of bystander cardio pulmonary resuscitation and survival following out-of-hospital cardiac arrest. December 2012. Available from: <http://www.ncbi.nlm.nih.gov/pubmed>
7. Bryan MN, Rachel R. Out-of-hospital cardiac arrest surveillance. Cardiac arrest registry to enhance survival (CARES). July 29, 2014; 1-19
8. Szogedi I, Zrinyi M, Betlehem J. Training nurses for CPR: support for the problem- based approach European Journal of Cardiovascular Nursing 2010; Mar.9 page:50-6.
9. Reddy CKB, Jaiswa S, Bhardwaj G. A study to assess the effectiveness of video assisted program me on cardio pulmonary resuscitation among nursing students of selected nursing schools. International Journal of Science & Healthcare Research. 2018; 3(2): 15-18.
10. Kirshnakumar. A study to evaluate the effectiveness of video assisted teaching program me(vatp) regarding cardio pulmonary resuscitation on knowledge and skill among staff nurses working in selected hospitals Bangalore. 2019 IJRTI | Volume 4, Issue 12
11. ArpanaAcharya. (2021). A study to assess the effectiveness of video assisted teaching program me on the level of knowledge regarding cardiopulmonary resuscitation among b.sc nursing iird year student sat shri guru ram rai university, college of nursing, dehradun. <https://doi.org/10.5281/zenodo.5763806>
12. Ruchir Joshi et al., study to assess the effectiveness of video assisted teaching on knowledge regarding cardiopulmonary resuscitation among undergraduate college students in selected colleges at Udaipur, Rajasthan . IOSR Journal of Nursing and Health Science (IOSR-JNHS). Volume 7, Issue 1 Ver. VIII. (Jan.- Feb .2018), PP 54-58
13. Aliyu I, Mohammed A, Ibrahim ZF. Caregivers' awareness and perception of cardiopulmonary resuscitation: Our experience. Acta Med Int 2018;5:63-8
14. Karthiga. Effectiveness of emergency preparedness protocol on knowledge and skill regarding pre hospital management of cardiac emergencies among patients with chronic illness and their caregivers, at selected hospitals, Chennai.2018.





Ravivarman and Kamala

15. Levy M. Improved CPR- increase CPR effectiveness through quality improvement tools and training. www.cpr-etc.com.2015.

Table: 1. Comparison of pre-test and post-test level of knowledge regarding Basic life support among care givers of cardiac patients n=50

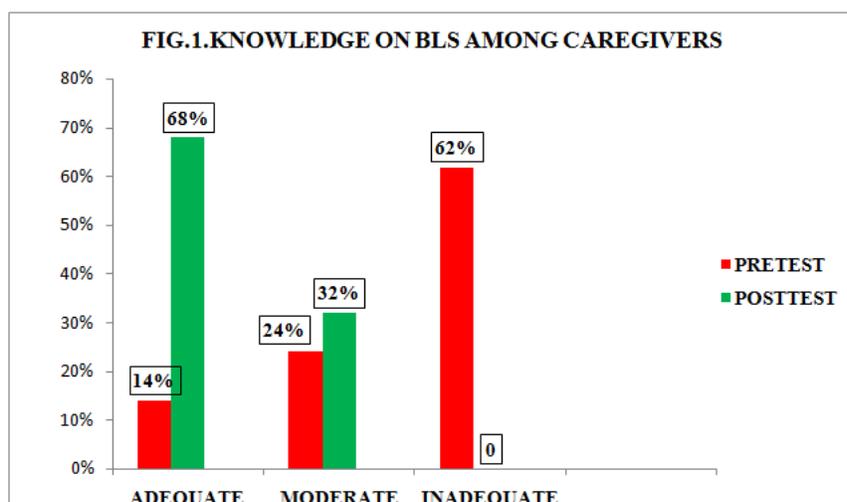
| Level of knowledge | Pre test | | Post test | |
|--------------------|-----------|------------|-----------|------------|
| | Frequency | Percentage | Frequency | Percentage |
| Adequate (>76%) | 7 | 14% | 34 | 68% |
| Moderate (51-75%) | 12 | 24% | 16 | 32% |
| Inadequate (<50%) | 31 | 62% | 0 | 0 |

Table.2. Comparison of Mean, SD, and mean percentage of pre-test and post- test knowledge regarding Basic life support among first year undergraduate Nursing students

| Area | Max score | Pre test scores | | | Post test score | | | Difference in mean | 't test Value |
|---|-----------|-----------------|------|-------|-----------------|------|-------|--------------------|--------------------|
| | | Mean | SD | Mean% | Mean | SD | Mean% | | |
| Knowledge on BLS among caregivers of cardiac patients | 30 | 17.4 | 4.56 | 58% | 26.4 | 3.82 | 88% | 30% | 19.76 *** HS |

Table.3. Association between pre-test levels of knowledge regarding BLS among care givers of cardiac patients with their selected demographic variables

| S.No | Demographic Variables | X ² value | Significance |
|------|--|----------------------|--------------|
| 1. | Age in years (care givers) | 7.21 | S* |
| 2. | Gender | 2.43 | NS |
| 3. | Education | 8.14 | S* |
| 4. | Relationship to patients | 3.43 | NS |
| 5. | Previous source of information regarding BLS | 9.24 | S* |





A Comparative Study of Two Freshwater Lakes of Mysore with Different Pollution Status

Namratha K.M.¹, Mahadevaswamy M^{2*} and Harsha T.S.³

¹Junior Research Fellow, University of Mysore, Mysuru, Karnataka, India.

²Department of Zoology, Yuvaraja's College (Autonomous), University of Mysore, Mysuru, Karnataka, India.

³Department of Environmental Science, Karnataka State Open University, Mysuru, Karnataka, India.

Received: 22 Apr 2022

Revised: 20 May 2022

Accepted: 02 July 2022

*Address for Correspondence

Mahadevaswamy M

Department of Zoology,
Yuvaraja's College (Autonomous),
University of Mysore, Mysuru,
Karnataka, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A comparative study of Physico-chemical parameters with Zooplankton abundance and two freshwater lakes was conducted for a period of two years from February 2018 to February 2020. The results showed that the most abundant zooplankton are phylum Rotifera in Dalvoy lake, followed by class Copepoda, Order Cladocera and Ostracod. Physico-chemical analysis showed that the surface water of Dalvoy lake is highly polluted due to eutrophication. The Rotifers are more abundant than any other zooplankton and group microcrustaceans i.e., ostracods abundance has low as they show high sensitivity to pollution. Cladocera showed a significant negative correlation with CO₂ and BOD, but a positive correlation with Nitrate. Ostracods showed a negative correlation with atmosphere and a positive correlation with COD. In total zooplankton abundance showed a negative correlation with Conductivity, Chloride and Phosphate. In Varuna Lake crustacean abundance, is followed by copepods, rotifers and ostracods as they show high sensitivity to pollution. Zooplankton abundance is because of seasonal variations, crustaceans were abundant and diverse. When compared to other groups, Varuna Lake noticed that the pH measured in the field showed a negative correlation with copepods and a positive correlation with Calcium, Conductivity and hardness of the water sample showed a positive correlation with Cladocerans, Chloride shows a negative correlation with Ostracods. The Abundance of Zooplankton showed no significance with any Physico-chemical parameters.

Keywords: Physico-chemical parameters, Zooplankton, Dalvoy lake, Varuna Lake, Crustaceans, Cladocera, Rotifera, Copepoda.



**Namratha et al.,**

INTRODUCTION

Water is an important natural resource; it covers about 71% of the earth's surface only 3% of fresh water is available on the earth. 2.5% of the earth's fresh water is locked up in glaciers, polar ice caps, atmosphere, and soil. 0.5% of the earth's water is available in freshwater bodies. Freshwater habitats can be classified by various factors, including temperature, light penetration, and vegetation. Fresh-water ecosystems are often categorized by two basic criteria that is water movement and size. Inland water bodies can be classified as either lotic (running water) or lentic (standing water). Lotic habitats include rivers, streams, and brooks, which are characterised by a flow of water[5].The lentic body is like large deep basins usually characterized by little or no flow existing within the basin[47].Freshwater bodies vary in size and quality of water as these water bodies are a major resource for consumption by humans and livestock mainly for drinking, domestic purposes and agricultural practices. Most of the freshwater bodies around the world are getting polluted, thus decreasing the potability of water. In recent years Lake pollution has become a serious environmental problem with socio-economics development, agriculture and domesticity [36].Surface water bodies are contaminated with many anthropogenic activities and toxic chemicals that can affect their natural communities. It is necessary to assess the effects of these chemicals to conserve aquatic ecosystems [15].Water quality assessment of Physico-chemical properties gives a proper indication of the status, productivity and sustainability of a water body [14]. The changes in the Physico-chemical characteristics like temperature, transparency and chemical elements of water such as dissolved oxygen, nitrate and phosphate provide valuable information on the quality which in turn impacts the aquatic biodiversity. Good quality of water is always important for the organisms inhabiting the ecosystem for growth and survival. Zooplanktons are the smallest organisms present in almost all the water bodies[17]. It will act as grazers on the phytoplankton and a food base for the carnivorous organisms in water bodies [14].They invariably form an integral component of freshwater communities and contribute significantly to biological productivity. It acts as the main source of food for many fishes[34].And few are recognized as bioindicators to help us detect pollution load and are also helpful for ameliorating polluted water [28].A bioindicator is given to a living entity or group of organisms that show the information, either based on the environment or a constituent of it. Indicator organisms are those species that have narrow and specific environmental tolerances [48].

REVIEW OF LITERATURE

Literature review showed that several researchers have carried out on freshwater lakes globally. The study was conducted by Islam, *et al.*, 2012;Keremah, *et al.*, 2014;Nwonumara and Nkwuda 2018 In India, many research studies have been carried out on Zooplankton and Water quality parameters Khan and Sinha 2002; Mukhopadhyay *et al.*, 2007George and Kowshy 2008; Pandey *et al.*, 2009; Ajay *et al.*, 2009; Minaret *et al.*, 2010; Puri *et al.*, 2011;Vipul *et al.*, 2012; Goswami and Mankodi 2012; Yannawar *et al.*, 2013; Athira and Jaya 2014; Dhanasekaran *et al.*, 2017; Sharma and Kumari 2018;Javed*et al.*, 2020;Hulyal and Kaliwal 2008; Suresh *et al.*, 2009; Murthuzasab *et al.*, 2010; Sayeswara *et al.*, 2011; Smitha *et al.*, 2013;Murthy *et al.*, 2014;Fahemeeda and Parveen 2015; Bhagde, *et al.*,2020 has made a comparative study of two freshwater ponds in Maharashtra, India. Very few studies are available on zooplankton abundance, and diversity correlated with Physico-chemical properties in the Mysore district. Padmanabha and Belagali 2008; KooroshJalilzadeh, 2009; Padmanabha 2010;Beenamma and Yamakanamardi 2010; Savitha and Yamakanamardi 2012. Hence, the present study was undertaken to compare the pollution status of two different lakes in relation to zooplankton abundance.





Namratha et al.,

MATERIALS AND METHODS

Description of the Study Area

The present study was carried out in two lentic ecosystems (Varuna and Dalvoy lake) (Fig. 1) in the Mysore district of Karnataka state, India. The sampling sites on Varuna and Dalvoy lakes are shown in Fig 1. Surface water samples were collected from Varuna Lake site No. 1. Dalvoy lake site No. 2. at about fortnightly intervals from February 2018 to February 2020.

Description of sampling sites

Varuna Lake: is a freshwater lake situated in the basin of the river Cauvery. The lake is situated at a latitude of 76° 44' E, a longitude of 12° 16' N at an elevation of 719 meters above the Mean Sea Level (MSL) and with a total area of about 0.8 sq. km. The lake is surrounded by agricultural fields and the lake water is suitable for irrigational purposes.

Dalvoy Lake: Dalvoy Lake, locally known as Dalvoy Kere has a water spread area of 54 hectares with a catchment zone of 15.5 Sq. Km. The lake is situated at a latitude of 76° 65' E, and a longitude of 12° 25' N at an elevation of 706.0 meters above the Mean Sea Level (MSL). The lake is elongated and oval, having 1.5 Km in length and 1.2 Km in its width. The main source of water to this lake is rainfall, urban runoff from the elevated area which comes through storm water drains and sewage water from surrounding industries and all parts of Mysore city [24]. In addition, the treated effluents of the municipality also added to the inflow. The pollution level of this lake can be seen from the out flowing water. As it is located near the National Highway, human influence are more to this lake.

Collection and Preservation of Samples

The observation of Physico-Chemical factors and zooplankton population were made for the period of 24 months from February 2018 to February 2020. Surface water samples were collected using clean sterilized bottles from both the lakes during the early morning from the site fortnightly from the Varuna and Davey lakes of Mysore during the study season. The samples are transported to the laboratory in a box containing ice and 50 ml from each site were preserved and were analyzed for 19 Physico-Chemical parameters following standard methods as given in [4] and [45]. To study the abundance of different groups of zooplankton, one hundred litres of water sample was collected from each sampling site and filtered through a 60µm mesh size net. After returning to the laboratory, the collected sample of zooplankton was fixed and preserved using 4% formalin., to estimate the zooplankton abundance, the modified Sedgwick Rafter method as given in [20] was followed. One ml from the concentrated sample was transferred into the Sedgwick Rafter counting chamber and observed under Olympus binocular microscope. The abundance of four groups (Rotifer, Cladocera, Copepod, and Outraced) of zooplankton was carried out using the following formula as given in [4].

$$\text{Number of Organisms/m}^3 = \frac{C \times V_1}{V_2 \times V_3}$$

Where C= number of organisms counted,
 V1= volume of concentrated sample (50 ml),
 V2= volume of sample counted (1 ml),
 V3= volume of grab sample (0.1m³).

Finally, to obtain organisms/L, the number of organisms per m³ was divided by 1000. Correlation between zooplankton and certain Physico-Chemical parameters was computed. The statistical analysis was done by using SPSS 11.5 version.





Namratha et al.,

Zooplankton found in Varuna Lake:

A Rotifer

- 1 *Filinia longiseta*
- 2 *Brachionus forficula*
- 3 *Brachionus caudatus*
- 4 *Keratella tropicana*

B Copepods

- 1 *Cyclops viridis*
- 2 *Thermocyclops*
- 3 *Cyclops sternus*
- 4 *Diaptomus dax*

C. Cladocerans

- 1 *Daphnia magna*
- 2 *Diaphanosoma sarsi*
- 3 *Diaphanosoma excisum*

D Ostracods

- 1 *Eucypris affinis*
- 2 *Cyclo cypris laevis*

Zooplankton found in Dalavoy Lake

A Rotifers

- 1 *Brachionus angularis*
- 2 *Brachionus calyciflorus*
- 3 *Brachionus plicatilis*
- 4 *Pseudo euclan is longipedia*

B Copepods

- 1 *Paradiapto musgreeni*
- 2 *Heliodiaptomus viduas*

C Cladocerans

- 1 *Diaphanosoma sarsi*
- 2 *Moinabra chiata*
- 3 *Simocephalous vetiloid*
- 4 *Ceriodaphnia cornuta*

D Ostracods

- 1 *Cypris protubera*
- 2 *Candocypris dentatus*

Frequency abundance of Zooplankton found in Varuna Lake

| Rotifers | Summer season | Rainy season | Winter season |
|-----------------------------|---------------|--------------|---------------|
| <i>Filinia longiseta</i> | ++ | ++ | ++ |
| <i>Brachionus forficula</i> | ++ | ++ | ++ |
| <i>Brachionus caudatus</i> | +++ | +++ | +++ |
| <i>Keratella Tropicana</i> | ++ | +++ | +++ |

| Copepods | Summer season | Rainy season | Winter season |
|------------------------|---------------|--------------|---------------|
| <i>Cyclops viridis</i> | ++ | +++ | +++ |
| <i>Thermocyclops</i> | +++ | +++ | +++ |
| <i>Cyclops sternus</i> | +++ | +++ | +++ |
| <i>Diaptomus dax</i> | +++ | +++ | +++ |

| Cladocerans | Summer season | Rainy season | Winter season |
|-----------------------------|---------------|--------------|---------------|
| <i>Daphnia magna</i> | +++ | +++ | +++ |
| <i>Diaphanosoma sarsi</i> | +++ | +++ | +++ |
| <i>Diaphanosoma excisum</i> | +++ | +++ | +++ |

| Ostracods | Summer season | Rainy season | Winter season |
|----------------------------|---------------|--------------|---------------|
| <i>Eucypris affinis</i> | +++ | +++ | +++ |
| <i>Cyclo cypris laevis</i> | +++ | +++ | +++ |

Note: Less abundant = +
 Frequent <= ++
 Most abundant <= +++





Namratha et al.,

Frequency abundance of Zooplankton found in Dalvoy Lake

| Rotifers | Summer season | Rainy season | Winter season |
|--------------------------------|---------------|--------------|---------------|
| <i>Brachionus angularis</i> | +++++ | ++++ | ++ +++++ |
| <i>Brachionus calyciflorus</i> | +++++ | ++++ | ++ + + + |
| <i>Brachionus plicatilis</i> | +++ | +++ | +++ |
| <i>Pseudoeuclanislompedia</i> | ++++ | +++ | +++++ |

| Copepods | Summer season | Rainy season | Winter season |
|------------------------------|---------------|--------------|---------------|
| <i>Paradiaptomus greeni</i> | +++++ | ++++ | ++ +++++ |
| <i>Heliodiaptomus viduas</i> | +++++ | ++++ | ++ + + + |

| Cladocerans | Summer season | Rainy season | Winter season |
|------------------------------|---------------|--------------|---------------|
| <i>Diaphanosomasarsi</i> | +++ | ++++ | ++ +++++ |
| <i>Moinabrachiata</i> | +++ | ++++ | ++ + + + |
| <i>Simocephalus vetiloid</i> | +++ | +++ | +++ |
| <i>Ceriodaphnia cornuta</i> | ++++ | +++ | +++++ |

| Ostracods | Summer season | Rainy season | Winter season |
|-----------------------------|---------------|--------------|---------------|
| <i>Cypris protubera</i> | +++++ | ++++ | ++ +++++ |
| <i>Candocypris dentatus</i> | +++++ | ++++ | ++ + + + |

Note: Less abundant = +
 Frequent <= + +
 Most abundant <= + + +

RESULTS

The seasonal variations in Physico-chemical parameters of the freshwater lakes are given in Table 1, The value of field pH showed a negative correlation with copepods but showed a positive correlation with Calcium. Conductivity and hardness of the water sample showed a positive correlation with Cladocerans, Chloride shows a negative correlation with Ostracods. The abundance of Zooplankton No significant relation with any Physico-Chemical parameters. The seasonal variations in Physico-chemical parameters of the freshwater lakes are given in Table 2 Rotifers showed negative correlation with conductivity, Chloride and Phosphate. Cladocera showed a negative correlation with CO₂ and BOD, but a positive correlation with Nitrate. Copepods showed a positive correlation with conductivity, Ostracods showed a negative correlation with air temperature and a positive correlation with COD. Zooplankton abundance showed a negative correlation with Conductivity, Chloride and Phosphate.

Zooplankton found in Varuna Lake

A. Rotifer

- Filinia giseta*
- Brachionus forficula*
- Brachionus caudatus*
- Keratella tropicana*

C. Cladocerans

- Daphnia magna*
- Diaphanosoma sarsi*
- Diaphanosoma excisum*





Namratha et al.,

B. Copepods

1. *Cyclops viridis*
2. *Thermocyclops*
3. *Cyclops sternus*
4. *Diatomusedax*

D. Ostracods

1. *Eucyprisaffinis*
2. *Cyclocyprislaevis*

Zooplankton found in Dalavoy Lake:

A. Rotifers

1. *Brachionusan gularis*
2. *Brachionus calyciflorus*
3. *Brachionus plicatilis*
4. *Pseudoeuclanislon gipedia*

C. Cladocerans

1. *Diaphanosoma sarsi*
2. *Moinab rachiata*
3. *Simocephalous vetiloid*
4. *Ceriodaphnia cornuta*

B. Copepods

1. *Paradiaptomus greeni*
2. *Heliodiapro musviduas*

D. Ostracods

1. *Cypris protubera*
2. *Candocypris dentatus*

ZOOPLANKTONS

Abundance of zooplankton Groups in Varuna Lake and Dalvoy lake (Table 3).

DISCUSSION

PHYSICO-CHEMICAL PARAMETERS

Air Temperature (°C)

The air and water temperature were determined with the help of a hand-held mercury thermometer soon after the collection of the surface water samples. The Air temperature ranged between 15.2°C-27.6 °CVaruna lake. The minimum value (15.2°C) was recorded during the winter season and the maximum value (27.6 °C) during the summer season. The Air temperature ranged between 15.9°C-27.4°Cin Dalvoy lake. The minimum value15.9°C recorded during the winter season and the maximum value was 27.4°Cduring the summer season. Similar observations have been reported in Kangsabati reservoir, West Bengal [37].

Water Temperature (°C)

The Water temperature ranged between 15.2°C-27.8 °CVaruna lake. The minimum value (15.2°C) was recorded during the winter season and the maximum value (27.8 °C) during the summer season. The Water temperature ranged between 15.9°C-27.8°Cin Dalvoy lake. The minimum value (15.9°C) was recorded during the winter season and the maximum value (27.8°C)during the summer season.[25]have reported the same in their study conducted on Tamadalge Water Tank in Kolhapur District, Maharashtra.

Field pH

pH is most important in determining the corrosive nature of water[2].Lower the pH value higher is the corrosive nature of water [9,33].The field pH ranged between 7.3-9.6 at Varuna Lake. The minimum value (7.3) was recorded during the winter season and the maximum value (9.6) during the summer season. The field pH ranged between 7.7-10.6at Dalvoy lake. The minimum value (7.7) was recorded during the rainy season and the maximum value (10.6) during the summer season. Similar observations were made at the Pravara River by [34].



**Namratha et al.,****Lab pH**

The lab pH ranged between 7.2-9.6 at Varuna Lake. The minimum value (7.2) was recorded during the winter season and the maximum value (9.6) during the summer season. The lab pH ranged between 7.8-10.8 at Dalvay lake. The minimum value (7.8) was recorded during the rainy season and the maximum value (10.8) during the summer season. There was not much difference found when measuring the pH at the lab and in the field.

Dissolved Oxygen

Winkler's method was used to determine the Dissolved Oxygen (DO) of the surface water samples. The Dissolved Oxygen ranged between 7.2 mg/L-10.4 mg/L at Varuna lake. The minimum value (7.2 mg/L) was recorded during the winter season and the maximum value (10.4 mg/L) during the summer season. The Dissolved Oxygen ranged between 2.0 mg/L-3.2 mg/L at Dalvay lake. The minimum value (2.0 mg/L) was recorded during the rainy season and the maximum value (3.2 mg/L) during the summer season [35] also made similar observations at two Temple Tanks in Kanyakumari District.

Free Carbon-Di-Oxide (CO₂ mg/L)

The free CO₂ was absent at Varuna lake throughout the study period. The value of CO₂ ranged between 19.4 mg/L-24.8 mg/L at Dalvay lake. The minimum value (19.4 mg/L) was recorded during the rainy season and the maximum value (24.8 mg/L) during the summer season.

Biological Oxygen Demand (BOD mg/L)

The Biological Oxygen Demand ranged (BOD) between 2.2 mg/L- 7.8 mg/L. The minimum value (2.2 mg/L) was recorded during the rainy season and the maximum value (7.8 mg/L) during the summer season. The Biological Oxygen Demand ranged (BOD) between 46.2 mg/L- 58.8 mg/L at Dalvay lake. The minimum value (46.2 mg/L) recorded during the winter season and maximum value (58.8 mg/L) during the summer season [8] reported a higher value of BOD during summers at Bandematta Hosakere Lake.

Chemical Oxygen Demand (COD mg/L)

The Chemical Oxygen Demand ranged between 29.3 mg/L- 77.0 mg/L. The minimum value (29.3 mg/L) was recorded during the summer season and the maximum value (77.0 mg/L) during the winter season. The Chemical Oxygen Demand ranged between 214.8 mg/L – 312.8 mg/L at Dalvay lake. The minimum value (214.8 mg/L) recorded during the summer season and the maximum value (312.8 mg/L) during the rainy season [18] made similar observations in their investigation.

Conductivity (μS/cm)

The conductivity ranged between 364 (μS-cm) -528 (μS-cm) at Varuna lake. The minimum value (364 (μS-cm)) was recorded during the winter season and the maximum value (528 (μS-cm)) during the summer season. The conductivity ranged between 818 (μS-cm) -1024 (μS-cm) at Dalvay lake. The minimum value (818 (μS-cm)) was recorded during the winter season and the maximum value (1024 (μS-cm)) during the rainy season [37] made similar observations at Kangsabati Reservoir.

Hardness (mg/L)

The Hardness ranged between 87 mg/L -157 mg/L. The minimum value (87 mg/L) was recorded during the rainy season and the maximum value (157 mg/L) during the summer season. The Hardness ranged between 243 mg/L-309 mg/L at Dalvay lake. The minimum value (243 mg/L) recorded during the winter season and maximum value (309 mg/L) during the summer season [37] also reported a high hardness value during the rainy season in their study conducted on Kangsabati Reservoir.

Turbidity (NTU): The Turbidity ranged between 2.0 NTU-5.9 NTU at Varuna Lake. The minimum value (2.0 NTU) was recorded during the summer season and the maximum value (5.9 NTU) during the rainy season. The Turbidity ranged between 11.4 NTU-15.4 NTU at Dalvay lake. The minimum value (11.4 NTU) was recorded during the winter season and the maximum value (15.4 NTU) during the rainy season [39] made similar observations in the lake waters.



**Namratha et al.,****Total Suspended Solids (TSS)**

Total suspended solids are the portion of solids that usually remains on the filter paper. Suspended solids consist of silt, clay, and fine particles of organic and inorganic matter, which is regarded as a type of pollution because water high in concentration of suspended solid may adversely affect the growth and reproduction rates of aquatic fauna and flora. The TSS ranged between 23.6 mg/L- 33.2 mg/L at Varuna lake. The minimum value (23.6 mg/L) was recorded during the winter season and the maximum value (33.2 mg/L) during the rainy season. The TSS ranged between 46.2 mg/L- 58.4 mg/L at Dalvoy lake. The minimum value (46.2 mg/L) was recorded during the winter season and the maximum value (58.4 mg/L) during the rainy season [8]reported similar observations at Bandematta Hosakere Lake.

Calcium (mg/L)

The Calcium ranged between 18.1 mg/L - 43.2 mg/L at Varuna lake. The minimum value (18.1 mg/L) was recorded during the rainy season and the maximum value (43.2 mg/L) during the summer season at Varuna lake. [44]made similar observations at Pariyej Lake, Gujrat. The Calcium ranged between 20.1 mg/L - 28.2 mg/L at Dalvoy lake. The minimum value (20.1 mg/L) was recorded during the winter season and the maximum value (28.2 mg/L) during the rainy season.

Chloride (mg/L)

The Chloride ranged between 24.8 mg/L- 45.6 mg/L. The minimum value (24.8 mg/L) was recorded during the winter season and the maximum value (45.6 mg/L) during the rainy season. The Chloride ranged between 46.81 mg/L- 70.4 mg/L at Dalvoy lake. The minimum value (46.81 mg/L) recorded during the rainy season and maximum value (70.4 mg/L) during the summer season [37]also reported a high chloride value during the summer season and low values during the rainy season at Kangsabati Reservoir.

Alkalinity (mg/L)

The Alkalinity ranged between 24.8 mg/L - 45.6 mg/L. The minimum value (24.8 mg/L) was recorded during the winter season and the maximum value (45.6 mg/L) during the summer season. The Alkalinity ranged between 578 mg/L – 682 mg/L at Dalvoy lake. The minimum value (578 mg/L) was recorded during the winter season and the maximum value (682 mg/L) during the summer season [44]also recorded higher values of alkalinity during the summer season.

Phosphate (mg/L)

The Phosphate ranged between 0.01 mg/L- 0.08mg/L. The minimum value (0.01 mg/L) was recorded during the summer season and the maximum value (0.08mg/L) during the winter season. The Phosphate ranged between 1.4 mg/L- 3.6mg/L Dalvoy lake. The minimum value (1.4 mg/L) was recorded during the rainy season and the maximum value (1.4 mg/L) during the summer season.

Sulphate (mg/L)

The Sulphate ranged between 0.01 mg/L- 0.08mg/L at Varuna Lake. The minimum value (0.01 mg/L) was recorded during the summer season and the maximum value (0.08mg/L) during the rainy season. The Sulphate ranged between 36.2 mg/L- 49.9 mg/L at Dalvoy lake. The minimum value (36.2 mg/L) was recorded during the rainy season and the maximum value (49.9 mg/L) during the winter season.

Nitrate (mg/L)

The Nitrate ranged between 0.01 mg/L- 0.08mg/L at Varuna Lake. The minimum value is recorded during the winter season and the maximum value during the rainy season. The Nitrate ranged between 1.7 mg/L- 5.1 mg/L at Dalvoy lake. The minimum value (1.7 mg/L) was recorded during the winter season and the maximum value (5.1mg/L) during the summer season [16]report the value of nitrate during the rainy season.





Namratha et al.,

Total Anion of the Strong Acids (TASA)

The TASA was found by adding the concentrations of Chloride, Nitrate and Sulphate. The TASA ranged between 40.9 mg/L- 72.9mg/L at Varuna Lake. The minimum value (40.9 mg/L) was recorded during the winter season and the maximum value (72.9mg/L) during the summer season. The TASA ranged between 84.3 mg/L - 117.8 mg/L at Dalvoy lake. The minimum value (84.3 mg/L) was recorded during the winter season and the maximum value (117.8 mg/L) during the summer season.

ZOOPLANKTON

During the study period, 8 species of Rotifer were found in Varuna Lake and Dalvoy lake. The extent of potential dependence of Zooplankton abundance on Environmental Variables was further investigated by stepwise multiple regression analysis revealed the following: Rotifer species found in Varuna Lake are *Filinia longiseta*, *Brachionus forficula*, *Brachionus caudatus*, *Keratella tropicana*. A slightly polluted Varuna Lake showed the rotifer's abundance but not the diversity compared to other zooplankton groups Rotifer abundance in Varuna Lake, has a positive correlation with conductivity and turbidity. Rotifers are more likely to be tolerant to the physical changes of the lakes but the other zooplankton such as crustaceans and ostracods decline in abundance. Eutrophication affects rotifers' abundance, therefore, when the abundance has seen in accordance with a seasonal variation the rotifers are more in summer seasons in both study years followed by monsoon and winter. The Rotifer species found in Dalvoy lake are *Brachionus angularis*, *Brachionus calyciflorus*, *Brachionus plicatilis*, *Pseudo euclanis longipedia*. Rotifers showed a negative correlation with three Physico-chemical parameters such as conductivity, Chloride and Phosphate in Dalvoy lake [39].

Cladoceran species found in Varuna Lake are *Daphnia magna*, *Diaphanosoma sarsi*, *Diaphanosoma excisum*, *Moina micrura*. Cladoceran have shown more diversity and abundance in the rainy season followed by the monsoon in the study period. Most of the species of the cladocerans need clear water for survival. Cladocerans showed a positive correlation with Conductivity and hardness in Varuna lake. Cladoceran species found in Dalvoy lake are *Diaphanosoma sarsi*, *Moina brachiata*, *Simocephalous vetiloid*, *Ceriodaphnia cornuta*. Cladocera showed a negative correlation with CO₂, and BOD and a positive correlation with Nitrate. Copepod species found in Varuna lake are *Cyclops viridis*, *Thermocyclops*, *Cyclops sternus*, *Diaptomusedax*, copepods showed a negative correlation with field pH in Varuna lake. Copepod species found in Varuna Lake are *Paradiaptomus greeni* and *Heliodiaptomus viduas*. Copepods showed positive correlation with conductivity in Dalvoy lake. Ostracod species found in Varuna Lake are *Eucypris affinis*, *Cyclocypris laevis*. The ostracod less abundance is usually affected by the pH of the lakes as calcium uptake for carapace calcification is difficult in acidic waters [9]. The slight pollution in Varuna Lake is due to the fewer domestic activities near the lake. Ostracods show a negative correlation with Chloride in Varuna Lake. Ostracod species found in Dalvoy lake are *Cyprisprotubera* and *Candocypris dentatus*. Ostracods showed a negative correlation with Air temperature and a positive correlation with COD in Dalvoy lake. Dalvoy lake is highly polluted due to industrial wastage untreated effluence and as mentioned previously the rotifers are most abundant in this lake due to its environmental variance capacity. The abundance of Zooplankton showed no significance with any Physico-chemical parameters.

REFERENCES

1. Ajay D. Chavan, Sharma, M.P and Bhargava, R. 2009. Water Quality Assessment of the Godavari River. *Hydro Nepal J Water and Env.* 5, 31-34.
2. Ali, HShaheen, I and F.H. Wattoo. 2019 Chemical and Microbial Analysis of Drinking Water of Different Localities in Rawalpindi. *Pak. J Agricul. Res.* 32(2):260-267.
3. Altaff K. 2004, manual of Zooplankton. Department of Zoology, the New College, Chennai.
4. APHA. In: Standard methods for examination of water and wastewater, 18th Ed., Greenberg AE, Clesceri LS, Eaton AD (eds), *Ame. Pub. Heal. Asso.* Washington, D.C., 1992.





Namratha et al.,

5. 5.Athira, N and Jaya, D.S., 2014. Assessment of water quality status of Anjarakandy river in Kannur district of Kerala. *Asian J. Environ Sci.* 9(2): 68-74.
6. 6.Beenamma, J and S.M. Yamakanamardi. 2010. Winter, summer and rainy seasonal changes in the abundance and biomass of zooplankton in relation to environmental variables in Kukkarahalli Lake of Mysore, Karnataka State, India. *J. Aqua. Biol.*, 25, 8-17.
7. 7.Bhagde, R.V. Pingle, S.A. Bhoje, M.R. Pansambal, S.S and Deshmukh, D.R. 2020. A comparative study of physico-chemical parameters of the freshwater ponds from sangamnertaluka of Ahmednagar, Maharashtra, India. *I. J. Bio. Inn.* 2 (2): 137-142.
8. 8.Bheemappa, K., Nandini, N., VijayKumar, M and Raghavendra, M. 2015. Temporal Variation in Water Quality Parameters of BandemattaHosakere Lake – Peri Urban Area of Bengaluru, Karnataka, India. *Int. J. Adv. Res.* 3(7): 1283-1291.
9. 9.Boomer, I. David, J.Horne and Smith R.J. 2006. Freshwater Ostracoda (Crustacea) from the Assynt region, NW Scotland: new Scottish records and a checklist of Scottish freshwater species. *Biol.* 76: 111-123.
10. 10.Dhanasekaran, M., Saravana Bhavan, P., Manickam, N and Kalpana, R., 2017. Physico-chemical characteristics and zooplankton diversity in a perennial lake at Dharmapuri (Tamil Nadu, India) *J. Entomol. and Zoo. Studies.* 5(1): 285-292.
11. 11.Djukie, N., Maletin, S., Pujin, V., Ivanc, A., Kojcic, K and Miljanovic, B. 1994. Ecological assessment of water quality of the Tisza by physico-chemical and biological parameters. - *Tiscia* 28, 37-40.
12. 12.Fahemeeda, S and Parveen, Z., 2015. Eco Biological Studies of Rural Fresh Water Bodies with Special Emphasis to Water Quality. Assessment. *Int. Res. J. Environment Sci.* 4(7): 29-34.
13. 13.George, A.V and Koshy, M. 2008 Water Quality Studies in Sasthamkotta Lake of Kerala. *Poll. Res.* 27(3): 419-424.
14. 14.Goswami A.P and Mankodi, P.C. 2012. Study on Zooplankton of Fresh Water Reservoir Nyari – II Rajkot district, Gujarat, India. *J. Biological Sci.* 1(1): 30-34.
15. 15.Hanazato, T. 2001. Pesticide effects on freshwater Zooplankton: An ecological perspective. *Env. Poll.* 112, 1-10.
16. 16.Harney, N.V., Dhamani, A.A. and Andrew, R.J. 2013. Seasonal Variations in the Physico-chemical Parameters of Pindavani Pond of Central India. *Weekly Sci.* Volume-1(6); 1-8.
17. 17.Hulyal, S. B and Kaliwal, B. B. 2008. Water quality assessment of Almatti Reservoir of Bijapur (Karnataka State, India) with special reference to zooplankton. *Environ. Monit. Assess.* 139, 299.
18. 18.Islam, S. M. Ismail, B.S. Barzani, M.G. Sahibin, A.R and Ekhwan, M.T. 2012. Hydrological Assessment and Water Quality Characteristics of Chini Lake, Pahang, Malaysia. *American-Eurasian J. Agric. & Environ. Sci.*, 12 (6), 737-749.
19. 19.Javed, N., Prajapati, D.K, Singh, J., Gangwar, R.K and Deval, R. 2020. Assessment of physico-chemical properties of River Ramganga Water quality in Moradabad and Bareilly region of Uttar Pradesh, India. *I. J. Ph Sci. and Res.* 11(11): 5741-5746.
20. 20.Kamaladasa, A.I and Jayatunga, Y.A. 2007. Composition, Density and Distribution of Zooplankton in South West and East lakes of Beira Lake soon after the restoration of south west lake. *J. Biosci.*, 36(1):1-7.
21. 21.Keremah R.I., Davies O.A and Abezi I.D. 2014. Physico-Chemical Analysis of Fish Pond Water in Freshwater Areas of Bayelsa State, Nigeria. *Greener J. Biol. Sci.*, 4 (2), 033-038.
22. 22.Khan, R.A and Sinha, C. 2002. Studies on the Physicochemical and Biological properties of two manmade lakes of Calcutta. *Rec. zool. Surv. India.* 100(3-4):1-19.
23. 23.Koorosh, J., S.M. Yamakanamardi and Altaff, K. 2009. Abundance of copepods from three contrasting lakes of Mysore city, Karnataka state. *J. Aqua. Biol.*, 24(2):1-9
24. 24.Mahesha and Balasubramanian, A. 2010. Analysis of water Quality Index (WQI) in Dalvoy Lake, Mysore City, India. *Nat. Environ. Pollut. Technol.* 9(4):663-670.
25. 25.Manjare, S.A., Vhanalakar, S.A and Muley. D.V. 2010. Analysis of water quality using physico-chemical parameters Tamdalge tank in Kolhapur District, Maharashtra. *IJABR.* 1(2), 115-119.
26. 26.Murthuzasab, M.R., Rajashekhar, M., Vijaykumar K and Haliked, N.S. 2010. Seasonal variation in physico-chemical parameters of Hirahalla reservoir, Koppal District Karnataka. *I. J. Systems Bio,* 2(2): 16-20.





Namratha et al.,

27. 27.Molinero, J. C., Ibanez, F., Nival, P., Buecher, I and Souissi, S. 2005. North Atlantic climate and north-western Mediterranean plankton variability. *Limnol. Oceanogr.* 50,1213- 1220.
28. 28.Mukhopadhyay, S.K., Chattopadhyay, B., Goswami, A. R and Chatterjee, A. 2007. Spatial variations in zooplankton diversity in waters contaminated with composite effluents. *J. Limnol.*, 66(2): 97-106.
29. 29.Natumanya, E., Kansime, F and Mwanuzi, F.L. 2009. Assessment of Nutrient Loading and Retention along Nsooba stream and Lubigi Wetland, Kampala, Uganda, National Environment Management Authority (NEMA) Report.
30. 30.Nwonumara and Nkwuda, G. 2018. Water Quality and Phytoplankton as Indicators of Pollution in a Tropical River. Proceedings of 6th NSCB Biodiversity Conference; Uniuyo. 83- 89.
31. 31.Padmanabha, B and Belagali, S.L. 2008. Ostracods as indicators of pollution in the lakes of Mysore. *J. Environ Bio.* 29(3):415-418.
32. 32.Padmanabha, B., 2010. Diversity of Rotifers in the Lakes of Mysore city. *Lake 2010: Wetlands, Bio. and Climate Change.* 1-11.
33. 33.Patil. P.N, Sawant. D.V and Deshmukh. R.N. 2012. Physico-chemical parameters for testing of water – A review. *I. J. Environ. Sci.* 3(3):1194-1207.
34. 34.Pawar, B. A. Pandarkar, A. K and Shendge, A. N. 2011. Studies on Water Quality of Pravara River in relation to Pisciculture, Ahmednagar District, Maharashtra. *J. Exp. Zool. India.*14(2), 651-655.
35. 35.Pushpam, M.P., Bhagan, U.V., and Kumaraswamy, A. 2013. Comparative Analysis of Physicochemical Parameters of Two Famous Temple Tanks in Kanyakumari District, S. India. *IJLTET.* 2(2); 235-240.
36. Puri, P. J., Yenkie, M.K.N., Sangal, S.P., Gandhare, N.V., Sarote, G.B and Dhanorkar, D.B. 2011. Surface water (lakes) quality assessment in Nagpur city (India) based on Water Quality Index (WQI). *RasayanJ.chem.* 4(1) 43-48.
37. 37.Ramulu, N. K and Banerjee, G. 2013. Physico-chemical factors influenced plankton biodiversity and fish abundance-a case study of Nagaram tank of Warangal, Andhra Pradesh. *Int. J. LifeSc. Bt& Pharm. Res.* 2(2): 65-69.
38. 38.Sadashivappa, S., Thirumala, S and Ravind, H.B. 2011. Zooplankton Diversity and its Relationship with Physico-Chemical Parameters in Kundavada Lake, Davangere District, Karnataka, India.*Pro Env.* 56-59.
39. 39.Savitha, N. and S.M. Yamakanamardi. 2012. Studies on abundance of zooplanktons in lakes of Mysore, India. *J. Environ. Biol.* 33, 1079-1085.
40. 40.Sayeswara, H. A., Goudar, M.A and Manjunatha, R. 2011. Water quality evaluation and phytoplankton diversity of Hosahalli pond, Shivamogga, Karnataka (India). *Int. J. Chem. Sci.* 9(1):1-11.
41. 41.Sharma, R.C and Kumari. R., 2018. Seasonal variation in zooplankton community and environmental variables of sacred Lake Prashar Himachal Pradesh, India. *Int. J. fish. Aqua.* 6(2), 207-213
42. 42.Smitha, Ajay. D and Shivashankar. P. 2013. Physico Chemical Analysis of the Freshwater at River Kapila, Nanjangudu Industrial Area, Mysore, India. *I. Res. J. Environ Sci.* 2(8), 59-65.
43. 43.Suresh, B., Manjappa, S and Puttaiah, E. T. 2009. The contents of zooplankton of the Tungabhadra River, near Harihar, Karanataka and the saprobiological analysis of water quality. *J Ecol. and Natural Environ.* 1(9):196-200.
44. 44.Thakor, F.J. Bhoi, D.K. Dabhi, H.R. Pandya, S.N and Nikitaraj B.C. 2011. Water Quality Index (W.Q.I.) of Pariyej Lake Dist. Kheda – Gujarat. *Curr. World Environ.* 6(2), 225-23.
45. 45.Trivedy, R.K and Goel, P. K., 1986. Chemical and biological methods of water pollution studies. *Environ. Publ, Karad,* 1-93.S
46. 46.Vipul, S., Kumar, V.B and Sudan, S.M., 2012. Zooplanktonic Fauna in Relation to Physico-Chemical Characteristics in Madar Tank, Udaipur, Rajasthan, India. *I. Res. J. Environment Sci.* 1(3):5-10.
47. 47.Wetzel, R.1983. Periphyton of freshwater ecosystems. Develop. *Hydrobiologia.* 346.
48. 48.Wilkomirski, B. 2013. History of bioindication (Historiabiobioindykacji). *Monitoring SrodowiskaPrzyrodniczego,* 14, 137-142.
49. 49.Yannawar, V.B., Shaikh, P.R., Bhosle A.B and Nagargoje, B.N., 2013. Water quality assessment of Nagzari Dam of Maharashtra. *J. App. Tech Environ. Sani.* 3(3):111-116.





Namratha et al.,

Table:1, Interrelationships between physicochemical parameters and abundance of zooplankton groups in the Varuna Lake, Feb 2018 – Jan 2020.

| Variables | Rotifer | Cladoceran | Copepod | Ostracod | Abundance |
|------------------------|---------|------------|---------|----------|-----------|
| Air Temp (°C) | NS | NS | NS | 0.41* | NS |
| Water Temp (°C) | NS | NS | NS | NS | NS |
| Field Ph | NS | NS | -0.60** | NS | NS |
| Lab Ph | NS | NS | NS | NS | NS |
| Conductivity(µS/cm) | NS | 0.52** | NS | NS | NS |
| Turbidity (NTU) | NS | NS | NS | NS | NS |
| DO (mg/L) | NS | NS | NS | NS | NS |
| CO ₂ (mg/L) | NS | NS | NS | NS | NS |
| Hardness (mg/L) | NS | 0.41* | NS | NS | NS |
| Calcium (mg/L) | NS | NS | 0.44* | NS | NS |
| Chloride (mg/L) | NS | NS | NS | -0.42* | NS |
| Alkalinity (mg/L) | NS | NS | NS | NS | NS |
| Phosphate (mg/L) | NS | NS | NS | NS | NS |
| Sulphate (mg/L) | NS | NS | NS | NS | NS |
| Nitrate (mg/L) | NS | NS | NS | NS | NS |
| TASA | NS | NS | NS | NS | NS |
| TSS | NS | NS | NS | NS | NS |
| COD | NS | NS | NS | NS | NS |
| BOD | NS | NS | NS | NS | NS |

Value is Pearson correlation coefficient, a 2- tailed test was applied and calculated after log₁₀ transformation of all variables after scaling so that, all values were >1, p<0.05, ** p<0.005, and NS = Non-Significant

Table:2, Interrelationships between physicochemical parameters and abundance of zooplankton groups in the Dalvoy lake, Feb 2018 – Jan 2020.

| Variables | Rotifer | Cladoceran | Copepod | Ostracod | Abundance |
|------------------------|---------|------------|---------|----------|-----------|
| Air Temp (°C) | NS | NS | NS | -5.8 | NS |
| Water Temp (°C) | NS | NS | NS | NS | NS |
| Field pH | NS | NS | NS | NS | NS |
| Lab pH | NS | NS | NS | NS | NS |
| Conductivity(µS/cm) | -0.85** | NS | 0.84 | NS | -0.72* |
| Turbidity (NTU) | NS | NS | NS | NS | NS |
| DO (mg/L) | NS | NS | NS | NS | NS |
| CO ₂ (mg/L) | NS | -0.72** | NS | NS | NS |
| Hardness (mg/L) | NS | NS | NS | NS | NS |
| Calcium (mg/L) | NS | NS | NS | NS | NS |
| Chloride (mg/L) | -0.72* | NS | NS | NS | -0.56* |
| Alkalinity (mg/L) | NS | NS | NS | NS | NS |
| Phosphate (mg/L) | -0.56 | NS | NS | NS | -0.48* |
| Sulphate (mg/L) | NS | NS | NS | NS | NS |
| Nitrate (mg/L) | NS | 0.62* | NS | NS | NS |
| TASA | NS | NS | NS | NS | NS |
| TSS | NS | NS | NS | NS | NS |
| COD | NS | NS | NS | 0.78** | NS |
| BOD | NS | -0.55* | NS | NS | NS |

Value are Pearson correlation coefficient, a 2- tailed test was applied and calculated after log₁₀ transformation of all variables after scaling so that, all values were >1, p<0.05, ** p<0.005, and NS = Non-Significant





Namratha et al.,

Table 3: Abundance of zooplankton Groups in Varuna Lake and Dalvoy lake

| Sl. No | Zooplankton Groups | Varuna lake | | | Dalvoy lake | | |
|--------|--------------------|-------------|---------|--------|-------------|---------|--------|
| | | Mean | (Range) | CV (%) | Mean | (Range) | CV (%) |
| 1. | Rotifer (Org/L) | 3 | 1-6 | 46 | 6 | 1-8 | 65 |
| 2. | Cladoceran (Org/L) | 4 | 1-8 | 50 | 9 | 1-8 | 54 |
| 3. | Copepod (Org/L) | 3 | 2-5 | 43 | 18 | 4-16 | 88 |
| 4. | Ostracod (Org/L) | 6 | 2-15 | 61 | 2 | 2-3 | 12 |

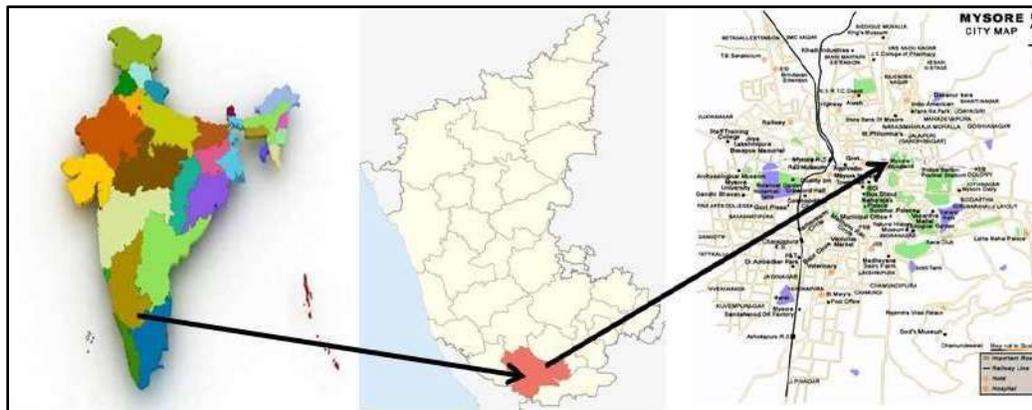


Fig.1.Study Area



Fig.2. Varuna Lake



Fig.3.Dalvoy Lake





To Assess the Effects of Kinesio-Tape on Pain Relief Medicines Intake in Participants with Abdominal Surgery

Vaishali D. Suthar^{1*} and V. P. Hathila²

¹Ph.D. Scholar at Parul University, Assistant Professor, Ahmedabad Institute of Medical Sciences (Affiliated to Gujarat University), Ahmedabad, Gujarat, India.

²Professor and Dean, Medical Faculty, Parul Institute of Medical Sciences (Affiliated to Parul University) Vadodara, Gujarat, India.

Received: 14 June 2022

Revised: 21 June 2022

Accepted: 09 July 2022

*Address for Correspondence

Vaishali D. Suthar

Ph.D. Scholar at Parul University,
Assistant Professor,
Ahmedabad Institute of Medical Sciences
(Affiliated to Gujarat University),
Ahmedabad, Gujarat, India.
Email: vaishu82in@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Abdominal surgeries within abdominal cavity lead to body function disorders manifested in postoperative paralysis of alimentary canal motoricity. Pain is a significant problem occurring after abdominal surgeries. Kinesio-tape helps to relieve pain. Several studies available on Kinesio-tape applications in musculoskeletal, neurological and sports injuries. Limited evidences are available on Kinesio-tape applications in abdominal surgery. The main objective of the study is to assess the level of pain relief medicines intake with application of Kinesio-tape. Total 26 participants with age between 25years to 50 years old both males and females underwent abdominal surgery allocated randomly. The participants were divided into two groups: Control group received conventional treatment by means of analgesic drugs and experimental group received conventional treatment by means of analgesic drugs and Kinesio-taping on abdominal muscles. Following assessment tool was used as outcome measure in both the groups and was administered after 4 hours of surgery. The assessment of pain relief medicines intake level. Pain relief medicines intake level was recorded 24 hours after the surgery and on the second, third and eighth day of surgery. Descriptive statistics and data were analysed on SPSS by adopting proper statistical tests. Statistically significant difference found between control and experimental group on 3rd and 8th day respectively. However, no statistical significant difference found within group. Kinesio tape applied in participants with abdominal surgery leads to decrease in pain perception and significantly reduces pain relief medicines' intake. It is recommended to apply kinesio-tape with





Vaishali D. Suthar and V. P. Hathila

physiotherapy in post abdominal surgery to relieve pain and further complications. Thus helps to reduce the dose of analgesics.

Keywords: Kinesio-tape, Pain, Medicines, Intake, Abdominal surgery

INTRODUCTION

Abdominal surgery or Laparotomy is the term used for the surgical procedures performed as an opening of the abdominal region of a person with various purposes to diagnose, examine or treat a medical condition involving the organs located in the abdomen. It consists of disease processes of various etio-pathology and may responsible to cause postoperative complications. Abdominal surgery always causes disturbances of body function in form of postoperative paresis of gastrointestinal tract motor function, hydro-electrolyte disorders and other disturbances, connected with the morbid process resulting in a surgical procedure, an aesthesia and possible concomitant diseases. Pain can be a serious postoperative problem. According to the IASP, pain is now defined as an “unpleasant sensory and emotional sensation, connected with actual or potential tissue damage or being a manifestation of such damage”. Postoperative pain causes limitation of patient motor activity, impairment of respiratory muscle function and makes it difficult for a patient to be self sufficient. These disorders cause flatulence and oedema of the abdominal integuments leading to pain. Pain accompanies the process of postoperative wound healing, what can be further complicated by oedema and exudation. Pain also results from postoperative lack of motion due to hypokinesia [1] Many studies concluded that postoperative pain is one of the most common therapeutic problems in hospitals [2,3,4]. It can increase morbidity, leading to reduced breathing and cough suppression, facilitating retained pulmonary secretions and pneumonia [5] delaying normal gastric and bowel function [6] which delays the recovery period. Post operative pain is commonly seen in both upper and lower abdominal surgery, however, respiratory disturbances are caused in upper abdominal surgery [7], Prolonged bed rest is associated with an increased risk of post-operative complications like venous thromboembolism, result in loss of muscle bulk and strength, increase insulin resistance, reduce pulmonary function and tissue oxygenation and increase levels of hospital associated depression also seen in lower abdominal surgery[8] There are many medical and complimentary strategies aim to reduce postoperative pain, increase patients’ comfort and may shorten hospital stay, although this has not been shown by compelling evidence. Pain is an unavoidable consequence of surgery, in the majority of patients postoperative pain is preventable with adequate analgesics and by the appropriate use of newer techniques. Physiotherapy aims to facilitate recovery from surgery by preventing or remediate post-operative complications and providing physical rehabilitation to assist a return to premorbid physical function and whilst primarily focusing on physical rehabilitation, physiotherapy may impact on a number of the other domains. Physiotherapy play a major role to treat both acute and chronic pain of various origins though it is post operative pain. There are many techniques and modalities available, one of the most popular technique Kinesio-tape is used to treat different malalignments and pain arise from musculoskeletal and neurological conditions to facilitate and inhibit muscle activity. Despite conflicting evidence regarding its efficacy, taping continues to be a widely used therapeutic intervention[9]. More than 30 years Kenzo Kase & the specialists from around the world explored the clinical effect of the application of Kinesio-taping’s method for various diseases and dysfunctions of the body. Taping is applied in different fields of physiotherapy, i.e. neurology, paediatrics, geriatrics, cardiology, obs.& gynaec, sports medicine etc. the results of different studies are surprising. They show a remarkable effect of kinesio-taping in dysfunctions and damages. According to the manufacturers of Kinesio-taping, the tape causes micro-convolutions or folds in the skin which causes a lifting of the skin away from the tissue beneath. This facilitates a release in pressure on tender tissues underneath and provides space for lymphatic fluid movement, increases circulation of blood which helps to fasten wound healing. This can help relieve pain, prevent over contraction, facilitate lymphatic drainage and improve kinesthetic awareness [9]. During inflammation of the muscles, tendons, ligaments & swelling or shortening, the space between the skin & fascia increases, there is a stagnation of lymph and blood flow and compression on the pain receptors. The pain known as myalgia is muscle



**Vaishali D. Suthar and V. P. Hathila**

pain. It is one of the reasons for limited ROM. Applying kinesio-taping improved freedom of movement, increases the relative space between skin & fascia, decreases the compression on nociceptors, improves the flow of lymph & blood circulation, thus natural biomechanical healing is achieved. Kinesio-taping applications individually suited to patients' needs, support, curing processes and provide new quality of physiotherapy [10]. Kinesio-taping can be applied in four basic therapeutic aims: Mechanical correction which gives stabilization, muscular and fascial tone normalization, improvement and correction of mobility range, pain and swelling reduction. Restoration of normal fluid perfusion helps in facilitation of lymph blood flow, swelling reduction and resulting reduction of incorrect sensibility and pain of skin and muscles. Provides support for muscular activity to relax muscles, fatigue reduction and restoration of mobility range and pain relief. Analgesic system activation helps in elimination of pain cause and activation of pain inhibitors [1] Kinesio taping is a commonly used intervention in the treatment for several musculoskeletal and neurological disorders in patients. Also in sports injuries, Kinesio-tape is useful, very few studies are available for using kinesio-tape in abdominal surgery patients. Therefore, need arise to assess the effects of kinesio-tape on pain relief medicines intake in participants with abdominal surgery.

AIM AND OBJECTIVES**AIM**

To assess the effects of kinesio-tape on pain relief medicines intake in participants with abdominal surgery.

OBJECTIVES

To study the effects of kinesio-tape on pain relief medicines intake in abdominal surgery.

To compare the effects of kinesio-tape between control and experimental group.

To determine the level of prescribing of kinesio-taping immediately after abdominal surgery.

MATERIALS AND METHODS**Materials**

Kinesio-tape roll, Scissor, pen, paper, sanitizer

Source of data

From Surgical and maternity hospitals.

Method of data collection

Convenient and allocation of group by randomization of participants.

Inclusion criteria

- Age between 25-50 years old both male and female, underwent both upper and lower abdominal surgery.

Exclusion criteria

Laparoscopy surgery

- Severe cardiac and lung conditions, known case of diabetes and post-operative complications (e.g. fever, wound infection) and neurological impairment
- Do not want to participate

Study design: Randomized controlled clinical trial

Before application of Kinesio-taping, skin sensitivity test was done pre-operatively to check any allergic reaction due to Kinesio-taping.





Vaishali D. Suthar and V. P. Hathila

Skin sensitivity test for Kinesio-taping: A piece of kinesio-tape was applied over flexor aspect of forearm for 6-8 hours with stretch of inhibitory technique [11]. Skin reaction by means of itching, redness was noted in randomly selected participants. The participants were randomly divided into two groups.

Group 1

Control group (13 participants) conventional treatment by means of pain relief medicines intake

Group 2

Experimental group (13 participants) conventional treatment by means of pain relief medicines intake with kinesio-tape

Sample size: 26

Assessment criteria

Basic demographic information was collected and baseline evaluations were performed at the time of post-operative. Both the groups were received standard methods of treatment by means of medical care and physiotherapy. The participants consents were obtained to participate in the study. All the volunteered participants were randomly divided into two groups. The control group and the experimental group. Following assessment tool was used as outcome measure in both the groups and was administered after 4 hours of surgery as the participant gets withdrawn from an aesthetic effect.

- The assessment of pain relief medicines intake level [15]. Pain relief medicines intake level was recorded 24 hours after the surgery and on the second, third and eighth day of surgery. The following intake levels and medicine types were defined.
- Level 0 - The patient felt no pain and did not take painkillers
- Level I – Ketoprofen pain relief 100mg ampoules were taken max. 3 times a day
- Level II – Pain relief pump was used intravenously
- In case of no pain perception, the patient did not take any pain killing tablets (level 0). Level I depended on the intensity of pain. Level II of medicines intake was applied when medicines from level I were insufficient and did not ensure patients comfort. The patients who participated in the study were not prescribed any additional medicines.

Group 1 (Control group)

Participants received conventional treatment by means of pain relief medicines. Pain relief medicines intake level was recorded 24 hours after the surgery and on the second, third and eighth day of surgery.

Group 2 (Experimental group)

Participants received conventional treatment by means of pain relief medicines and Kinesio-tape applications. A clear explanation about the kinesio-tape procedure was given to each participant, that was applied post-operatively after the conventional treatment by means of pain relief medicines and intake level was recorded 24 hours after the surgery and on the second, third and eighth day of surgery.

Following kinesio-taping techniques were used over abdominal area.

Muscle inhibition application

Kinesio-taping was applied from distal to proximal attachment on external oblique (EO) muscle on the left side with 15% of stretch⁷. This technique is more preferable in very acute stage as mechanically it inhibits and relaxes the muscle and thus inhibits pain.

Muscle facilitation application

Kinesio-taping was applied from proximal to distal attachment on internal oblique (IO) muscle on right side with 25% of stretch⁷. For transversus abdominis (TA) muscle Kinesio-tape was applied proximal to distal attachment of bilaterally with 25% of stretch. During the application patient was instructed to inhale in his/her comfort zone to





Vaishali D. Suthar and V. P. Hathila

stimulate the stretch reflex. Kinesio-tape was applied for 24 hours. Informed consent form was delivered to each participant prior to procedure.

Statistical methods for analysis

All the collected data were inserted in the SPSS to apply both descriptive and inferential statistical analysis. Mann Whitney test was used to compare the outcome between groups and one way ANOVA was used to compare the outcome within groups. The level of significance was at 0.05.

RESULT

Total 26 patients (21 females, 5 males) were participated in the current study with mean age (36.83±5.99). They underwent different abdominal surgeries, the experimental group (8 LSCS, 2 abdominal hysterectomy, 2 cholecystectomy and 1 appendicectomy) and the control group (9 LSCS, 1 abdominal hysterectomy, 1 cholecystectomy and 2 appendicectomy). The pain relief medicines intake was measured in both the groups at 24hour of surgery, 2ndday, 3rdday and 8th day of surgery. Between group both experimental and control group showed significant difference on pain relief medicines intake on 3rd and 8th day of surgery. After 24hour of surgery between group there was no significant difference found in control (1.58±0.28) and experimental group (3.85±0.52). ($p>0.05$). Further, on 2nd day of surgery between group analysis was done however there was no significant difference found in control (2.73±0.91) and experimental group(4.97±0.84). ($p>0.05$) On 3rd day of surgery between group analysis was done and there was significant difference found, control group (3.25±0.48) and experimental group (6.55±0.91) which suggested that there was lower level of intake of pain relief medicines in experimental group. ($p<0.05$). On 8rd day of surgery between group analysis was done and there was significant difference found, control group (4.27±0.57) and experimental group (8.42±0.89) which was higher in experimental group. ($p<0.05$)

DISCUSSION

The current study showed significant ($p<0.05$) lower level of pain relief medicines intake in experimental group and the possible explanations to this reduction are, along with pain relief medicines and application of kinesio-tape, the mechanism is kinesio tape's elasticity creates skin folds which can lift the skin to increase space between skin and muscle to improve circulation of blood and lymph. Since this space contains a variety of nerve receptors that send specific information to the brain. Kinesio tape modulates the information that is sent by the receptors to the brain and makes less reactive responses in the body. This process allows the body to have an adaptive normal function by moving out of the barrier which naturally slow down the recovery process[12]. In this study there was significant pain reduction noted at or near the incisional site subjectively. In addition taping activates neurological suppression in order to reduce pain and increase joint range of motion. Also, Kinesio tape lift the fascia and soft tissue above the areas of pain, align fascial tissues and provide positional stimulus through the skin[13]. Yoshida and Kahanov stated that Kinesio tape is to decrease pain by stimulating the neuromuscular system; assists in restoration of proper muscle function and realignment of joints as a result of injury or disease. Finally, Kinesio tape enhances comprehensive body function by improving the flow of blood and lymphatic fluid throughout the body [14]. One more study by Marcin Krajczyk et al. on Kinesio taping in patients after laparoscopic cholecystectomy found that Kinesio taping employed in physiotherapy of patients after laparoscopic cholecystectomy leads to a decrease in pain perception and significantly reduces pain relief medicines' intake, improvement in effort tolerance achieved and provides effective support for physiotherapy and through postoperative wound stabilization, reduces functional activity disorders resulting from cholecystectomy allowing for shortening of hospitalization time[15]. Marcin Krajczyk *et al* concluded that kinesio taping is an effective method of physiotherapy support in patients after abdominal surgery, there was regular and significant reduction was obtained in abdominal circumference what caused pain relief and use of fewer analgesic agents [1]. Another possible theory to be taken into account for the analgesic effects of KT is the gate control theory of pain modulation. The tape has been suggested to stimulate neuromuscular pathways via afferent feedback. Increased





Vaishali D. Suthar and V. P. Hathila

afferent stimulus to large diameter nerve fibers might reduce pain perception level due to an input decrease from the small diameter nerve fibers conducting nociception [15]. Research results confirm the positive influence of kinesio-tape on the decrease in pain perception resulting in a lower intake of painkilling tablets. Limitations of the study are small sample size, pain scale is not used and specific region of abdominal surgery not measured.

CONCLUSION

Kinesio tape applied in participants with abdominal surgery helps to decrease in pain perception and significantly reduces the level of pain relief medicines' intake.

Ethical clearance

Ethical clearance is received from Institutional Ethical Committee for Human Research (PU-IECHR).

Declaration

The prior consent of the participants was taken before application of Kinesio-taping and the work was carried out after getting clearance from the institutional ethics committee.

REFERENCES

1. Marcin Krajczyk, Jan Szczegielniak, Katarzyna Bogacz, Kinesiotaping in physiotherapy after abdominal surgery, *Fizjoterapia Polska*, January 2007, Vol. 7, 299-307.
2. Donovan M, Dillon P, McGuire L. Incidence and characteristics of pain in a sample of medical-surgical inpatients. *Pain* 1987; 30: 69-78.
3. Royal College of Surgeons of England and College of Anaesthetists' Commission on the Provision of Surgical Services. Report of the Working Party on Pain after Surgery: Royal College of Surgeons 2000.
4. McQuay H, Moore A, Justins D. Treating acute pain in hospital. *Br Med J* 1997; 314: 1531-1535.
5. Sydow, W. The influence of anesthesia and postoperative analgesic management on lung function. *Acta Chir Scand* 1989; 550 (Suppl.): 159-165.
6. Wattwil, M. Postoperative pain relief and gastrointestinal motility. *Acta Chir Scand* 1989; 550 (Suppl.): 140-145.
7. Zeljko Mimica, Zenon Pogorelic, Zdravko Perko, Darko Srsen, Effect of surgical incision on pain and respiratory function after abdominal surgery: A randomized clinical trial", *Hepato-Gastroenterology*; 2007;54:2216-2220.
8. Kate Sullivan et al, Physiotherapy following emergency abdominal surgery, chapter 7, Actual problems of emergency abdominal surgery, INTECH open science, <http://dx.doi.org/10.5772/63969>, 2016, pg. 109-128.
9. Sayed Tantawy, Dalia Kamel, Effect of kinesio-taping on pain post laparoscopic abdominal surgery: randomized controlled trial, *International Journal of Therapies and Rehabilitation Research*, October 2015; 4 (5): 250-255.
10. Mariya Gramtikova, Evelina Nikolova and Stamenka Mitova, *Activities in Physical Education & Sports*; 2014; vol.4, No.2, pp. 115-119.
11. K Taping, An Illustrated guide, author: B. Kumbrink, Kinesio-taping. DOI 10.1007/978-3-642-12932-2, Springer-Verlag Berlin Heidelberg 2012.
12. Kase K, Wallis J, Kase T. *Clinical Therapeutic Applications of the Kinesio Taping Method*. Tokyo, Japan 2003; Ken Ikai Co Ltd.
13. Maruko K. Tokyo, Japan: Kinesio taping association 1999, 70-73.
14. Yoshida and Kahanov, The effect of Kinesio taping on lower trunk range of motions. *Research in Sports Medicine*, 15: 103-112, 2007.
15. Marcin Krajczyk, Katarzyna Bogacz, Jacek Luniewski, The influence of Kinesio taping on the effects of physiotherapy in patients after laparoscopic cholecystectomy. *The Scientific World Journal*, volume, 2012. Article ID 948282, 5 pages doi:10.1100/2012/948282.
16. Patnaik, Surgical Incisions- Their anatomical basis, *J. Anat. Soc. India* 50(2) 170-178 (2001).





Vaishali D. Suthar and V. P. Hathila

Table 1. Gender distribution

| Gender distribution in both the group | | | |
|---------------------------------------|-------|-----------|---------|
| Group | | Frequency | Percent |
| Experimental Group | F | 11 | 84.62 |
| | M | 2 | 5.38 |
| | Total | 13 | 100.0 |
| Control Group | F | 10 | 76.92 |
| | M | 3 | 23.08 |
| | Total | 13 | 100.0 |

Table 2. Difference in pain relief medicines intake in both groups

| Medicine Intake | Experimental | | Control | | Man Whitney | P Value |
|--|--------------|------|---------|------|-------------|---------|
| | Mean | SD | Mean | SD | | |
| Difference in level of pain medicines intake after 24 hours | 3.85 | 0.52 | 1.58 | 0.28 | 2.1 | 0.079 |
| Difference in level of pain medicines intake on 2 nd day of surgery | 4.97 | 0.84 | 2.73 | 0.91 | 1.5 | 0.058 |
| Difference in level of pain medicines intake on 3 rd day of surgery | 6.55 | 0.91 | 3.25 | 0.48 | 0 | <0.05 |
| Difference in level of pain medicines intake on 8 th day of surgery | 8.42 | 0.89 | 4.27 | 0.57 | 1.7 | <0.05 |





A Study on Efficacy of an Ergonomic Intervention Programme among Standing Workers by using Rapid Upperlimb Analysis and Rapid Entire Body Assessment

S.Senthilkumar^{1*}, S.Jeyakumar¹, Anjali suresh² and Prasanna mohan³

¹Professor, School of Health Sciences, Department of Physiotherapy, Gardencity University, Bangalore, Karnataka, India.

²HoD and Professor, School of Health Sciences, Department of Physiotherapy, Gardencity University, Bangalore, Karnataka, India

³Associate Professor, School of Health Sciences, Department of Physiotherapy, Gardencity University, Bangalore, Karnataka, India

Received: 29 Apr 2022

Revised: 03 June 2022

Accepted: 05 July 2022

*Address for Correspondence

S.Senthilkumar

Professor, School of Health Sciences,
Department of Physiotherapy,
Gardencity University,
Bangalore, Karnataka, India..



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Workers in manufacturing industries are often exposed to ergonomics-related injury risks, such as heavy object lifting, bending, reaching overhead, pushing and pulling heavy loads, working in awkward body postures, apposition, and performing the same or similar tasks repeated using. Based on twenty four interviews of each section of 6 out of 24 workers conducted in various sectors of manufacturing, it is evident that adequate attention is not given to their physical postures of employees while they work and these results in loss of productivity and those irregular postures are responsible for the musculoskeletal disorders developed. This study aims to discuss about the study on efficacy of an ergonomic intervention among standing workers and ergonomic way of working by using Rapid Upper Limb Analysis (RULA) and Rapid upper limb assessment after ergonomically interventions. This study also provides recommendations and ergonomic solutions for industries to enhance personnel awareness of ergonomics-related risk factors, alleviate muscle fatigue, increase productivity, and reduce the number and severity of work-related musculoskeletal disorders.

Keywords: RULA, Ergonomics, industrial design, ergonomics in manufacturing.



Senthilkumar *et al.*,

INTRODUCTION

Work-related Musculoskeletal Disorders (WMSDs) have become a major problem in many industrialized countries including India. Improving worker productivity, and occupational health and safety (OHS) are important concerns in industry, especially in developing countries. The major common problems are improper workplace design, ill-structured jobs, contra version between workers abilities and job demands, adverse environment, poor human-machine system design and inappropriate management and operating programs. Large number of workers performs heavy manual material handling (MMH) jobs in developing countries, especially in the unorganized sectors. Studies from developing countries like India show that these workers suffer from assorted health problems of MSDs like back pain, leg pain, neck pain etc. due to awkward postures, pushing, pulling and carrying heavy loads not compliance to the legal requirements. The automobile component manufacturing industries involve in standing like machine operation, fettling, drilling, CNC operation, electrical works, and quality checking also welding works. This kind of prolonged standing work postures causes musculoskeletal disorders such as back pain, neck pain, leg pain etc. The awkward postures adopted by the workers in their working place depends upon the type of work, the design of the work place, personal characteristics, the tools required to perform the particular work and also the duration and frequency of the work cycle (Bridger, 1995). It is conformed that ergonomic deficiencies in industry are a root cause of workplace health hazards, low levels of safety, and reduced worker productivity and quality. Lower injuries mean lower medical and compensation costs, less loss of wages and workdays, and financial benefit to the company. So, various techniques have been reported for postural analysis to identify the stress and fatigue during different phases of work. The objectives of this current research were to investigate ergonomic intervention of pre-score and post score result analytically and mathematically also to reduce the low back injury, neck injury, wrist injury, leg injury of standing workers in the automobile manufacturing industry by technical design analysis.

MATERIALS AND METHODS

The study was conducted on 6 standing workers out of 24 direct observation and interviews (all are male) selected randomly engaged in 6 different fields of standing workers from Tamilnadu state. The workers with at least one year of experience were chosen and the age of the workers were 20-22. The workers carried out the following activities: (i) drilling (ii) welding clay, (iii) CNC operation (iv) quality check (v) fettling (vi) electrical operation (vii) moving the dried bricks to kiln for burning (viii) loading bricks on to the truck, tractor, and cycle or on others. To carry out such activities, workers most often have to adopt awkward postures for a longer period i.e. near about 11 hours that result in musculoskeletal Pain/discomfort affecting different body parts.

Oral questionnaire of face to face interview

The questionnaire consisted of a series of objective questions with yes or no response and some were in detailed explanation about the posture and the ergonomical disorders. To investigate discomfort, it included detailed questions on work-related pain in different body parts. The participants were interviewed about any kind of discomfort affecting different body parts during every activity associated with different operations.

Standing working Postural analysis

Standing Working postures were evaluated directly by visual observation as well as indirectly by using a still photography and video of the different activities performed by the workers. The photographs and video were later used to identify the different categories of work postures prone to injury such as bending, twisting, tilting the head forward. These were later used to evaluate the risk level by the techniques RULA and REBA.

Rapid Upper Limb Assessment (RULA)

RULA is a tool survey method for use in ergonomic investigations and analysis of workplaces where MSD's are reported (McAtamney, L. and Corlett 1993). It is a standard screening tool that assesses biomechanical and postural





Senthilkumar *et al.*,

loading on the body. It focuses on the neck, trunk and upper limbs, and is ideal for sedentary workers. It is a simple, quick and easy to complete. RULA scores indicate the level of intervention required to reduce MSD risks. It is compliments from other ergonomic methods. RULA method is assesses the posture, force and movement associated with sedentary tasks such tasks include computer tasks, manufacturing or retail tasks where the worker is seated or standing without moving in any way. This tool is no special equipment in providing a quick assessment of postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. A coding system is used to generate an action list which indicates the level of intervention required to reduce the risks of injury due to physical loading on the operator (Table 1).

Rapid entire body assessment (REBA)

REBA (Rapid Entire Body Assessment) was developed by (Hignett, S. and Mc Atamney, 2000), to provide a quick and easy observational postural analysis tool for whole activities (static and dynamic) giving musculoskeletal risk action level. The Development of REBA is aimed to divide the body into segments to be coded individually with reference to movement planes. It provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures. It reflects that the coupling is important in handling of the loads and may not always be via the hands. It also gives an action level with an indication of urgency of the work tasks. This method was specifically developed to be useful for assessing MSD risks/working postures found in healthcare and other service industries.

Investigation Analysis By Rula And Reba Before Ergonomic Intervention (Pre-Score) Analysis

RULA Investigation for Standing Workers before Ergonomic Intervention

In this investigation, ergonomic assessment were made visually as well as photographic images to identify the workers standing posture analysis of arm, wrist, trunk and leg by ergonomic tool rapid upper limb assessment(RULA). Standing posture final risk scores has been investigated as shown in table-2.

REBA Investigation for Standing Workers before Ergonomic Intervention

In this investigation, ergonomic assessment were made visually as well as photographic images to identify the workers standing posture analysis of arm, wrist, trunk and leg by ergonomic tool rapid entire body assessment (REBA). Standing posture final risk scores has been investigated as shown in table-3.

Investigation Analysis by RULA and REBA after Ergonomic Intervention (Post-Score) Analysis

Analysis of Ergonomic Intervention posture

Ergonomical design postures to reduce the risk of standing postures been analysed are:

1. Standing stools for the machine operators, welders, drilling machine operators, electrician, and quality check workers to reduce the risk of back injury, neck injury etc. and also the reduction in trunk score as shown in fig1.
2. Machine adjustment been made for the standing workers to work ergonomically to reduce the neck injury of reduction in flexion that reduces the neck score.
3. Replace of carrying components of 25 kg load by a manual conveyor system been analysed such that the load score will reduce.
4. Of all the ergonomical design analyses been made such that by RULA and REBA final score investigation analysis been considerably reduced as shown in Table 4&5.

RESULTS AND DISCUSSION

The analysis been done after the ergonomic posture intervention analysis score been mathematically proved by taking samples of before and after ergonomic intervention of RULA and REBA been made and there is improvement in safe working score of standing working posture workers as shown in table 6 and table7. In the t-test for single mean and difference of two means have assumed that the samples have come from normal populations and they are not independent.





Senthilkumar *et al.*,

No. of samples taken (2) dependent = 6

Assume = working score (%) = risk score + safe working score

df = n-1 = 6-1=5

H₀: μ₁=μ₂ (there is no significant difference between the standing workers of RULA before and after ergonomic intervention)

H₁: μ₁<μ₂(there is significant difference between the standing workers of REBA before and after intervention)

$$s = \frac{\sqrt{\sum(di-\bar{d})^2}}{n-1} = 46.65$$

$$d^- = \frac{\sum d}{n} = -40.57$$

$$t \text{ test} = \left| \frac{\bar{d}}{\frac{s}{\sqrt{n}}} \right| = \text{calculated value} |t| = 2.129$$

Tabulated value = 2.015, so calculated value > tabulated value

Therefore H₀ is rejected and there is significant difference between the standing workers before and after ergonomic intervention. Finally the standing workers after intervention are beneficial and improved design safety features.

df = n-1 = 6-1=5

H₀: μ₁=μ₂ (there is no significant difference between the standing workers of RULA before and after ergonomic intervention)

H₁: μ₁<μ₂(there is significant difference between the standing workers of REBA before and after intervention)

$$s = \frac{\sqrt{\sum(di-\bar{d})^2}}{n-1} = 46.43$$

$$d^- = \frac{\sum d}{n} = -39.58$$

$$t \text{ test} = \left| \frac{\bar{d}}{\frac{s}{\sqrt{n}}} \right| = \text{calculated value} |t| = 2.088$$

Tabulated value = 2.015, so calculated value > tabulated value

Therefore H₀ is rejected and there is significant difference between the standing workers of REBA before and after ergonomic intervention. Finally the standing workers after intervention are beneficial and improved ergonomical design safety features.

CONCLUSIONS

From this study the following conclusions could be drawn with regard to ergonomics, OHS in the automobile manufacturing environment. The theory that reporting of results is biased toward positive outcomes would appear to be borne out by the fact that, out of 24, 6 standing workers samples been investigated before and after ergonomic intervention of technical design analysis and mathematically proved to be beneficially efficient to improve productivity, reduce the severity of work- related disorders, stress, fatigue and absenteeism. As per this paper analysis, welder (overhead) is still to be reduced to lower risk, so the recommendations further to reduce the MSDs.

RECOMMENDATIONS

Some of the strategies still to improve the above ergonomical standing posture conditions as evident from the study are stated below:





Senthilkumar et al.,

- A. Ergonomical exercise training by a competent medical specialist for the workers once in a month, this to be followed by the workers during frequent breaks in working hours also after returning home to reduce further stress and fatigue that leads to back injury, neck etc.
- B. Especially for overhead welders it is necessary to take frequent breaks, to be more effective convert it into automotive welding machines that will reduce the risk score.
- C. Effective implementation of specific written policies concerning health and safety must be ensured through inspection, periodic reporting and enforcement of government laws.

REFERENCES

1. Ashraf A. Shikdara*, Naseem M. Sawaqedb, "Ergonomics, and occupational health and safety in the oil industry: a managers' response", Computers & Industrial Engineering 47 (2004) 223–232.
2. Richard W. Gogginsa, Peregrin Spielholz, Greg L. Nothsteinc, "Estimating the effectiveness of ergonomics interventions through case studies: Implications for predictive cost-benefit analysis", Journal of Safety Research 39 (2008) 339–344.
3. Qutubuddin S.M., S.S. Hebbal & A.C. S. Kuma, "Ergonomic Evaluation of Tasks Performed by Workers in Manual Brick Kilns in Karnataka, India", Volume 13 Issue 4 Version 1.0 Year 2013.
4. N. Sadra Abarghouei, H. Hosseini Nasab, "An Ergonomic Evaluation and Intervention Model: Macro ergonomic approach", International Journal of Scientific & Engineering Research, Volume 3, Issue 2, February 2012 ISSN 2229-5518.
5. Robin Burgess-Limerick, Bill Green, "Using multiple case studies in ergonomics: an example of pointing device use", International Journal of Industrial Ergonomics 26 (2000) 381-388.
7. Gary A. Mirka*, Christy Smith, Carrie Shivers, James Taylor, "Ergonomic interventions for the furniture manufacturing industry. Part I: lift assist devices", International Journal of Industrial Ergonomics 29 (2002) 263–273.

Table-1: Level of risks for RULA and REBA

| RULA | | REBA | | |
|------------|-----------------------|---------------------------|------------|--------------------|
| RULA Score | Action Required | Action level (Risk level) | REBA Score | Corrective Measure |
| 1-2 | Acceptable | 0(Negligible) | 1 | Not necessary |
| 3-4 | Change necessary | 1(Low) | 2-3 | Maybe necessary |
| 5-6 | Change necessary soon | 2(Medium) | 4-7 | Necessary |
| 7 | Change immediately | 3(High) | 8-10 | Necessary soon |
| | | 4 (Very High) | 11-15 | Necessary Now |





Senthilkumar et al.,

Table-2 RULA analysis for standing workers before ergonomic intervention

| S.No | TYPE OF WORKER | ARM & WRIST ANALYSIS | NECK, TRUNK AND LEG ANALYSIS | FINAL SCORE |
|------|-----------------------|----------------------|------------------------------|-------------|
| 1 | Electrical technician | 3 | 6 | 5 |
| 2 | Fettling operator | 5 | 7 | 7 |
| 3 | Welder(overhead) | 5 | 6 | 7 |
| 4 | Drilling m/c operator | 3 | 5 | 4 |
| 5 | CNC Machine operator | 4 | 5 | 5 |
| 6 | QC checker | 5 | 7 | 7 |

 = Investigate and change immediately
 = Investigate and change further soon
 = Investigate further

Table-3 REBA analysis for standing workers before ergonomic intervention

| S.NO | TYPE OF WORKER | ARM & WRIST ANALYSIS | NECK, TRUNK AND LEG ANALYSIS | FINAL SCORE |
|------|-----------------------|----------------------|------------------------------|-------------|
| 1 | Electrical technician | 5 | 5 | 6 |
| 2 | Fettling operator | 4 | 5 | 5 |
| 3 | Welder(overhead) | 4 | 7 | 7 |
| 4 | Drilling m/c operator | 5 | 3 | 4 |
| 5 | CNC Machine operator | 3 | 3 | 3 |
| 6 | QC checker | 6 | 5 | 8 |

 =high risk, investigation and implement change immediately
 = high risk, change soon
 = medium risk, further investigation, changes so
 = low risk, change may be needed

Table 4-RULA Analysis for Standing Workers After Ergonomic Intervention

| S.NO | TYPE OF WORKER | ARM & WRIST ANALYSIS | NECK, TRUNK AND LEG ANALYSIS | FINAL SCORE |
|------|-----------------------|----------------------|------------------------------|-------------|
| 1 | Electrical technician | 2 | 2 | 2 |
| 2 | Fettling operator | 2 | 3 | 3 |
| 3 | Welder(overhead) | 4 | 5 | 5 |
| 4 | Drilling m/c operator | 2 | 2 | 2 |
| 5 | CNC Machine operator | 4 | 3 | 3 |
| 6 | QC checker | 3 | 3 | 3 |





Senthilkumar et al.,

Table5-REBA Analysis for Standing Workers after Ergonomic Intervention

| S.NO | TYPE OF WORKER | ARM & WRIST ANALYSIS | NECK, TRUNK AND LEG ANALYSIS | FINAL SCORE |
|------|-----------------------|----------------------|------------------------------|-------------|
| 1 | Electrical technician | 2 | 3 | 2 |
| 2 | Fettling operator | 2 | 3 | 2 |
| 3 | Welder(overhead) | 3 | 5 | 4 |
| 4 | Drilling m/c operator | 1 | 3 | 1 |
| 5 | CNC Machine operator | 2 | 3 | 2 |
| 6 | QC checker | 3 | 3 | 3 |

Table-6- RULA t-test analysis

| Workers sample | Safe working score | | d = x-y | d ² |
|----------------|--------------------|---------------------|--------------|----------------------------|
| | Pre-safe score(x) | Post safe score (y) | | |
| 1 | 25 | 71.43 | -42.85 | 1836.1225 |
| 2 | 37.5 | 57.15 | -57.15 | 3266.12 |
| 3 | 0 | 28.58 | -28.58 | 832.32 |
| 4 | 42.86 | 71.43 | -28.57 | 816.81 |
| 5 | 28.58 | 57.15 | -28.85 | 832.32 |
| 6 | 0 | 57.15 | -57.43 | 3298.20 |
| | | | Σ d= -243.43 | Σd ² =10,881.89 |

Table-6- REBA t-test analysis

| Workers sample | Safe working score | | d = x-y | d ² |
|----------------|--------------------|--------------------|-------------|----------------------------|
| | Pre-safe score(x) | Post safe score(y) | | |
| 1 | 25 | 75 | -50 | 2500 |
| 2 | 37.5 | 75 | -37.5 | 1406.25 |
| 3 | 12.5 | 50 | -37.5 | 1406.25 |
| 4 | 50 | 87.5 | -37.5 | 1406.25 |
| 5 | 62.5 | 75 | -12.5 | 156.25 |
| 6 | 0 | 62.5 | -62.5 | 3906.25 |
| | | | Σ d= -237.5 | Σd ² =10,781.25 |

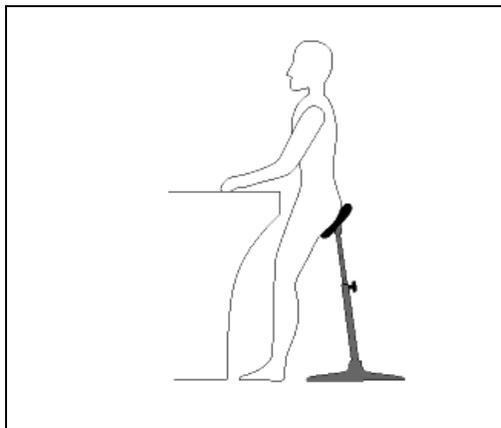


Fig. 1- standing stool for the standing workers with height adjustment





Yield Performance of Finger Millet (*Eleusine coracana* L.) as Influenced by Integrated Nutrient Management in Rainfed Condition of Uttarakhand

Shagun^{1*}, Priyanka Bankoti Rawat², Sanjay Kumar³ and Vibhuti Singh Jhala¹

¹Research Scholar, Department of Agronomy, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India.

²Professor, Department of Agronomy, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun- 248 001, Uttarakhand, India.

³Assistant Professor, Krishi Vigyan Kendra, G.B. Pant University of Agricultural and Technology, Dhakrani, Dehradun- 248142, Uttarakhand, India.

Received: 04 June 2022

Revised: 19 June 2022

Accepted: 08 July 2022

*Address for Correspondence

Shagun,

Research Scholar, Department of Agronomy,

School of Agricultural Sciences,

Shri Guru Ram Rai University,

Dehradun, Uttarakhand, India.

Email: shagungupta01@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A field experiment was carried out at Crop Research Centre, School of Agricultural Sciences, Shri Guru Ram Rai University, Pathribhag, Dehradun, Uttarakhand. The treatments consist of two establishment methods in main plots (consisting of two cultivars: V1: VL Mandua- 347 and V2: VL Mandua- 352) and six nutrient management practices in sub plots (twelve combinations) was laid out in split plot design (SPD) with three replications. The result revealed that the growth attributes *viz.* number of ear head/ m², number of ear head/plant, earhead weight (g), test weight (1000 grains), grain yield (kg/ha), straw yield (kg/ha) and biological yield (kg/ha) were significantly influenced by the application 50% RDF (NPK@ 30:15:15) + Vermicompost (1t/ha) and was on par with the application of 75% RDF (NPK@ 30:15:15) + FYM (4t/ha). The highest observed grain yield (2162 kg/ha), straw yield (4421 kg/ha), biological yield (6583 kg/ha) in 2019 and grain yield (2232 kg/ha), straw yield (4592 kg/ha), biological yield (6824 kg/ha) in 2020 was found with 50% RDF (NPK@ 30:15:15) + Vermicompost (1t/ha). The lowest yield was found in the control treatment. There was no significant difference between the cultivars in the establishment method.

Keywords: Finger millet, establishment method, cultivars, PSB, vermicompost.





Shagun et al.,

INTRODUCTION

Among the millets of the world, finger millet (*Eleusine coracana* sub species *coracana*) ranks fourth in importance after sorghum, pearl millet, and foxtail millet [1]. Millet is a collective term referring to several small-seeded annual types of grass that are cultivated as grain crops, primarily on marginal lands in dry areas in temperate, subtropical, and tropical regions [2]. Grains of finger millet is consumed as unleavened bread, porridge, and making beer [3]. Finger millet is an African native that originated in the highlands of Ethiopia and Uganda, where subsistence farmers have been growing it for thousands of years. It is estimated that, in India, the crop covered an area of 1.27 million hectares with a total production and productivity of 1.93 million tonnes and 1.60 tonnes per hectare respectively [4]. It is a staple food crop in many hilly regions of Uttarakhand and Himachal Pradesh.

Ragi may be grown as a hot weather crop, from May to September. The crop is well adapted to very poor and marginal lands where other Kharif crops cannot be grown successfully. The crop has extraordinary potential to adapt itself to multiple stresses encountered in rainfed to dry areas. Finger millet is the principal tropical millet with adaptations to survive drought and nutrient deficiencies in the dry and semi-dry regions of India [5]. To improve productivity, integrated nutrient management (INM) is an important practice in modern agriculture where conjunctive use of chemical fertilizer and organic amendments would prove advantageous to the soil health management and improvement of soil fertility as well as the overall crop productivity[6].

Continued use of fertilizers alone can have some adverse effects on the physical, chemical, and biological properties of the soil, which in turn affect yield levels and soil health. In recent years, there has been growing concern that the use of chemical fertilizers, especially inorganic ones, can lead to serious environmental consequences. For this reason, the balanced use of organic and inorganic fertilizers is important not only to improve growth and yield but also to maintain soil health[7]. It is suggested to optimize the use of inorganic fertilizers along with the organic manures such as farmyard manure (FYM) and vermicompost for getting the higher yields of better quality and keeping the cost of production at a sustainable level. Hence the present study was undertaken to optimize the FYM and vermicompost requirement of rainfed transplanted finger millet in conjunction with biofertilizers (PSB).

MATERIALS AND METHOD

The field experiment was conducted on sandy loam texture soil Department of Agronomy, School of Agricultural Sciences, Shri Guru Ram Rai University (30°30' N latitude and 78°30' E longitude), Dehradun, Uttarakhand during the *Kharif* season in 2019 and 2020. The soil of the experimental site was sandy loam, having neutral in soil reaction (pH 7.1), high in organic carbon (2.22%), very low in available nitrogen (0.007 kg/ha), high in available phosphorus (23.16 kg/ha), low in available potassium (69.20 kg/ha). The maximum and minimum temperature recorded during the growing season of the crop in 2019 from June to December was 37°C and 2.77°C respectively whereas in 2020 from June to December was 35.60°C and 1.5°C. It was recorded that Dehradun received 1489.6mm and 1032.8mm of rainfall from June to December 2019 and 2020 respectively. The experiment was laid out in split plot design (SPD) with establishment method in main plots and nutrient management practices in sub-plots with three replications.

The finger millet cultivars V1: VL Mandua- 347 and V2: VL Mandua- 352 with a seed rate of 5 kg/ha each are used for nursery and it was transplanted 25 days after sowing (DAS) with the spacing of 25 cm × 10 cm which was an establishment method. Nutrient management practices consisted of treatment of T1. Control, T2. 100% Recommended dose of fertilizers (RDF: NPK@ 40:20:20), T3. 75% RDF (NPK@ 30:15:15) + FYM (4t/ha), T4. 75% RDF (NPK@ 30:15:15) + Vermicompost (1t/ha), T5. 75% RDF (NPK@ 30:15:15) + 50% Phosphate solubilising bacteria (PSB) (20g/seed), T6. 50% RDF (NPK@ 20:10:10) + FYM (2t/ha) + Vermicompost (0.5t/ha) + PSB (20g/seed). Inorganic sources of nutrients used in the experiment were N, P, and K consisting fertilizers such as Urea, Single super phosphate, and Murate of potash.



**Shagun et al.,**

Organic sources of nutrients were farm yard manure (FYM) and vermicompost and biofertilizer used for seed inoculation was phosphate solubilizing bacteria (PSB) which was executed in the nursery. Organic nutrients FYM and vermicompost were applied in requisite quantity as per the treatment and incorporated well in advance i.e. two weeks before transplanting of the crop. One-third of urea, full dose of SSP, and Murate of Potash were applied at the time of transplanting as basal dose, and the remaining urea was applied in two split doses *viz.*, 1/3 at tillering stage and 1/3 before ear head initiation as per various treatments. The experimental data recorded for yield and yield attributes were statistically analyzed using the method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984).

RESULT AND DISCUSSION

Yield Parameters

The observations on yield parameters *viz.* number of ear head/m², number of ear head/ plant, ear head weight (g), test weight (1000 grains), grain yield (kg/ha), straw yield (kg/ ha) and biological yield (kg/ha) were taken at harvest in 2019 and 2020. Number of ear head/m² was highest in T4: 50% RDF (NPK@ 30:15:15) + Vermicompost (1t/ha) and T6: 50% RDF (NPK@ 20:10:10) + FYM (2t/ha) + Vermicompost (0.5t/ha) + PSB in both the years, whereas in establishment method V2 showed slightly higher result than V1. Number of ear head/ plant was significantly higher in T6 and T4 during 2019 and 2020 respectively, at par with 100% RDF (Table 1).

In case of ear head weight (g), test weight (1000 grains) (Table 2) similar trend was observed as noted earlier in ear head/ m² and ear head/ plant, whereas V2 showed higher number of ear head weight and test weight compared to V1. Control expressed the least value in all the above mentioned parameters which is significantly at par T5: 75% RDF+ PSB. Grain, straw and biological yield of finger millet differed significantly with varying level of inorganic fertilizers in association with FYM and vermicompost over control. Application of 50% RDF (NPK@ 30:15:15) + Vermicompost (1t/ha) recorded maximum grain yield (2162 kg/ha), straw yield (4421 kg/ha) and biological yield (6583kg/ha) in 2019 and grain yield (2232 kg/ha), straw yield (4592 kg/ha) and biological yield (6824 kg/ha) in 2020 and at par with 75% RDF + FYM (4t/ha).

It was significantly superior to rest of the treatment under investigation. V1 was significantly similar in grain yield as compared to V2 in 2019 whereas V2 was slightly higher in grain yield in 2020 (Table 3). Higher yield with combined application of inorganic fertilizer, FYM, vermicompost and biofertilizer may be regards as formation of humus and organic carbon which increased availability of nutrients and improved the soil properties. Organic manure provide a good environment for microorganisms, ie. *Azospirillum*, which fixes atmospheric nitrogen available to plants. Furthermore, PSBs are one of the most important nutrient-dissolving microorganisms, converting insoluble phosphates to soluble forms by secreting several organic acids. Earlier researchers also noted similar type of observation. [8][9]

CONCLUSION

Based on the above research it clearly stated that different yield parameters were found significantly higher with the use of RDF along with vermicompost and FYM. Use of organic manure not only enhances the yield but also improved the soil condition. PSB + RDF alone showed no influence on yield of finger millet. It is well proved that use INM improves the production of finger millet.

REFERENCES

1. Upadhyaya, H.D., Gowda, C.L.L and Reddy, G.V. "Morphological diversity in finger millet germ plasm introduce from Southern and Eastern Africa". An open access journal published by ICRISAT. 2007





Shagun et al.,

2. Baker, R.D. "Millet production. Guide A-414". At: <http://www.google.com>. p. 6. 1996
3. Desai, A.D., Kulkarni, S.S., Sahoo, A.K., Ranveer, R.C. and Dandge, P.B. "Effect of supplementation of malted ragi flour on the nutritional and sensorial quality characteristics of cake". Advance journal of food science and technology, 2010 2: 67-71.
4. DES [Directorate of Economics and Statistics]. Pocket Book of Agricultural Statistics. Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, New Delhi, 2017, 115p.
5. Mandal S, Swamy SN. Productivity potential and economics of finger millet (*Eleusine coracana*) based intercropping patterns with legumes in rainfed alfisol of Hyderabad. Agriculture Science Digest 2005; 25(2):115-117.
6. Maitra, S., Reddy, M. D., Nanda, S. P., "Nutrient Management in Finger millet (*Eleusine coracana* L. Gaertn) in India". International Journal of Agriculture, Environment and Biotechnology, 2020, 13(1): 13-21.
7. Pullicino, D.S., Massacesia, L., Dixon, L., Bolb, R. and Gigliottia, G. "Organic matter dynamics in a compost-amended anthropogenic landfill capping-soil". European Journal of Soil Science. 2009 61: 35-47.
8. Khan, M.A.A., Rajamani, K. and Reddy, A.P.K." Nutrient management in *rabi* sweet sorghum grown as intercrop in Pongamia based agri-silvi culture system". Journal of the Indian Society of Soil Science 2012.60(4): 335-339.
9. Jat, M.L., Gathala, M.K., Saharawat, Y.S., Tatarwal, J.P., Gupta, R. and Singh, Y. "Double no-till and permanent raised beds in maize-wheat rotation of north-western Indo-Gangetic Plains of India: effects on crop yields, water productivity, profitability and soil physical properties". Field Crops Research 2013 149: 291-299

Table 1: Number of ear head m² and number of ear head plant⁻¹ as influenced by the treatments at different crop growth stages

| Treatments | 2019 | | 2020 | |
|---|-----------------------------------|--|-----------------------------------|--|
| | Number of ear head m ² | Number of ear head plant ⁻¹ | Number of ear head m ² | Number of ear head plant ⁻¹ |
| Establishment methods | | | | |
| V ₁ : VL Mandua- 347 | 87 | 3.5 | 87 | 3.8 |
| V ₂ : VL Mandua- 352 | 88 | 3.71 | 89 | 4 |
| S.E.m (±) | 0.03 | 0.06 | 0.10 | 0.38 |
| C.D. (5%) | 0.25 | NS | 0.68 | 1.13 |
| Nutrient Management | | | | |
| Control (N:P:K) | 70 | 2.58 | 72 | 3.0 |
| 100% RDF | 89 | 4.0 | 87 | 4.10 |
| 75% RDF+ FYM(4t/ha) | 91 | 3.96 | 92 | 4.01 |
| 75%RDF+Vermicompost(1t/ha) | 96 | 4.10 | 97 | 4.59 |
| 75% RDF+50%PSB | 84 | 3.01 | 82 | 3.28 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 96 | 4.16 | 97 | 4.55 |
| S.E.m (±) | 0.43 | 0.10 | 0.05 | 0.05 |
| C.D. (5%) | 1.29 | 0.30 | NS | 0.15 |



Shagun *et al.*,

Table 2: Effect of INM treatments on earhead weight (g) and test weight (1000 grains) of finger millet at harvest

| Treatments | 2019 | | 2020 | |
|---|--------------------|---------------------------|--------------------|---------------------------|
| | Earhead weight (g) | Test weight (1000 grains) | Earhead weight (g) | Test weight (1000 grains) |
| Establishment methods | | | | |
| V ₁ : VL Mandua-347 | 6.11 | 3.25 | 6.37 | 3.35 |
| V ₂ : VL Mandua-352 | 6.18 | 3.26 | 6.42 | 3.41 |
| S.E.m (±) | 0.3 | 0.3 | 0.35 | 0.01 |
| C.D. (5%) | NS | NS | NS | NS |
| Nutrient Management | | | | |
| Control (N:P:K) | 4.80 | 2.90 | 4.92 | 3.0 |
| 100% RDF | 6.35 | 3.4 | 6.49 | 3.49 |
| 75% RDF+ FYM(4t/ha) | 6.6 | 3.54 | 6.72 | 3.6 |
| 75%RDF+Vermicompost(1t/ha) | 7.74 | 3.68 | 7.80 | 3.74 |
| 75% RDF+50%PSB | 5.9 | 2.9 | 6.1 | 3.20 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 6.20 | 3.1 | 6.34 | 3.24 |
| S.E.m (±) | 0.08 | 0.07 | 0.05 | 0.04 |
| C.D. (5%) | 0.25 | 0.23 | 0.17 | 0.12 |

Table 3. Effect of INM treatments on Grain yield (kg ha⁻¹), Straw yield (kg ha⁻¹) and Biological yield (kg ha⁻¹) of finger millet at different growth stages

| Treatments | 2019 | | | 2020 | | |
|---|------------------------------------|------------------------------------|---|------------------------------------|------------------------------------|---|
| | Grain yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) | biological yield (kg ha ⁻¹) | Grain yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) | biological yield (kg ha ⁻¹) |
| Establishment methods | | | | | | |
| V ₁ : VL Mandua- 347 | 1751 | 3868 | 5608 | 1798 | 3971 | 5432 |
| V ₂ : VL Mandua- 352 | 1750 | 3874 | 5612 | 1801 | 3973 | 5774 |
| S.E.m (±) | 0.77 | 4.77 | 5.53 | 1.80 | 7.70 | 7.79 |
| C.D. (5%) | NS | NS | NS | NS | NS | NS |
| Nutrient Management | | | | | | |
| Control (N:P:K) | 1062 | 2721 | 3783 | 1074 | 2801 | 3875 |
| 100% RDF | 1684 | 3744 | 5428 | 1710 | 3789 | 5499 |
| 75% RDF+ FYM(4t/ha) | 2124 | 4392 | 6516 | 2210 | 4400 | 6610 |
| 75%RDF+Vermicompost(1t/ha) | 2162 | 4421 | 6583 | 2232 | 4592 | 6824 |
| 75% RDF+50%PSB | 1764 | 4078 | 5842 | 1810 | 4289 | 6099 |
| 50% RDF + FYM (2t/ha) + Vermicompost (0.5t/ha) +PSB | 1710 | 3801 | 5511 | 1764 | 3964 | 5728 |
| S.E.m (±) | 8.52 | 5.42 | 10.18 | 2.17 | 6.44 | 6.96 |
| C.D. (5%) | 25.31 | 16.12 | 30.26 | 6.45 | 19.15 | 20.70 |





Antioxidant Evaluation of Some Novel Methoxy Substituted Thiophene and Benzothiophene Derivatives Bearing Chalcone Moieties

Mejo Joseph^{1*}, S.Alexander², J.Banurekha², K. Anandkumar³ and D.Sudhahar⁴

¹Assistant Professor, Nehru College of Pharmacy, Pampady, Kerala, (Part Time Research Scholar, Vinayaka Mission College of Pharmacy, Salem, Tamil Nadu) India

²Associate Professor, Vinayaka Mission College of Pharmacy, Vinayaka Mission Research Foundation (Deemed To Be University), Salem, Tamil Nadu. India.

³Professor, Swamy Vivekanandha College of Pharmacy, Tiruchengode, Namakkal, Tamil Nadu, India

⁴Professor, Nehru College of Pharmacy, Pampady, Kerala. India

Received: 13 June 2022

Revised: 18 June 2022

Accepted: 12 July 2022

*Address for Correspondence

Mejo Joseph,

Assistant Professor,

Nehru College of Pharmacy,

Pampady, Kerala, India.

(Part Time Research Scholar,

Vinayaka Mission College of Pharmacy,

Salem, Tamil Nadu, India)

Email: mejojoseph000@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Antioxidants are the substances having the potential to quench free radicals and significantly delay or inhibit oxidation of the substrate, thus protect biological systems against potentially harmful effects of free radicals in low concentration. In this context newly designed six novel series of thiophene and benzothiophene analogous successfully synthesized and evaluated for their antioxidant activities. Molecular docking has become an important process in the course of drug discovery and docking aim is to predict the binding mode and binding affinity of the protein ligand complex. By using boivia discovery studio2020,Chems sketch,Molinspiration utilized for *Insilico* designed drug molecules and their physiochemical properties, drug likeness, Lipinski rule of five, Admet are analyzed. Compounds having better docking score selected for synthesized by conventional synthetic method through a series of steps. Further its antioxidant property evaluated by DPPH, Hydroxyl Radical Scavenging assay (Fenton Reaction Based Radical Assay).Ascorbic acid was used as standard drug. Final result reveals that BT-IV-A,BT-IV-E,BT-IV-B,BT-IV-D and T-IV-I shows significant antioxidant activity. The chemical structures of the synthesized compounds were confirmed by using IR, ¹HNMR,¹³CNMR and mass spectral studies.

Keywords: : Benzothiophene, Chalcones, Thiophene, Antifungal, Antioxidants,



Mejo Joseph *et al.*,

INTRODUCTION

Drugs are the chemical entity that prevents disease or assist in restoring health to diseased individuals. As such, they play an indispensable role in the modern system of medicine [1]. Medicinal chemistry is the branch of science that provides these drugs either through discovery or design. In the last century, classical drugs were primarily discovered either by altering natural substances or entirely by laboratory synthesis [2]. In recent years, an ever-increasing understanding of the pathophysiology of diseases has increasingly led to novel opportunities to deliberate design, synthesis, and evaluation of candidate drug molecules [3]. Pharmaceutical chemistry is the branch of science that deals with the study of molecular and mechanical aspects of pharmaceuticals. The discipline emphasizes the chemistry of drug design and development, drug action, drug transport, drug delivery, and targeting [4]. The development of new pharmaceuticals is critically dependent on a molecular-level understanding of biological processes and mechanisms of drug action. Progress in the field now depends on designing and synthesizing new molecules using structure-activity relationships, combinatorial chemistry, and computer-aided drug design [5]. In recent years, the rational design of drugs tuned to specific target sites is becoming a reality due to concurrent advances in chemistry and biology, including elucidation of the human genome [6].

Chemists continue to be at the forefront of drug design, synthesis, testing, and development [7]. Molecular biology and genetic engineering have produced a deluge of potential new targets for drug design and have unraveled the structures and mechanisms of traditional targets, while advances in computers and computer-aided design have allowed medicinal chemists to take full advantage of this newly earned knowledge [8]. The first successful attempts at actually designing a drug to work at a particular target happened nearly simultaneously in 1976 with the discovery of cimetidine, a selective H₂-antagonist and Captopril, an angiotensin-converting enzyme inhibitor. Since then, the art of rational drug design has undergone an explosive evolution, using the sophisticated computational and structural methodology to help in the effort. Literature survey reveals that when one biologically active heterocyclic system is coupled with another, there will be an increase in the biological activity of the resultant molecule. Keeping in view these facts, in the present study, sulphur-containing heterocyclic compounds have been synthesized in which thianaphthene and thiophene are linked with methyl ketone and different aldehyde to form chalcones. In sulfur-containing heterocycles, thiophene and benzothiophene substituted chalcone derivatives are at the focus as these candidates have structural similarities with active compounds to develop new potent lead molecules in drug design [9].

Thiophene and Thianaphthene scaffold is one of the privileged structures in drug discovery as this core exhibit various biological activities allowing them to act as antimicrobial, anticancer anti-inflammatory, antioxidant, anti-tubercular, antidiabetic, anticonvulsant agents and many more [10]. The chemistry of chalcones has generated intensive scientific studies throughout the world. Primarily interest has been focused on the synthesis and biodynamic activities of chalcones. Kostanecki and Tambor gave the name "Chalcones." These compounds are also known as benzalacetophenone or benzylidene acetophenone. An aliphatic three carbon chain links two aromatic rings in chalcones. Chalcone bears a very good synthon, so a variety of novel heterocycles with a good pharmaceutical profile can be designed [11].

Chalcones are -unsaturated ketone containing the reactive ketoethylenic group $-\text{CO}-\text{CH}=\text{CH}-$. These are coloured compounds because of the Chromophore $-\text{CO}-\text{CH}=\text{CH}-$, which depends on the presence of other auxochromes. Chalcones and their derivatives demonstrate wide range of biological activities such as antidiabetic, anti-neoplastic, anti-hypertensive, anti-retroviral, anti-inflammatory, anti-parasital, anti-histaminic, anti-malarial, antioxidant, anti-fungal, anti-obesity, anti-platelet, anti-tubercular, immunosuppressant, anti-arrhythmic, hypnotic, anti-gout, anxiolytic, anti-spasmodic, anti-nociceptive, hypolipidemic, anti-filarial, anti-angiogenic, anti-protozoal, anti-bacterial, etc. The present **scheme 1** describes the synthesis of novel substituted methoxy derivatives of benzothiophene and their different chalcone derivatives. The compounds were prepared from malonic acids that reacted with para anisaldehyde in the presence of pyridine and piperidine to form para methoxy cinnamic acid. In



Mejo Joseph *et al.*,

the presence of a catalytic amount of pyridine, thionyl chloride gently oxidizes carboxylic acid and ketone at alpha carbon atoms to form α -chloro- α -chlorosulfonyl derivatives and their subsequent reaction products. Thus 3-phenylpropionic acid when treated with an excess of thionyl chloride and a small amount of pyridine, can be converted to sulfonyl chloride, which undergoes further reaction to form benzothiophene and α -chloro cinnamoyl chloride.

MATERIALS AND METHODS

Experimental section

The synthetic strategies adopted for constructing the target molecules are illustrated in Scheme-I describes about synthesis of novel substituted methoxy derivatives of benzothiophene and their different chalcone derivatives [7]. The compounds were prepared from malonic acids which on reacted with para anisaldehyde in presence of pyridine and piperidine to form para methoxy cinnamic acid. In presence of catalytic amount of pyridine, thionyl chloride gently oxidizes carboxylic acid and ketone at alpha carbon atoms to form α -chloro- α -chlorosulfonyl derivatives and their subsequent reaction products. Thus 3-phenylpropionic acid when treated with an excess of thionyl chloride and a small amount of pyridine, can be converted to sulfonyl chloride which is then undergo further reaction to form benzothiophene and α -chloro cinnamoyl chlorid which on further refluxed with para amino acetophenone in presence of dry acetone to form 4-(acetyl phenyl)-3-chloro-methoxy-1-benzothiophene-2-carboxamide which further on by Claisen Schmidt condensation which involves crossed aldol condensation of appropriate aldehyde in presence of base catalysed reactions followed by dehydration to form different derivatives of 3-chloro-6-methoxy-N-[4-(2E)-3-phenylprop-2-enyl]phenyl-1-benzothiophene-2-carboxamide in respectively.

General procedure for the synthesis of functionalized benzothiophene substituted chalcone derivatives.

Meta-chloro-6-methoxy-N-[4-(2E)-3-phenylprop-2-enyl]phenyl-benzothiophene-2-carboxamide was prepared. Yields was 78% (m.p. 168-170). 3.6gm(0.01mole) of 4-(acetyl phenyl)3-chloro-6-methoxy-1-benzothiophene-2-carboxamide dissolved in 20ml DMF and 1.06gm(0.01mole)corresponding aldehydes was added to the reaction mixture with constant stirring at room temperature, then 40%potassium hydroxide in distilled water was added to the reaction mixture with constant stirring at room temperature. After 24 hrs the reaction mixture was poured in to crushed ice and neutralized with HCl. The ppt was filtered washed with water dried and recrystallized in methanol to obtain the corresponding aldehyde derivatives of compound (BT-IV). Check the TLC by n-hexane and chloroform (9:1) as an eluent. All selected compounds were prepared by similar methods. **Table 1** mentioned physical and chemical characterization of synthesized compounds.

N-(4-(3-(3-nitrophenyl)acryloyl)phenyl)thiophene-2-carboxamide(T-IV-I)

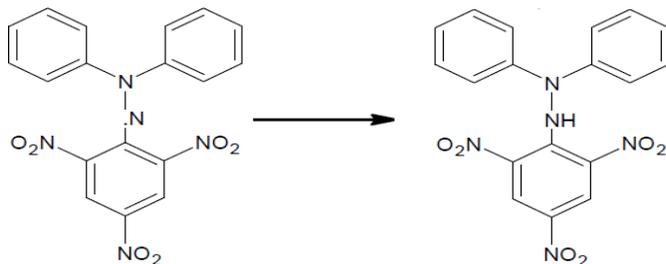
A mixture of ketone like 4-(acetyl phenyl) thiophene 2-carboxamide and different ortho, meta, para substituted benzaldehyde ((0.01m) and 40% aqueous potassium hydroxide is added to 30 ml of ethanol and was stirred at room temperature for about 2-6 hrs. The resulting products was keep overnight in refrigerator. The solid separated out was filtered, washed with water and recrystallized from ethanol yields pure crystalline products. After drying in an oven at about 70°C yield was 68%. Melting point was found to be 132°C. TLC was checked by n-hexane and chloroform (9:1) ratio as an eluent. All compounds were prepared by same method. Yield was 69%.

RESULTS AND DISCUSSION

To evaluate the antioxidant potential of all the compounds in-vitro free radical scavenging activity using DPPH (2,2-diphenyl-1-picrylhydrazyl) reduction method¹¹.

Principle: DPPH [2,2-diphenyl-1-picryl hydrazyl] is a stable free radical with Purple colour. Antioxidant reduces DPPH to 2,2-diphenyl-1-picryl hydrazine, a colorless compound that is measured at an absorbance of 517nm.



Mejo Joseph *et al.*,

Procedure

Preparation of Control (DPPH) Solution

10 mg of DPPH was dissolved in 10 ml of methanol. From this stock solution, dilutions were prepared to obtain 10, 20, 30, 40 µg/ml concentrations. The absorbance was recorded for these dilutions at 517 nm in a u-v spectrophotometer [12].

Preparation of standard solution (Ascorbic acid)

10 mg of ascorbic acid was dissolved in 10 ml of methanol. From this stock solution, dilutions were made to obtain concentrations of 10, 20, 30, 40 µg/ml. 1 ml from each of these solutions was taken in different volumetric flasks to which 1 ml of DPPH solution (300 µg/ml concentration) was added and volume was made up to 10 ml. The absorbance was recorded for these dilutions at 517 nm after a duration of 30 mins.

Preparation of test solutions

The test solutions were prepared similarly as that of standard Ascorbic acid and the absorbance was recorded at 517 nm after duration of 30 minutes. The percentage of inhibition was calculated by using the formula,

$$\% \text{ of inhibition} = \frac{\text{Control absorbance} - \text{sample absorbance}}{\text{Control absorbance}} \times 100$$

The IC₅₀ value was obtained by plotting the graph taking % of inhibition on Y-axis and concentration is on X-axis. Table:2. Shows antioxidant properties of compound code with % of inhibition and IC₅₀ Values by DPPH method. Minimum inhibitory concentrations for antioxidant activity of synthesized compounds were calculated by following graphs.

Hydroxyl radical scavenging method

Hydroxyl Radical Scavenging assay (Fenton Reaction Based Radical Assay) is used to find the scavenging activity of free hydroxyl radicals (which damage the body cells) like hydrogen peroxide in the presence of different concentrations of antioxidants [13]. Hydroxyl radical was generated by Fe³⁺-ascorbate-EDTA-H₂O₂ system (Fenton reaction). This is a totally aqueous system in which ascorbic acid, iron and EDTA conspire with each other to generate hydroxyl radicals.

Hydrogen peroxide free radicals are toxic because they may release hydroxyl free radical in the cells even though they were not very reactive. So, removal of hydrogen peroxide radicals is need for antioxidant activities in cell. Ability of scavenging hydrogen peroxide free radicals and 50 % inhibitory concentrations (IC₅₀) for each compound were calculated and are given Table: 3 Absorbance of the solutions was measured using a UV-VISIBLE spectrophotometer at 532nm. Ascorbic acid in varying concentrations ranging from 10 to 50 µg/ml was used as a positive control. Percentage inhibition = $\frac{Ac-As}{Ac} \times 100$.



**Mejo Joseph et al.,**

CONCLUSION

New series of thiophene and benzothiophene derivatives tagged with different chalcone moieties were synthesized successfully and evaluated for their antioxidant activities. The synthetic route for the preparation of different series of substituted thiophene and benzothiophene analogues were synthesized from thiophene 2 carbonyl chloride and 3-(4-methoxy phenyl) acrylic acid. The physicochemical properties and drug-receptor binding interactions of synthesized compounds depend on the ligands bearing different hetero atoms or functional group in the thiophene and benzothiophene scaffold. Condensation of malonic acid with para anisaldehyde in the presence of pyridine and piperidine to form 3-(4-methylphenyl) acrylic acid(I), which on further refluxed with thionyl chloride in the presence of pyridine at 95-98^o C to form 3-chloro-6-methoxy benzothiophene carbonyl chloride(II). Which, further refluxed with 4-amino acetophenone in the presence of dry acetone to form 4-(acetyl phenyl)-3-chloro-6-methoxy-1-benzothiophene-2-carboxamide(III), which on substituted with a different aldehyde in the presence of KOH/Ethanol to form corresponding derivatives of [4-(2E)-3-phenylprop-2-Enoyl]phenyl-1-benzothiophene-2-carboxamide(IV).

A similar protocol was adopted to synthesize 4-(acetyl phenyl) thiophene-2-carboxamide para aminoacetophenone moiety by reflux under 4Hrs in the presence of dry acetone which on substituted with different aldehydes under suitable conditions using KOH/Ethanol as catalyst as explained in general scheme 4. The structure of synthesized compounds was established based on physicochemical and spectral data (ATR, FTIR, ¹HNMR, [13]CNMR and Mass spectra). All the target exhibited good biological activity especially BT-IV-A, BT-IV-B, BT-IV-D, BT-IV-E, and T-IV-B, T-IV-I shown good antioxidant due to the presence of different substituted functional group. Docking simulations showed that the selective compounds can be accommodated with Peroxiredoxin 5 (PDB ID: 1HD2) as selective inhibitors and analysis of the compounds through ADMET filters and molecular docking studies. The spectral data's of all the synthesized compounds specified to proven the chemical nature. From a library selected compounds were chosen which had binding energy more to good could serve as lead compound for the development of newer potent anti-oxidant activities. Structural optimization and detailed SAR investigations with protein binding studies involving cellular targets and mechanism of action of newly synthesized substituted benzothiophene and thiophene with their chalcone derivatives were not done due to time-constraints subjected to future studies.

ACKNOWLEDGEMENT

The authors are thankful to Sophisticated Instrumentation Facility provided by M.G University, Kottayam, for the help regarding IR, NMR and MASS analysis. I am also thankful to staffs Nehru college of pharmacy to support laboratory work to carry out in Department of pharmaceutical chemistry, Vinayaka Mission college of pharmacy, Salem, Tamil Nadu.

AUTHOR'S CONTRIBUTION STATEMENT

Mr. Mejo Joseph has prepared the original manuscript, Dr. S. Alexander reviewed, edit the draft, discussed methodology, analyzed the spectral data. Dr. J. Banurekha provided valuable inputs towards designing the manuscript. All authors approved, read, and approved the final version of the manuscript.

DECLARATION OF COMPETING INTEREST

Conflict of interest declared none

REFERENCES

1. Hosseinzadeh S, Jafarikukhdan A, Hosseini A, Armand R. The application of medicinal plants in traditional and modern medicine: a review of *Thymus vulgaris*. International Journal of Clinical Medicine. 2015;6(09):635.
2. Cragg GM, Grothaus PG, Newman DJ. Impact of natural products on developing new anti-cancer agents. Chemical reviews. 2009 Jul 8;109(7):3012-43.



Mejo Joseph *et al.*,

3. Chandrakant ss. Synthesis characterization spectral analysis and pharmacological evaluation of different 1 4 naphthoquinone derivatives and their metal chelates.
4. Wermuth CG, editor. The practice of medicinal chemistry. Academic Press; 2011 May 2.
5. Yang GF, Huang X. Development of quantitative structure-activity relationships and its application in rational drug design. Current pharmaceutical design. 2006 Dec 1;12(35):4601-11.
6. Singh SB, Barrett JF. Empirical antibacterial drug discovery—foundation in natural products. Biochemical pharmacology. 2006 Mar 30;71(7):1006-15.
7. Yendapally R, Lee RE. Design, synthesis, and evaluation of novel ethambutol analogues. Bioorganic & medicinal chemistry letters. 2008 Mar 1;18(5):1607-11.
8. Neamati N. New paradigms in drug design and discovery. Current Topics in Medicinal Chemistry. 2002 Mar 1;2(3):211-27.
9. Keri RS, Chand K, Budagumpi S, Somappa SB, Patil SA, Nagaraja BM. An overview of benzo [b] thiophene-based medicinal chemistry. European journal of medicinal chemistry. 2017 Sep 29; 138:1002-33.
10. Keri RS, Chand K, Budagumpi S, Somappa SB, Patil SA, Nagaraja BM. An overview of benzo [b] thiophene-based medicinal chemistry. European journal of medicinal chemistry. 2017 Sep 29; 138:1002-33.
11. Kishore RK, Halim AS, Syazana MN, Sirajudeen KN, Tualang honey hKaur R, Sharma P, Gupta GK, Ntie-Kang F, Kumar D. Structure-Activity-Relationship and Mechanistic Insights for Anti-HIV Natural Products. Molecules. 2020 Jan; 25(9):2070.
12. Varghese RA, Anandhi P, Arunadevi R, Boovisha A, Sounthari P, Saranya J, Parameswari K, Chitra S. Satin leaf (*Chrysophyllumoliviforme*) extract mediated green synthesis of silver nanoparticles: antioxidant and anticancer activities. Journal of Pharmaceutical Sciences and Research. 2015 Jun 1;7(6):266.
13. Russo A, Izzo AA, Borrelli F, Renis M, Vanella A. Free radical scavenging capacity and protective effect of *Bacopa monniera* L. on DNA damage. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2003 Sep;17(8):870-5.
14. Aswathy J, Binuja SS, Bravin DE, JaneeraBeevi S. Insilico drug design and molecular docking studies of novel phthalazine derivatives for anticancer activity.
15. Chen X, Li H, Tian L, Li Q, Luo J, Zhang Y. Analysis of the physicochemical properties of acaricides based on Lipinski's rule of five. Journal of computational biology. 2020 Sep 1;27(9):1397-406.

Table 1: Physical and chemical characterization of synthesized compounds.

| Compound | Substitutions | Molecular formula | Mol.wt | %Yield | Rf Value | M.P.°C |
|----------|--------------------------|---|--------|--------|----------|--------|
| BT-IV-A | Benzaldehyde | C ₂₅ H ₁₈ O ₃ NCl | 413.51 | 69 | 0.65 | 176 |
| BT-IV-B | Ortho-chlorobenzaldehyde | C ₂₅ H ₁₇ O ₃ SNCl ₂ | 482.38 | 184 | 72 | 0.77 |
| BT-IV-D | 3-nitrobenzaldehyde | C ₂₅ H ₁₇ O ₅ SN ₂ Cl | 458.51 | 73 | 0.81 | 182 |
| BT-IV-E | Furfuraldehyde | C ₂₃ H ₁₆ O ₄ SNCl | 437.93 | 71 | 0.59 | 179 |
| T-IV-B | Para-methyl benzaldehyde | C ₂₁ H ₁₇ NO ₂ S | 347.45 | 151 | 65 | 0.44 |
| T-IV-I | 3-nitrobenzaldehyde | C ₂₀ H ₁₄ O ₄ N ₂ S | 378.43 | 66 | 0.30 | 159 |

Table 2: Shows antioxidant properties of compound code with % of inhibition and IC₅₀

| Compound code | % Inhibition | | | | | IC ₅₀ |
|---------------|--------------|---------|---------|---------|----------|------------------|
| | 10µg/ml | 20µg/ml | 30µg/ml | 40µg/ml | 50 µg/ml | |
| BT-IV-A | 49.43 | 55.34 | 59.16 | 66.75 | 67.29 | 9.64 |
| BT-IV-B | 48.29 | 54.15 | 58.93 | 62.87 | 64.31 | 11.08 |
| BT-IV-D | 45.93 | 54.87 | 57.48 | 60.89 | 61.03 | 13.33 |
| BT-IV-E | 48.94 | 54.28 | 56.03 | 60.11 | 62.83 | 10.84 |
| T-IV-B | 46.21 | 55.89 | 58.32 | 61.02 | 62.82 | 12.13 |
| T-IV-I | 44.91 | 54.81 | 57.40 | 59.81 | 60.01 | 14.69 |
| Ascorbicacid | 52.04 | 57.95 | 59.05 | 65.91 | 72.87 | 6.71 |



Mejo Joseph *et al.*,**Table: 3.** Shows antioxidant properties of compound code with % of inhibition and IC₅₀ Values by Hydroxyl Radical Scavenging method

| Compound code | % Inhibition | | | | | IC ₅₀ |
|---------------|--------------|---------|---------|---------|---------|------------------|
| | 10µg/ml | 20µg/ml | 30µg/ml | 40µg/ml | 50µg/ml | |
| BT-IV-A | 49.98 | 54.78 | 62.75 | 64.39 | 68.04 | 8.16 |
| BT-IV-B | 48.99 | 55.44 | 60.15 | 64.14 | 68.04 | 10.01 |
| BT-IV-D | 49.28 | 51.26 | 55.15 | 63.14 | 67.04 | 14.87 |
| BT-IV-E | 49.18 | 55.78 | 62.95 | 64.99 | 68.84 | 8.69 |
| T-IV-B | 49.78 | 51.44 | 54.83 | 62.11 | 65.29 | 13.96 |
| T-IV-I | 47.94 | 49.95 | 54.05 | 62.81 | 66.07 | 17.46 |
| Ascorbicacid | 50.98 | 56.78 | 63.75 | 65.39 | 69.04 | 5.00 |

Table no: 4. Spectral details of the synthesized Compounds.

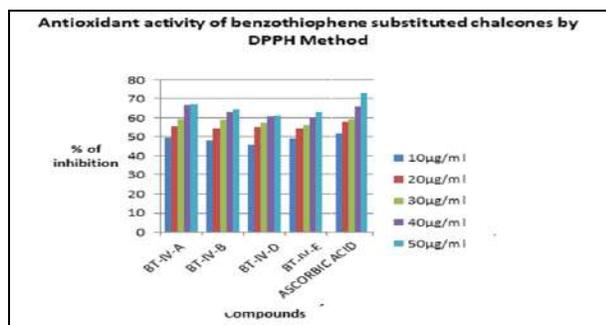
| COM PD | AT-FT-IR | ¹ H-NMR & ¹³ C-NMR | MASS m/z |
|---------|---|--|----------|
| BT-IV-A | 3342(N-H, Stretching), 1710(C=O Stretching, Ketone), 1674(C=O, Stretching, Amide), 2825(OCH ₃), 1587(C=C Aromatic Stretch), 1060(=C-Cl, Stretch) 825(C-H Aromatic), 738(CH=CH, Stretching), 674(C-S-C, Stretch) | ¹ H-NMR-δ ppm: 9.15(s, 1H, CONH), 8.09-7.01(m.12H. Ar-H), 8.07-7.59(d, 2H, CH=CH), 3.87(s, 3H, OCH ₃). ¹³ C-NMR-δ ppm: 145.1,121.3-Ar-C Ethylene,55.8-CH ₃ Aliphatic,189.7-Ar-C(C=C)Carbonyl,135.2,128.6,128.5,127.9-Ar-C(C=C)Benzene,143.7,133.5,131.4,122.1-Ar-C(N-C=O)Benzene,159.4,152.8,143.7,141.6,129.9,125.7-Ar-C(C=O) Cl Benzothiophene | 448.91 |
| BT-IV-B | 3340(N-H Stretching),2833(OCH ₃ Stretching),1710(C=O, Stretch Ketone),1674(C=O, Stretch Amide),1482(C=C, Aromatic stretching), 1060(=C-Cl, Stretch) 740(CH=CH, Stretching), 607(C-S-C Stretching) | ¹ H-NMR-δ ppm: 9.18-(s, 1H, CONH), 8.48-7.07(m, 14H, Ar-H), 8.30-7.48, (d,2H,CH=CH), 3.83(s, 3H, OCH ₃). ¹³ C-NMR-δ ppm: 145.1,121.3-ArC- of ethylene(C-H), 55.8-Aliphatic (CH ₃),189.7-(ArC) of carbonyl,161.8-ArC of N-Amide,126.3,129.3,127.3,129.9,131.4,134.7-ArC of Benzene(C=C)Cl,131.4,122.1,133.5,143.7-ArC of Benzene(N-C=O),129.9,141.6,152.8,125.7-ArC of Benzothiophene (C=O)Cl,124.2ArC of Benzothiophene (O-C) | 483.39 |
| BT-IV-D | 3328(N-H Stretching),2825(OCH ₃ , Stretching), 1721(C=O, Stretching Ketone),1678(C=O, stretching, Amide), 1579-C=C, Aromatic Stretching), 1339(NO ₂ | ¹ H-NMR-δ ppm: 9.18-(s,1H.CONH), 8.30-7.07-(m,11H, Ar-H), 7.90-8.87(d, 2H,CH=CH),3.83- (s,3H,OCH ₃). ¹³ C-NMR-δ ppm: 129.9,141.6,ArC- (C=O)Cl of Benzothiophene,152.8,125.7-Arc (C=O) Benzothiophene,159.4ArC(O-C) from benzene,147.8-ArC(-N(C=O)),(C=C)Benzene,143.7,122.1,131.4-ArC(N-C=O),(C=O)Benzene,115.2,124.2,126.3ArC-Benzothiophene(O- | 493.95 |





Mejo Joseph et al.,

| | | | |
|---------|--|--|--------|
| | Stretch), 1067(=C-Cl, Stretch) 739(CH=CH, Stretching) | C)from benzene,137.7,122.7.134.6,123.1,129.5ArC-(N(=O)=O, Benzene(C=C), Benzothiophene,161.8-ArC-(Amide),189.7-Carbonyl,55.8-(CH ₃),141.5,121.3-ArC(CH)Ethylene. | |
| BT-IV-E | 3391(NH, Stretching), 2817(OCH ₃ ,Stretching), 1718 (C=O, Stretching, Ketone),1658(C=O, Amide),1482(C=C, Aromatic Stretching),1171(C-O-C, Stretching), 1062(=C-Cl, Stretch) 756(CH=CH, Stretching), 682(C-S-C, Stretching), | ¹ H-NMR-δppm:9.18(s,1H,CONH),8.18-6.89 (m,10H,ArH),7.12-7.09(d,2H,CH=CH),3.87-(s,3H, OCH ₃) ¹³ C-NMR-δppm:129.9,141.6ArC(C=O)Cl-Benzothiophene,152.8,125.7ArC(C=O)Cl,(OC)Benzothiophene,143.0,139.0,124.4,ArC(C=C)Furan,159.4,115.8,126.3,124.2Ar(CH)Benzothiophene,143.7,133.5,122.1,131.4-ArC(CH)Benzene.161.8-ArC-(N-Amide),189.7-Carbonyl, 55.8-9CH ₃), 145.1, 127.3- ArC(CH)-C=O ethylene. | 438.90 |
| T-IV-B | 3340(N-H Stretch), 2880(CH ₃ Stretching), 1721(C=O Stretching Ketone), 1655(C=O, Stretching, Amide), 1588 (C=C, Stretching Aromatic), 1376(CH ₃ Stretching), 1023(=C-Cl Stretch),807(CH=CH Stretch), 695(C-S-C, Stretching). | ¹ H-NMR-δ ppm:9.15(s,1H.CONH),8.37-7.18(d,11H,ArH), 7.87-7.85(d,2H,CH=CH),2.03(s,3H,CH ₃). ¹³ C-NMR-δ ppm:139.4ArC,130.3ArC(CH), 131.9ArC(CH)129.0ArC(CH)(C=O)Thiophene, 143.7,133.5ArC-(NC=O)Benzene,132.2,137.6ArC(C=C) Benzene,122.1,131.4ArC(NC=O)Benzene,128.5,128.9ArC(C=C)Benzene, 161.8(N-Amide),189.7-ArC(C=C),145.1,121.3ArC(C=O)Ethylene, 121.3ArC(CH ₃). | 348.44 |
| T-IV-I | 3380(N-H Stretching), 1721(C=O Stretching Ketone), 1678(C=O Stretching Amide), 1604(C=C Stretching), 1380(NO ₂ Stretching), 1015(=C-Cl, Stretching), 975(CH=CHStretching). 794(C-S-C, Stretching) | ¹ H-NMR-δ ppm: 9.15 (s,1H,CONH),8.31-7.23(m,11H,ArH),8.17-7.84(d,2H,CH=CH). ¹³ C-NMR-δ ppm: 139.4,130.3,131.9,129.0ArC(C=O)Thiophene,147.7,127.3,123.8,128.8,134.7ArC(N(=O)=O,(C=C)Benzene,143.7,133.5,122.1, 131.4 ArC(N-C=O) (C=O) Benzene, 161.8(N-Amide), 145.1,121.3ArC(C=O)Ethylene. | 379.41 |



Figno:1.Graphical representation of antioxidant activity of benzothiophene substituted chalcone derivatives by DPPH Method

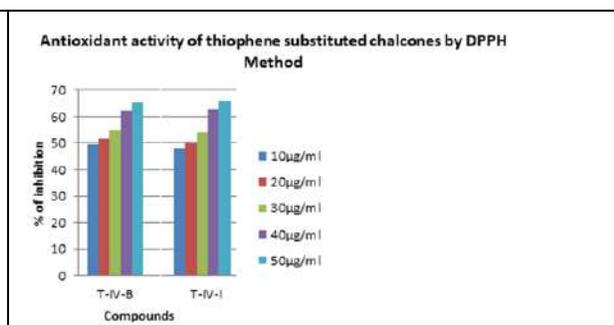


Fig no: 2. Graphical representation of antioxidant activity of Thiophene substituted chalcone derivatives by DPPH Method





Mejo Joseph *et al.*,

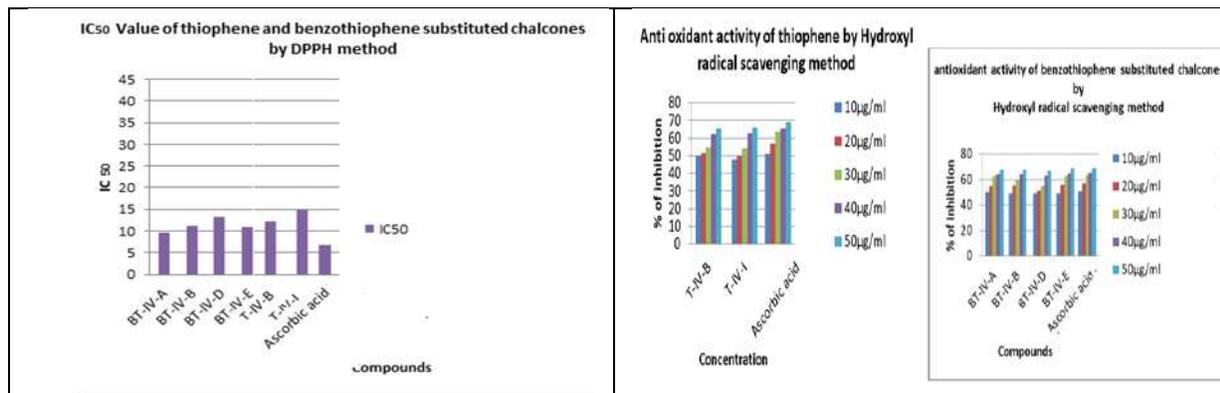


Fig no:3. Graphical representation of IC₅₀ Value of thiophene and benzothiophene substituted chalcones by DPPH method

Fig no: 4. Graphical representation of antioxidant activity of Thiophene and benzothiophene substituted chalcone derivatives by Hydroxyl radical scavenging method

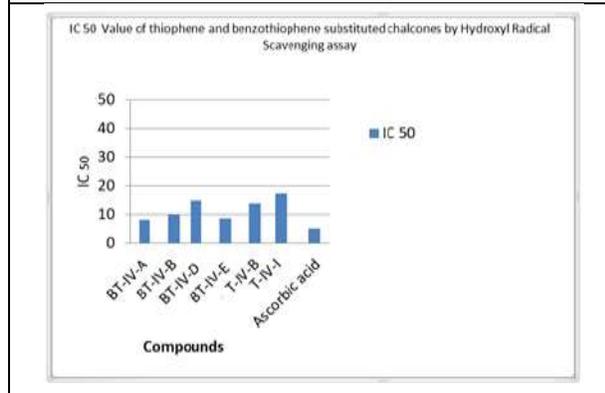


Fig no: 5. Graphical representation of IC₅₀ Value of thiophene and benzothiophene substituted chalcones by Hydroxyl Radical Scavenging assay.

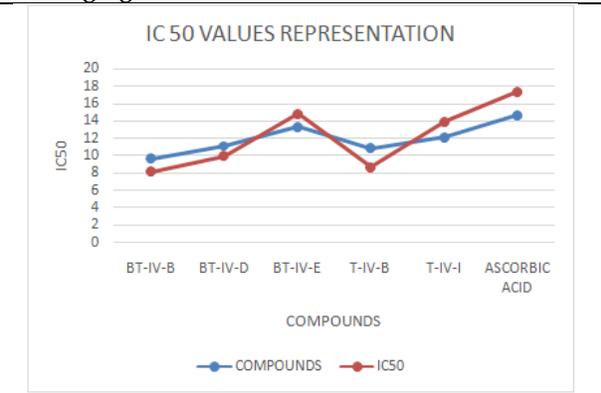
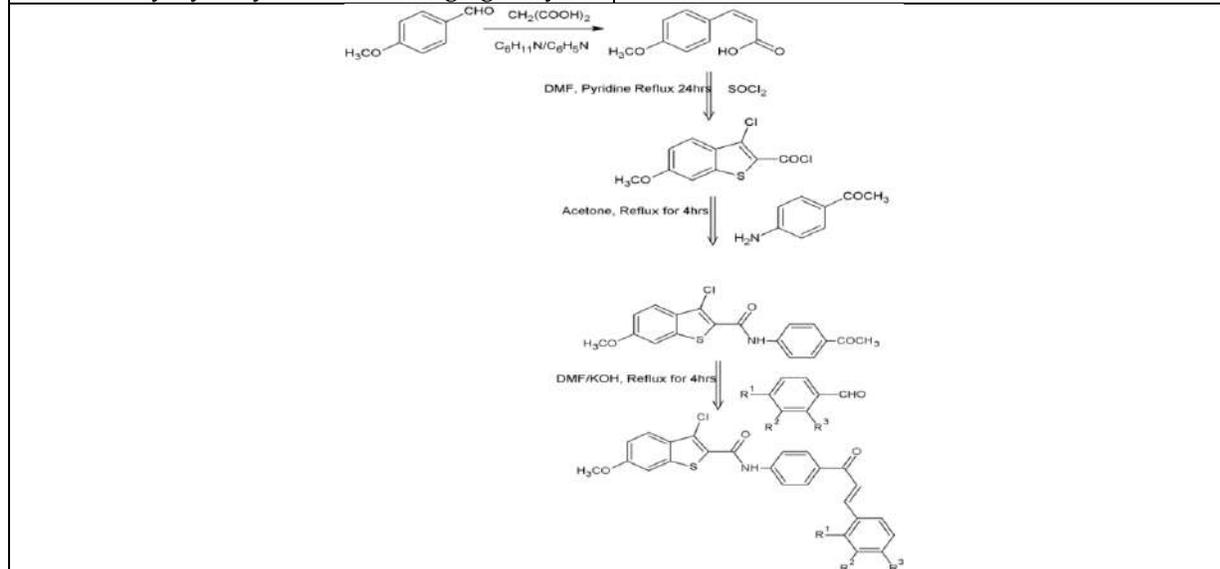
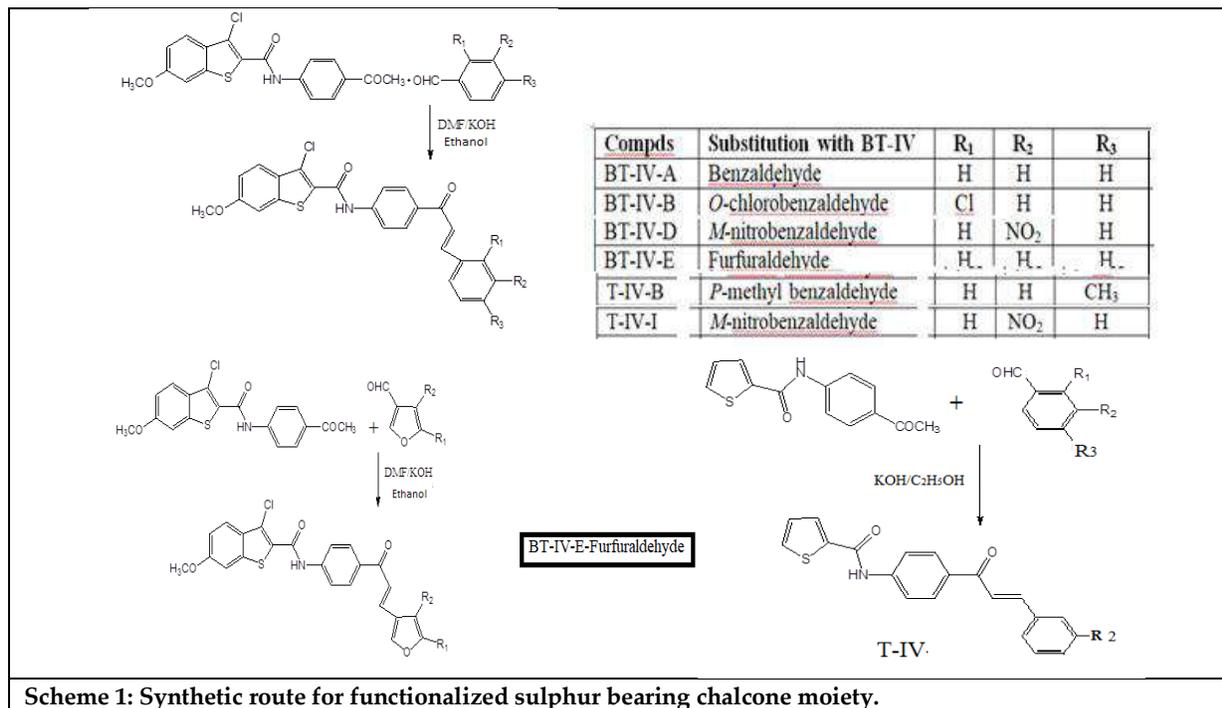


Fig no: 6. IC₅₀ Values of Benzothiophene and Thiophene Substituted Chalcones





Mejo Joseph *et al.*,



Scheme 1: Synthetic route for functionalized sulphur bearing chalcone moiety.





Designing and Validation of a Clinical Tool for Assessment of Volitional Motor Control for Stroke Survivors: A Scoping Review

Sneha Dineshbhai Dhanani^{1*} and Amalkumar Bhattacharya²

¹Ph.D Scholar, Parul Institute of Physiotherapy, Parul, University, P.O.Limda, Waghodia, Vadodara, Gujarat, India

²Professor and Head, Medicine Department Parul Institute of Medical Science and Research, Parul University, Vadodara, Gujarat, India.

Received: 10 May 2022

Revised: 15 June 2022

Accepted: 18 July 2022

*Address for Correspondence

Sneha Dineshbhai Dhanani

Ph.D Scholar, Parul Institute of Physiotherapy,

Parul, University, P.O.Limda,

Waghodia, Vadodara,

Gujarat, India.

Email: physiosneha03@yahoo.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Stroke is a significant global health problem and a major cause of mortality and morbidity in developed countries and increasingly in low-middle income countries (LMICs). Seventy percent of strokes occur in LMICs, and the subsequent disease burden is greater than that of high-income countries. A scoping review of recent literature was performed on volitional control in stroke survivors. It was done to map the literature on volitional control in stroke population and also to find the types of available evidence and to find the gap on available literature on this topic. Age wise segregation of cases in stroke is important due to several reasons. Age has been shown to have a strong association with the incidence of stroke. The purpose of this study was to review the existing literature and to quickly capture the evidence found in current research regarding volitional control and stroke.

Keywords: Stroke, Age, countries, literature, disease.

INTRODUCTION

Stroke is a significant global health problem and a major cause of mortality and morbidity in developed countries and increasingly in low-middle income countries (LMICs). Seventy percent of strokes occur in LMICs, and the subsequent disease burden is greater than that of high-income countries. Life expectancy in India has recently increased to over 60 years of age leading to an increase in age-related, non-communicable diseases including stroke; making stroke India's fourth leading cause of death and fifth leading cause of disability [1]. To address the rising



**Sneha Dineshbhai Dhanani and Amalkumar Bhattacharya**

burden of stroke in India, reliable data on stroke incidence, prevalence, and outcome is needed to inform healthcare policies and the organization of stroke services and to track the impact of any changes in care. In 2016, the Global Burden of Disease project estimated the number of incident cases of stroke in India to be 1,175,778. In a recent systematic review, consisting mainly of cross-sectional studies, the incidence of stroke in India was estimated to be between 105 and 152/100,000 people per year [1,2].

Stroke is the leading cause of adult disability and the third leading cause of adult death in industrialized countries. The impact of stroke can be devastating, leaving a person with residual impairments in physical, social, emotional and cognitive functions. The patient's perceptions of his/her health and adjustment to the disability are critical for planning treatment and evaluating outcome. Traditional stroke rehabilitation focuses on the alleviation of symptoms and restoration of function. However, evaluation of the effectiveness of interventions should take into account not only the perspective of the healthcare professional or clinician, but also that of the patient. Because some treatment effects, such as changes in mood, are known only to the patient, systematic assessment of the patient's perspective may provide valuable information for treatment outcomes [1,2].

In recent years, there has been increasing interest in patient-centered assessment, inclusive of an expanded range of outcomes, such as health status, social participation or health-related quality of life (HRQOL). Several stroke-specific multi-domain measures have reflected this aspect, assessing the patient's self perceived health status and adjustment after a stroke. Although these measures have reported the use of patient-centered approaches, their sample sizes were modest, and studies have not included patients who have had severe strokes (Salter et al., 2005). These factors affect the robustness of the psychometric testing and limit the generalizability of their results. Thus, there remains a need to further investigate the impact of stroke on the patient's perceived health status and adjustment to the disability [2].

Severe upper extremity (UE) paresis seriously impacts the quality of life of patients with stroke. Patients with severe UE paresis may have no or very limited voluntary UE movement. They may perform partial UE movement, usually scapular, shoulder, or elbow movement, but they are unable to do simple daily tasks (e.g., hold a cup). Although only about one-third of patients suffer from severe UE paresis after stroke, they consume the majority of medical and social resources. Research has shown that the severity of one's impairment in voluntary control of UE motor units, paresis, is the primary determinant of UE functional loss and daily function restriction after stroke [2,3].

The voluntary UE movement was found to recover rapidly during the first three to six months and then to slow down in the chronic phase of recovery. Therefore, facilitating optimal recovery of voluntary UE movement is a major concern in inpatient rehabilitation. If patients do not show recovery potential, therapists may shift to compensatory strategies to help patients regain their functions in daily activities. Therefore, accurate judgment of a patient's voluntary UE movement recovery is an essential issue for rehabilitation therapists to provide proper interventions in patients with severe UE paresis [3].

The prediction of voluntary UE movement recovery in patients with severe UE paresis has not been examined well and remains inconclusive. Three reasons might explain such an observation. First, although previous studies have suggested that poor initial voluntary UE movement is associated with poor prognosis at or after discharge, these findings are difficult to generalize to patients with severe UE paresis. Previous studies investigated the association between initial UE impairment severity and recovery in a group of patients with heterogeneous severity of UE paresis. However, the association estimated in a heterogeneous group is a weighted result among the pooled sample and may not represent all subgroups accurately, for different recovery patterns exist between different subgroups. In other words, the estimated association between initial severe UE paresis with poor recovery may be biased when such results are analyzed together with mildly and moderately impaired patients. Therefore, further investigation with a homogeneous group of severe UE paresis patients is necessary.



**Sneha Dineshbhai Dhanani and Amalkumar Bhattacharya**

Second, the outcome measures did not assess voluntary UE movement in most studies that investigated motor recovery in patients with severe paresis. For example, the Scandinavian Stroke Scale assesses muscle strength, which cannot describe whether an individual can perform isolated wrist or forearm movements. Some studies used functional assessments of UE. UE function is a broad term, covering a range of abilities including voluntary UE movement, muscle tone, multiple joints movement coordination, and adjusting interactions with objects. For instance, “take up and put down an object” is a UE function that involves several joints in voluntary movements simultaneously; i.e., the thumb, fingers, elbow or shoulder. Different sizes and weights of objects also influence the results of functional assessments. Thus, the results of these studies are difficult to apply to the interpretation of voluntary UE movement recovery in patients with severe paresis. Voluntary UE movement is the foundation of UE function and reflects the basic control of the brain over the musculoskeletal system. Investigating voluntary UE movement recovery in patients with severe UE paresis provides the most fundamental research evidence regarding UE motor recovery after stroke.

Third, potential predictors have not been broadly explored in patients with severe UE paresis. Initial severity of UE movement and lesion locations were associated with voluntary UE movement recovery at 3 or 6 months after stroke in patients with severe UE paresis. However, the initial severity of UE movement alone can explain only 16.0% of the variance of patients’ recovery. It is unknown whether the other variables, such as duration after stroke onset and lesion volume, could be predictors as well and might increase the total predictive power for patients’ recovery.[3] Therefore; we aimed to investigate the extent and variation of voluntary UE movement recovery during inpatient rehabilitation in patients with severe UE paresis. Furthermore, we aimed to investigate the best predictive model (i.e., minimal variables with maximal predictive power) of the recovery of voluntary UE movement by clinical variables in patients with severe UE paresis [3].

Strokes are the most common cause of neurological disability in the community as a whole. The primary disability is loss of voluntary movement control on the side of the body contra lateral to the lesion. Other symptoms may include sensory loss, perceptual difficulties, intellectual impairment, problems of communication and psychosocial adjustment [4]. A common method of measuring recovery after stroke is to measure the patient’s functional ability in terms of performance of activities of daily living (ADL). Such scales are appropriate descriptors for purposes such as indicating the long-term effects of stroke. However, in the context of deciding an appropriate therapy program me ADL scales suffer from a number of deficiencies. Many tasks employed can be carried out with minimal use of the involved side. The tasks do not require fine motor control of the kind needed in many activities involving hand function. The results of this study have supported the need for a battery of tests to measure recovery following stroke. The tests evaluated were able to measure different aspects of the recovery of upper limb function, of the 30 patients followed. It was observed that the tests continued to record changes beyond 6 months post-onset of stroke. Therefore it is considered that, by using the tests appropriate to the individual patient, recovery can be monitored beyond 6 months post-onset.

The final test battery will comprise the following tests: Rivermead ADL, motor assessment, grip, peg test and bimanual coordination task. Together these tests are considered to provide a comprehensive and sensitive measurement of recovery following stroke.[4] So, designing a tool to assess volitional control grading for stroke patients can be helpful for Neuro therapists working with neurologically ill patients to set appropriate goals regarding volitional motor development and can guide their family to plan for future realistically.

METHODS

A scoping review of recent literature was performed on volitional control in stroke survivors. It was done to map the literature on volitional control in stroke population and also to find the types of available evidence and to find the gap on available literature on this topic. Steps involved in scoping review¹¹ are: (1) Identified the research question,



**Sneha Dineshbhai Dhanani and Amalkumar Bhattacharya**

(2) Found the relevant studies, (3) Selected the studies relevant to research question, (4) Charted the data, (5) Collected, summarized and reported the data.

Step 1: Identifying the research question

The research question explored was: what is volitional control grading?

Step 2: Finding the relevant studies

It was done by comprehensive computerized search on WOS, Science direct, National Library of Medicine (Pubmed), DOAJ, Google Scholar, CINAHL, Pubmed central and Oxford Press. The key words “volitional control” AND/OR “volitional movement and stroke” was used in combination with following terminologies: volitional control in stroke patients OR sub acute stroke OR chronic stroke, volitional control in stroke affecting older age group. Additionally, reference lists of most pertinent articles were searched to increase the search accuracy, as much as possible. The search was limited to English language articles available online. All abstracts from the search category were reviewed for eligibility. Articles published from 2006 to 2021 were included in the review. Participants were sub acute stroke patients and volitional control was the main concept of the studies included. Studies that were not retrievable were excluded.

Step 3: Selecting the studies.

As shown in figure 1, the search included a total of 63 articles. Out of these, 35 articles found from data base searching and through the reference searching. Other 28 articles found from other data base. No studies were removed of duplication. After the abstract of articles were reviewed, 45 studies have been excluded due to not matching the inclusion criteria. Remaining full text reviewed 16 articles leads to exclusion of 2 articles as they were not actually discussing the volitional control. 14 articles were finally included in the scoping review.

Step 4: Charting the data

The literature on the volitional control in sub acute stroke patients included volitional control development in different stages of stroke e.g., acute, sub acute, chronic phase and grading of volitional movement using various scales.

Step 5: Collating, summarizing and reporting the results.

Figure 1: Flow diagram of scoping review

RESULTS**Prevalence of stroke in India**

Age wise segregation of cases in stroke is important due to several reasons. Age has been shown to have a strong association with the incidence of stroke. While the peak age of stroke occurrence is 55–65 years[12], events occurring at a younger age assume importance in being occurring in a productive age group and having a different set of causes which have to be looked into apart from the conventional ones. They are also different from childhood strokes which have been classified as those occurring in less than fifteen years of age. The cumulative incidence of stroke ranged from 105 to 152/100,000 persons per year, and the crude prevalence of stroke ranged from 44.29 to 559/100,000 persons in different parts of the country during the past decade. These values were higher than those of high-income countries[13]. Across most studies, stroke incidence rates were higher for men. The exception was 100/100,000 for men and 149/100,000 for women in Kolkata; 115/ 100,000 and 119/100,000 in Trivandrum, 28 and 170/ 100,000 and 173/100,000, respectively, in the rural villages of Ludhiana. One-month case fatality rates ranged from 18% to 42% and were highest in the studies based in Kolkata (41–42%), where premature stroke deaths were twice as high amongst men than women[14].





Volitional movement and stroke

Ailie J Turton et al, have conducted study on a test battery to measure the recovery of voluntary movement control following stroke. Tests of upper limb function and activities of daily living (ADL) index were selected to measure recovery following stroke. Thirty stroke patients were assessed at intervals for up to 6 months to 1 year post-stroke using the battery. The results showed that the ADL index is insensitive to upper limb recovery. All the tests measured recovery in some of the patients after 24 weeks post-stroke. Since the presentation and recovery of patients was variable, it is argued that it is necessary to offer a selection of assessment tests to measure recovery and to aid treatment planning [4].

Chia-Lin Koh et al, have conducted study on Predicting Recovery of Voluntary Upper. Extremity Movement in Sub a cute Stroke Patients with Severe Upper Extremity Paresis. They have taken 140 (out of 590) stroke patients with severe UE paresis, completed all assessments. Voluntary UE movement was assessed using the UE subscale of the Stroke Rehabilitation Assessment of Movement (STREAM-UE). Two outcome measures, STREAM-UE scores at discharge (DCSTREAM-UE) and changes between admission and discharge (Δ STREAM-UE) were investigated to represent the final states and improvement of the recovery of voluntary UE movement. Stepwise regression analyses were used to investigate 19 clinical variables and to find the best predictive models of the two outcome measures. The participants showed wide variation in both DCSTREAM-UE and Δ STREAM-UE. 3.6% of the participants almost fully recovered at discharge (DCSTREAM-UE > 15). A large improvement (Δ STREAM-UE \geq 10) occurred in 16.4% of the participants, while 32.9% of the participants did not have any improvement.

The four predictors for the DCSTREAM-UE ($R^2 = 35.0\%$) were 'baseline STREAM-UE score', 'hemorrhagic stroke', 'baseline National Institutes of Health Stroke Scale (NIHSS) score', and 'cortical lesion excluding primary motor cortex'. The three predictors for the Δ STREAM-UE ($R^2 = 22.0\%$) were 'hemorrhagic stroke', 'baseline NIHSS score', and 'cortical lesion excluding primary motor cortex'. Concluded Recovery of voluntary UE movement varied widely in patients with severe UE paresis after stroke. The predictive power of clinical variables was poor. Both results indicate the complex nature of voluntary UE movement recovery in patients with severe UE paresis after stroke[3]. Michelle L. Woodbury et al, have conducted study on Dimensionality and Construct Validity of the Fugl-Meyer Assessment of the Upper Extremity. They have taken A total of 512 subjects, ages 69.8_11.1 years, who were 0 to 145 days post stroke. Dimensionality was examined with principal components analysis and Rasch item-fit statistics. The Rasch-derived item hierarchy was examined for consistency with the expected course of post stroke upper-extremity recovery suggested by the reflex-hierarchical conceptual model underlying the assessment. Fugl-Meyer chose items to exemplify the construct of motor recovery including reflex items and voluntary movement items. Moreover, because the assessment is intended to measure recovery, the items are arranged (from easy to hard) to map this process. Accordingly, we would expect FMA-UE items to reflect a reflexive-to-voluntary and synergy-to-isolated ordering [5].

DISCUSSION

The purpose of this study was to review the existing literature and to quickly capture the evidence found in current research regarding volitional control and stroke. However there are no supporting literatures available for Volitional movement grading for Stroke patients. Ailie J Turton, et al, they have done study on Voluntary Movement Control Following Stroke by using A Test Battery. Upper limb function and activities of daily living (ADL) index were selected to measure recovery following stroke. Thirty stroke patients were assessed at intervals for up to 6 months to 1 year post-stroke using the battery. The results showed that the ADL index is insensitive to upper limb recovery. All the tests measured recovery in some of the patients after 24 weeks post-stroke. Since the presentation and recovery of patients was variable, it is argued that it is necessary to offer a selection of assessment tests to measure recovery and to aid treatment planning. The final test battery will comprise the following tests: Rivermead ADL, motor assessment, grip, peg test and bimanual coordination task. Together these tests are considered to provide a comprehensive and sensitive measurement of recovery following stroke, but it does not give idea regarding



**Sneha Dineshbhai Dhanani and Amalkumar Bhattacharya**

volitional control post recovery [4]. Same way, the other study done by Chia-Lin Koh et al, on Predicting Recovery of Voluntary Upper Extremity Movement in Sub acute Stroke Patients with Severe Upper Extremity Paresis. Voluntary UE movement was assessed using the UE subscale of the Stroke Rehabilitation Assessment of Movement (STREAM-UE). Two outcome measures, STREAM-UE scores at discharge (DCSTREAM-UE) and changes between admission and discharge (Δ STREAM-UE), were investigated to represent the final states and improvement of the recovery of voluntary UE movement. Stepwise regression analyses were used to investigate 19 clinical variables and to find the best predictive models of the two outcome measures. Also they have concluded Recovery of voluntary UE movement varied widely in patients with severe UE paresis after stroke. The predictive power of clinical variables was poor. Both results indicate the complex nature of voluntary UE movement recovery in patients with severe UE paresis after stroke[3].

Similarly, Michelle L. Woodbury, have studied Dimensionality and Construct Validity of the Fugl-Meyer Assessment of the Upper Extremity and also found that Fugl-Meyer chose items to exemplify the construct of motor recovery including reflex items and voluntary movement items. Moreover, because the assessment is intended to measure recovery, the items are arranged (from easy to hard) to map this process. Accordingly, we would expect FMA-UE items to reflect reflexive-to-voluntary and synergy-to-isolated ordering. So, they states that Fugl-Meyer focuses reflexive and synergy aspect rather than volitional movements.

CONCLUSION

In stroke, muscle strength is not reliable. Other scale is assessing functions not movements. There is no any objective method to quantify quality of movement in stroke patients which is very important for tracking progression of motor/physical performance recovery. As it is proven that brain recognizes movement, brain does not recognize muscle, it is of vital importance to grade movement rather than manual muscle testing. In Neuro, Voluntary control plays a key role in assessing volitional movements compared to MMT. It is of vital importance to check Voluntary control to imply MMT in particular muscle. There are no guidelines available for usage of voluntary control. There are few scales which also measure movement analysis like STREAM, FMA. In STREAM- cumulative score is not available. In STREAM score, quantification of total basic mobility is not possible. So it is always topic of discussion that how to track recovery in voluntary control as the post stroke duration increases.

In FMA, after investigating the dimensionality and construct validity of the FMA-UE, researchers suggest that assessment of reflexes in the FMA-UE gives little information about volitional movement [5]. Commonly used outcome measures like FMA, STREAM do not quantify quality of isolated movements. Voluntary control is significantly associated with the functional independence and quality of life in stroke patients. One can predict the stroke recovery using this assessment scale [6]. so; there is a strong need to develop a Scale who measures Volitional movement.

REFERENCES

1. Jones SP, Baqai K, Clegg A, Georgiou R, Harris C, Holland EJ, Kalkonde Y, Lightbody CE, Maulik PK, Srivastava PM, Pandian JD. EXPRESS: Stroke in India: a systematic review of the incidence, prevalence and case fatality. *International Journal of Stroke*. 2021 Jun 11:17474930211027834.
2. Lee YC, Chen YM, Hsueh IP, Wang YH, Hsieh CL. The impact of stroke: insights from patients in Taiwan. *Occupational therapy international*. 2010 Sep;17(3):152-8.
3. Koh CL, Pan SL, Jeng JS, Chen BB, Wang YH, Hsueh IP, Hsieh CL. Predicting recovery of voluntary upper extremity movement in sub acute stroke patients with severe upper extremity paresis. *PLoS One*. 2015 May 14;10(5):e0126857.





Sneha Dineshbhai Dhanani and Amalkumar Bhattacharya

4. Turton AJ, Fraser CM. A test battery to measure the recovery of voluntary movement control following stroke. *International rehabilitation medicine*. 1986 Jan 1;8(2):74-8.
5. Woodbury ML, Velozo CA, Richards LG, Duncan PW, Studenski S, Lai SM. Dimensionality and construct validity of the Fugl-Meyer Assessment of the upper extremity. *Archives of physical medicine and rehabilitation*. 2007 Jun 1;88(6):715-23.
6. Shah ZR, Diwan SJ. Association of severity, voluntary control, cognition, balance and gait parameters to the functional independence and quality of life in stroke. *Int J Health Sci Res*. 2019; 9(8):163-169.
7. Feys H, De Weerd W, Nuyens G, Van De Winckel A, Selz B, Kiekens C. Predicting motor recovery of the upper limb after stroke rehabilitation: value of a clinical examination. *Physiotherapy Research International*. 2000 Mar;5(1):1-8.
8. Baker K, Cano SJ, Playford ED. Outcome measurement in stroke: a scale selection strategy. *Stroke*. 2011 Jun;42(6):1787-94.
9. Bonita R, Beaglehole R. Recovery of motor function after stroke. *Stroke*. 1988 Dec;19(12):1497-500.
10. Cauraugh J, Light K, Kim S, Thigpen M, Behrman A. Chronic motor dysfunction after stroke: recovering wrist and finger extension by electromyography-triggered neuromuscular stimulation. *Stroke*. 2000 Jun;31(6):1360-4.
11. Hilary Arksey & Lisa O'Malley (2005) Scoping studies: towards a methodological framework, *International Journal of Social Research Methodology*, 8:1, 19-32, DOI: 10.1080/1364557032000119616
12. P.M. Dalal, "Burden of stroke - Indian perspective," *Journal of Association of Physicians of India*, vol. 52, pp. 695–696, 2004.
13. Kamalakannan S, Gudlavalleti AS, Gudlavalleti VS, Goenka S, Kuper H. Incidence & prevalence of stroke in India: A systematic review. *The Indian journal of medical research*. 2017 Aug;146(2):175.
14. Jones SP, Baqai K, Clegg A, Georgiou R, Harris C, Holland EJ, Kalkonde Y, Lightbody CE, Maulik PK, Srivastava PM, Pandian JD. Stroke in India: A systematic review of the incidence, prevalence, and case fatality. *International Journal of Stroke*. 2021 Jul 2:17474930211027834.

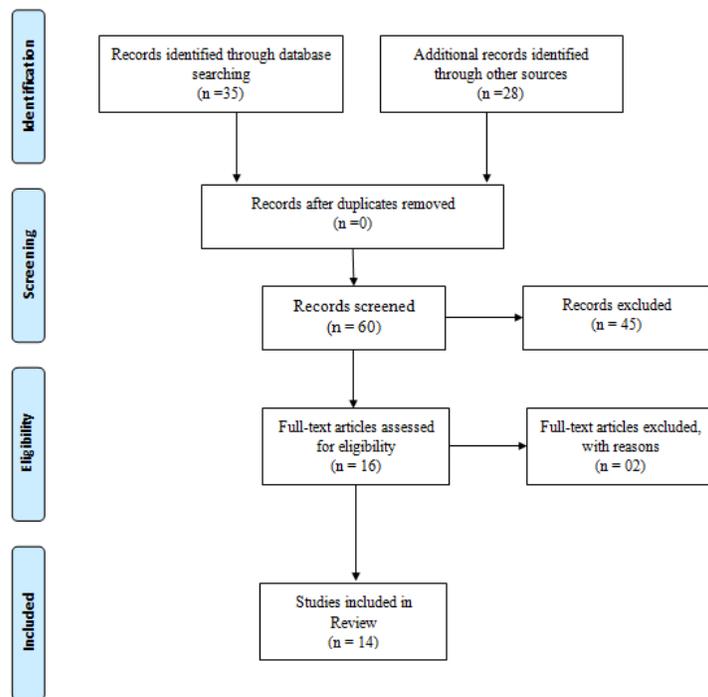


Figure 1: Flow diagram of scoping review





A Study on the Overall Performance of Human Resource Development Practices with Reference to Canara Bank, Bangalore City

Asha. A^{1*} and Syed Mohammad Ghouse²

¹Research Scholar, Presidency University, Bengaluru, Karnataka, India.

²Associate Professor, SOM, Presidency University Bengaluru, Karnataka, India.

Received: 08 June 2022

Revised: 23 June 2022

Accepted: 20 July 2022

*Address for Correspondence

Asha. A

Research Scholar, Presidency University,
Bengaluru, Karnataka, India.

Email: asha.a@presidencyuniversity.in.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Managing cash flow, executing commercial transactions, communicating via various media, and addressing customers would be impossible without the help of human resources, which are the organization's most significant assets. The study entitled the overall performance of human resource development practices with reference to Canara Bank, Bangalore City. The descriptive research design was used for this study. The study's subjects are people who work at Canara Bank in Bangalore. Questionnaires were distributed to all 148 employees. A stratified random sample strategy was used in this study. A random sample of Canara Bank employees in Bangalore City was used in this investigation. Researchers used a structured questionnaire to gather primary data on many facets of the study's concerns. Secondary data were collected from academic publications and research publications. Descriptive statistics have been used to analyze the data in this study.

Keywords: Employee Participation Human Resource Planning, Performance Appraisal, Staffing Practices, Team Work.

INTRODUCTION

Organizations rely on their human resources to carry out daily tasks like monitoring cash flow, conducting business, connecting with clients via various media, and dealing with them. For a company to be successful, it must have access to its people and the potential they hold. Today's businesses are continually evolving due to globalization and technological advancements. As a result, the company and its employees are affected by organizational changes. Human potentials, individual talents, time, and abilities must be controlled and developed to maximize organizational effectiveness. A company's or organization's success or failure is related to the amount of work done by its staff, which is why human resources are so necessary. HRD is utilized to understand better what it takes to improve employee relations or workplace relationships, which is human resources.



**Asha and Syed Mohammad Ghouse**

REVIEW OF LITERATURE

The HRQ instrument created by Bhasi M. (2005) is based on a thorough literature review and the opinions of experts in the field. The instrument's statistical validity has been proven. Human Resource Quality can be measured using this instrument in chosen organizations where quality management methods have been adopted. It was revealed that all of the indicators of Human Resource Quality had changed significantly. CCI, QWLI, and Employee Satisfaction indexes have increased in the past year (ESI). All firms have seen a considerable boost in the Human Resource Quality index. According to the findings of the research, implementing TQM has a substantial impact on improving the quality of human resources. Human Resource Quality (HRQ) can be measured with this instrument, which has been used to identify weak and strong points in HRQ. The equipment has undergone modifications in preparation for the subsequent studies. This study has given the researcher a lot of room for self-improvement and the confidence to carry out similar projects for the benefit of the learning community.

Willem, the name of Johannes Kruger, is pronounced Kru (2007). By providing an integrated and systematic HR strategy, the research intends to help HR to become more professional by providing firms with a socio-technical environment in which they operate. For this reason, the study will focus on "what to do" rather than the question of "how-to" implement the HR practices as a system. Organizational HR practices must be based on or driven by business processes. There has been an increase in this demand due to changes in global trade. Consequence of the global economy being a process, organizations are practically becoming processes. In addition to Andreas Xyrichis (2008). Collaboration has long been seen as a critical enabler in the provision of high-quality healthcare services around the world. However, studies on health care teamwork have been criticized for failing to grasp this fundamental concept. In the published literature, there is a lack of a standard definition for healthcare settings and practitioners. Praise for teamwork without a shared understanding of these concepts compromises the study of this work method and its practical application. Using the proposed definition, nurses, doctors, and other health care professionals may all agree on what this idea means. In educational, research, and clinical contexts, a common understanding can enhance communication and improve the clarity and validity of the future study.

According to Singh (2009), HRD practices significantly impact the culture of some of India's most well-known business and public sector enterprises. Human resource development strategies in India's commercial and public sectors greatly influenced organizational culture. This association between HRD activities and business culture is well documented. Alain Villarreal, among others (2010). A primary objective of his study is to create a framework for analyzing the impact of human resource practices on a small-medium business's absorption capacity. Our research also examines the human costs that result from implementing these practices. After the decentralization policy was established in Thailand, Piyawadee Rohitarachoon (2012) examined the implementation of recruitment, selection, training and development, and managing performance in decentralized human resource management. Executing and engaging, performing and accomplishing, establishing relationships and resources, learning and adapting, and managing trade-offs are all essential characteristics of this research's human resource capacity-building process. Decentralized human resource methods in Thai local governance are

the first focus of the study. As a second objective, it investigates how human resource practices to aid in developing individual human resource potential. Finally, it discusses the potential policy implications of promising capacity-building human resource approaches.

NEED FOR THE STUDY

The overall success of an organization is directly related to the relationship between bosses and subordinates. Optimal productivity can only be achieved if the workplace favors a harmonious working relationship. A human resources development environment and interpersonal connections that are not up to the norms and recommendations for human resource development have also been found in a small number of specific industries.



**Asha and Syed Mohammad Ghouse**

Though, in the real world, there are several constraints imposed by the organizational structure on HRD. In today's globalized economy, Canara Bank has had to contend with fierce competition. Because of shifting demographics in the workforce and expectations among employees, Canara Bank's expansion and growth plans fell short. Managerial philosophies are founded on the assumptions of the organization's top management regarding its employees. As a result, HRD managers are under continual scrutiny and pressure to maintain the morale of their employees and assist them in performing at their best. Managers, staff, and technology executives are well-versed in human resource development practices in the industry.

OBJECTIVES OF THE STUDY

To analyze the overall performance of human resource development practices with reference to Canara Bank, Bangalore City.

SCOPE OF THE STUDY

All aspects of human resource planning, staffing, incentive methods, performance evaluations, training programs, teamwork, and employee participation in human resource development practices were examined in this study. Canara Bank's HRD procedures are being studied to determine what personnel think and how satisfied they are with them. The research aims to learn what bank workers believe about HRD subsystems and metrics.

LIMITATION OF THE STUDY

Canara Bank will be the focus of the investigation and inquiry. Some respondents may favor the questions because the primary data is collected from Canara Bank employees in Bangalore.

RESEARCH METHODOLOGY

The descriptive research design was used for this study. The study's subjects are people who work at Canara Bank in Bangalore. Questionnaires were distributed to all 148 employees. A stratified random sample strategy was used in this study. A random sample of Canara Bank employees in Bangalore City was used in this investigation. Researchers used a structured questionnaire to gather primary data on many facets of the study's concerns. Secondary data were collected from academic publications and research publications. Descriptive statistics have been used to analyze the data in this study.

DATA ANALYSIS AND INTERPRETATION

The average, standard deviation, and coefficient of variation have been calculated to ascertain the significance of the seven impact categories. Table 1 shows the details of the perceptions of the respondents of the various kinds of human resource development practices. It is shown in table 1 that the perception of the employees towards the Employee Participation factor occupies the first place (Mean 15.5068; Standard Deviation 2.44531; Co-efficient of Variation 5.980), followed by the Human Resource Planning factor. Staffing Practices, Team Work, Training Program, Performance Appraisal, and Incentives Practices factors occupy the third, fourth, fifth, sixth, and seventh place, respectively. Hence, it can be concluded that Employee Participation is a highly influencing factor in the human resource development practices of Canara Bank. The Canara Bank employees gave high preference to Employee Participation; the Canara Bank management should concentrate on motivating the employees to participate in all the activities and introduce a new methodology in employee participation to improve the performance of its employees in Canara Bank. Also, it indicates that the Incentives Practices factor has the lowest impact on human resource development practices, so Canara Bank should be given more importance to trying the Incentives Practices in their firm.





CONCLUSION

The Canara Bank's proficiency and viability are directly tied to its use of cutting-edge technology tools. To help the Canara Bank be more productive, consider using PCs, tablets, smartphones, and other mobile devices. Use software programming or sharing devices to prevent specific employees from staying up to date on the status of a project, even if they are not effectively tackling a particular sector of the Canara Bank experience. To protect the safety of your business and consumer data, collaborate with professionals in cutting-edge technology. Make the most of software packages designed specifically for the office. Spreadsheets can be used to improve coordination, or you can create a comprehensive framework for sharing data amongst Canara Bank colleagues and specialists.

REFERENCES

1. Alain Villarreal and Marco Cisamolo (2010). Human Resource Practices, Absorptive Capacity and Human Costs in SMEs. Thesis. Jonkoping University.
2. Andreas Xyrichis, et al (2008). Teamwork: a concept analysis. Journal of Advanced Nursing. Vol 61, Issue 2, pp. 232-241.
3. Bhasi M. (2005). Development of an instrument to assess Human Resource Quality (HRQ) and measure the impact of TQM efforts on HRQ using the instrument. Thesis. School of Management Studies, Cochin University of Science and Technology, Kochi.
4. Piyawadee Rohitarachoon (2012). Human Resource Capacity Building for Local Governance in Thailand: Current Challenges and Future Opportunities. Thesis. Institute for Development Policy and Management (IDPM). School of Environment and Development. The Faculty of Humanities.
5. Singh, Anil Kumar (2009). HRD practices & organization culture in India. Indian Journal of Industrial Relations. Volume: 45. Issue: 2.
6. Willem Johannes Kruger (2007). A Process Evaluation of an HR Model for Business Excellence. Thesis. The University of Johannesburg.

Table 1. Overall Performance of Human Resource Development Practices

| Factors | Mean | Standard Deviation | Co-efficient of Variation | Rank |
|-------------------------|---------|--------------------|---------------------------|------|
| Human Resource Planning | 14.6959 | 2.47617 | 6.131 | II |
| Staffing Practices | 12.0878 | 3.20910 | 10.298 | III |
| Incentives Practices | 10.5000 | 2.42857 | 5.898 | VII |
| Performance Appraisal | 10.6959 | 1.94712 | 3.791 | VI |
| Training Program | 10.9189 | 2.42300 | 5.871 | V |
| Team Work | 11.7027 | 1.80121 | 3.244 | IV |
| Employee Participation | 15.5068 | 2.44531 | 5.980 | I |





A Study of Contribution of Indian Women in Higher Education

Pankty Fruitwala and Tanvi Bhavsar*

Assistant Professor, School of Engineering, P.P. Savani University, Gujarat, India

Received: 31 May 2022

Revised: 25 June 2022

Accepted: 05 July 2022

*Address for Correspondence

Tanvi Bhavsar

Assistant Professor,
School of Engineering,
P.P. Savani University,
Gujarat, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The article aims to discuss analyse the women participation in higher education especially in science stream and their role for the sustainable development of our nation. To achieve this purpose, we analysed data from a national survey of the female and male students enrolled in higher education. This includes data for Post Graduate and Ph. D course in science subjects such as Mathematics, Physics, Chemistry and Biological sciences. The survey includes data from 2016-17 to 2019-20. The survey found a hopeful trend toward female empowerment, yet disparities remain significant. Our analysis suggested that in post-graduation female to male is higher in all the sciences but scenario are different for higher level course (PH.D). For Physics and Chemistry Male participation is higher compare to female students but for Life science subjects results are completely opposite. Finally, realistic suggestions for increasing female involvement in higher education are highlighted, which will aid in overcoming the pressures that influence their career choices in higher education.

Keywords: Women, higher education, science stream, career, contribution

INTRODUCTION

Women are the important human resource and also backbones of the world economy. Women have made significant contributions in almost every area of life, including social, educational, and financial [1]. They are even representing their countries in different Beauty pageants, sports, Science and even in politics. However, in developing nations, women's education and their contribution towards the society in higher education, particularly in science stream a matter of concern. Government of India have become increasingly more concerned about the admission and employment of women in science [1].



**Pankty Fruitwala and Tanvi Bhavsar****Government Programs to Increase Women's involvement in Science and Technology in India**

The Department of Science and Technology (DST) is attempting to increase women's participation in science and technology at all different levels through several programs [2]. The following are some of the government programs:

KIRAN

KIRAN stands for Knowledge Involvement in Research Advancement through Nurturing. The goal of this initiative was to achieve gender parity. This programme focuses on difficulties connected to break on scientific career due to relocation, family obligations, and other factors [3].

Women in Science and Technology (Women in S&T)

This programme is part of the KIRAN programme. The goal was to achieve gender parity in science and empower women [2,3].

WOS-A (Women Scientist Scheme-A)

The aim is to inspire women to pursue research in the basic or applied sciences in science and engineering [2,3].

WOS-B (Women Scientists Scheme-B)

This project aims to increase women's involvement in science and technology with the goal of offering solutions at the grassroots level for social benefit [2,3].

WOS-C (Women Scientists Scheme – C)

This programme intends to encourage women in science and technology to pursue self-employment and long-term careers [2,3]. As we have discussed earlier, women have made significant progress in raising their involvement in higher education, yet they remain underserved in these areas. Quantitative studies on women's higher education show that gender inequalities continue in terms of jobs, earnings, and career advances, and this is a problem that must be addressed.

Women in Science: Requirement

Science and society are strongly connected, and changes in the social system for women are required. Women working in science make up a small percentage of all working women in India. In India, women are less when it comes to science scholarships, grants, and professional positions.

In India, women's underrepresentation in science, particularly at higher levels of teaching and research field, has become a serious issue. As a result, there is a need to raise awareness of science careers for women and then sustain them in the science field.

Women in science: challenges and Issues

The reason why women do not opt for higher education in science in India, Scientific careers starts after graduation, and it is difficult for women to establish themselves in their early 30s. However, for most Indian women, this age phase corresponds with marriage and household work and responsibilities.

Taking a break or taking a temporary research post for 4-5 years at this time does not provide the benefit in the development of women herself and society.

In this way, a huge number of qualified women/ women researchers have to compromise and take undergraduate or school level jobs or totally drop out of science.

Data and Method

The present study mainly focused on women's higher education particularly in science stream.



**Pankty Fruitwala and Tanvi Bhavsar**

The study is designed to analyse the female participation in different science field such as Mathematics, Physics, Chemistry, zoology, Botany, microbiology and Bio-technology in higher education specially in Post-Graduation and in PhD.

This study was conducted using the Government of India's All India Survey on Higher Education (AISHE) to analyze the trend in women's participation in science subjects in higher education in India [4,5,6,7].

The survey covers four year's data from 2016-2017 to 2019-2020.

RESULTS AND DISCUSSION

Education is an essential step toward women's empowerment since it allows them to face daily obstacles and transform their life. Educating women is the most effective strategy to enhance a household's health, nutrition, education and financial status, which has contribution in the country's economy and development. In present paper we have done data analysis of women in higher education in science field starting from the year 2016-17 to 2019-20. Until the mid-nineteenth century, girls and women were exclusively educated for traditional household tasks including cooking, child care, and other family and household chores. The situation is now changing, with more women in society being empowered. Despite the apparent progress, the proportion of women in higher education compared to men remains significantly lower than their population share. According to current research, women's participation in higher education is declining, despite the fact that it takes significant work and support from all sectors of society. Individually, women must rise in society and exercise their legal, social and economic rights. This action will surely improve the current condition of women's roles and expectations. In Mathematics, we can see (Graph 1 and 2) that number of female students are higher than male students in Post-Graduation course but the situation is not same for PH.D degree. In PH. D participation of male students are higher than female students. Graph 3 and 4 shows year wise enrolment of students in Post Graduation and PH.D in Mathematics.

In Graph 3 we can observe that in post graduation enrolment of female students are continuously increasing but for male students results are fluctuating. Contradictory in graph 4 we can see that for male and female students enrolment are increasing in 4 years. For Physics, enrolment of male and female students in post-graduation are fluctuating but we can clearly see (in graph 5 and 6) the similar trend as mathematics that strength of female students are higher than male counterpart. In PH.D physics also we can observe same trend as mathematics as very few female students are not opting for PH.D. Enrolment of female student is less than male students. Graph 7 and 8 shows Year wise enrolment of students in Post-Graduation and PH.D. In Graph 8, it can be seen that number of male students are almost double that the female students, who are opting for PH.D. Graph 8 and 9 represents the Gender wise enrolment of students in post-graduation and PH.D in chemistry. Again, the trend for post graduation in Chemistry is same as Mathematics and Physics but if we look at graph 9 we can observed that PH. D enrolment of female students are comparatively high than Mathematics and Physics. Graph 10 and 11 represents year wise analysis of male and female students of Chemistry. From Graph 11, we can observed that number of female students are continuously in PH.D course in Chemistry. In Biological Science subject, we have analysed data for Zoology, Microbiology, Botany and Bio-Technology subjects (Graph 13 to 28). Our analysis suggested that result trend is same for all the subjects from Graph no. 13,14,17,18,21,22,25,26. Analysis from graph 13 to 28 suggested that for both Post-Graduation and PH.D, the enrolment for female students are much more higher than male students. In Post-Graduation, 70% female students and 30% male students are there in zoology (Graph 13,15), botany (Graph 17,19), and Bio-Technology (Graph 25,27), but in Microbiology the participation in female is slightly higher (75%) (Graph 21,23), than other three subjects of life science. One trend is also noted that year wise male student enrolment is decreasing as compared to female student enrolment in Post-Graduation of Zoology (graph 13,15) and Botany (graph 17,19) but for Microbiology (graph 21,23) and Bio-technology (graph 25,27) male participation increase by kipping the male female enrolment ratio is same in 4 years. In Microbiology almost 75% (25% male students) (graph 21,23) and in Bio-Technology 70% (30% male students) (graph 25,27) female students are taking the admission in



**Pankty Fruitwala and Tanvi Bhavsar**

masters. For PH.D the results are slightly different. It is observed here from graph 14,16,18,20,22,24,26,28 that the enrolment ratio for male (40%) and female students (60%) is almost same in all four subjects in 4 years. Interestingly in all 4 biological sciences, enrolment of female students are increasing as well as enrolment for male students are also increasing (From graph 14,16,18,20,22,24,26,28). Women who have received an education are on the verge of making the leap from tradition to modernity. The women themselves want to see their prestige and position in society improve. Women's conventional roles and status are changing and new roles and responsibilities based on achievement, independence, and equality are rapidly emerging.

CONCLUSION

The present study on gender parity in higher education in several science fields was undertaken using AISHE data from 2016–2017 to 2019–2020 [4,5,6,7]. Higher education in India, specifically in science and technology fields, has experienced great changes as the demand for the development of society and country. This is encouraged by a change in parent's thinking toward sending their daughters to opt higher level courses. Graph 29 and 30 consist the information of number of female students involved in Post-Graduation and PH.D in different science subjects. From Graph 29, it is observed that large number of female students are enrolled in Mathematics but majority students will not opt for higher education i.e PH.D. We can see in Graph 30, chemistry has highest number of students who are enrolled for PH.D and microbiology has least number of female students as compared to other science subjects. However number of female students enrolled are less in PH.D in the comparison of Post-graduation (Data table in Graph 29 and 30).The participation of women enrolled in science higher education in last few years needs more analysis on equality in educational opportunities. Women's less involvement in science and technology is a crucial problem that must be addressed. proper treatment is also needed at home and at work. And addressing the challenges also demands large-scale research for the participation of women in science.

Future Prospects

By 2023-24, India will have the world's greatest population, and women will play an important role in determining the nation's future. To make actual, long-term changes in the recruitment of women in science subjects, a number of strategies is required. Women's engagement in science should be promoted beginning in primary school and continuing through higher education. Women's career possibilities should be supported and understood by the society. Changing perspectives and overcoming stereotypes. Companies may provide additional internship opportunities for women and Science scholarships to deserving but economically weaker young women. To ensure that women succeed, government agencies, colleges, and society must collaborate.

REFERENCES

1. Final Report on Status of Women in Science among Select Institutions in India. Policy Implications by Society for Socio-Economic Studies and Services (SSESS), Kolkata
2. <https://dst.gov.in/scientific-programmes/scientific-engineering-research/women-scientists-programs>
3. <https://byjus.com/free-ias-prep/women-participation-scientific-research-development/>
4. Survey report by All India Survey on Higher Education (AISHE) in 2016-17. <https://www.educationforallindia.com/AIHES2016-17.pdf>
5. Survey report by All India Survey on Higher Education (AISHE) in 2017-18. <https://epsiindia.org/wp-content/uploads/2019/02/AISHE-2017-18.pdf>
6. Survey report by All India Survey on Higher Education (AISHE) in 2018-19. https://www.education.gov.in/sites/upload_files/mhrd/files/statistics-new/AISHE%20Final%20Report%202018-19.pdf





Pankty Fruitwala and Tanvi Bhavsar

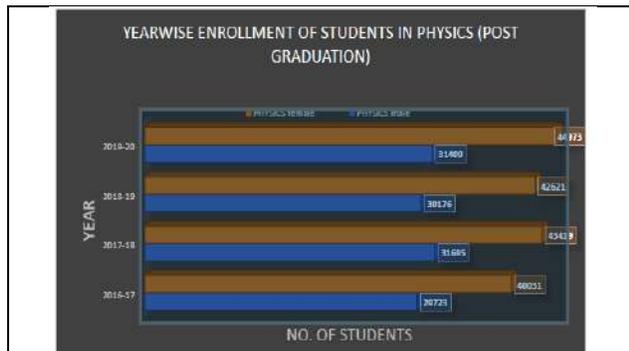
7. Survey report by All India Survey on Higher Education (AISHE) in 2019-20.
https://www.education.gov.in/sites/upload_files/mhrd/files/statistics-new/aishe_eng.pdf

| <p>GENDER WISE ENROLMENT OF STUDENTS IN POST-GRADUATION (MATHEMATICS) IN 4 YEARS</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Post graduate male</th> <th>Post graduate female</th> </tr> </thead> <tbody> <tr> <td>2016-17</td> <td>54438</td> <td>85304</td> </tr> <tr> <td>2017-18</td> <td>62098</td> <td>92341</td> </tr> <tr> <td>2018-19</td> <td>47924</td> <td>89712</td> </tr> <tr> <td>2019-20</td> <td>51823</td> <td>91503</td> </tr> </tbody> </table> | Year | Post graduate male | Post graduate female | 2016-17 | 54438 | 85304 | 2017-18 | 62098 | 92341 | 2018-19 | 47924 | 89712 | 2019-20 | 51823 | 91503 | <p>Gender wise enrolment of students in Ph.D (MATHEMATICS) in 4 years</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Ph.D male</th> <th>Ph.D female</th> </tr> </thead> <tbody> <tr> <td>2016-17</td> <td>1427</td> <td>1908</td> </tr> <tr> <td>2017-18</td> <td>1751</td> <td>2143</td> </tr> <tr> <td>2018-19</td> <td>2054</td> <td>2446</td> </tr> <tr> <td>2019-20</td> <td>2367</td> <td>2924</td> </tr> </tbody> </table> | Year | Ph.D male | Ph.D female | 2016-17 | 1427 | 1908 | 2017-18 | 1751 | 2143 | 2018-19 | 2054 | 2446 | 2019-20 | 2367 | 2924 |
|--|---|----------------------|----------------------|---------|-------|-------|---------|-------|-------|---------|-------|-------|---------|-------|-------|--|------|--------------|----------------|---------|------|------|---------|------|------|---------|------|------|---------|------|------|
| Year | Post graduate male | Post graduate female | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2016-17 | 54438 | 85304 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017-18 | 62098 | 92341 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2018-19 | 47924 | 89712 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2019-20 | 51823 | 91503 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year | Ph.D male | Ph.D female | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2016-17 | 1427 | 1908 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017-18 | 1751 | 2143 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2018-19 | 2054 | 2446 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2019-20 | 2367 | 2924 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Graph 1: Gender wise enrolment of students in Post-Graduation (MATHEMATICS) in 4 years</p> | <p>Graph 2 : Genderwise enrolment of students in Ph.D (MATHEMATICS) in 4 years</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>YEARWISE ENROLMENT OF STUDENTS IN MATHEMATICS (POST GRADUATION)</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Post graduate female</th> <th>Post graduate male</th> </tr> </thead> <tbody> <tr> <td>2019-20</td> <td>91503</td> <td>51823</td> </tr> <tr> <td>2018-19</td> <td>89712</td> <td>47924</td> </tr> <tr> <td>2017-18</td> <td>92341</td> <td>62098</td> </tr> <tr> <td>2016-17</td> <td>85304</td> <td>54438</td> </tr> </tbody> </table> | Year | Post graduate female | Post graduate male | 2019-20 | 91503 | 51823 | 2018-19 | 89712 | 47924 | 2017-18 | 92341 | 62098 | 2016-17 | 85304 | 54438 | <p>YEAR WISE ENROLLMENT OF STUDENTS IN MATHEMATICS (PH.D)</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Ph.D female</th> <th>Ph.D male</th> </tr> </thead> <tbody> <tr> <td>2019-20</td> <td>2924</td> <td>2367</td> </tr> <tr> <td>2018-19</td> <td>2446</td> <td>2054</td> </tr> <tr> <td>2017-18</td> <td>2143</td> <td>1751</td> </tr> <tr> <td>2016-17</td> <td>1908</td> <td>1427</td> </tr> </tbody> </table> | Year | Ph.D female | Ph.D male | 2019-20 | 2924 | 2367 | 2018-19 | 2446 | 2054 | 2017-18 | 2143 | 1751 | 2016-17 | 1908 | 1427 |
| Year | Post graduate female | Post graduate male | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2019-20 | 91503 | 51823 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2018-19 | 89712 | 47924 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017-18 | 92341 | 62098 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2016-17 | 85304 | 54438 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year | Ph.D female | Ph.D male | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2019-20 | 2924 | 2367 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2018-19 | 2446 | 2054 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017-18 | 2143 | 1751 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2016-17 | 1908 | 1427 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Graph 3 : Yearwise enrolment of students in Post Graduation(MATHEMATICS)</p> | <p>Graph 4 : Yearwise enrolment of students in Ph.D (MATHEMATICS)</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>GENDERWISE ENROLMENT OF STUDENTS IN POST-GRADUATION (PHYSICS) IN 4 YEARS</p> <table border="1"> <thead> <tr> <th>Year</th> <th>PHYSICS male</th> <th>PHYSICS female</th> </tr> </thead> <tbody> <tr> <td>2016-17</td> <td>29725</td> <td>40021</td> </tr> <tr> <td>2017-18</td> <td>31895</td> <td>43410</td> </tr> <tr> <td>2018-19</td> <td>30176</td> <td>42621</td> </tr> <tr> <td>2019-20</td> <td>31409</td> <td>44973</td> </tr> </tbody> </table> | Year | PHYSICS male | PHYSICS female | 2016-17 | 29725 | 40021 | 2017-18 | 31895 | 43410 | 2018-19 | 30176 | 42621 | 2019-20 | 31409 | 44973 | <p>GENDERWISE ENROLMENT OF STUDENTS IN Ph.D (PHYSICS) IN 4 YEARS</p> <table border="1"> <thead> <tr> <th>Year</th> <th>PHYSICS male</th> <th>PHYSICS female</th> </tr> </thead> <tbody> <tr> <td>2016-17</td> <td>1970</td> <td>3331</td> </tr> <tr> <td>2017-18</td> <td>2127</td> <td>3805</td> </tr> <tr> <td>2018-19</td> <td>2340</td> <td>3614</td> </tr> <tr> <td>2019-20</td> <td>2807</td> <td>4652</td> </tr> </tbody> </table> | Year | PHYSICS male | PHYSICS female | 2016-17 | 1970 | 3331 | 2017-18 | 2127 | 3805 | 2018-19 | 2340 | 3614 | 2019-20 | 2807 | 4652 |
| Year | PHYSICS male | PHYSICS female | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2016-17 | 29725 | 40021 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017-18 | 31895 | 43410 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2018-19 | 30176 | 42621 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2019-20 | 31409 | 44973 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year | PHYSICS male | PHYSICS female | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2016-17 | 1970 | 3331 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2017-18 | 2127 | 3805 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2018-19 | 2340 | 3614 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2019-20 | 2807 | 4652 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Graph 5: Gender wise enrolment of students in post-graduation (PHYSICS) in 4 years</p> | <p>Graph 6: Gender wise enrolment of students in Ph.D (PHYSICS) in 4 years</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

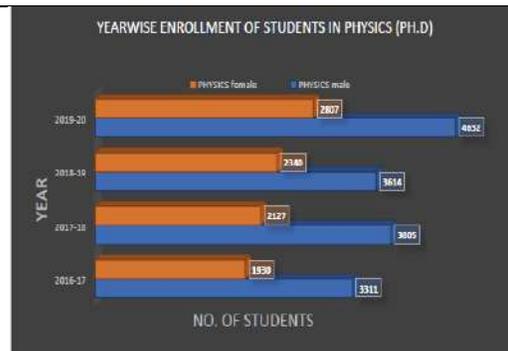




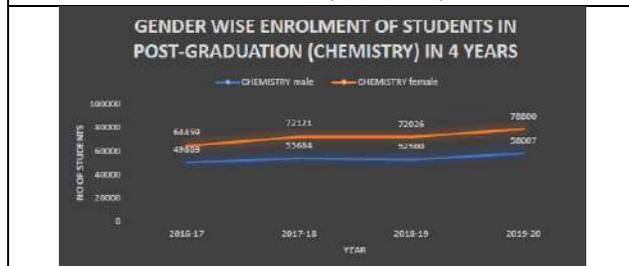
Pankty Fruitwala and Tanvi Bhavsar



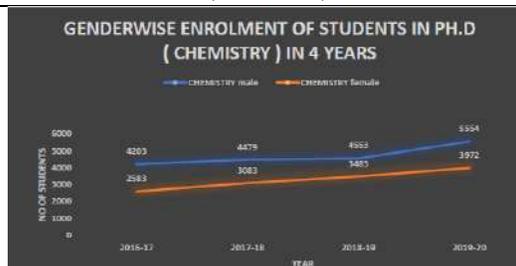
Graph 7: Year wise enrolment of students in Post-Graduation (PHYSICS)



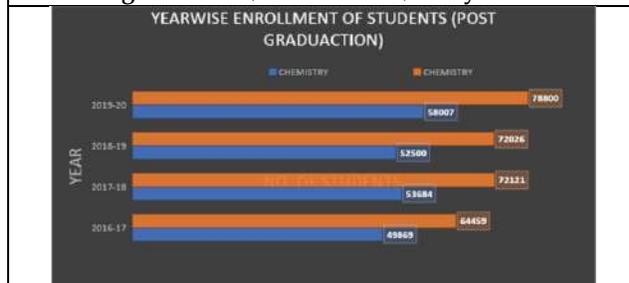
Graph 8: Yearwise enrolment of students in PH.D (PHYSICS)



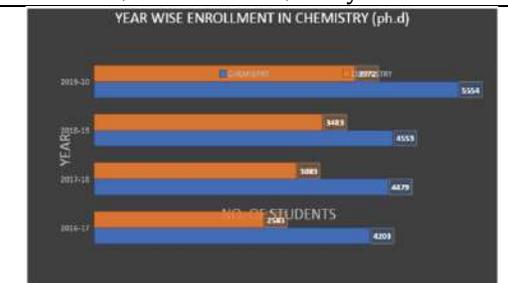
Graph 9: Gender wise enrolment of students in post-graduation (CHEMISTRY) in 4 years



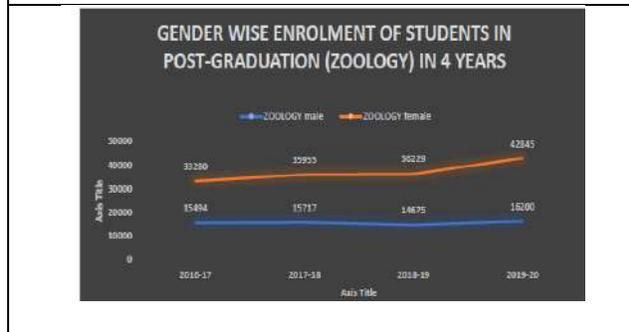
Graph 10: Gender wise enrolment of students in PH.D (CHEMISTRY) in 4 years



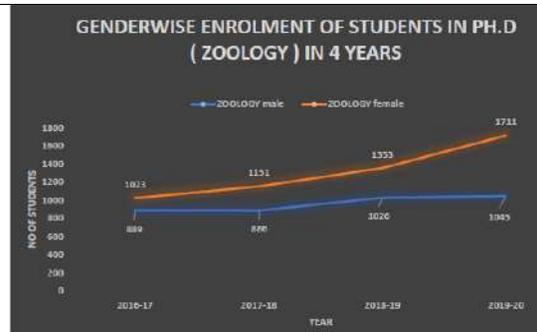
Graph 11: Year wise enrolment of students in Post-Graduation (CHEMISTRY)



Graph 12: Year wise enrolment of students in PH.D (CHEMISTRY)



Graph 13: Gender wise enrolment of students in post-graduation (ZOOLOGY) in 4 years

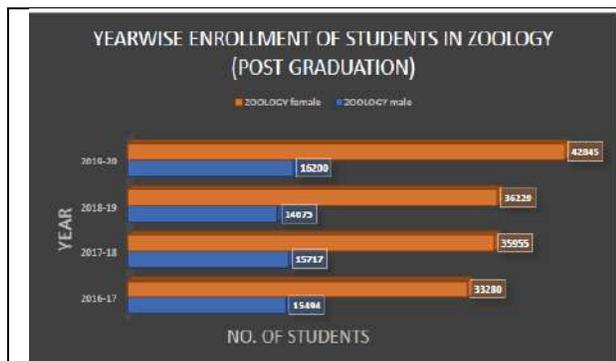


Graph 14: Gender wise enrolment of students in PH.D (ZOOLOGY) in 4 years

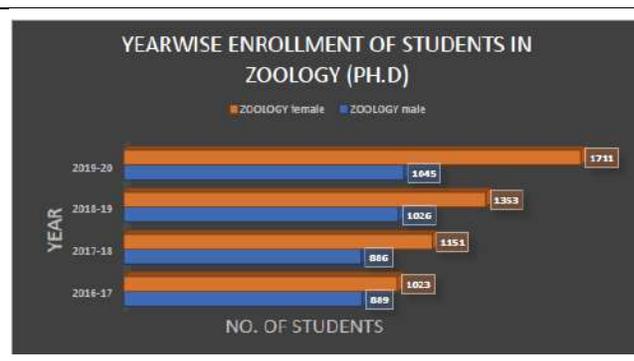




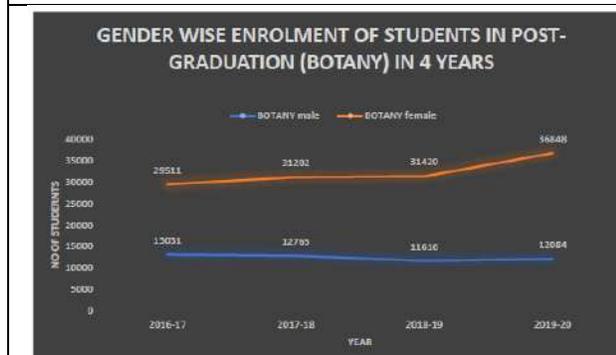
Pankty Fruitwala and Tanvi Bhavsar



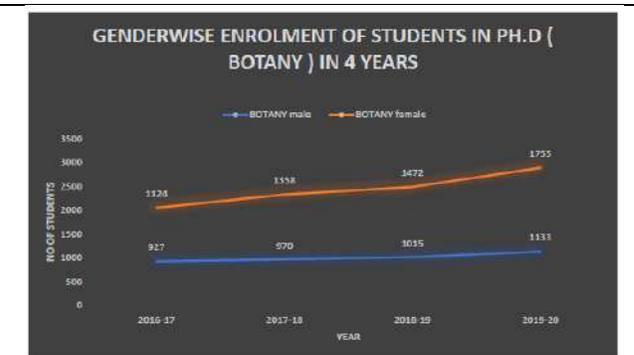
Graph 15: Year wise enrolment of students in Post Graduation (ZOOLOGY)



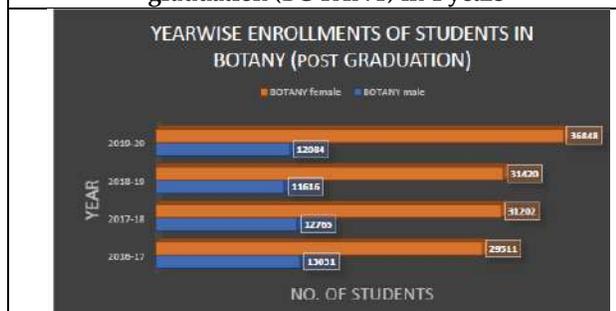
Graph 16: Year wise enrolment of students in PH.D (ZOOLOGY)



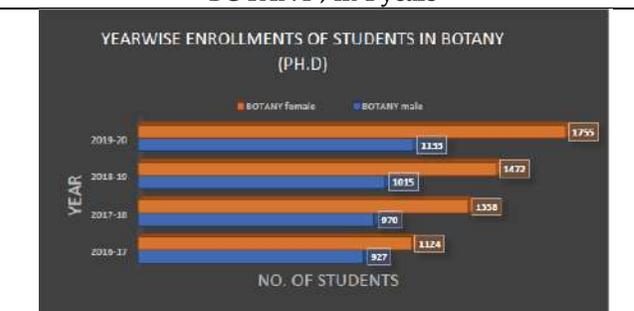
Graph 17: Gender wise enrolment of students in post-graduation (BOTANY) in 4 years



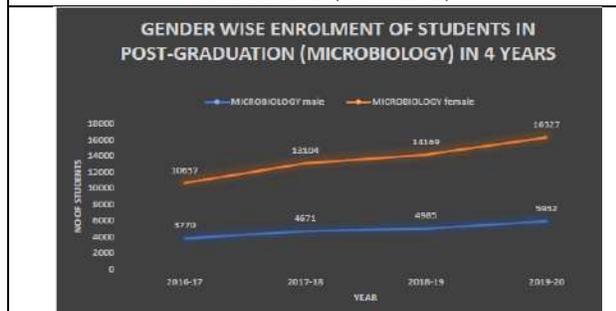
Graph 18: Gender wise enrolment of students in PH.D (BOTANY) in 4 years



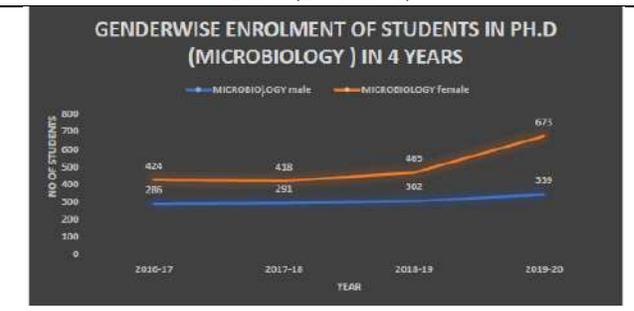
Graph 19: Year wise enrolment of students in Post Graduation (BOTANY)



Graph 20: Year wise enrolment of students in PH.D(BOTANY)



Graph 21: Gender wise enrolment of students in post-graduation (MICROBIOLOGY) in 4 years

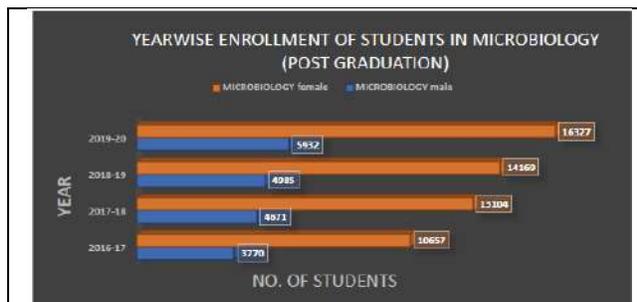


Graph 22: Genderwise enrolment of students in PH.D (MICROBIOLOGY) in 4 years

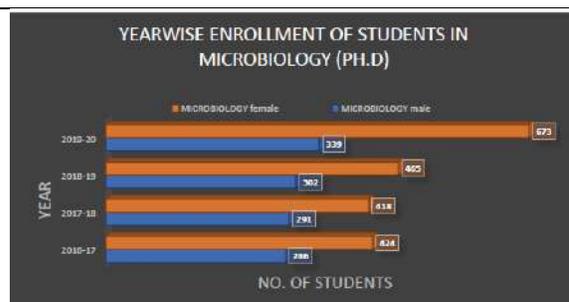




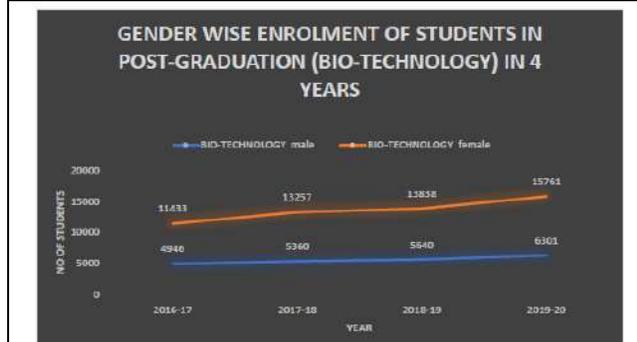
Pankty Fruitwala and Tanvi Bhavsar



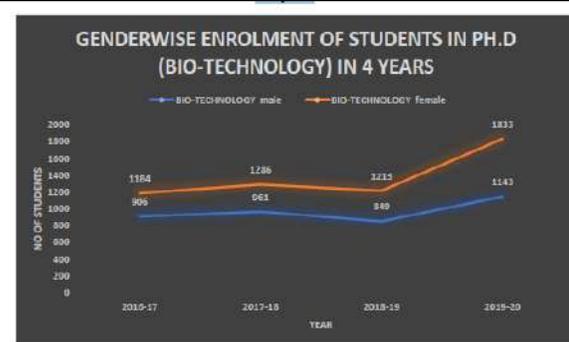
Graph 23: Year wise enrolment of students in Post-Graduation(MICROBIOLOGY)



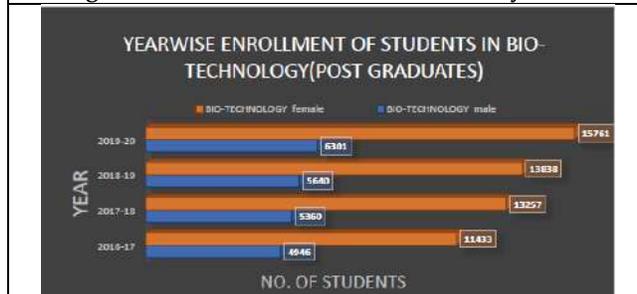
Graph 24: Yearwise enrolment of students in PH.D(MICROBIOLOGY)



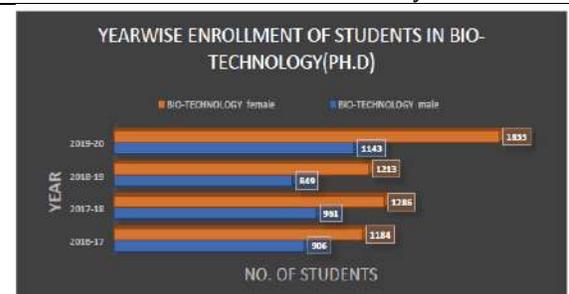
Graph 25: Gender wise enrolment of students in post-graduation (BIO-TECHNOLOGY) in 4 years



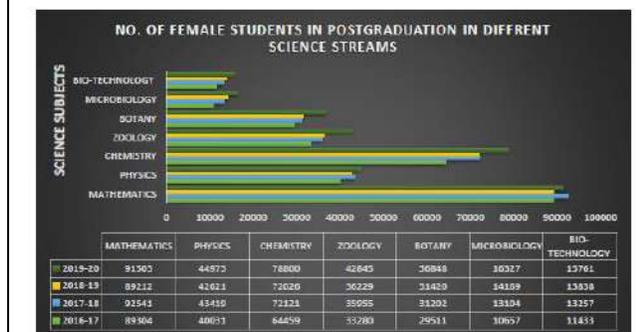
Graph 26: Genderwise enrolment of students in PH.D (BIO-TECHNOLOGY) in 4 years



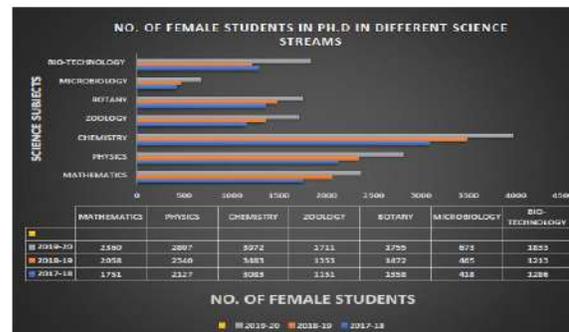
Graph 27: Yearwise enrolment of students in Post Graduation (BIO-TECHNOLOGY)



Graph 28: Yearwise enrolment of students in Ph.D(BIO-TECHNOLOGY)



Graph 29: Number of female students enrolled in postgraduation course in different science streams



Graph 30: Number of female students enrolled in Ph.D course in different science streams





Analyzing the Customer's Experience to Business Development with Artificial Intelligence

T H. M. Bilal* and Mohammed Imran E

Assistant Professor Department of Commerce (Computer Applications), Islamiah College (Autonomous), Vaniyambadi, Tamil Nadu, India.

Received: 10 June 2022

Revised: 28 June 2022

Accepted: 18 July 2022

*Address for Correspondence

T H. M. Bilal

Assistant Professor, Department of Commerce (Computer Applications),
Islamiah College (Autonomous),
Vaniyambadi, Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Artificial Intelligence (AI) is primarily concerned with the research of business management antecedents, the systematical incorporation of company facts, and the focus on business expansion. The primary goal of this research is to learn about the ethics of AI-related services in order to improve marketing and commercial development. This research reveals the views of marketers in order to determine the value of AI. We offer a research model that allows the study to be viewed as a whole. The 4Ps (Product, Price, Place, Promotion), the 4Cs (Consumer, Cost, Convenience, Communication), and the 4Es (Engagement,

Keywords: Artificial Intelligence, management, mobile communications

INTRODUCTION

We demonstrated that the data is reliable and legitimate, allowing it to be used for further investigation. We provided a hypothesis that demonstrated the association between each marketing service and artificial intelligence (AI) in the context of business development[1-2]. As a result, all services, with the exception of evangelism, have a favourable association with AI, according to the findings. Furthermore, the study found that AI has a significant impact on corporate growth. Furthermore, marketing has a big impact on the growth of a business. The study also has crucial implications for business development, such as the need for more research into various services, areas, and audiences.

Internet Marketing-Inspired Market Research for Communication Operators

My country's mobile communications business has grown in tandem with the economy. At the same time, there is a lot of competition among mobile phone companies. In terms of marketing strategy, all operators are looking for new ideas. To accomplish differentiated marketing and expand market share, they employ a variety of marketing strategies. Network marketing's properties of high engagement, various users, and a large audience have made it a



**Bilal and Mohammed Imran**

popular method of marketing and promotion for modern businesses. Communication operators can cut marketing and publicity expenditures, fulfil marketing goals more effectively, and increase markets by employing network marketing in a rational and reasonable way. The network marketing methods of communication operators for market development are discussed and analysed in this article using pertinent network marketing theories. This article's author hopes that these techniques will aid in the development of the communications operator market.

According to the India Network Information Centre's "India's Internet Development Status," as of March 2022, my country had 904 million Internet users, with a 64.5 percent Internet penetration rate[3]. This has laid a strong foundation for the growth of the digital economy in my country. While India's mobile communication network is constantly evolving and upgrading, mobile communication carriers face fierce competition: Consumers' habits of getting information have also changed as a result of the Internet's development. As a result, consumers' primary means of obtaining information is through the network media. The Network marketing's properties of intense engagement, many users, and a wide audience have made it a popular marketing and publicity approach used by modern businesses. Furthermore, in order to fulfil the marketing goals of lowering marketing costs, promoting corporate brands, developing target customers, and better emerging markets, mobile phone operators must employ online marketing in a scientific and fair manner [4-5]. A Review of Theories Relating to Internet Marketing Network marketing is extremely important in today's corporate marketing. Various businesses use networks to successfully connect businesses, users, and the general public.

Technology of communication and digital media They make use of the network's characteristics and benefits to communicate the company's information and value quest to users and the general public, resulting in management operations that are aligned with customer value and the company's marketing goals [6-10]. It is, in general, a marketing plan. Companies mostly rely on the mobile Internet platform to "tailor-made" products and services for segmented customers in specific market segments, using the platform's related marketing ideas and methodologies. Furthermore, businesses can combine online and offline resources for simultaneous marketing and promotion in order to meet marketing and strategic objectives'-mail marketing, for example. Online marketing, Weibo marketing Advertising marketing, video marketing, and media marketing are all terms that can be used to describe different types of marketing. Online marketing comes in a variety of shapes and sizes, with numerous marketing tactics to choose from. These are modern business's newest marketing techniques. Time and space are less of a constraint for internet marketing. It also offers high interactivity and personalisation capabilities, allowing it to employ many media for marketing and promotion at the same time. Internet marketing not only aids in the implementation of integrated marketing strategies, but it also aids in the diversification of information delivery channels. In any case, it can improve the timeliness of data transfer. There will be additional channels and sources available. It can also use the network to assess target customers' needs and preferences, allowing for precise marketing. Network marketing can improve the efficiency, cost-effectiveness, and practicality of a company's marketing efforts.

Analysis on the Current Situation of Communication Operator Market Development

On the one hand, my country's mobile communication network is constantly developing and upgrading as part of its ongoing economic development. SC commercialisation is supporting industrial innovation and upgrading in my country. My country has built over 135,000 5G base stations as of January 2022, and the 5G era is on its way. People's lives in modern India are becoming increasingly intertwined with the Internet. Mobile communication and mobile Internet have pervaded many sectors of life, slowly altering people's information habits and lifestyles. People are beginning to use simple mobile communications, such as text messages, phone calls, and other forms of social engagement, for example. Interacting with one another on Weibo and We Chat is common; online Shopping, internet food ordering, and other daily necessities are becoming more common. Mobile payment through scan code on a mobile phone is also becoming more popular. People's habits of watching and publishing information, interacting with others, watching and publishing videos, and other forms of amusement have all changed since the media age. This has paved the way for the growth of mobile communication activities. On the other hand, severe competition among numerous communication operators has aided the development of my country's communication business significantly. Traditional marketing and publicity approaches, such as offline promotion and personal sales, are no



**Bilal and Mohammed Imran**

longer sufficient to meet the objectives of today's social development communication operators in terms of expanding markets, developing and tapping new users, and maintaining existing customers. As a result, the impact of its promotion is considerably diminished. Operators must also constantly reinvent marketing strategies and produce differentiated marketing through the use of a variety of marketing approaches and methods, resulting in increased market share.

Because network marketing has a high level of interaction, it attracts a large number of users and a broad audience, making it a popular method of marketing and promotion for modern businesses. Furthermore, communication operators must be directed by consumer wants and employ network marketing in a scientific and fair manner in order to reduce marketing and publicity costs and better accomplish the goal of marketing promotion and market expansion.

Network Marketing Analysis of Communication Operators' Market Development Strategies

Integrated Network Marketing Strategy It is vital to properly comprehend and assess the company's numerous resources during the market development process in communication operations. Furthermore, businesses should continue to extend resource dissemination channels through online media and platforms in order to better integrate and utilise the company's diverse resources and fulfil its market expansion goals. It can be done in a variety of ways.[11-14] Include the target market in the mix. Major Customer consumption and browsing are tracked in depth using a management platform. Furthermore, businesses must use the system and platform to study the needs and preferences, buying habits, and behaviours of target potential customers in order to retain existing customers and accomplish target market and customer relationship integration.

Then, corporations are expected to utilise scientific and reasonable methods to push product and advertising information to targeted potential buyers using online platforms and diverse online media. At the same time, they can improve services and work to turn potential customers into loyal clients Integrated marketing and publicity strategies. Operators must employ online and offline marketing tactics to integrate multiple communication methods and ways of market expansion in a scientific and reasonable manner. The company's channels Also, by scientifically and precisely studying and grasping the target market and target clients, the marketing effect can be strengthened.3) Marketing strategies and tactics that are integrated. Operators must execute classic "4P marketing techniques" well as they expand their market. That is, using network marketing scientifically and rationally to achieve customer-centricity, meet customer cost and convenience needs, and increase communication with customers, on the basis of doing a good job in product, pricing, channel, and promotion-related work. Also, with the help of network marketing, interactive marketing, momentum marketing, and word-of-mouth marketing may be carried out.

In this way, we can effectively use the Internet to enhance the marketing and publicity effects of communication operators, as well as better achieve the marketing goals of communication operators to increase the market's. **Network Communication Strategy in Three Dimensions** The expense of online marketing is significantly minimal when compared to traditional offline marketing. Furthermore, online marketing may not only achieve a relatively accurate positioning of the target market, but it can also adjust to the modern audience's habit of getting information. To begin with, internet marketing can make use of We Chat, video, and other forms of media to promote topical marketing and borrowings in order to encourage client engagement and contact. Second, there is more information available with online marketing. It may express the brand culture and business philosophy to consumers' hearts at all levels, from the exterior to the inside, in an all-round and three-dimensional manner. Communication operators must employ network media and network communication methods in a scientific and sensible manner to continuously extend the channels in the process of market expansion.

CONCLUSION

In conclusion, network marketing has a tremendous impact on modern business marketing and promotion. To begin, communication operators must not only utilise network marketing techniques to promote products, information,





and preferential activities in order to attract target audiences, but they must also boost brand building and pay attention to network marketing's pertinence and adaptability. Furthermore, organisations should evolve from a single "price" marketing model to varied services, connotation, and brand creation as part of their marketing and promotion processes. Second, businesses should improve their customers' sense of experience and brand loyalty. Third, businesses should engage more closely with other network providers to gain complementary benefits. Finally, to maximise the impact of internet marketing, all businesses should focus on customer mining and analysis, customer relationship management, interactive marketing, word-of-mouth marketing, and so on.

REFERENCES

1. L. Mathanprasad and M. Gunasekaran, "Analysing the Trend of Stock Market and Evaluate the performance of Market Prediction using Machine Learning Approach," *2022 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI)*, 2022, pp. 1-9, doi: 10.1109/ACCAI53970.2022.9752616.
2. M. Gu, J. Kim, Y. Shim and J. P. Jeong, "SNS Influencer Marketing Platform for Market Advertisement of Small-Sized Business Runners," *2022 24th International Conference on Advanced Communication Technology (ICACT)*, 2022, pp. 513-517, doi: 10.23919/ICACT53585.2022.9728965.
3. B. A. Januário, A. E. d. O. Carosia, A. E. A. d. Silva and G. P. Coelho, "Sentiment Analysis Applied to News from the Brazilian Stock Market," in *IEEE Latin America Transactions*, vol. 20, no. 3, pp. 512-518, March 2022, doi: 10.1109/TLA.2022.9667151.
4. T. Sun, D. Huang and J. Yu, "Market Making Strategy Optimization via Deep Reinforcement Learning," in *IEEE Access*, vol. 10, pp. 9085-9093, 2022, doi: 10.1109/ACCESS.2022.3143653.
5. R. Qussous, N. Harder, M. Schäfer and A. Weidlich, "Increasing the realism of electricity market modeling through market interrelations," *2022 Open Source Modelling and Simulation of Energy Systems (OSMSES)*, 2022, pp. 1-6, doi: 10.1109/OSMSES54027.2022.9769124.
6. A. Gulati, N. Sahgal, N. Narayan, A. Atrey and J. S. Jadon, "Mining Influence of people on Viral Marketing," *2022 12th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*, 2022, pp. 228-233, doi: 10.1109/Confluence52989.2022.9734146.
7. Ruchika Tulshyan; Ijeoma Oluo, "10 Inclusion in the Global Market," in *Inclusion on Purpose: An Intersectional Approach to Creating a Culture of Belonging at Work*, MIT Press, 2022, pp.219-244.
8. I. Mohamed and F. E. B. Otero, "A Performance Study of Multiobjective Particle Swarm Optimization Algorithms for Market Timing," *2022 IEEE Symposium on Computational Intelligence for Financial Engineering and Economics (CIFER)*, 2022, pp. 1-10, doi: 10.1109/CIFER52523.2022.9776019.
9. Y. Qu, "Using Data Mining Techniques to Discover Customer Behavioural Patterns for Direct Marketing," *2022 7th International Conference on Big Data Analytics (ICBDA)*, 2022, pp. 361-365, doi: 10.1109/ICBDA55095.2022.9760309.
10. S. Chakra borty, S. Gangopadhyay and S. Das, "Feasibility of Data Markets in Smart Grids: an Online Survey," *2022 IEEE Power and Energy Conference at Illinois (PECI)*, 2022, pp. 1-8, doi: 10.1109/PECI54197.2022.9744011.
11. V. Goel, A. K. Goyal, A. Sharma and M. Singh, "Analyze Performance and Market Share of Various Crypto currencies," *2022 International Mobile and Embedded Technology Conference (MECON)*, 2022, pp. 494-499, doi: 10.1109/MECON53876.2022.9752449.
12. M. Hirano, H. Sakaji and K. Izumi, "Concept and Practice of Artificial Market Data Mining Platform," *2022 IEEE Symposium on Computational Intelligence for Financial Engineering and Economics (CIFER)*, 2022, pp. 1-10, doi: 10.1109/CIFER52523.2022.9776095.
13. S. A. Rehman Khan, M. Umar, M. Tanveer, Z. Yu and L. R. Janjua, "Business Data Analytic and Digital Marketing: Business Strategies in the Era of COVID-19," *2022 7th International Conference on Data Science and Machine Learning Applications (CDMA)*, 2022, pp. 13-18, doi: 10.1109/CDMA54072.2022.00008.
14. X. Wu and A. J. Conejo, "Distribution Market Including Prosumers: An Equilibrium Analysis," in *IEEE Transactions on Smart Grid*, doi: 10.1109/TSG.2022.3151338.





RESEARCH ARTICLE

Comparative Evaluation of Wheat Protein Extract from Natural and Commercial Wheat Flour

Prasanthi Cheekurumelli^{1*}, Sr. Prema Kumari², V. Anjali Devi³, SK. Valisha³ and R. Jaya Lakshmi⁴, P.Nandini⁴, S.Nooka Bhavana⁴, K.Roshini⁴, D.Sri Harshitha⁴ and K. Bhuvaneshwari⁴

¹Associate Professor, Department of Microbiology, St. Ann's Degree College for Women Opp. HPCL, Malkapuram, Visakhapatnam-530011, Andhra Pradesh, India.

²Principal of the College, Department of Botany, St. Ann's Degree College for Women Opp. HPCL, Malkapuram, Visakhapatnam-530011, Andhra Pradesh, India.

³Lecturer, Department of Chemistry, St. Ann's Degree College for Women Opp. HPCL, Malkapuram, Visakhapatnam-530011, Andhra Pradesh, India.

⁴B.Sc., Student, Department of Microbiology, St. Ann's Degree College for Women Opp. HPCL, Malkapuram, Visakhapatnam-530011, Andhra Pradesh, India.

Received: 23 Apr 2022

Revised: 17 Jun 2022

Accepted: 02 July 2022

*Address for Correspondence

Prasanthi Cheekurumelli

Associate Professor,
Department of Microbiology,
St. Ann's Degree College for Women Opp.
HPCL, Malkapuram, Visakhapatnam-530011,
Andhra Pradesh, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Wheat and wheat product play an important role for food industries, comprising among all other cereal products wheat occupy the first position due to its nutritional values. There was huge scientific challenge of today to develop a easily biodegradable wheat protein. The use of excess of proteins, lipids and polysaccharides in commercially available wheat flour have thus been disturbing the human health which would bring the acute health issues. The present study is aimed to check the biodegradability of wheat protein by using *E.coli* as these bacterial cells are beneficial and symbiotic in their nature of digestion. The wheat protein content varies from 114.4gm/500gm - 34.5gm/500gm. The highest wheat protein extract was observed in commercially available wheat flour when compared with naturally grinded wheat flour. The wheat protein Gluten was insoluble in water, alkaline and also acid due to its polymeric nature. The test for polymer presence showed negative results.

Keywords: Wheat protein, Gluten, biodegradability, *E.coli* and Polymer





Prasanthi Cheekurumelli et al.,

INTRODUCTION

Wheat flour proteins, when mixed with water, form visco-elastic mixtures used for bread and baked goods that play a major role in human diets. India expects a fifth record wheat crop in a row, 87.5 million metric tons, on higher planted area and optimal growing conditions in major growing areas in the year 2012[6]. Wheat and wheat product play an important role for bakery food, comprising more than half of the daily energy consumption worldwide, among all wheat flour occupy the first position due to its nutritional values. Protein is considered the most important nutrient for humans and animals, as manifested by the origin of its name, from the Greek proteios for primary, wheat is unique among cereals and other proteinaceous plant in the milled product, flour alone is capable of forming a dough due to its gluten content, the dough retains the gas evolved during fermentation [4].

Qualitative ratio of wheat proteins fraction provided an important information to determine the food value [3]. The gluten proteins consist of monomeric gliadins and polymeric glutenin's. Glutenin's and gliadins are recognized as the major wheat storage proteins, constituting about 75–85% of the total grain proteins with a ratio of about 1:1 in common or bread wheat [1]. The main types of glutenin proteins, the high-molecular-weight glutenin subunits (HMW-GS) of 66-88 kDa and the low-molecular-weight glutenin subunits (LMW-GS) of 32-45 kDa, are linked into polymers that range in size from about 150 kDa to over 1,500 kDa [2]. Most Celiac Disease (CeD) patients agree that such a diet would be much more sustainable, while the needed strictly gluten free diet (less than 20 ppm of gluten in all foods, i.e., less than 20 mg/kg) is a great challenge in everyday life [7]. *E. coli* is commonly found in the large intestine of humans and other warm-blooded animals. These strains can be commensal, existing in a symbiotic state providing resistance against pathogenic organisms, or be pathogenic and cause diseases of intestinal and extra-intestinal sites [5].

MATERIAL AND METHODS

Separation of wheat protein

500gms of wheat grains were taken, grinded (natural) and commercial wheat flour of 500gms were used to prepare wheat dough. Separation of wheat protein gluten from wheat dough by washing under a stream of running water till transparent appearance. Water soluble starch has been washed, where elastic mass like insoluble protein was separated and weighed it immediately.

Quantitative protein test

Preliminary quantitative test was done by using Ninhydrin solution to know the presence of protein for both wheat protein extracts.

Solubility test

Series of test tubes were taken and 0.5gms of wheat protein was added to each test tube. These test tube were treated with water, Concentrated HCl, Base (Na_2CO_3) and 99% ethyl alcohol to know its required time period of solubility.

Biodegradability test

0.5gms of freshly extracted wheat protein gluten of both the flours was added to 50ml of nutrient broth with *E. coli* culture separately and incubated at 37°C for 24hours. Test was repeated on plates with lawn of *E. coli*.

Polystyrene test

Both natural and artificial wheat protein have submitted for polystyrene test by using Acrylonitrile Butadiene-Styrene





RESULTS

Separation of wheat protein

The amount of wheat protein has been extracted from 500gms natural refined wheat flour was 38.4gms where as 111.4gms was extracted from commercially wheat flour as shown in Fig: 1&2

Quantitative protein test

Both the wheat protein extracts showed purple colour after treating with ninhydrin solution which was the one of the confirmative test for presence of protein in the extract as shown in Fig:3

Solubility test

The extract of naturally refined wheat flour was easily soluble in Conc. Hcl with in 2hours whereas the extract of commercially available wheat flour was not solubilised with Conc. Hcl. Both the extracts of wheat protein was insoluble in the water, Base Na₂CO₃ and 99% ethyl alcohol as shown in the Figure:4 Fig:3-Positive Ninhydrin test Fig:4- Solubility test

Biodegradability test

0.5gms of natural wheat protein extract was degraded by the *E.coli* bacteria with in 8days, where it takes about 23days for degradation commercial wheat protein by *E.coli* bacteria cells as shown in Fig:5a,5b Fig:5a Biodegradation of commercial wheat protein Fig:5b Natural wheat protein extract

Polystyrene test

Both the extracts doesn't showed any reddish colour which was the positive indication for the presence of polystyrene in the massive extract of wheat protein. By the observation it

DISCUSSION AND CONCLUSION

Wheat and wheat product play an important role for bakery food, comprising more than half of the daily energy consumption worldwide, among all wheat flour occupy the first position due to its nutritional values. The main types of glutenin proteins, the high-molecular-weight glutenin subunits (HMW-GS) of 66-88 kDa and the low-molecular-weight glutenin subunits (LMW-GS) of 32-45 kDa, are linked into polymers that range in size from about 150 kDa to over 1,500 kDa [2]Present study reveals the due to its high content of gliadin, glutenin and total protein is high in commercial available wheat flour protein as compared to naturally refined wheat flour was investigated. Hence, it can be explored for baking products which effects the health of consumers. *E. coli* is commonly found in the large intestine of humans and other warm-blooded animals. These strains can be commensal, existing in a symbiotic state providing resistance against pathogenic organisms, or be pathogenic and cause diseases of intestinal and extra-intestinal sites [5]Wheat protein from natural wheat flour was easily digested in the intestine by the *E.coli* cell when compared with commercially extracted wheat flour protein. To increase the demand of market value excess amount of wheat protein was added to the wheat flour which was not easily digested by intestinal bacterial *E.coli* and also causing celiac disease. Furthermore investigation should be done to know the interaction between the gluten protein with the *E.coli* cells. It is better to use the gluten free cereal products and also naturally refined wheat flour to overcome acute health issues.

REFERENCES

1. Abdel-Aal, E-S. M. Salama, D.A. Hucl, P. Sosulski, F.W & Cao, W. 1996. Electrophoretic characterization of spring spelt wheat gliadins. Journal of Agriculture and Food Chemistry 44:2117–2123.





Prasanthi Cheekurumelli et al.,

2. Bean SR, Lookhart GL: Factors influencing the characterization of gluten proteins by size-exclusion chromatography and multiangle laser light scattering (SEC-MALLS). *Cereal Chem*2001, 78:618–608
3. Gafurova, D.A. Tursunkhodzhaev, P.M. Kasymova, T.D. &Yuldashev, P.K. 2002. Fractional and amino-acid composition of wheat grain cultivated in Uzbekistan. *Chemistry of Natural Compounds* 38: 462–465
4. Hosoney, R.C .1998. Principles of cereals Science and technology. 2nd Edn. American Association of Cereal Chemists.St. Paul, Minnesota.
5. Salyers AA, Whitt DD. *Bacterial pathogenesis: a molecular approach*. Washington DC: ASM Press; 2002
6. USDA Foreign Agricultural Service and Global Agricultural Information network – Annual GrainReport2012http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_New%20Delhi_India_2-23-2012.pdf
7. White, L.E.; Bannerman, E.; Gillett, P.M. Coeliac disease and the gluten-free diet: A review of the burdens; factors associated with adherence and impact on health-related quality of life, with specific focus on adolescence. *J. Hum. Nutr. Diet.* 2016, 29, 593–606.



Fig:1 Natural refined wheat flour protein



Fig:2 Commercially available wheat flour protein



Fig:3-Positive Ninhydrin test



Fig:4- Solubility test





Prasanthi Cheekurumelli et al.,

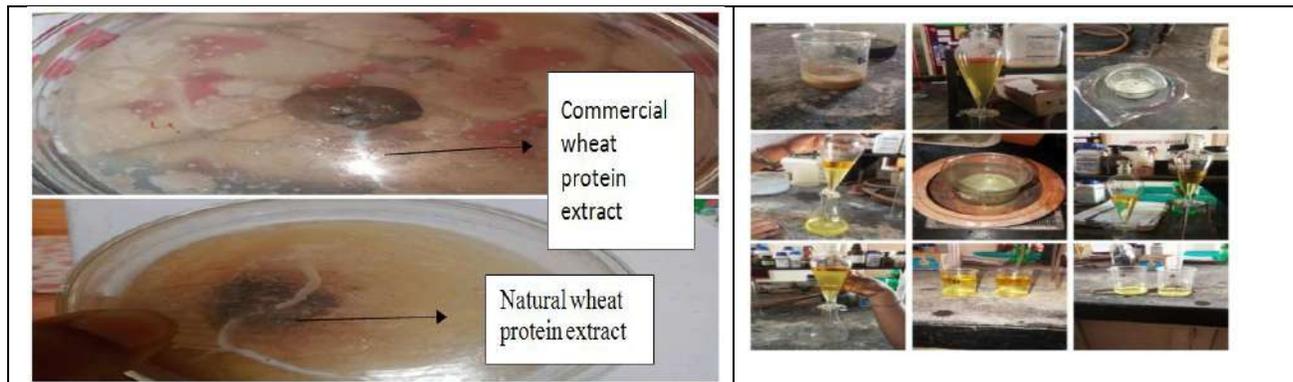


Fig:5a Biodegradation of commercial wheat protein **Fig:5b**
Natural wheat protein extract

Fig:6 -Acrylonitrile Butadiene-Styrene test





Impact of Online Education and It's Benefits during this Pandemic Era

S. Pallavi¹, Latha P², and Thangadurai. N^{3*}

¹Head of the Department, Department of Business Administration, Sri Amaraavathi College of Arts and Science, Velliyanai, Karur, Tamil Nadu, India

²Assistant Professor, College of Occupational Therapy, Faculty of Medical and Health Sciences, SRM Institute of Science and Technology, Tiruchirappalli, Tamil Nadu, India

³Professor and Associate Director - Research, Department of Information and Communication Technology, Sankalchand Patel University, Gujarat, India

Received: 23 May 2022

Revised: 08 June 2022

Accepted: 09 July 2022

*Address for Correspondence

Thangadurai. N

Professor and Associate

Director - Research,

Department of Information and Communication Technology,

Sankalchand Patel University,

Gujarat, India

Email: mrgoldjain2015@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Entire the world has been affected by COVID 19 Pandemic. So, the desperate attempt to face the situation. The government restricts the student to allow the students inside the campus. The emergence of this situation online education plays a vital role in schools and colleges. It is dynamic and flexible. Digital initiative in India implements online learning. Online education is a growing industry all over the world. It offers various programs at a low cost and restricts the commuting to learn and has some challenges like health issues and lack of technical knowledge. Before entering the real world, online learning has helped students become autonomous learners. Further, education became necessary to make sure a high level of fulfillment and performance for online courses in education system.

Keywords: Virtual learning, self-regulation, digital literacy, online, performance.

INTRODUCTION

The online courses will provide a safe, comfortable group dynamic and it is a socialization concept and it facilitates getting to know each other, creates the right environment, and develops the participating skills (British council). Recently the scholars analyzed education emotions and learning and engagement and achievement can be done in online teaching Anthony R. Artino (2012). Blended learning which combined both face-to-face learning and online learning and it develops an enquiry panel discussed Lisa R. Halverson Charles and R. Graham et al., (2014). In





Pallavi et al.,

the beginning, virtual learning class outcomes were decreased after that increasing level discussed by Cassandra M.D. Hart, Dan Berger(2019) Digital literacy is the social sign which is any form of activity and systematic functional linguistics and it is used for virtual learning as discussed by Ola Knutsson & MonaBlåsjö et al(2012). Student satisfaction is important to the quality of online programs and student performance and students character's related to three types that is internet self-efficacy, self-regulated learning and class levels predictors like course category and academic program detailed by Yu-ChunKuo Andrew E .Walker et al (2013). Social media enhance research interest pinrest and instagram also attract the learning interest and the general population regard in a single platform detailed in Stefania Manca(2020). According to Mckenna, B. M., Finamoreet.al.(2018), online student success includes organizational skills, goal setting as well as orientation and the students have the option to get extra seminars. In Indian education system need to enhance to improve retention patterns, remove disparities in education and fulfill shortages of teachers in remote areas. Effective utilization of ICT infrastructure will help this issue to enhance the education system as detailed by Ravindra Kumar Soni(2020).Flipped classes build a lifelong class for learners and they need strong evidence to evaluate the student's outcome(Jacqueline O'Flaherty, Craig Phillips et. al., (2015)).Educator's contribution is essential for the institution for wide learning analytics and implementation and they encourage learning analytics for their students (AntonetteShibaniSimonKnightet.al., (2020)). Online interpersonal relates positively relates to student's grades and the rapid growth of online courses, where it is essential to implement quality online course observation to evaluate student-instructor interaction (Shanna SmithJaggars (2016)).

The outbreak of corona virus in various countries transferred to online education and which affects directly the quality of online education is forced to construct user satisfaction. During this pandemic, online education shifted to face-to-face interaction to avoid social gatherings and crowds to block the transmission of the virus. Chen T.Peng L.Cong G. (2020)advised that the platform supply users with additional learning resources to guarantee that all disciplines are covered. Additionally, new course activities may be introduced to the platform to maintain learners' engagement. In worldwide universities are forced to shut down their campus without mentioning an indefinite period and they are moving into online platforms so universities are prepared for online education transition and doing online teaching-learning gradually and students appreciated online study material (Chakraborty P.(2020)). Ambika S (2021) states that study covers a wide range of themes linked to online classes, including the quality of learning settings and physical or mental strains that are current. The firsthand feedback we got from students and instructors from schools and institutions around the country will aid in identifying crucial areas for development.

Online education in India

Our honorable prime minister dreaming transforming our nation and creating opportunities for all the citizens to utilize technologies through the digital initiative. Computers, Big data &business analytics &MBA in business are the most familiar subjects learned online by Indians. Digital marketing courses are offered at the University of Cambridge. Like those international forensic sciences (IFS) education department provide online short-term certificate courses in cipher forensics, cipher law and various other courses. And some of the expected courses are also provided in India online, for example, The Dawson Academy of India offers online postgraduate dental training for general dentists, specialists &lab technicians.

Facts about online education in India

According to an expert school management system says that in India online, the education market was worth \$247 million in 2016and it is expected to grow to about \$1.96 billion by 2021various number of users enrolled in various online learning courses and is estimated 1.6 million in 2016and expected to grow 9.6 million by the end of 2021.In India, 48% population between the 15-40 age group desire but lower-income, and the targeted market is online education.

Benefits of Online education

Online education is the newest form of distance education often referred as eLearning. It is the pedagogical shift in the way teachers teach how students learn. In this mode of learning teacher's role is a guide.





Pallavi et al.,

As for the providers and faculty members, the top reasons they consider when offering a new online program include employment demand for specific skills and demand from students (Duffin, 2020).

Variety of programs and courses

Now a day's higher education offers a variety of courses online. Even if it is algebra, English algebra, or biology lab work can take online and we can study humanities, sociology and business administration

Multiple ways to communicate with our instructor

It is a flexible way to with our professor. We can connect with an instructor in live chat, telephone conversation, or email and have more opportunities to get feedback in question and answer sessions. Active instruction, assignments and discussion take place fully in online classes .It enhances continuous teaching. Online education enhances blended and hybrid learning to reinforce learning by asking questions and interacting with their instructor. The students can get pre-recorded content and lectures available 24/7 through massive open online courses. synchronous learning includes real-time teaching feed and connectivity with the instructor requires a fast internet connection. Asynchronous teaching online materials submitted by the internet via classroom portals, messages, emails, etc.

Low cost

For want to get a degree we have spent more amount of money and we have right hardware and software to log on and complete assignment and effective study material is given in online.

Better opportunities to concentrate and a learning environment

Online courses provide opportunities to study anywhere and help to learn the material to gain a greater understanding. Even if it's home, on the road, or at a friend's house we can study class materials and home assignments. Somebody feels pressure to face the other students that kind of pressure can be removed. Online courses offer recorded material and it gives extra time for references.

Helps lifelong skill and technical skills:

Online courses offer lifelong learning skills after a college degree. It helps with time management tools like and scheduling time and tasks in an online calendar, helps to improve computer skills in learning management systems (LMS) and programs. By participating, online courses give many professions like creating, sharing, documents, and incorporating with audiovisual materials into assignments and online training sessions, etc.

Avoid travelling:

In natural disasters, pupils are not able to travel from one place to another place at the time they miss some important classes. At the time online classes helps the students to attend by participating in chat sessions and watching lectures or being able to see the materials.

Challenges in online education

Isolate the students

Online courses are digital islands quarantined from all other landmasses. It restricts the physical movement of the students and it gives fatigue to be in front of the monitor for a longtime. All online learners are not fully engaged with online, they may be distracted, busy or unmotivated. In classroom learning instructors expect active participation and encouragement to concentrate on a subject that kind of motivation and encouragement is missing in online education.

Language and technical barrier

Students who are in first-generation aspirants suffered from language and technical barriers. By that their effective participation is restricted. Some of them are from rural back grounds they are affected by technical barriers. If they did not have such facilities the outcome of online learning is not possible. Poor network connection interrupts the continuity of the students learning.





Pallavi et al.,

Health issues

Learners suffered from health issues by continuously sitting in front of the system like vision problems and it affects physically by increasing the rate of obesity as well as stress.

CONCLUSION

Online education provides connectivity between students and educators. Technology development provided hybrid, blended, synchronized and asynchronous learning to our doorstep. In this, they face some drawbacks like poor network connections, the non-availability of smart phones and desktop/laptops in rural and backward areas. Even though it's a pedagogical shift in learning. The efficiency of online classrooms in distant education courses or other student or teacher training programs has been studied. As a result, users were worried about the dependability, platform access speed, and timeliness of video information transmission, and the cloud platform provided the best user experience. Finally, the findings show that instructors reply to queries quickly and offer timely feedback on assignments to promote approaches that help students in online courses enhance teacher engagement, interaction, understanding, and participation. Feedback can help students focus on their performance and improve their learning.

REFERENCES

1. Artino, A. R. (2012). Emotions in online learning environments: Introduction to the special issue. *The Internet and Higher Education*, 15(3), 137–140.
2. Chen, T., Peng, L., Jing, B., Wu, C., Yang, J., & Cong, G. (2020). The impact of the COVID19 pandemic on user experience with online education platforms in China. *Sustainability (Switzerland)*, 12(18). <https://doi.org/10.3390/SU12187329>
3. Halverson, L. R., Graham, C. R., Spring, K. J., Drysdale, J. S., & Henrie, C. R. (2014). A thematic analysis of the most highly cited scholarship in the first decade of blended learning research. *The Internet and Higher Education*, 20, 20–34. <https://doi.org/10.1016/j.iheduc.2013.09.004>
4. Hart, C. M. D., Berger, D., Jacob, B., Loeb, S., & Hill, M. (2019). Online Learning, Offline Outcomes: Online Course Taking and High School Student Performance. *AERA Open*, 5(1), 233285841983285. <https://doi.org/10.1177/233285841983285>
5. Khalili, H. (2020). Online interprofessional education during and post the COVID-19 pandemic.
6. Kumar, R., Supervisor, S. C.-S., & Sharma, J. (n.d.). A study of Problems and Prospects of e-Learning in India. Retrieved May 2, 2020, from <https://shodhganga.inflibnet.ac.in/bitstream/10603/112974/8/cover%20pages.pdf>
7. Kuo, Y.-C., Walker, A. E., Schroder, K. E. E., & Belland, B. R. (2014). Interaction, Internet self-efficacy, and self-regulated learning as predictors of student satisfaction in online education courses. *The Internet and Higher Education*, 20, 35–50. <https://doi.org/10.1016/j.iheduc.2013.10.001>
8. Manca, S. (2020). Snapping, pinning, liking or texting: Investigating social media in higher education beyond Facebook. *The Internet and Higher Education*, 44, 100707. doi: 10.1016/j.iheduc.2019.100707
9. Mckenna, B. M., Finamore, D., Hewitt, V., Watson, L., Millam, L. A., & Reinhardt, M. (2018). The Effect of a Multifactor Orientation on Student Performance: Organizational Skills, Goal setting, Orientation to Classroom, and Academic Support. *Online Learning*, 22(4). doi:10.24059/olj.v22i4.1207
10. O., Bläsjö, M., Hällsten, S., & Karlström, P. (2012). Identifying different registers of digital literacy in virtual learning environments. *The Internet and Higher Education*, 15(4), 237–246. <https://doi.org/10.1016/j.iheduc.2011.11.002>
11. O'Flaherty, J., Phillips, C., Karanicolas, S., Snelling, C., & Winning, T. (2015). Corrigendum to "The use of flipped classrooms in higher education: A scoping review" [*The Internet and Higher Education* 25 (2015) 85–95]. *The Internet and Higher Education*, 27, 90. <https://doi.org/10.1016/j.iheduc.2015.05.001>





Pallavi et al.,

12. Palvia, S., Aeron, P., Gupta, P., Mahapatra, D., Parida, R., Rosner, R., & Sindhi, S. (2018). Online Education: Worldwide Status, Challenges, Trends, and Implications. In *Journal of Global Information Technology Management* (Vol. 21, Issue 4). <https://doi.org/10.1080/1097198X.2018.1542262>
13. Shibani, A., Knight, S., & Buckingham Shum, S. (2020). Educator perspectives on learning analytics in classroom practice. *The Internet and Higher Education*, 46, 100730. <https://doi.org/10.1016/j.iheduc.2020.100730>
14. *The Internet and Higher Education* | Vol 27, Pages 1-90 (October 2015) | ScienceDirect.com. (n.d.). <https://www.sciencedirect.com/journal/the-internet-and-higher-education/vol/27/suppl/C>
15. <https://www.teachingenglish.org.uk/#sldr-0>
16. <https://educationdata.org/online-education-statistics>

Table. 1 Kinder Garden to 12th Standard Covid Impact

| | |
|--|-----|
| LACK ADEQUATE DIGITAL ACCESS | 30% |
| VERY SATISFIED WITH IN PERSON INSTRUCTION ONLY | 54% |
| VERY SATISFIED WITH ATLEAST LEAST SO ONLINE INSTRUCTION | 29% |
| PARENTS INDICATED THEIR STUDENTS RECEIVING INSTRUCTION IN PERSON ONLY | 20% |
| PARENTS INDICATED THEIR STUDENTD RECEIVING INSTRUCTION IN ONLINE ONLY | 46% |
| PARENTS FELT ONLINE EDUCATION CONCERNED ABOUT TOO MUCH SCREEN TIME | 63% |
| PARENTS FEELONLINE EDUCATION CONCERNED ABOUT MAINTAININGSOCIAL CONNECTIONS AND FRIENDSHIPS | 60% |
| PARENTS FEELONLINE EDUCATION CONCERNED ABOUT THEIR CHILDREN NOT GETTING ENOUGH EXERCISE | 52% |
| HIRED SOMEONE FOR ADDITIONAL INSTRUCTIONS | 9% |
| PARENTS FEELONLINE EDUCATION CONCERNED ABOUT HAVING ACCCESS TO EXTRACURRICULAR ACTIVITES | 58% |

Ref. <https://educationdata.org/online-education-statistics>

Table. 2 Factors students consider when choosing online Program

| | Graduates | Under Graduates |
|---|-----------|-----------------|
| Affordability | 60% | 46% |
| reputation of the school program | 39% | 39% |
| proximity to home | 20% | 21% |
| program offered the quicke | 29% | 31% |
| favourable admission requirements | 18% | 21% |
| quality of faculty | 34% | 20% |
| matching values and culture | 17% | 17% |
| positive interactions with school staff | 16% | 16% |
| familiarity with school | 13% | 16% |





Pallavi et al.,

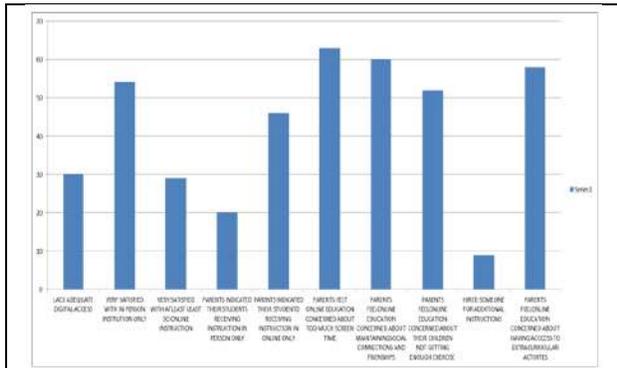


Fig. 1 Online education statistics

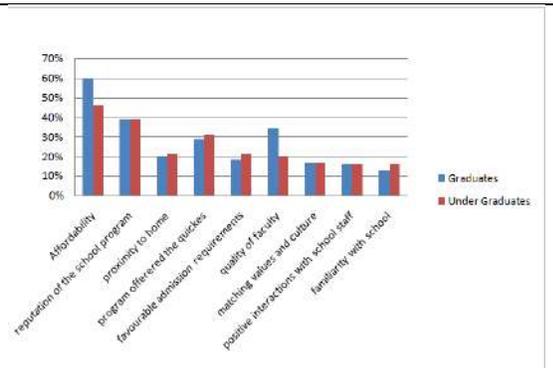


Fig. 2 Factors students consider when choosing online Program

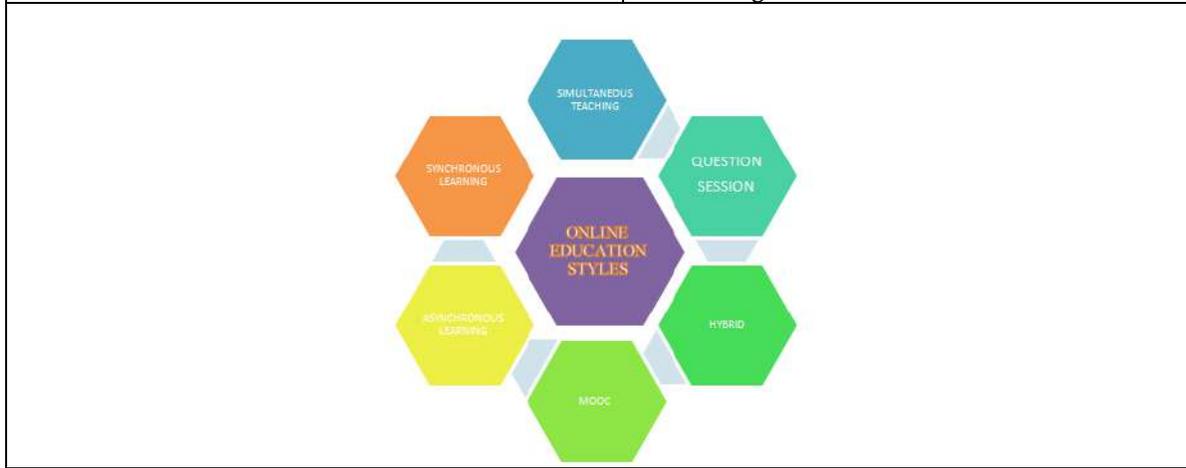


Fig. 3 Online Education Styles





Prevalence of Gingival Pigmentation among a Diverse Population of Ahmednagar District – A Clinical Study

Preeti Prakash Kale ^{1*}, Akshaya Shetti², Ameet Mani³, Varsha Jotteppa⁴, Shraddha Bhandari⁵, Asawari Lawande⁶, Raju Anarthe⁷ and Rachita Mustilwar¹

¹Lecturer, Department of Periodontology, Rural Dental College and Hospital, Loni: 413736, Ahmednagar, Maharashtra, India.

²Professor, Department of Anesthesiology and Critical Care, Dr. BVP Rural Medical College, PIMS (DU), Loni, Maharashtra, India

³Professor and HoD, Department of Periodontology, Rural Dental College and Hospital, Loni: 413736, Ahmednagar, Maharashtra, India.

⁴Lecturer, Department of Prosthodontics, Saraswati Dhanvantari Dental College and Hospital, Parbhani, Maharashtra, India.

⁵Lecturer, Department of Periodontology, CSMSS Dental College and Hospital, Aurangabad, Maharashtra, India.

⁶Lecturer, Department of Periodontology, Yashvant Chavhan Dental College and Hospital, Ahmednagar, Maharashtra, India.

⁷Professor, Department of Periodontology, Rural Dental College and Hospital, Loni: 413736, Ahmednagar, Maharashtra, India.

Received: 26 May 2022

Revised: 20 June 2022

Accepted: 18 July 2022

*Address for Correspondence

Preeti Prakash Kale

Lecturer, Department of Periodontology,
Rural Dental College and Hospital,
Loni: 413736, Ahmednagar,
Maharashtra, India.
Email:preetikale20jan@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Melanin pigmentation of the oral tissue is normal characteristics which occurs in gingiva of all ethnicities. Excessive pigmentation is an aesthetic concern that has increased awareness about depigmentation procedures. The purpose of the present study is to correlate skin colour and gender with intensity and distribution of gingival melanin pigmentation in a group of Ahmednagar district population for treatment strategies. 500 patients, who were in age group 18-35 years of both gender (Male: 225, Female: 275) reporting to Department of Periodontology, Rural Dental College, Loni, Dist. Ahmednagar, were selected by simple random sampling method. Gingival pigmentation pattern and biotype was assessed.





Preeti Prakash Kale *et al.*,

Statistical analysis: The values obtained will be noted, tabulated and subjected to statistical analysis by paired-t-test for intra group comparisons. Prevalence of Thick gingival biotype and Class II gingival pigmentation pattern in Ahmednagar district populations was observed, it is an indication for surgical depigmentation procedures and this makes us to have additional responsibility to educate the patients and overcome the aesthetic concerns related to gingival pigmentation This clinical study concluded need for aesthetic awareness, highlighted aesthetic concerns and need to create awareness about cosmetic gingival depigmentation and gingival biotype among Ahmednagar district population.

Keywords: Gingiva, Pigmentation, Biotype, Depigmentation

INTRODUCTION

'Smile' is important part of personality which helps in enhancement of 'Self-confidence.' The harmony of smile depends on health and appearance of Gingiva and other adjacent structure. The gingival shape, colour and position of teeth in conjunction with gingival tissue are important attributes that adds to attractive smile. Generally gingival colour is described as 'coral pink'. But the clinical appearance of gingiva may vary from individual to individual at different sites in oral cavity. These characteristics are genetically influenced or can be determined by external factors and biological factors such as growth, age, gender, smoking etc.

Physiology of melanin pigmentation primarily depends upon:

- Blood supply/ Vasculature of gingiva
- Thickness of epithelial tissue
- Degree of keratinization
- Pigments within the gingival epithelium, melanin, carotene, reduced haemoglobin and oxy-haemoglobin are prime pigments contributing to normal colour of gingiva, out of which melanin pigment has maximum incidence rate. [1]

Melanin is non hemoglobin derived pigment formed by the cells called melanocytes which are dendritic cells of neuroectodermal origin located in the basal and spinous cell layers of the gingival epithelium. Melanin is synthesised by a process called melanogenesis, which takes place in cytoplasmic organelles called melanosomes [2]. It is end product of complex multistep transformations of L-tyrosine, which are polymorphous and multifunctional biopolymers represented by eumelanin, pheomelanin, neuromelanin. [3] Excessive deposition of melanin which is located in the basal and supra-basal cell layers of the epithelium will result in gingival hyper pigmentation [4]. Gingival Pigmentation may be caused by *exogenous* factors like Heavy metal pigmentation, Various drugs like Amiodarone, Bleomycin, Chloroquine, Ketoconazole etc associated with oral pigmentation, Amalgam and Graphite tattoo and various *endogenous* factors like physiologic pigmentation or racial pigmentation, pathological pigmentation includes PeutzJeghers syndrome, Addisons disease, Kaposis sarcoma, post inflammatory pigmentation, Smoker's melanosis, pigmented nevi, angiosarcoma, vascular malformation, hemangioma, melanoma, etc.

This gingival hyper pigmentation is benign and can cause cosmetic concerns especially in patient who have high smile line or gummy smile as much of gingiva is visible during speaking and smiling which may lead to psychosocial problems especially in individuals whose appearance is of vital importance affecting the individual's self-confidence and hence social interaction of these patients is affected. There are several treatment modalities available to treat gingival depigmentation which are still un know to public. So, the primary of this study is to create awareness about gingival depigmentation procedure to common public by assessing the prevalence of gingival pigmentation and the role of gingival biotype in pigmentation, in a diverse population of Ahmednagar District.





Preeti Prakash Kale *et al.*,

MATERIALS AND METHODS

500 patients, who were in age group 18-35 years of both gender (Male: 225, Female: 275) reporting to Department of Periodontology, Rural Dental College, Loni, Dist. Ahmednagar, were selected by simple random sampling method. Informed consent was obtained from study participant and institutional ethical committee clearance was granted for study. (Registration No: PIMS/DR/RDC/2020/365 dated on 05/10/2020). Patients who gave history of smoking or any drug intake, those diagnosed with periodontitis, patient who underwent periodontal surgery in the past and pregnant females were excluded from the study.

Evaluation and Assessment

Gingival pigmentation pattern

Gingival pigmentation pattern was assessed as per classification given by Ponnaiyan et al. in 2013: [5]

Class - I: Melanin Pigmentation in the attached gingiva only.

Class - II: Melanin Pigmentation in the attached gingiva & interdental papilla.

Class - III: Diffuse pigmentation involving all parts of gingiva.

Class - IV: Melanin Pigmentation in marginal gingiva only.

Class - V: Melanin Pigmentation in interdental papilla only.

Class -VI: Melanin Pigmentation in marginal gingiva & interdental papilla.

These classes were then compared with gender and biotype of gingiva.

Biotype of Gingiva

This parameter was assessed using TRAN probe method as thin or thick gingiva. Biotype is considered thin if the probe is visible through margin and thick if the probe did not show [6], [7], [8].

RESULTS

The values obtained were noted, tabulated and subjected to Statistical analysis by Paired-t-test for intra group comparisons. The subjects were evaluated on the basis of classification describing the distribution of gingival pigmentation. As per classification six categories were defined. Thin biotype was prevalent among females when compared to males and thick biotype was more prevalent among male. The correlation between gender and gingival biotype was found to be statistically significant (p value < 0.001). (Table 1, Chart 1). On statistical analysis, correlation between gingival biotype and intensity of gingival pigmentation was significant ($P < 0.001$). When compared both thin and thick biotype displayed gingival pigmentation class II pigmentation pattern as more prevalent followed by class III and class I gingival pigmentation pattern whereas class V and class VI patterns were least seen. Among pigmentation patterns, class II was predominant and class VI was last seen among males compared to females. (Table 2, Chart 2)

DISCUSSION

Gingival pigmentation is benign and can be caused by various exogenous and endogenous factors which causes cosmetic concerns especially in patient who have high smile line or gummy smile. Mainly the pigmentation is caused due to melanin, which is brown in colour endogenous pigment produced by melanocytes. Pigmentation occurs in all races of human origin affecting both genders, male and females. The intensity and distribution of patterns are variable within races. [9] The above study was done in the diverse population of Ahmednagar district, which is largest district in Maharashtra, who reported to department of Periodontology, Rural dental college, Lonito assess the prevalence of gingival pigmentation pattern and also to create awareness among the people regarding the presence of pigmentation and introduce them with various treatment modalities available to correct it. This study evaluated the pigmentation patterns based on Ponnaiyan et al.





Preeti Prakash Kale *et al.*,

classification 2013, associated with gingival biotype and gender distribution. [5] Role of gingival biotype was also taken into consideration keeping in mind treatment aspects available, biotype was assessed in this study using TRAN technique which was considered in assessing the thickness of gingiva. The gingival patterns were divided in 6 patterns according to distribution of melanin pigmentation. Gingival biotype was found to be thinner among females and thicker among males more than half of the females (n= 141) had thicker gingival biotype. When correlation was tried to established among pigmentation distribution pattern, class II, Class III and class I was seen to be prominent when compared with other pattern which had equal distribution among the gender.

The distribution of gingival pigmentation amongst Ahmednagar populations was unique as it was observed that the majority of pigmentation was in the attached gingiva or interdental papilla i.e Class II. Similar results were observed with the study done on south Indian population (Ponnaiyan et al 2013) [5] These findings were in contrast to study conducted on Israeli Jewish population and South African population where they observed that attached gingiva and interdental papilla where the most pigmented sites which could be attributed to human race variations. [10],[11]Thin gingival biotype is not indicated for depigmentation procedure as it may lead to marginal tissue recession, may cause injury to periosteum and bone, and also delayed wound healing .As prevalence of Thick gingival biotype and Class II gingival pigmentation pattern in Ahmednagar district populations was observed, it is an indication for surgical depigmentation procedures and this makes us to have additional responsibility to educate the patients and overcome the aesthetic concerns related to gingival pigmentation [12].

CONCLUSION

Anatomic presentation of gingiva pigmentation and their etiological factors may help to design treatment strategies in gingival depigmentation procedure. Gingival pigmentation is benign and can be caused by various exogenous and endogenous factors. It can be concluded that prevalence of Class II gingival pigmentation gingival and thick gingival biotype is most commonly seen in males. This study data can be utilised to create awareness amongst Ahmednagar district population about depigmentation procedures and address the aesthetic concern associated with melanin pigmented gingiva.

REFERENCES

1. Antony VV, Khan R. Management of Gingival Hyperpigmentation-2 case reports. Journal of Dental and Medical Sciences. 2013; 6(4):20-22.
2. Dummett CO, Barends G. Oromucosal pigmentation: An updated literary review. Journal of periodontology. 1971; 42(11):726-36.
3. Slominski A, Tobin DJ, Shibahara S, Wortsman J. Melanin pigmentation in mammalian skin and its hormonal regulation. Physiological reviews. 2004; 84(4):1155-228.
4. Dummett CO. Physiologic pigmentation of the oral and cutaneous tissues in the Negro. J Dent Res 1946; 25:421-32.
5. Ponnaiyan D, Gomathy L, Anusha JA. The correlation of skin color and gingival pigmentation patterns in a group of South Indians in Tamil Nadu, India. SRM J Res Dent Sci 2013; 4:54-8.
6. Bhusari BM, Chelani LR, Suthar NJ, Anjanekar JP. Gingival Biotypes. JMDSR 2015;2:7-10
7. Cook DR, Mealey BL, Verrett RG, Mills MP, Noujeim ME, Lasho DJ, Cronin RJ.
8. Kan JY, Morimoto T, Rungcharassaeng K, Roe P, Smith DH. Gingival biotype assessment in esthetic zone: visual versus direct measurement. Int J Periodontics Restorative Dent 2010;30:237-43
9. Rouck DT, Eghbali R, Collys K, De Bruyn H, Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through gingival margin as a method to discriminate thin from thick gingival. J Clin Periodontol 2009; 36:428-33.





Preeti Prakash Kale et al.,

10. Rathee M, Rao PL, Bhoria M. Prevalence of Gingival Biotypes among Young Dentate North Indian Population: A Biometric Approach. Int J Clin Pediatr Dent 2016;9:104-8.
11. Van Wyk CW. Mouth pigmentation patterns in a group of healthy South African Bantu. S Afr Med J 1970;44:177-80.
12. Gorsky M, Buchner A, Fundoianu-Dayan D, Aviv I. Physiologic pigmentations of the gingiva in Israeli Jews of different ethnic origin. Oral Surg Oral Med Oral Pathol 1984; 58:506-9.

Table 1: Co-relation between gender and gingival biotype.

| BIOTYPE | GENDER | | TOTAL | P VALUE |
|---------|--------|--------|-------|---------|
| | MALE | FEMALE | | |
| THICK | 175 | 141 | 316 | |
| THIN | 50 | 134 | 184 | |
| TOTAL | 225 | 275 | 500 | |

Table 2: Co-relation between Gingival pigmentation pattern, Gingival biotype and Gender.

| PATTERN | BIOTYPE | | | | TOTAL | P < 0.001 |
|---------|---------|--------|------|--------|-------|-----------|
| | THICK | | THIN | | | |
| | MALE | FEMALE | MALE | FEMALE | | |
| I | 19 | 15 | 12 | 20 | 66 | |
| II | 110 | 91 | 24 | 84 | 309 | |
| III | 37 | 32 | 12 | 26 | 107 | |
| IV | 5 | 1 | 1 | 2 | 09 | |
| V | 2 | 1 | 1 | 1 | 05 | |
| VI | 2 | 1 | 0 | 1 | 4 | |
| TOTAL | 175 | 141 | 50 | 134 | 500 | |

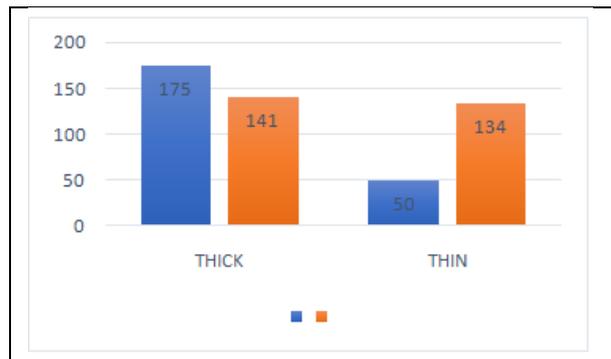


Chart 1: Co-relation between gender and gingival biotype.



Chart 2: Co-relation between Gingival pigmentation pattern, Gingival biotype and Gender.





Organic Poultry Farming in India - Issues and Approaches

N.Rajesh Kumar*

Principal, Nagarathinam Angalammal Arts and Science College, Madurai, Tamil Nadu, India

Received: 20 May 2022

Revised: 10 June 2022

Accepted: 19 July 2022

*Address for Correspondence

N.Rajesh Kumar

Principal,

Nagarathinam Angalammal Arts and Science College,

Madurai, Tamil Nadu, India.

Email: nrjesh75@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The poultry sector of modern India has shifted from organic agriculture to a commercially organized, scientific, and vibrant industry in recent decades. Today's consumers are increasingly familiar with their food's safety, quality, and taste, especially among rural landless workers, smallholders, and females. The research on organic poultry farming and issues and approaches were taken through primary and secondary data. The main objective is to know the process and methodology of organic poultry farming and its role and efficiency in society. The aim of choosing the sample of organic poultry farming this idea is more innovative and analyzing various information sources we tend to are victimization each primary and secondary data this concept of organic poultry farming is multi-benefit for both farmers to increase their income second healthy benefits human life. Organic poultry farming is more beneficial for farmers and provides more health to society. Agri farmers these firms are one of the growing segmenting agricultural sectors. This perfect trend in India an organic poultry business is growing mainly because of more benefits and government support as well consumers buying behavior and farmers' interests; in the present era, the consumer can think only about the health benefits don't think about the cost of products these organic poultry farming in India creates a trend to Organic products buyer some challenges also faced by the farmers main is proper infrastructure facilities and Markets support.

Keywords: Organic Poultry Farming, Nutrition, Savage Mortality, Soil Pollution, Water Pollution.

INTRODUCTION

THE STUDY

The poultry sector of modern India has shifted from organic agriculture to a commercially organized, scientific, and vibrant industry in recent decades. Today's consumers are increasingly familiar with their food's safety, quality, and taste, especially among rural landless workers, smallholders, and females. Organic Poultry has expanded the scope of this agriculture and chemicals. They are interested in consuming safe products without paying more as the



**Rajesh Kumar**

purchasing power of the public continues to grow. Expanding the role of producing safe poultry products without microbial residues is the order of the day. In the other hand, the increasing importance of animal welfare in Poultry has gradually adversely affected trade at the international level, as intensive cage breeding, forced molting, etc., are claimed to be unethical and unfriendly to animal welfare. Therefore, by focusing on organic Poultry, safer poultry products can be produced without production, but organic animal production has become more critical over the last decade. In general, organic affects the agricultural output of Indian Poultry and livestock. Initially, organic farming focused primarily on plant livestock legislation based on the same principles as organic farming. Resources can be used sustainably without the addition of synthetic substances such as fertilizers and herbicides. However, animal welfare is an entirely different topic, and it is stipulated that animals should be bred under conditions that give them a wide range of social behaviors. There are only a limited number of organic products related to farmers' environmental awareness and, in part, rising consumer demand.

The most vital feature of the organic manufacturing gadget is the relationship with the various assets in which Poultry is a part of the 's broader natural machine. Poultry and agriculture are believed to be complementary. The interweaving of fowl and plant cultivation is like the plant being fed the fertilizer left via the chook and the plant cultivation acting as a hen distribution, imparting bedding with straw. The organic poultry machine is loose-variety and can't be caged. Therefore, establishing a natural poultry farm calls for the right flowers that are nicely controlled inside the farm region. Organic farms ought to have ok protection against birds and other essential residences that promote the spread of birds. If feasible, you need access to natural waters, including streams, ponds, and lakes. Otherwise, opportunity precautions can be taken that meet the ecological criteria.

It must be indeed cited that the size of the organic poultry herd is an awful lot smaller than that of different conventional and unfastened-variety farms. The original idea of preserving a small variety of sis to permit cellular housing units to move birds across the backyard is a quintessential part of the rotation at the farm. Inorganic poultry farms, all species (physiological and environmental) stress on birds should be reduced to at the very least stages. For outside farms, you must select slow-developing birds and conventional types. If you've got rapid-growing lines, do no longer sacrifice this s by way of 81 days of age. Beak trimming isn't allowed in natural chicken farms, and birds should be free to express their honest conduct, have sufficient area centers, and get entry to different hen companions. This form of bird breeding is known as adequate animal welfare, wherein birds are handled with utmost care. The organic chicken farm believes in preventing the sickness instead of curing it.

This is carried out using bio security measures that include farm cleansing and disinfection between batches, with a spoil of at least months a year. Better feeding and watering facilities have additionally been introduced to prevent the spread of the ailment. The most effective sure antibiotics that meet natural requirements are utilized in emergencies on farms. Basic hygiene and dis-contamination techniques are practiced saving the spread of disease on farms by visitors and people. The wildfowl control plan should be neatly clear if you want to be provided to the Organic Certification Committee authorized for farm registration. This plan wishes to be up to date yearly.

STATEMENT OF THE PROBLEM

Over the most recent couple of years, the poultry industry has changed from simple terrace poultry to business ranches, yet the issues of food handling and quality are ignored. Consequently, natural Poultry cultivation has turned into a way to address these issues. These organic poultry farming endeavors to talk about the different topics of biological cultivation alongside critical mediations needed in poultry rearing, taking care of, lodging, and medical care the board under the Indian Scenario. Further, necessary arrangement mediations were additionally proposed to advance natural Poultry cultivation.

Because of the expanded well-being mindfulness and shopper inclinations, a natural land region, just as wild animals/Poultry cultivation, is expanding worldwide. The market worth of different nations' genuine items worldwide stretched around 28 billion US dollars and is relied upon to develop to 102 billion US dollars in 2010 (NAAS, 2005). The natural meat area is filling quickly in the USA, in which raw poultry meat is unmistakable. In



**Rajesh Kumar**

2005, Poultry represented around 75% of the all-out wild meat market and comprised of natural Poultry, which is overwhelmed by chicken. This pattern is relied upon to proceed with the yearly development of natural Poultry assessed at 33% Chicken has turned into the most significant raw meat because of its short creation cycle, which grants makers to build supply rapidly. Poultry natural meat creation costs nearly lower than other domesticated animals' meat. It is also interesting to note that raw chicken is just around 20% higher opportunity estimated than regular, contrasted with 30-40% cost conduct expenses peak other natural meats. The interest in innovative work endeavors in the poultry area increases as the world exchange limits genuine poultry items. European India traded natural farming. Open-air access is a significant component of raw Poultry, which can give Poultry new grass, bugs, and bugs and further develop item quality. There is proof that fed poultry meat might have a few extra healthful advantages because of its low-fat and high nutrient and mineral substances.

Simultaneously, the executives can accomplish well-being and prosperity in a great field. This outline outlines the area the executives rehearse that can be utilized to forestall expected dangers to natural poultry frameworks like uncontrolled climate conditions and savage mortality. In the field's different impacts, the executives on physical well-being, lack of hunger and illness, poultry health and well-being, including opportunities for motivated behavior, a meat quality, and consumers and nutrition. Investigate the impact: quality and sensory characteristics discussed grass synthesis and uptake.

NEED AND RELEVANCE OF STUDY

Consumers' decisions to support organic farming are made for various reasons. Most consumers who buy organic products believe that organic eggs and chicken are healthier because they are free from chemicals, antibiotics, and genetically modified feed ingredients, so they buy for health reasons. Increase. There is controversy over whether organic chicken and eggs taste good, but the meat in the organic chicken system is of better quality than usual. People also get good factors when helping local farmers and buying ethically made products. In summary, sustainability is a complex issue, and there is no easy answer as to which poultry production system is more sustainable. Both have their strengths and weaknesses, and which one you prioritize depends on who is doing the assessment and what their priorities are. However, the growing popularity of organic poultry meat and eggs indicates that these breeding systems will survive, and future studies will ensure optimal bird welfare, sustainability, and agricultural productivity. We need to find out how to improve those operations further.

OBJECTIVES OF THE STUDY

- To understand the issues of organic poultry farming in India.
- To provide an opportunity for organic poultry farming in India.
- To suggest various approaches to improve organic poultry farming in India.

METHODOLOGY

The research on organic poultry farming and issues and approaches were taken through primary and secondary data. The main objective is to know the process and methodology of organic poultry farming and its role and efficiency in society. The aim of choosing the sample of organic poultry farming this idea is more innovative and analyzing various information sources we tend to are victimization each primary and secondary data this concept of organic poultry farming is multi-benefit for both farmers to increase their income second healthy benefits human life.

SOURCES OF DATA

Sources for research are primary and secondary sources, respectively. The first source of information includes the farmers' secondary knowledge and the National Agricultural Commission's report on the expansion and development of the organic poultry population. The interviews that have been conducted show an old tendency for Indians to be organically grown. Chicken breeds were assigned to respondents for grouping information, such as their socio-economic background. This knowledge has been vigorously analyzed using the size of farms. Average.





Rajesh Kumar

Percentage etc. Sources for research represent each primary and secondary source in addition to the secondary knowledge; the first source of information is the Farmers, National Commission research on the expansion and trends of organic poultry populations. Includes reports. You can see an interview for agriculture because the old Trend for Indians is organically grown. The planned chicken breeds were communicated to respondents to group information on socio-economic backgrounds, issues, approaches, etc. Knowledge was analyzed in relevance, and the farms and ICAR-National Research Centre on Meat for consumer health benefits market trends analyzed data sources.

STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND CHALLENGES OF THE RESEARCH

Strengths

- Breeding organic chickens are considered more beneficial than other forms of organic meat production due to the small space occupied by the animals and the relatively fast growth of enormous size.

Organic chicken is raised without antibiotics.

- The natural chicken brought up in an indigenous habitat benefits from the regular feed with no anti-infection agents.
- Raw chicken meat has a high nutrient and dietary use, influencing the human body.
- Natural chicken doesn't contain unsafe microbes like salmonella or helicobacter pylori, adversely affecting human well-being.
- Standard utilization of raw chicken meat keeps a thin and solid body.
- Organic chicken has more health benefits
- Maintenance is low
- Lesser food costs
- Insects and pest controls
- Saves the money by eating less feed
- Producing More energetic and healthier chickens
- Fewer coop spaces
- It doesn't need a lot of funding to turn into a natural poultry rancher
- Farmers needn't bother with a great deal of room accessible space to start raw Poultry cultivating
- Organic Poultry cultivation can be quickly worthwhile
- There are fewer support necessities to consider for natural poultry ranchers
- Most natural poultry ranchers don't need a permit to get everything rolling
- Natural Poultry cultivating item that has a quick interest
- It makes different degrees of business openings
- For the most part, natural poultry ranches are free-range farms, so the birds approach the field.
- Works on the nature of the space where the ranch is set up because of the techniques associated with the cultivating.
- Significantly less or no utilization of synthetic compounds, which is the main component that impacts the well-being of the shopper.
- The flavor of the birds or the items' nature is better than the following expectedly cultivated birds.
- Low venture because there is the relationship between trimming and Poultry inside a similar Homestead.
- More prominent interest in natural items.
- High profit enjoyed by the organic poultry farmers
- Organic poultry farming reduces the exposure to pesticides
- Organic farmers use holistic preventive health care practices
- Organic poultry farming helps protect the environment

Weakness

- A lot of space needs
- It requires a generous measure of funding to begin for enormous creation
- The low inclination of bank advances for natural Poultry cultivation in India



**Rajesh Kumar**

- Poultry sicknesses are a danger to your whole birds
- Some chicken varieties may not dominate in specific natural conditions
- Low well-being
- No assurances with nutrition
- Free ranges chickens can be chaotic
- Simple sickness episode
- Logical administration can't be followed because there are zero commands over the birds.
- Misfortunes might be experienced by flying predators and from an inability to observe eggs laid in thick regions. the poultry run requires a lot of fencing problems in the infrastructure facility
- Low awareness of organic poultry farming
- Lack of support from the government in the form of subsidies for organic poultry farmers

Opportunities

- It makes its image in the natural meat market
- Interest in natural poultry creations at the worldwide level
- European nations import huge extents of raw poultry items
- genuine items watch out for retail at higher costs than their traditionally developed
- freedom to exchange the worldwide level
- The local natural poultry creations breeds are conspicuous in tropical nations

CHALLENGES

- Their main challenge is disease challenges in nutrition.
- Lack of credit and loan facilities
- Poor growth of chicks
- Inadequate management costs of cleaning water
- Less training facilities for poultry farmers in India
- So many of the rules for sanitation and quality are followed by the developed countries, which makes it a problem for Indian farmers to export their products
- Lack of adequate knowledge about organic poultry farming both at the production level and marketing level
- It produces are gains the quick bulk amount of money

OUTCOMES OF THE STUDY

Increasing the demand for organic poultry products, a holistic approach to improving food security and consumer safety is just one method of organic poultry farming in India. India has great potential in organic poultry production, as many India are organically grown by default. Meanwhile, the adverse effects of traditional agriculture have forced consumers to switch to organic products. Government support for Indian organic Poultry helps farmers double their income. Finally, organic Poultry has its strengths and weaknesses; as shown in this study, raising the number of organic poultry farming with the health problem is decreased near poultry farms will also reduce the primary air pollution, water pollution, and soil pollution.

PEST ANALYSIS**Political**

Institutional Support and Awareness-Government of India and Research Universities have various programs to maintain a population of native chickens as a platform for screening organically grown agricultural products and having a significant impact on the organic sector. The government of India has a solid policy to promote the production of local organic foods. There are organic-based certification systems and various funding programs for organic start-ups. Therefore, if you choose to get strong government support, there are many ways to support poultry farming.



**Rajesh Kumar****Economical**

Growing Producers' Interest in Cooperative Agriculture-Indian farmers who want to switch from traditional methods to organic poultry methods cite the lack of knowledge and commercial support as obstacles. A cooperative farming model where skilled producers flatten newcomers' speed bumps helps the poultry sector shift new hires and increase production efforts. Additional Income Opportunities for Rural Communities-Indian rural communities can increase their income from organic poultry farmers. Demand in his big city could be an urgently needed sales market for trade. Farming directly to consumers (farm-to-table model) is steadily progressing - which has an innovative retail platform that goes more directly to consumers and creates personalized sales opportunities for consumers. I'm out. Organic Poultry can use such an innovative launch pad to enable its brand to reach a wider urban audience and the organic pop-up market in many cities.

Tight margins from brokers in traditional agriculture led to direct sales efforts-avoiding. The involvement of agents and other brokers to close deals leads to even more cost savings for organic poultry farmers. Domestic chickens are superior to commercial broilers and spawning chickens in terms. Organic chicken varieties feed on available plants, insects, and mollusks of input cost stability. This is a tremendous advantage for poultry cost models. Traditional farmers have a proportional poultry cost of up to 70% of the total production cost.

Social

Increasing consumer awareness of poisoning from chemical residues in food-this means increased demand for organically grown chicken and eggs. Next, this new in terestin early organic conversion is followed by research to learn about all kinds of natural choices and varieties available. Consumers are moving towards the composition of foods more, and consumers are worried about what the food contains more than what is on the label. I have noticed that it includes foods from. Also, then utritional value is of tenmuchlower than expected. All this goes back to the intensive cultivation methods used. Compared to other countries, India's organic consumption is significantly lower-So when it comes to organic products, India still has a lot to do compared to other international markets. Indian consumers are also increasingly favoring locally produced products. As a result, organically grown foods and locally produced foods are rising. The perish ability of food is like knowing that consumers must come from a local farm to make it fresh.

Global pandemics are driving demand for organic foods-During the recent outbreak of Pandemics, the effects of organic foods on boosting their natural immunity are in the limelight. In development, the organic poultry farm business was estimated to grow by 20% in 2020 during the blockade of India. Animal welfare makes organic farming more attractive for consumers now better understand. The route that cows take to the table significantly impacts their products' nutritional value and quality. Demand for organic foods is directly related to the use of the Internet. Smart phones are increasing-The increasing number of people looking for information related to smart phone purchasing decisions has helped the organic food trend proliferate. E-commerce allowed small start-ups to gain significant market share-The high quickly.

The proportion of consumers and buyers of organic foods that commonly use the Internet makes online marketplaces a very profitable tool. Medical practitioners advocating the health benefits of organic Poultry continue to open. The market-this is a more excellent perception of the health benefits of eating organically raised chickens and eggs from local varieties. Connect and give expert awareness to the locally grown organic chicken market, E-Commerce Offers More Customer Reach and Sales Growth Potential for Organic Producers-Organic Poultry can use e-commerce as a convenient sales channel with buyers in distant cities. The e-commerce platform acted as an intermediary to reach potential customers across the country.

Technological

Internet use by many in rural Indian communities exceeds that of urban dwellers-This provides organic Poultry with an excellent opportunity to use the Internet as a medium to teach rural entrepreneurs about profitable environmental practices.



**Rajesh Kumar****Experiences**

It is one of the best experiences to do a project on the challenges and approaches of organic poultry farming in India. In this study, the benefits and marketing trends for organic agriculture. It reduces unemployment opportunities in India and provides more health benefits. A how can be into step for organic Poultry farming what's the principals and concepts can be analyses the farmer before its start an organic poultry farming provides the employment environment for a longer time it requires comparatively less space proper intimation. Curtains. And drinking water and food arrangement are enough to build this organic poultry farming.

Learning's

The study of the organic poultry farm is coming to know to reach the meager capital. Otherwise, it depends on the size of the farm. It is beneficial and benefits the society, directly and indirectly; this study discloses that poultry farming measures the various sorts like duck rearing, rearing chicken, quails, turkey, etc. But the principles and practices underlying measure's constant an organic poultry farmers get more profits for more particular periods; through study, it is understood the investment will be based on the area of land and space of market conditions, for organic poultry production land and birds free from pesticides. It generates employment opportunities in rural areas. It is easy to start up organic poultry production, but the only thing is it is essential to take preventive measures on the health issues of birds. Also, organic hygiene factors are considered the same as organic feed and maintenances in the organic poultry sector in India.

CONCLUSION

Organic poultry farming is more beneficial for farmers and provides more health to society. Agri farmers these firms are one of the growing segmenting agricultural sectors. This perfect trend in India an organic poultry business is growing mainly because of more benefits and government support as well consumers buying behavior and farmers' interests; in the present era, the consumer can think only about the health benefits don't think about the cost of products these organic poultry farming in India creates a trend to Organic products buyer some challenges also faced by the farmers main is proper infrastructure facilities and Markets support. It's decreased the unemployment rates in rural areas. I suggest that this research on organic poultry farming in India is more beneficial to consumers and producers.

REFERENCES

1. A case study on organic poultry farming in India issues and approaches <https://www.researchgate.net/publication/228976146> Organic Poultry Farming in India-issues and approaches.
2. Organic poultry farming concept's <https://www.agrifarming.in/organic-poultry-farming-raisingmethods>.
3. Research of organic meats in India <https://nrcmeat.icar.gov.in/>





Analysis of a Markovian Queueing system with Setup time and Multiple Working Vacation and Vacation Interruption under Bernoulli schedule

P. Manoharan^{1*} and K. Sethu Raman²

¹Associate Professor, Department of Mathematics, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

²Research Scholar, Department of Mathematics, Annamalai University Annamalai Nagar, Tamil Nadu, India

Received: 23 Feb 2022

Revised: 10 June 2022

Accepted: 14 July 2022

*Address for Correspondence

P. Manoharan

Associate Professor,

Department of Mathematics,

Annamalai University,

Annamalai Nagar,

Tamil Nadu, India.

Email: manomaths.hari@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

This work is concerned with the M/M/1 queue with Setup time and Vacation Interruption under the Bernoulli schedule. While there are no customers in the system, the server takes a Setup time with probability p or a working vacation with probability $(1 - p)$ where $0 \leq p \leq 1$. During the working vacation, the server is either expected to interrupt the vacation and return to the non-vacation period with probability $(1 - q)$, or to continue the vacation with probability q . A matrix geometric technique is used to obtain the stationary distributions for the mean queue length and mean waiting time, as well as the associated stochastic decomposition structures. The effects of system parameters on performance measurements are calculated.

Keywords: M/M/1 queue, Working vacation, Vacation Interruption, Matrix-geometric solution.

INTRODUCTION

The use of queueing models in computer systems with a vacation policy is not limited. There has been a lot of research on computer systems and production management. The versatility of the queueing systems is enhanced by a variety of vacation policy. Various scholars have researched queueing models incorporating server vacations or working vacations over the last two decades. Two types of literature exist. (i) when the server is taking a vacation and (ii) when the server is taking a working vacation. When the server is on a vacation, the readers might resort to Doshi's survey study from 1986 and Takagi's monograph from 1991. Takagi (1991) and Doshi (1986) focused their

45088





Manoharan and Sethu Raman

research on a single server. Recently, Zhang and Tian (2003a, 2003b) offered sufficient analysis of the M/M/C queue with synchronous multiple/single vacations of partial servers. This paper is coordinated as follows. In section 2, the model is described and discussed as a quasi-birth and death process (QBD). The state probability of the server and the stationary distribution of queue length were computed in section 3. The stochastic decomposition structures of the stationary queue length and Sojourn time are discussed in Section 4.

Model description

We analyse an M/M/1 queueing system, where the customers arrive according to poisson process with rate λ . The server begins to serve the customer at rate μ which is exponentially distributed. When there are no customer in the system, the server takes a setup time with probability p or a working vacation (WV) with probability $(1 - p)$, where $0 \leq p \leq 1$. During the working vacation and service in busy period customer are served at an exponentially distributed at the rate μ_w and μ_b respectively, where $\mu_b > \mu_w$ in the customer is served at a reduced service rate. Moreover, at the instants of service completion during the working vacation either the server is supposed to interrupt the vacation and return back to the regular busy period (RBP) with probability $(1 - q)$ or the server will carry on the vacation with probability q . The setup time and the working vacation time are also assumed to the exponential distributed with parameter β and α , respectively.

Let $Q(t)$ represent the number of consumers in the system at time t , and $J(t)$ represent the server status, as well as the following definition

$$J(t) = \begin{cases} 0, & \text{at the time } t, \text{ server is in WV period,} \\ 1, & \text{at the time } t, \text{ server is in setup time,} \\ 2, & \text{at the time } t, \text{ server is in RBP.} \end{cases}$$

Then $\{(Q(t), J(t)); t \geq 0\}$ defines a continuous time state space Markov Process.

$$S = \{(k, j): k = 0, 1, 2, \dots, j = 0, 1\}$$

The lexicographical order of the states determines the infinitesimal generator.

$$Q = \begin{pmatrix} B_0 & A_0 & & & \\ C_0 & B & A & & \\ & C & B & A & \\ & & C & B & A \\ \vdots & & & \vdots & \vdots & \vdots \end{pmatrix}$$

where

$$B_0 = \begin{pmatrix} -\lambda & 0 \\ 0 & -\lambda \end{pmatrix}, \quad A_0 = \begin{pmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \end{pmatrix}, \quad C_0 = \begin{pmatrix} \mu_w & 0 \\ 0 & 0 \\ (1-p)\mu_b & p\mu_b \end{pmatrix}$$

$$B = \begin{pmatrix} -(\lambda + \mu_w + \alpha) & 0 & \alpha \\ 0 & -(\lambda + \beta) & \beta \\ 0 & 0 & -(\lambda + \mu_b) \end{pmatrix}, \quad n \geq 1, \quad C = \begin{pmatrix} q\mu_w & 0 & \mu_w(1-q) \\ 0 & 0 & 0 \\ 0 & 0 & \mu_b \end{pmatrix}$$

$$A = \begin{pmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \lambda \end{pmatrix}.$$

As shown by the Q matrix structure, the Markov Chain $\{(Q(t), J(t)); t \geq 0\}$ is a QBD process. To investigate the QBD process, we must find the lowest non-negative solution to the matrix quadratic equation, known as the rate matrix and represented by R.

$$R^2C + RB + A = 0 \tag{1}$$

The explicit solution of R is given by the following lemma.





Manoharan and Sethu Raman

Lemma 1. If $\rho = \frac{\lambda}{\mu} < 1$, The matrix quadratic problem's least non-negative solution is as follows (1)

$$R = \begin{pmatrix} a & 0 & \eta \\ 0 & \sigma & \rho \\ 0 & 0 & \rho \end{pmatrix} \tag{2}$$

where

$$a = \frac{(\lambda + \mu_w + \beta) - \sqrt{(\lambda + \mu_w + \alpha)^2 - 4q\mu_w\lambda}}{2q\mu_w}, \quad 0 < \alpha < 1$$

$$\eta = \frac{a[(1 - q)\mu_w a + \alpha]}{\mu_b(1 - a)}$$

$$\sigma = \frac{\lambda}{\lambda + \beta}$$

Proof. The solution matrix R can be regarded of as having the same structure as A, B and C in (1) because they are all upper triangular matrices.

$$R = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ 0 & a_{22} & a_{23} \\ 0 & 0 & a_{33} \end{pmatrix}$$

The result of substituting the values of R^2 and R into (1) is

$$q\mu_w a_{11}^2 - (\lambda + \mu_w + \alpha)a_{11} + \lambda = 0 \tag{3}$$

$$\mu_b a_{33}^2 - (\lambda + \mu_b)a_{33} + \lambda = 0 \tag{4}$$

$$\lambda - (\lambda + \beta)a_{22} = 0 \tag{5}$$

$$(1 - q)\mu_w a_{11}^2 + \mu_b(a_{11}a_{13} + a_{13}a_{33}) + \alpha a_{11} - (\lambda + \mu_b)a_{13} = 0 \tag{6}$$

$$\beta a_{22} - (\lambda + \mu_b)a_{23} + \mu_b(a_{22}a_{23} + a_{23}a_{33}) = 0 \tag{7}$$

Utilizing the way that (3) has a unique solution of a, from the given set of equations, we can find the smallest non-negative solution to (1).

$$a = \frac{(\lambda + \mu_w + \beta) - \sqrt{(\lambda + \mu_w + \alpha)^2 - 4q\mu_w\lambda}}{2q\mu_w}$$

in interval (0,1). Subbing $a_{11} = a$ and $a_{33} = \rho$ into (6), we get $a_{13} = \frac{a[(1-q)\mu_w a + \alpha]}{\mu_b(1-a)} = \eta$. Subbing the value $a_{22} = \frac{\lambda}{\lambda + \beta} = \sigma$ and $a_{33} = \rho$ into (7), we get $a_{23} = \rho$

Theorem 1. The QBD process $\{(Q(t), J(t)); t \geq 0\}$ is positive recurrent if and only if $\rho < 1$.

Proof. According to Neuts (1981) lemma1, the QBD process $\{(Q(t), J(t)); t \geq 0\}$ is positive recurrent if and only if the spectral radius $SP(R)$ of the rate matrix R is less than 1, and the set of equations $(x_0, x_1, x_2)B[R] = 0$ has a positive solution where

$$B[R] = \begin{pmatrix} B_0 & A_0 \\ C_0 & RC + B \end{pmatrix},$$

$$= \begin{pmatrix} -\lambda & 0 & \lambda & 0 & 0 \\ 0 & -\lambda & 0 & \lambda & 0 \\ \mu_w & 0 & -(\alpha + \mu_w(1 - aq) + \lambda) & 0 & a(1 - q)\mu_w + \eta\mu_b + \alpha \\ 0 & 0 & 0 & -(\beta + \lambda) & (\beta + \lambda) \\ (1 - p)\mu_b & p\mu_b & 0 & 0 & -\mu_b \end{pmatrix} q \tag{8}$$

$B[R]$ is an irreducible, finite-state aperiodic generator. As a result, $(x_0, x_1, x_2)B[R] = 0$. has a positive outcome (for example, the balance probability vector of $B[R]$ is positive solution). As a result, the process $\{(Q(t), J(t)); t \geq 0\}$ is positive recurrent if and only if

$$SP(R) = \max(a, \rho) < 1$$





Stationary distribution of queue length

If $\rho < 1$, let (Q, J) be the stationary limit of the QBD process $\{(Q(t), J(t)); t \geq 0\}$ and define

$$\pi_0 = (\pi_{00}, \pi_{01})$$

$$\pi_k = (\pi_{k0}, \pi_{k1}, \pi_{k2}), \quad k \geq 1$$

$$\pi_{kj} = P\{Q = k, J = j\}, \quad k \geq 0, \quad J = 0, 1$$

Theorem 2. If $\rho < 1$, the Stationary probability distribution of $\{(Q(t), J(t)); t \geq 0\}$ is

$$\left. \begin{aligned} \pi_{k0} &= \frac{\lambda K}{\lambda + \mu_w(1 - aq) + \alpha} a^{k-1}, \quad k \geq 0 \\ \pi_{k1} &= \frac{\lambda p K (\lambda - qa\mu_w + \alpha)}{(\beta + \lambda)(1 - p)\lambda + \mu_w(1 - aq) + \alpha} \sigma^{k-1}, \quad k \geq 0 \\ \pi_{k2} &= \frac{\lambda K \eta}{\lambda + \mu_w(1 - aq) + \alpha} \sum_{j=0}^{k-1} \rho^j a^{k-1-j} + \frac{p K (\lambda - qa\mu_w + \alpha)}{(1 - p)(\lambda + \mu_w(1 - aq) + \alpha)} \rho \sum_{j=0}^{k-1} \rho^j \sigma^{k-1-j} \\ &\quad - \frac{\lambda K \eta \rho^{k-1}}{a(\lambda + \mu_w(1 - aq) + \alpha)} + \frac{K(\lambda - qa\mu_w + \alpha)\rho^k}{(\lambda + \mu_w(1 - aq) + \alpha)}, \quad k \geq 1 \end{aligned} \right\} \quad (9)$$

where

$$K = \frac{\lambda + \mu_w(1 - aq) + \alpha}{\left[\frac{\lambda}{(1-a)a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)(1-\rho)(1-\sigma)} + \frac{\lambda\eta}{(1-a)(1-\rho)} + \frac{(\lambda - qa\mu_w + \alpha)\rho}{(1-\rho)} \right]}$$

Proof. We obtain the following results using Neuts (1981) matrix geometric solution method:

$$\pi_k = (\pi_{k0}, \pi_{k1}, \pi_{k2}) = (\pi_{10}, \pi_{11}, \pi_{12}) R^{k-1}, \quad k \geq 1 \tag{10}$$

and $(\pi_{00}, \pi_{01}, \pi_{10}, \pi_{11}, \pi_{12})$ is satisfied by the set of equations below

$$(\pi_{00}, \pi_{01}, \pi_{10}, \pi_{11}, \pi_{12}) B[R] = 0$$

When we replace $B[R]$ in (8) with the above relation, we obtain

$$-\lambda\pi_{00} + \mu_w\pi_{10} + (1 - p)\mu_b\pi_{12} = 0 \tag{11}$$

$$-\lambda\pi_{01} + p\mu_b\pi_{12} = 0 \tag{12}$$

$$\lambda\pi_{00} - (\lambda + \mu_w(1 - aq) + \alpha)\pi_{01} = 0 \tag{13}$$

$$\lambda\pi_{01} - (\beta + \lambda)\pi_{11} = 0 \tag{14}$$

$$a(1 - q)\mu_w + \eta\mu_b + \alpha)\pi_{10} + (\lambda + \beta)\pi_{11} - \mu_b\pi_{12} = 0 \tag{15}$$

We get $\pi_{00} = K$ when we solve the foregoing equations in terms of K .

$$\pi_{01} = \frac{pK(\lambda - qa\mu_w + \alpha)}{(1 - p)(\lambda + (1 - qa)\mu_w + \alpha)}, \quad \pi_{10} = \frac{\lambda K}{(\lambda + (1 - qa)\mu_w + \alpha)},$$

$$\pi_{11} = \frac{\lambda p K (\lambda - qa\mu_w + \alpha)}{(\beta + \lambda)(1 - p)(\lambda + (1 - qa)\mu_w + \alpha)}, \quad \pi_{12} = \frac{\lambda K (\lambda - qa\mu_w + \alpha)}{(1 - p)\mu_b(\lambda + (1 - qa)\mu_w + \alpha)}$$

From (2), we acquire

$$R^k = \begin{pmatrix} a^k & 0 & \eta \sum_{j=0}^{k-1} \rho^j a^{k-1-j} \\ 0 & \sigma^k & \rho \sum_{j=0}^{k-1} \rho^j \sigma^{k-1-j} \\ 0 & 0 & \rho^k \end{pmatrix}, \quad k \geq 1$$

Similarly

$$R^{k-1} = \begin{pmatrix} a^{k-1} & 0 & \eta \sum_{j=0}^{k-2} \rho^j a^{k-2-j} \\ 0 & \sigma^{k-1} & \rho \sum_{j=0}^{k-2} \rho^j \sigma^{k-2-j} \\ 0 & 0 & \rho^{k-1} \end{pmatrix}, \quad k \geq 1$$

We get (9) by substituting (π_{10}, π_{11}) and the matrix equation R^{k-1} into (10), and noting that the normalisation condition can be used to determine the constant factor K .





Manoharan and Sethu Raman

The probabilities of the server in different states are as follows.

$$P\{j = 0\} = P\{\text{The server is in WV period}\}$$

$$\sum_{k=0}^{\infty} \pi_{k0} = \left(\frac{\lambda K}{\lambda + \mu_w(1 - aq) + \alpha} \right) \frac{1}{a(1 - a)}$$

$P\{j = 1\} = P\{\text{The server is in setup time period}\}$

$$\sum_{k=0}^{\infty} \pi_{k1} = \left(\frac{\lambda K p(\lambda - qa\mu_w + \alpha)}{(\lambda + \mu_w(1 - qa) + \alpha)(1 - p)} \right) \frac{1}{(1 - \sigma)}$$

$P\{j = 2\} = P\{\text{The server is in RBP}\}$

$$\sum_{k=1}^{\infty} \pi_{k2} = \frac{K}{(\lambda + \mu_w(1 - qa) + \alpha)} \left[\frac{\lambda \eta}{a(1 - a)(1 - \rho)} \right] + \frac{p\rho(\lambda - qa\mu_w + \alpha)}{(1 - \sigma)(1 - \rho)(1 - p)} - \frac{\lambda \eta}{a(1 - \rho)} + \frac{\rho(\lambda - qa\mu_w + \alpha)}{(1 - \rho)}$$

4 Stochastic decompositions

To achieve a better comparison with previous queuing models, we frequently try to decompose the quantities of interest into several variables. The influence of system vacation on system performance measures such as mean queue length and mean sojourn periods is highlighted. In a similar manner, we wish to decompose the system under investigation.

Theorem 3. If $\rho < 1$ and $\mu_b > \mu_w$, the number of customers Q in a system can be decomposed into the sum of two independent random variable $Q = Q_0 + Q_d$, where Q_0 is the number of customers of a classic $M/M/1$ queue in steady state and follows a gementric distribution with parameter $(1 - \rho)$, Q_d is the additional number of customer has a modified geometric distribution.

$$Q_d(z) = \delta_1 + \delta_2 z + \delta_3 \frac{(1 - a)}{(1 - az)} z + \delta_4 \frac{(1 - \rho)}{(1 - \rho z)} z \tag{16}$$

where

$$\delta_1 = \left[\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1 - p)} \right] (1 - a)(1 - \sigma), \quad \delta_2 = \left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda \eta}{a} \right] (1 - a)(1 - \sigma)$$

$$\delta_3 = (1 - \sigma) \left[\frac{\lambda}{a}(a - \rho) + \frac{\lambda \eta}{a} \right], \quad \delta_4 = (1 - a) \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1 - p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1 - p)} \right]$$

$$K^* = \frac{K}{(1 - a)(1 - \sigma)(1 - \rho)(\lambda + \mu_w(1 - aq) + \alpha)}$$

Proof. The probability generating function (PGF).

$$Q(z) = \sum_{k=0}^{\infty} \pi_{k0} z^k + \sum_{k=0}^{\infty} \pi_{k1} z^k + \sum_{k=1}^{\infty} \pi_{k2} z^k$$

$$= K \left[\frac{\lambda}{a(1 - az)} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1 - p)} \frac{1}{\sigma(1 - \sigma z)} + \frac{\lambda \eta z}{a(1 - \rho z)(1 - az)} + \frac{p\rho(\lambda - qa\mu_w + \alpha)}{(1 - p)} \frac{z}{(1 - \sigma z)(1 - \rho z)} - \frac{\lambda z}{(1 - \rho z)} + (\lambda - qa\mu_w + \alpha) \frac{\rho z}{(1 - \rho z)} \right]$$

$$= \frac{(1 - \rho)}{(1 - \rho z)} K^* \left[\delta_1 + \delta_2 z + \delta_3 \frac{(1 - a)}{(1 - az)} + \delta_4 \frac{(1 - \rho)}{(1 - \rho z)} z \right] \tag{17}$$

where

$$\delta_1 = \left[\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1 - p)} \right] (1 - a)(1 - \sigma), \quad \delta_2 = \left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda \eta}{a} \right] (1 - a)(1 - \sigma)$$

$$\delta_3 = (1 - \sigma) \left[\frac{\lambda}{a}(a - \rho) + \frac{\lambda \eta}{a} \right], \quad \delta_4 = (1 - a) \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1 - p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1 - p)} \right]$$





Manoharan and Sethu Raman

Now we prove that $\delta_1 + \delta_2 + \delta_3 + \delta_4 = (K^*)^{-1}$

$$(K^*)^{-1} = \frac{(1-\sigma)(1-a)(1-\rho)(\lambda + \mu_w(1-aq) + \alpha)}{K}$$

$$= (1-\sigma)(1-a)(1-\rho) \left[\frac{\lambda}{a(1-a)} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)(1-\sigma)} + \frac{\lambda\eta}{(1-\rho)(1-a)} + \frac{(\lambda - qa\mu_w + \alpha)\rho}{(1-\rho)} + \frac{pp(\lambda - qa\mu_w + \alpha)}{(1-p)(1-\sigma)(1-\rho)} \right]$$

$$(K^*)^{-1} = \left[\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] (1-a)(1-\sigma) + \left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right] (1-a)(1-\sigma)$$

$$+ (1-\sigma) \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] + (1-a) \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{pp(\lambda - qa\mu_w + \alpha)}{(1-p)} \right]$$

The above condition demonstrates.

$$Q(z) = \frac{(1-\rho)}{(1-\rho z)} Q_d(z)$$

is a function that generates probabilities $Q_d(z)$ is expanded into a power series of z . The distribution of an additional number of consumers Q_d is obtained.

We can simply obtain means using the stochastic decomposition structure in theorem 4.

$$E(Q_d) = K^* \left[\left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right] (1-\sigma)(1-a) + (1-\sigma) \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] \frac{1}{(1-a)} + (1-a) \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{pp(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \frac{1}{(1-\sigma)} \right]$$

$$E(Q) = \frac{\rho}{(1-\rho)} + E(Q_d)$$

Theorem 4. The stationary waiting time W of an arrival can be decomposed into the sum of two independent variables If $\rho < 1$ and $\mu_b > \mu_w$. $W = W_0 + W_d$, where W_0 is the arrival waiting time in a corresponding classical M/M/1 queue and is exponentially distributed with parameter $\mu_b(1-\rho)$ and W_d is the additional delay with the LST provided by

$$W_d^*(s) = K^* \left\{ \left(\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} + \rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} - \frac{1}{a} \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] \right) (1-\sigma)(1-a) \right.$$

$$\left. - \frac{1}{\sigma} \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{pp(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \right\}$$

$$- \left(\frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} + \rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right) \frac{(1-\sigma)(1-a)}{\lambda} + \frac{1-\sigma}{a} \left(\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right) \frac{\frac{\lambda}{a} - \lambda}{\frac{\lambda}{a} - \lambda + s}$$

$$- \frac{1-a}{\sigma} \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{pp(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \frac{\frac{\lambda}{\sigma} - \lambda}{\frac{\lambda}{\sigma} - \lambda + s}$$

Proof. The classical relationship (Keilson and Servi) between the PGF of L and the LST of waiting time W is

$$Q(z) = W^*(\lambda(1-z))$$

The PGF of the number of customers Q can be represented as follows using theorem 3.





Manoharan and Sethu Raman

$$Q(z) = \frac{(1-\rho)}{(1-\rho z)} K^* \left[\left(\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right) (1-a)(1-\sigma) + \left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right] (1-a)(1-\sigma)z + (1-\sigma) \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] \frac{1-a}{1-az} z + (1-a) \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \frac{1-\sigma}{1-\sigma z} z \right]$$

Taking $z = 1 - \frac{s}{\lambda}$ in (12), we obtain

$$\frac{(1-\rho)}{(1-\rho z)} = \frac{\mu_b(1-\rho)}{\mu_b(1-\rho) + s}, \quad \frac{1-a}{1-az} = \frac{\frac{\lambda}{a} - \lambda}{\frac{\lambda}{a} - \lambda + s}, \quad \frac{1-\sigma}{1-\sigma z} = \frac{\frac{\lambda}{\sigma} - \lambda}{\frac{\lambda}{\sigma} - \lambda + s}$$

Subbing the above outcome into (12), we get

$$W^*(s) = \frac{(1-\rho)\mu_b}{(1-\rho)\mu_b + s} K^* \left\{ \left(\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right) (1-a)(1-\sigma) + \left[(\lambda - qa\mu_w + \alpha)\rho - \frac{\lambda\eta}{a} \right] (1-a)(1-\sigma) \left(1 - \frac{s}{\lambda} \right) - \frac{(1-a)(1-\sigma)}{a} \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] + \frac{(1-\sigma)}{a} \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] \frac{\frac{\lambda}{a} - \lambda}{\frac{\lambda}{a} - \lambda + s} - \frac{(1-a)(1-\sigma)}{\sigma} \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] + \frac{(1-a)}{\sigma} \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \frac{\frac{\lambda}{\sigma} - \lambda}{\frac{\lambda}{\sigma} - \lambda + s} \right\}$$

$$W_d^*(s) = K^* \left[\left\{ \frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} + \rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} - \frac{1}{a} \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] - \frac{1}{\sigma} \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \right\} (1-\sigma)(1-a) - \left(\frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} + \rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right) \frac{(1-\sigma)(1-a)}{\lambda} + \frac{1-\sigma}{a} \left(\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right) \frac{\frac{\lambda}{a} - \lambda}{\frac{\lambda}{a} - \lambda + s} - \frac{1-a}{\sigma} \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \frac{\frac{\lambda}{\sigma} - \lambda}{\frac{\lambda}{\sigma} - \lambda + s} \right] \tag{18}$$

The analogous expression of K^* is given in the proof of the theorem 4.

$$(K^*)^{-1} = \left[\frac{\lambda}{a} + \frac{p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] (1-a)(1-\sigma) + \left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right] (1-a)(1-\sigma) + (1-\sigma) \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] + (1-a) \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right]$$

As a result, this establishes that $W_d^*(s)$ is an LST.

We can easily obtain the following means based on the above stochastic decomposition structure

$$E(W_d) = \frac{1}{\lambda} K^* \left\{ \left[\rho(\lambda - qa\mu_w + \alpha) - \frac{\lambda\eta}{a} \right] (1-a)(1-\sigma) + (1-\sigma) \left[\frac{\lambda}{a}(a-\rho) + \frac{\lambda\eta}{a} \right] - a \left[\frac{p(\lambda - qa\mu_w + \alpha)(\sigma - \rho)}{(1-p)} + \frac{\rho p(\lambda - qa\mu_w + \alpha)}{(1-p)} \right] \right\}$$

$$= \frac{1}{\lambda} E(Q_d)$$





$$E(W) = \frac{1}{\mu_b(1-\rho)} + E(W_d)$$

REFERENCES

1. Banik, A. Analysis of single server working vacation in GI/M/1/N and GI/M/1/1 queueing systems, International Journal of Operational Research 2010; 7(3): 314-333.
2. Chao, X. and Zhao, Y.Q. Analysis of multiserver queues with station and server vacations, European Journal of Operational Research 1998; 110(2): 392-406.
3. Doshi, B.T. Queueing systems with vacations a survey, Queueing Systems 1986; 1: 29-66.
4. Gao, S. and Liu, Z. An M/G/1 queue with single working vacation and vacation interruption under Bernoulli schedule, Applied Mathematical Modelling 2013;37:1564-1579.
5. Ke, J., Wu, C. and Zhang, Z. Recent developments in vacation queueing models, A short survey, International Journal of Operations Research 2010; 7(4): 3-8.
6. Laxmi, P. and Yesuf, O. Renewal input infinite buffer batch service queue with single exponential working vacation and accessibility to batches, International, Journal of Mathematics in Operational Research 2011; 3(2): 219-243.
7. Lee, D.H. and Kim, B.K. A note on the sojourn time distribution of an M/G/1 queue with a single working vacation and vacation interruption, Operations Research Perspectives 2015; 2: 57-61.
8. Levy, Y. and Yechiali, U. (1976). An M/M/c queue with servers vacations, INFOR 1976; 14(2): 153-163.
9. Li, J.H. and Tian, N.S. The M/M/1 queue with working vacations and vacation interruptions, Journal of Systems Science and Systems Engineering 2007;16(1): 121-127.
10. Li, J.H. Tian, N.S. and Ma, Z.Y. Performance analysis of GI/M/1 queue with working vacation and vacation interruption, Applied Mathematical Modelling 2008; 32(12), 2715-2730.
11. Manoharan. P and Jeeva. T . Impatient customers in an M/M/1 single vacation queue and setup time, International journal of information and computing science 2018; Vol.5, Issue.12, pp. 56-63 .
12. Manoharan. P and Ashok. Impatient customers in an M/M/1 single vacation queue and setup time, Solid State Technology 2020; Vol. 63, Issue. 6, pp. 5969-5975.
13. Servi, L.D. and Finn, S.G. M/M/1 queues with working vacations (M/M/1/WV), Perform 2002; Eval. 50: 41-52.
14. Takagi, H. Queueing Analysis, A Foundation of Performance Evaluation Vacation and Priority Systems, Vol.1: North-Holland, New York.1991
15. Wu, D.A. and Takagi, H. M/G/1 queue with multiple working vacations, Performance Evaluation 2006; 63(7): 654-681.
16. Zhang, M. and Hou, M. Performance analysis of MAP/G/1 queue with working vacations and vacation interruption, Applied Mathematical Modelling 2011; 35(4): 1551-1560.
17. Zhang, Z.G. and Tian, N. Analysis of queueing systems with synchronous single vacation for some servers, Queueing Systems 2003a; 45: 161-175.
18. Zhang, Z.G. and Tian, N. Analysis on queueing systems with synchronous vacations of partial servers, Perform. Eval 2003b; 52: 269-282.





Effects of Salt Stress on Accumulation of Osmolytes and Antioxidant Compounds in *Excoecaria agallocha* L.

Jamuna Nagarajan¹, Sozharajan Rajendren² and Natarajan Sabanayagam^{3*}

¹Research Scholar, Department of Botany, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India

²Guest Lecturer, Department of Botany, Govt Arts College, Attur, Salem, Tamil Nadu, India

³Professor, Department of Botany, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India.

Received: 30 Apr 2022

Revised: 28 May 2022

Accepted: 09 July 2022

*Address for Correspondence

Natarajan Sabanayagam

Professor, Department of Botany,
Annamalai University, Chidambaram,
Tamil Nadu, India.

Email: s.natarajan20@yahoo.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of this study was to see how varying sodium chloride concentrations affected the accumulation of osmolytes and antioxidant compounds in different parts of *Excoecaria agallocha*. The plant could withstand NaCl concentrations ranging from 100 to 1000 mM. The upper limit for this species survival was 500 mM NaCl. However, the seedlings positive growth response was limited to 300 mM NaCl. The accumulation of osmolytes such proline and glycine betaine was increased to 500 mM NaCl. Up to 300 mM NaCl antioxidant compounds including catalase, peroxidase and superoxide dismutase significantly increase. The enzyme activity steadily decreased at higher concentrations.

Keywords: Mangroves, *E. agallocha*, Salinity, Osmolytes, Antioxidant compounds

INTRODUCTION

Salinity is critical stressor in agricultural production. It will be difficult to feed 9.3 billion people in 2050. It is anticipated that agricultural production will need to expand by more than 60% from 2005-2007 levels by 2050 [1]. Stress circumstances such as salinity, on the other hand, are always a threat to capable agricultural productivity [2]. Plant growth, yield and quality production are all hampered by salinity in the soil [3]. The tendency of soil Stalination is increasing, despite the fact that more than 950 million hectares of land are affected by salt stress [4]. Osmotic stress, ionic stress and secondary stress, i.e., reactive oxygen species (ROS) over accumulation, are the three main components of salt stress in plants [5]. To begin with, high salinity lowers the water potential around plant





Jamuna Nagarajan *et al.*,

roots when salt stress occurs, decreasing root water absorption [6]. Second, ion toxicity is caused by an excess of sodium and chloride in plants. It not only disturbs ion homeostasis, such as Na⁺ and K⁺ homeostasis [7], but it also prevents the efficient uptake of nutritional elements [8, 9]. Plants suffer from oxidative stress as a result of osmotic and ionic stressors that cause an over abundance of reactive oxygen species [10]. Excess, superoxide anion (O₂⁻) and hydrogen peroxide (H₂O₂) accumulate in chloroplasts and mitochondria, impairing photosynthesis and respiration of plants during salt stress [11]. Furthermore, ROS can disrupt the structure of macromolecules like DNA and protein [12]. ROS scavenging in plants mainly involves the antioxidant compounds like catalase, peroxides and superoxide dismutase [13, 9]. Catalase and peroxides mainly scavenge hydrogen peroxide accumulated in plants [14, 15]. Superoxide dismutase catalyzes O₂⁻ to produce H₂O₂ and O₂ [16]. The objective of the present investigation was to study the effect of salt stress on accumulation of osmolytes and antioxidant compounds in *Excoecaria agallocha*.

MATERIALS AND METHODS

The species *Excoecaria agallocha* L., an evergreen mangrove, was used in this study. Pichavaram was the source of the mature seedlings. Healthy seedlings of uniform size were planted individually in polythene bags, which was filled with a homogenous mixture of garden soil containing red soil, sand and farmyard manure combined in a 1:2:1 ratio, and irrigated on a regular basis. Salt stress was applied to one month old seedlings at various NaCl concentrations. The treatment consisted to 100 - 1000 mM NaCl. Each of the NaCl concentrations was applied to fifty plants. There was no exogenous salt addition in the control group. On the 90th day after salt treatment, a second sampling was taken for these studies.

Examine the Osmolytes

Proline and Glycine betaine was determined by the method of [17] and [18].

Determination of Antioxidant Compounds

Catalase was measured by [19].

Peroxidase activity was measured by [20].

Superoxide dismutase activity was described by [21].

STATISTICAL ANALYSIS

With three replicates of each treatment, the experiment was set up in a (CRBD) completely randomized block design. With the help of the SPSS 16.0 software programmed, the results were analysed using one way ANOVA with a significance level of $P \leq 0.05$ and means were separated using Duncan ($P \leq 0.05$). Three replications were used to calculate means and standard errors.

RESULTS AND DISCUSSION

Figure 1 and 2 shows the influence of NaCl on proline and glycine betaine content in the leaf, stem and root. With increasing NaCl concentrations up to 500 mM, the levels of proline and glycine betaine in all three tissues gradually increased. In comparison to the stem and root, the leaf had more osmolytes. Proline is one of the most essential osmolytes, serving as antioxidants to scavenge ROS [22, 12], as well as preserving osmotic balance and membrane integrity [12]. According to our findings, *E. agallocha* accumulated considerably more proline under high NaCl stress than under lower salt conditions. Some halophytes like *C. pepo* [23] and *H. ammodendron* [12] showed similar results. According to Ahmad *et al.* [24] Gb is generated within the cell from either choline or glycine. The enzymes choline monooxygenase (CMO) and betaine aldehyde dehydrogenase (BADH) are involved in the two step synthesis of glycine betaine from choline. When exposed to NaCl stress, the levels of osmoprotectants increased. It can retain thylakoid and plasma membrane integrity at higher salinities [25]. Figure 3-5 shows the effects of NaCl on catalase, peroxidase and superoxide dismutase activities in the leaf, stem and root at different NaCl concentrations. All enzyme activity increased steadily until 300 mM NaCl was reached. The activity of these enzymes gradually





Jamuna Nagarajan et al.,

decreased at higher concentrations. The activities of these enzymes in the leaves were higher than those in the stem and root. Malar *et al.* [26] found that the catalase enzyme is involved in the main defense mechanism against the buildup and toxicity of reactive oxygen species. The CAT enzyme removes cellular hydrogen peroxide and protects the cell from oxidative damage. Plants ROS processing enzyme activity is often increased under stress conditions [27, 28]. With increasing salinity, peroxidase activity increased as well, reaching an optimum level of 300 mM NaCl. Peroxidase activity was observed to increase with increasing salt concentration in *Aegiceras corniculatum* [29]. Peroxidase is engaged not only in the oxidation of toxic substances, growth and development processes, but also in the decomposition of co-substrates such as phenolic compounds and antioxidants [30, 31]. In *Excoecaria agallocha*, sodium chloride increased superoxide dismutase activity until it reached an optimal concentration, after which it gradually decreased as salinity increased. The SOD content increased up to an optimal level in certain halophytes, *Acanthus ilicifolius* [32], *Alternanthera bettzickiana* [33] and *Iris lactea* [34]. SOD activity increases in response to salt stress, which can be viewed as a defense mechanism for scavenging ROS and eventually leading to salt tolerance. An increase in the rate of ROS production may be linked to increased antioxidant activity of SOD. SOD protects organisms from ROS damage [35]. The increased CAT, POD and SOD of *E. agallocha* plants cultivated in soil in this study could imply ROS generation caused by increasing salt. *Bruguiera parvifolia* [36], *Atriplex portulacoides* [37], and *Cenopodium quinoa* [38] were shown to have similar results.

CONCLUSION

In conclusion, the findings of this study suggest that higher osmolyte accumulation and antioxidant defense system activity may provide superior protection against reactive oxygen species under salinity stress.

ACKNOWLEDGEMENTS

The authors are thankful to Professor Dr. K. C. Ravindren, Head of the Department of Botany, Annamalai University for having provided laboratory facilities.

REFERENCES

1. Fita, A., Rodriguez-Burruezo, A., Boscaiu, M., Prohens, J., and Vicente, O. 2015. Breeding and domesticating crops adapted to drought and salinity: a new paradigm for increasing food production. *Front. Plant Sci.* Vol. 6: 978.
2. Qian, D., Xiong, S., Li, M., Tian, L., and Qu, L.Q. 2021. *OsFes1C*, a potential nucleotide exchange factor for *OsBiP1*, is involved in the ER and salt stress responses. *Plant Physiol.* Vol. 187: 396-408.
3. Yang, Y., and Guo, Y. 2018a. Elucidating the molecular mechanisms mediating plant salt stress responses. *New Phytol.* Vol. 217: 523-539.
4. Yang, Y., and Guo, Y. 2018b. Unraveling salt stress signaling in plants. *J. Integr. Plant Biol.* Vol. 60: 796-804.
5. Morton, M.J.L., Awlia, M., Al-Tamimi, N., Saade, S., Pailles, Y., and Negrao, S. 2018. Salt stress under the scalpel - dissecting the genetics of salt tolerance. *Plant J.* Vol. 97: 148-163.
6. Negrao, S., Schmoekel, S.M., and Tester, M. 2016. Evaluating physiological responses of plants to salinity stress. *Ann. Bot.* Vol. 119: 1-11.
7. Zhu, J.K. 2002. Salt and drought stress signal transduction in plants. *Annu. Rev. Plant Biol.* Vol. 53: 247-273.
8. Wu, H. 2018a. Plant salt tolerance and Na⁺ sensing and transport. *Crop J.* Vol. 6: 215-225.
9. Li, Z., Hu, Y., Chang, M., Kashif, M.H., Tang, M., and Luo, D. 2021. 5-azacytidine pre-treatment alters DNA methylation levels and induces genes responsive to salt stress in kenaf (*Hibiscus cannabinus* L.). *Chemosphere.* Vol. 271: 129562.
10. Wu, H., Lana, S., Elisa, A., Huang, Y., Camilla, P., and Su, N. 2018b. Na⁺ extrusion from the cytosol and tissue-specific Na⁺ sequestration in roots confer differential salt stress tolerance between durum and bread wheat. *J. Exp. Bot.* Vol. 69: 3987-4001.





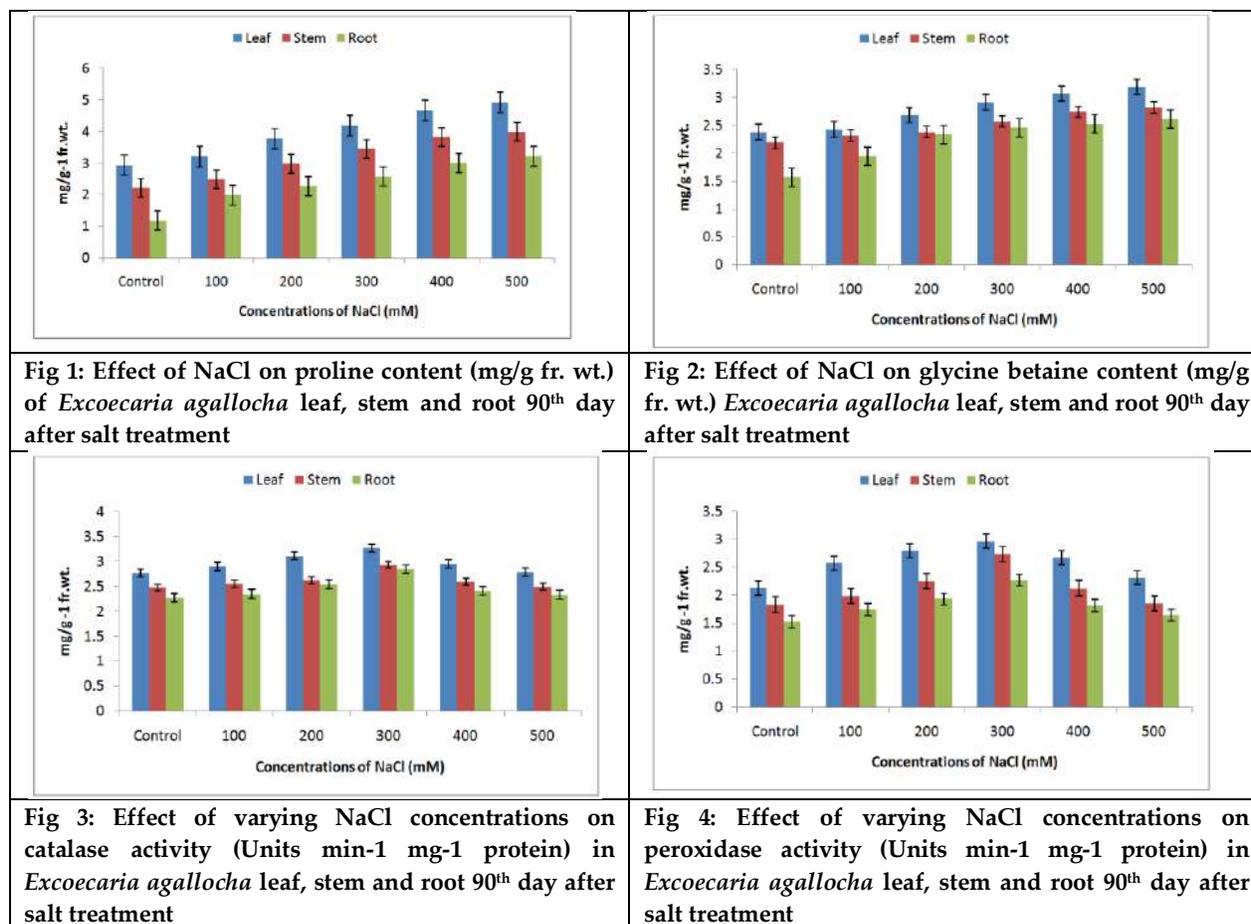
Jamuna Nagarajan et al.,

11. Balal, R.M., Ashraf, M.Y., Khan, M.M., Jaskani, M.J., and Ashfaq, M. 2011. Influence of salt stress on growth and biochemical parameters of citrus rootstocks. Pak. J. Bot. Vol. 43: 2135-2141.
12. Hu, D., Lv, G., Qie, Y., Wang, H., Yang, F., and Jiang, L. 2021. Response of morphological characters and photosynthetic characteristics of *Haloxylon ammodendron* to water and salt stress. Sustainability. Vol. 13: 388.
13. Irshad, A., Rehman, R.N.U., Abram, M.M., Saeed, Q., Sharif, R., and Hu, T. 2021. Contribution of rhizobium-legume symbiosis in salt stress tolerance in *Medicago truncatula* evaluated through photosynthesis, antioxidant enzymes, and compatible solutes accumulation. Sustainability. Vol. 13: 3369.
14. Hou, Q., Ufer, G., and Bartels, D. 2016. Lipid signaling in plant responses to abiotic stress. Plant Cell Environ. Vol. 39: 1029-1048.
15. Liu, J., Shen, F., Xiao, Y., Fang, H., and Han, Z. 2020. Genomics-assisted prediction of salt and alkali tolerances and functional marker development in apple rootstocks. BMC Genomics. Vol. 21: 550.
16. Zhu, J.K. 2016. Abiotic stress signaling and responses in plants. Cell. Vol. 167: 313-324.
17. Bates, L.S., Waldren, R.P., and Teare, I.D. 1973. Rapid determination of the free proline in water stress studies. Plant Soil. Vol. 38: 205-8.
18. Grieve, C.M., and Grattan, S.R. 1983. Rapid assay for determination of water soluble quaternary ammonium compounds. Plant Soil. Vol. 70: 303.
19. Chandlee, J.M., and Scandalios, J.G. 1984. Analysis of variants affecting the catalase development programme in maize scutellum. Theoretical and Applied Genetics. Vol. 69: 71-77.
20. Kumar, K.B., and Khan, P.A. 1982. Peroxidase and polyphenol oxidase in excised rai (*Eleusine corocana* CN. Pr. 202) levels during senescence. Indian J Exp Biol. Vol. 5: 412-416.
21. Beauchamp, C., and Fridovich, I. 1971. Superoxide dismutase: improved assays and an assay applicable to acrylamide gels. Analytical Biochemistry. Vol. 44(1): 276-287.
22. Brahimova, U., Kumari, P., Yadav, S., Rastogi, A., and Brestic, M. 2021. Progress in understanding salt stress response in plants using biotechnological tools. J Biotechnol. Vol. 329: 180-191.
23. Siddiqui, M.H., Al-Whaibi, M.H., Faisal, M., and Sahli, A. 2015. Nano-silicon dioxide mitigates the adverse effects of salt stress on *Cucurbita pepo* L. Environ. Toxicol. Chem. Vol. 33: 2429-2437.
24. Ahmad, R., Lim, C.J., and Kwon, S.Y. 2013. Glycine betaine: a versatile compound with great potential for gene pyramiding to improve crop plant performance against environmental stresses. Plant Biotechnol Rep. Vol. 7: 49-57.
25. Rhodes, D., and Hanson, A.D. 1993. Quaternary ammonium and tertiary sulfonium in higher plants. Ann Rev Plant Physiol Plant Mol Biol. Vol. 44: 357-384.
26. Malar, S., Vikram, S.S., Favas, P.J.C., and Perumal, V. 2014. Lead heavy metal toxicity induced changes on growth and antioxidative enzymes level in water hyacinths [*Eichhornia crassipes* (Mart.)]. Bot Stud. Vol. 55: 515-521.
27. Kibria, M.G., Hossain, M., Murata, Y., and Hoques, A. 2017. Antioxidant defense mechanisms of salinity tolerance in rice genotypes. Rice Sci. Vol. 24: 155-162.
28. Noctor, G., Reichheld, J.P., and Foyer, C.H. 2018. ROS-related redox regulation and signaling in plants. Semin Cell Dev Biol. Vol. 80: 3-12.
29. Manikandan, T., and Venkatesan, A. 2004. Influence of NaCl on growth, organic constituents and certain antioxidant enzymes of *Aegiceras corniculatum* Blanco. Geobios. Vol. 31: 30-33.
30. Dicko, M.H., Gruppen, H., Traore, A.S., Voragen, A.G.J., and Van Berkel, W.J.H. 2006. Phenolic compounds and related enzymes as determinants of sorghum for food use. Biotechnol Mol Biol Rev. Vol. 1: 21.
31. Maqtari, M.A., and Nagi, H.M. 2014. Screening of Salt-stress, Antioxidant Enzyme, and Antimicrobial Activity of Leave extracts of Mangroves *Avicennia marina* L. from Hodaidah, Yemen. J Stress Physiol Biochem. Vol. 10(2): 190-199.
32. Shackira, A.M., and Puthur, J.T. 2017. Enhanced phytostabilization of cadmium by a halophyte -*Acanthus ilicifolius* L. Int J Phytoreme. Vol. 19(4): 319-326.
33. Tauqeer, H.M., Ali, S., Rizwan, M., Ali Saeed, R., and Iftikhar, M. 2016. Phytoremediation of heavy metals by *Alternanthera bettzickiana*: growth and physiological response. Ecotox Environ Safe. Vol. 126: 138-146.





34. Guo, G., Meng, L., Zhang, Y., Mao, P., Tian, X., Li, S., and Zhang, L. 2017. Antioxidative systems, metal ion homeostasis and cadmium distribution in *Iris lactea* exposed to cadmium stress. *Ecotoxicol Environ Saf.* Vol. 139: 50-55.
35. Ahmad, I.T., Khaliq, A., Ahmad, S.M.A., Basra, Z., and Hussain, A. 2012. Effect of seed priming with ascorbic acid, salicylic acid and hydrogen peroxide on emergence, vigor and antioxidant activities of maize. *Afr J Biotechnol.* Vol. 11: 1127-1132.
36. Parida, A.K., Das, A.B., and Mohanty, P. 2004. Defense potentials to NaCl in a mangrove, *Bruguiera parvifolia*: differential changes of isoforms of some antioxidative enzymes. *J Plant Physiol.* Vol. 161: 531-542.
37. Benzarti, M., Rejeb, K.B., Debez, A., Messedi, D., and Abdelly C. 2012. Photosynthetic activity and leaf antioxidative responses of *Atriplex portulacoides* subjected to extreme salinity. *Acta Physiol Plant.* Vol. 34:1679-1688.
38. Amjad, M., Akhtar, S.S., Yang, A., Akhtar, J., and Jacobsen, S.E. 2015. Antioxidative response of quinoa exposed to iso-osmotic ionic and non-ionic salt stress. *J Agron Crop Sci.* Vol. 201: 452-460.





Jamuna Nagarajan et al.,

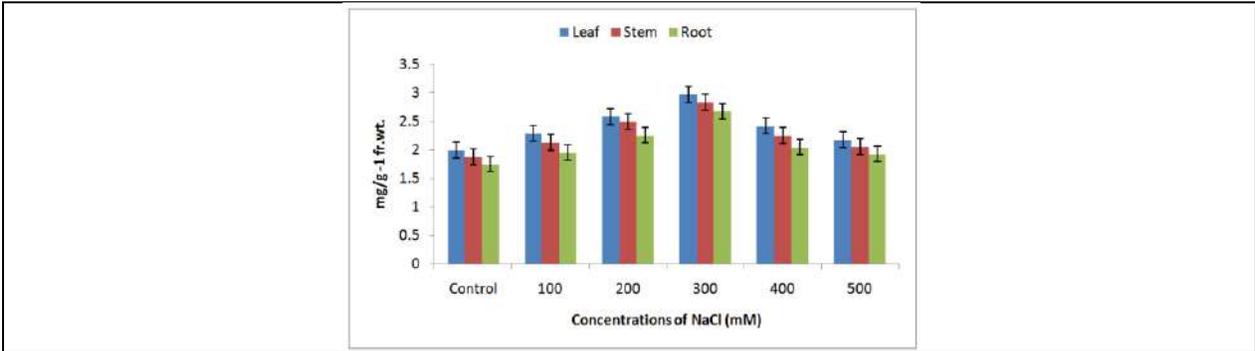


Fig 5: Effect of varying NaCl concentrations on SOD activity (Units min⁻¹ mg⁻¹ protein) in *Excoecaria agallocha* leaf, stem and root 90th day after salt treatment





RESEARCH ARTICLE

Ethnomedicinal plants used by the Vetans of Kanniyakumari District, Tamil Nadu, India

S. Jayakumar¹, M.S. Kala Swarna², T.S. ShyninBrintha³, C. Domettila⁴, R. Mary Sujin⁵,
A. R. Florence⁶, A. AyunVinuba⁷, V. Sathia Geetha⁸ and S. Jeeva^{3*}

¹Assistant Professor, Department of Botany, Nesamony Memorial Christian College, Marthandam, Kanyakumari, Tamil Nadu, India.

²Research Scholar, Department of Botany, Scott Christian College (Autonomous), Nagercoil, Tamil Nadu, India.

³Assistant Professor, Department of Botany, Scott Christian College (Autonomous), Nagercoil, Tamil Nadu, India.

⁴Assistant Professor, Department of Botany, St. Jude's College, Thoothor, Tamil Nadu, India.

⁵Assistant Professor, Department of Botany, P.T.M.T.M College, Kamuthi, Ramanathapura, Tamil Nadu, India.

⁶Assistant Professor, Department of Botany, Holy Cross College (Autonomous), Nagercoil, Tamil Nadu, India.

⁷Assistant Professor, T.D.M.N.S College, T. Kallikulam, Tirunelveli, Tamil Nadu, India.

⁸A.V.V.M. Sri Pushpam College. Poondi, Thanjavur, Tamil Nadu, India.

Received: 14 May 2022

Revised: 15 June 2022

Accepted: 18 July 2022

*Address for Correspondence

S. Jeeva

Assistant Professor,
Department of Botany, Scott Christian
College (Autonomous), Nagercoil,
Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

An ethnobotanical survey was carried out among the *Vetan* community people who inhabit in periphery of the southern Western Ghats of Kanniyakumari district. A total of 153 plant species distributed in 134 genera belonging to 60 families were identified as commonly used ethnomedicinal plants used by the *Vetan* communities for the treatment of various ailments. The documented ethnomedicinal plants were mostly used to cure skin diseases, fever, ulcer, cold and cough and rheumatism. Leaves were the most frequently used plant parts. Herbs (70 taxa) were the primary source of medicine, followed by shrubs (52 taxa) trees (30 taxa), climbers (8 taxa). Medicinal plants are arranged alphabetically to their botanical names, vernacular names, family, part of the plant used and ethnomedicinal uses are tabulated along with their major phytochemical constituents. This finding reveals that the study area rich in medicinal flora and the community people still using medicinal plants in their daily life. Traditional knowledge of





Jayakumar et al.,

this community people should be recorded before it disappears. Their knowledge should be saved for future generations. Pharmacological investigation should be done for the plants with more use for finding potential new drugs.

Keywords: Ailments, Ethnobotany, Kanniyakumari, *Vetan* Community.

INTRODUCTION

According to the World Health Organization (WHO) about 65-80 % of the world's population in developing countries depends essentially on plants for their primary healthcare due to poverty and lack of access to modern medicine (1). About 85% of the rural population of India depends on varieties of plants for the treatment of various diseases they suffer from (2). India is rich in cultural and floristic diversity and also storehouse of ethnobotanical knowledge. The indigenous tribal communities possess a broad knowledge about medicinal plants, passed through oral communication from generation to generation (3). The knowledge of the tribes, associated with the traditional healing practices using plants, is now fast disappearing due to modernization, rate of deforestation with the concurrent loss of biodiversity, there is a need for accurate documentation of the tribal knowledge. During the last few decades there has been an increasing interest in the study of medicinal plants and their traditional use in different parts of India. In the recent years number of reports on the use of plants in traditional healing by either tribal people or indigenous communities of India is increasing (4-8). There is no report available in the literature about *Vetan* community people. Therefore this study was undertaken to ascertain the detailed information on plants used by *Vetan* community people and their usage based on ethnobotanical knowledge.

MATERIALS AND METHODS

Study area and people

Shankaranputhur is a small village situated near Kulasekeranputhur, with 40 acres of land in Kanniyakumari district and covers an area of nearly 1684 sq. kms. This village was named after 'Shankaranthambi' who was the Divan of Travancore King. In Tamil language the word 'Vettuvan' or 'Vetan' means hunter. Most of the people are farmers. The grains produced were transported to Travancore Samasthanam with the help of bullock carts. Farmers suffered a lot to bring their yield to Samasthanam. The King knew their difficulties and provided land as well a shield (*Cheppu Patayam*- shield containing details about *Vetan* community). *Vetan* community people have the knowledge of medicinal plants that are used for first aid remedies and other simple ailments. They still depend on medicinal plants to meet their primary healthcare needs.

Data collection

An ethnobotanical survey was conducted among the *Vetan* community people who inhabit Shankaranputhur village of Kanniyakumari district. Intensive field surveys were conducted between July 2019 and August 2020 according to the methods proposed by Martin (1995), with slight modifications. During the study trips, information were gathered by interviewing the local medicine men, experienced old aged people who have good knowledge about the medicinal uses of plants. Hundred seventy eight informants (98 males and 80 females) between the ages of 35-50 were consulted to gather information in the study area. Ethnobotanical information was collected through questionnaires and discussions among the informants in their local language (Tamil), which include formulations such as mode of preparation (*i.e.*, decoction, paste, powder and juice), diseases it cured and the dosage. Plant specimens were collected, prepared herbariums and identified with the help of local and regional floras (9,10). Plant names have been checked and updated with the online website (www.theplantlist.org) of the Royal Botanic Gardens, Kew. Herbarium specimens were deposited in the Department of Botany, Nesamony Memorial Christian College, Marthandam.



Jayakumar *et al.*,

RESULTS AND DISCUSSION

The present investigation revealed that the *Vetan* community people were using 153 plant species distributed in 134 genera belonging to 60 families for medicinal use. Euphorbiaceae (10 taxa) and Solanaceae (9 taxa) predominates followed by Amaranthaceae (8 taxa), Cucurbitaceae (8 taxa), Fabaceae (8 taxa), Verbenaceae (7 taxa), Lamiaceae (6 taxa), Asteraceae (5 taxa), Malvaceae (5 taxa), Moraceae (5 taxa), Rutaceae (5 taxa), Arecaceae (5 taxa), Mimosaceae (4 taxa), Poaceae (4 taxa), Caesalpiniaceae (3 taxa), Asclepiadaceae (3 taxa), Araceae (2 taxa), Apiaceae (2 taxa), Annonaceae (2 taxa), Convolvulaceae (2 taxa), Nyctaginaceae (2 taxa), Rubiaceae (2 taxa), Sapotaceae (2 taxa), Zingiberaceae (2 taxa) remaining families were monospecific. Ahmad *et al.* (11) and Ogbulie *et al.* (12) reviewed a variety of Euphorbiaceae family contains wide variety of phytochemicals including alkaloids, phenols, flavonoids, saponin, tannins and essential oils and described their origins, characteristics and their therapeutic uses. For each species, botanical names, local names, family, habit, part used, method of preparation, ailments treated and the phytochemical constituents are provided (Table 1).

Vetan community people are using these plants to cure diseases like asthma, blood pressure, chicken-pox, constipation, cough & cold, diabetics, diarrhea, epilepsy, fever, bone fracture, headache, jaundice, malaria, menstrual disorder, oral disease, (bleeding gums, mouth blisters, tooth ache), piles, poison bites (dog bite, snake bite), skin diseases (eczema, leprosy, ring worm, burns, cut, wounds), stomach complaints (ulcer). Similar studies were done among *Kani* tribes of Pechiparai forest and documented 58 medicinal plants belonging to 27 families to treat various ailments (13). Herbs (70 species) 44% were found to be the most used plants species followed by shrubs (52 species) 32 %, trees (30 species) 19% and climbers (8 species) 5% (Figure 1). The frequent use of herbs among the indigenous communities is the result of a wealth of herbaceous plants in their environs (3). Among the different plant leaves (80 species) were most frequently used for the traditional medicine preparation followed by fruits (40 taxa), roots (28 taxa), whole plant (15 taxa), bark, seed and stem (10 taxa each), bulbs (2 taxa), rhizome (5 taxa), tuber (4 taxa). Many indigenous communities elsewhere also utilized mostly leaves for medicine preparation (14-17). Medicines were prepared in the form of paste, powder, juice, infusion and decoction. Preparing paste for the treatment of ailments was a widespread practice among the tribal communities in India (3).

In the present study, plants like *Abutilon indicum*, *Phyllanthus amarus* were used for healing wounds, while *Eclipta prostrata*, *Vitex negundo* were used to cure head ache. *Punica granatum* was used to treat abdominal pain. *Terminalia catappa* used to treat asthma, *Cynodon dactylon* used for body ache, *Coccinia grandis* was used as a remedy for cholera, *Acalpha indica* to treat ear ache and constipation, *Ocimum tenuiflorum* leaf paste was used to cure cough, cold and ear ache and *Phyllanthus emblica* fruit was used to heal skin diseases and as a blood purifier. In the present study 4 plant species *Achyranthes aspera*, *Mukia maderaspatana*, *Raphanus sativus* and *Aristolochia bracteolata* were used to treat pneumonia, fever, cuts and wounds. These findings were correlated with the *Kani* tribals in Kanniyakumari district, Tamil Nadu, India (18) and Margala hills national park tribal people (19). In the present study, some of these plants are given for problems such as white discharge (*Tephrosia purpurea*), *Solanum surattense* and *Calotropis gigantea* are applied for tooth infections *Acalpha indica*, *Adhatoda vasica*, *Euphorbia hirta*, *Ocimum tenuiflorum*, *Solanum surattense* and *Leucas aspera* were used for asthma, cold, cough, and fever. The same plants were used by the tribals of Kanjamalai hills of Salem district of Tamil Nadu (20). The *Vetan* people used the stem and leave for decoction of *Solanum surattense* to cure fever, cough and asthma. These findings were compared with earlier work (21-23).

Kidney stone and urinary tract disorders are treated with *Beta vulgaris*, *Aerva lanata*, *Tridax procumbens*, *Tribulus terrestris* and *Ricinus communis* (19). In the present study 5 plant species (*Tephrosia purpurea*, *Acacia nilotica*, *Aerva lanata*, *Ipomea quamoclit* and *Tribulus terrestris*) were used to treat urinary tract disorders. The bulb juice of *Allium sativum* and *Allium cepa* plants were used to cure diabetes, hypertension, cooling agent for eyes and also to treat leprosy (23). Leaf extract of *Phyllanthus nodiflora* was used to reduce dandruff, skin related disease and for joint pains. Similarly, the same plant is used by the rural people of Attock district [21]. *Cynodon dactylon* was used to treat wounds and also used for cracks in foot (21-23). In addition major phytochemical constituents of the ethnomedicinal





Jayakumar et al.,

plants studied in this paper. Of the 153 plants studied, major phytochemical constituents are reported for 150 plants (Table 1). From this account it was clear that the *Vetan* community people, like other ancient communities have the awareness about the character of various plants and their beneficial properties.

CONCLUSION

This study shows that usage of plants for treating various ailments is still practiced by *Vetan* community people. Documentation of this knowledge is valuable for the communities and their future generations and for scientific consideration of wider uses of traditional knowledge. The findings of the investigation envisage that the medicinal plants have excellent potentiality to treat various ailments. Their mode of preparation and mode of administration are also easy and suitable and the treatment has no side effects. This study would provide some basic clues of medicinal properties of plants used by native of *Vetan* community of Shankaranputhur village, Kanniyakumari district of Tamilnadu. Ethnomedicinal studies clearly defined that the knowledge of medicinal plants is important not just for *Vetan* themselves but for the entire world.

REFERENCES

1. Farnsworth NR, Kerele O, Bingei AS (1985). Medicinal plants in therapy. *Buletin of the World Health Organisation*, 63: 965-981.
2. Farnsworth NR, Jain SK (1994) Ethnopharmacology and drug development, In: *Ethnobotany and search for New Drugs*, edited by DJ Chadwick & March U, (Ciba Foundation Symposium 183, Wiley, Chichester), pp. 153.
3. Sukumaran S, Sujin RM, Geetha VS, Jeeva S (2021) Ethnobotanical study of medicinal plants used by the Kani tribes of Pechiparai Hills, Western Ghats, India. *Acta Ecologica Sinica*, 41(5), 365-376.
4. Pradeesh DS, Sukumaran S, Jeeva S, Jenisha SR (2020) Ethnobotanical Studies of Kanies in Mothiramalai, Kilamalai Reserve Forest, Kalial Range, Kanniyakumari Forest Division, Tamilnadu. *High Technology Letters* 26(7): 989-1002.
5. Karuppusamy S (2007) Medicinal plants used by Paliyan tribes of Sirumalai hills of Southern India. *Natural product Radiance*, 6: 436-442.
6. Jeeva S, Florence AR, Sujin RM (2019) Therapeutic biology of *Gmelina asiatica* Linn. In *Ethnomedicinal Plants with Therapeutic Properties*, CRC Press, pp. 113-123.
7. Jeeva S, Joseph J, Sujin RM (2019) *Hyptis suaveolens* (L.) Poit.: a review of its ethnobotany, phytochemical, and pharmacological profile. *Ethnomedicinal Plants with Therapeutic Properties*, CRC Press, pp.125-148.
8. Prakash JW, Raja RD, Anderson NA, Williams C, Regini GS, Bensar K, Rajeev R, Kiruba S, Jeeva S, Das SSM (2008) Ethnomedicinal plants used by Kani tribes of Agasthiyarmalai biosphere reserve, southern Western Ghats. *Indian Journal of Traditional Knowledge*, 7(3): 410-413.
9. Gamble JS, Fischer CEC (1915-1935) *Flora of the Presidency of Madras*. Adlord and Sons Limited, London.
10. Nair NC, Henry AN (1983) *Flora of Tamil Nadu, India*, Botanical Survey of India, Coimbatore.
11. Ahmad M, Khan MA, Qureshi RA (2003) Ethnobotanical study of some cultivated plants of Chhuchh Region (District Attock), *Hamdard Medicus*, 46(3) :15-19.
12. Ogbulie JN, Ogueke OO, Okoli IC, Anyanwu BN (2007) Antibacterial activities and toxicological potentials of crude ethanolic extracts of *Euphorbia hirta*. *African Journal of Biotechnology*, 6: 1544-1548.
13. Subitha T, Ayyanar M, Udaya Kumar M, Sekar T (2011) Ethnomedicinal plants used by Kani tribals in Pechiparai forests of Southern Western Ghats, Tamilnadu, India. *Journal of Plant Science* 2, 349-354.
14. Laloo RC, Kharlukhi L, Jeeva S, Mishra BP (2006) Sacred forests of Mehalaya as a treasure house of Medicinal plants: effect of disturbance and population structure of important tree specioes. *Current Science*, 9(2): 225-232.
15. Jeeva S, Femila V (2012) Ethnobotanical investigation of Nadars in Atoor village, Kanniyakumari District, Tamilnadu, India. *Asian Pacific Journal of Tropical Biomedicine*, 2(2), pp.S593-S600.





16. Prakash JW, Raja RD, Anderson NA, Williams C, Regini GS, Bensar K, Rajeev R, Kiruba S, Jeeva S, Das SSM (2008) Ethnomedicinal plants used by Kani tribes of Agasthiyarmalai biosphere reserve, southern Western Ghats. *Indian Journal of Traditional Knowledge*, 7(3): 410-413.
17. Kingston C, Jeeva S, Jeeva GM, Kiruba S, Mishra BP, Kannan D (2009) Indigenous knowledge of using medicinal plants in treating skin diseases in Kanniyakumari district, Southern India. *Indian Journal of Traditional Knowledge*, 8(2): 196-200.
18. Ayyanar M, Ignacimuthu S (2005) Traditional knowledge of Kani tribals in Kouthalai of Tirunelveli hills, Tamilnadu India. *Journal of Ethnopharmacology*, 102 : 246- 255.
19. Katewa SS, Galav PK (2005) Traditional herbal medicines from Shekhawati region of Rajasthan. *Indian Journal of Traditional Knowledge*, 4(3): 237-245.
20. Alagesaboopathi C (2011) Ethnobotanical Studies on useful plants of Kanjamalai hills of Salem District of Tamil Nadu, Southern India. *Archives of Applied Science*, 3: 532-539.
21. Jenisha SR, Jeeva S (2014) Traditional remedies used by the inhabitants of Keezhakrishnanputhoor - a coastal village of Kanniyakumari district, Tamilnadu, India. *Medicinal and Aromatic plants*, 3(4): 175-180.
22. Sukumaran S, Brintha TSS, Subitha P, Sheeba YA, Jeeva S (2014) Usage of medicinal plants by two cultural communities of Kanniyakumari District, Tamilnadu, South India. *Journal of Chemical and Pharmaceutical Research*, 6(8): 67-79.
23. Kiruba S, Dhruw SK, Sahu PK, Geetha VS, Jeeva S (2014) Phytotherapeutic drugs used by the tribal folk of Achanakmar Amarkantak Biosphere Reserve, Central India. *International Journal of Pharma Research and Health Sciences*, 2(2), 157-65.

Table 1. List of ethnomedicinal plants used by the Vetan community people

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|---------------|-----------------|---------------------|--------------|---------|---|
| <i>Abelmoschus esculentus</i> (L.) Moench | Malvaceae | Vendai | Ladies finger | Fruit | Shrub | Daily intake of fruits helps in increasing the memory power and normalizes the blood sugar level. |
| <i>Abrus precatorius</i> L. | Fabaceae | Kunni | Crab's Eye | Leaf | Climber | Leaves with a little sugar chewed to get relieve from throat pain. |
| <i>Abutilon indicum</i> (L.) Sweet | Malvaceae | Thutti | Indian mallow | Leaf | Herb | Decoction is taken orally seven days for immediate recovery from bleeding piles |
| <i>Acacia nilotica</i> (L.) Willd | Mimosaceae | Karuvelam | Taruakadam | Bark | Tree | Bark paste applied on infectious parts to cure wounds, ulcer and gum mixture taken orally once a day to cure urinogenital discharges. |
| <i>Acalypha indica</i> L. | Euphorbiaceae | Kupaimeni | Indian copper leaf | Leaf | Herb | Leaf paste applied topically on scabies. |
| <i>Achyranthes aspera</i> L. | Amaranthaceae | Naiyurvi | Prickly chaf flower | Root | Herb | Root paste mixed with honey taken twice a day is given orally to cure cough. |
| <i>Acmella paniculata</i> (Wall. ex DC.) R.K.Jansen | Asteraceae | Manjal poochedi | Tooth ache plant | Flower | Herb | Flower paste applied externally to treat tooth ache. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|--|------------------|-------------------|------------------------|---------------|----------|---|
| <i>Acorus calamus</i> L. | Araceae | Vasambu | Sweet flag | Rhizome | Creepers | Rhizome decoction taken orally once in day to cure dysentery. |
| <i>Aegle marmelos</i> (L.) Correa | Rutaceae | Vilvam | Bengal quince | Fruit | Tree | Fruits and leaf decoction are taken for three day used to cure diarrhoea, fever. |
| <i>Aerva lanata</i> (L.) A. L. Juss. ex Schultes | Amaranthaceae | Sirukanpilai | Mountain knot grass | Leaf | Herb | Leaf decoction taken orally for 21 days used to cures kidney stone. |
| <i>Albizia lebeck</i> (L.) Benth. | Mimosaceae | Vagai | Lebeck tree, flea tree | Stem | Tree | Stem decoction are used to reduce cholesterol, cures asthma and rheumatism. |
| <i>Allium cepa</i> L. | Lilliaceae | Vengayam | Onion | Bulb | Herb | Bulb juice and paste used to treat ear ache and head ache. |
| <i>Allium sativum</i> L. | Lilliaceae | Vellaipundu | Garlic | Bulb | Herb | Daily intake of bulb cures gas trouble. |
| <i>Aloe vera</i> (L.) Burm. f. | Lilliaceae | Chothukathalai | Aloe | Root and Leaf | Herb | Root used to cure indigestion and leaf gel used to reduce Leucorrhoea. |
| <i>Alternanthera sessilis</i> (L.) R. Br. ex DC. | Amaranthaceae | Ponnangani keerai | Ruby alternanthera | Leaf | Herb | Daily intake of cooked leaves taken orally cures night blindness. |
| <i>Amaranthus roxburghianus</i> H.W.Kung | Amaranthaceae | Sirukeerai | Tumble weed | Leaf | Herb | Leaf paste is applied topically on affected places twice a day to heal wounds. |
| <i>Amaranthus spinosus</i> L. | Amaranthaceae | Mullukeerai | Prickly amaranth | Leaf | Herb | Cooked Leaves is taken orally used to cure anemia and fever. |
| <i>Amaranthus tricolor</i> L. | Amaranthaceae | Thandankeerai | Chinese spinach | Leaf | Herb | Decoction of leaves drunk to reduce the menstrual pain. |
| <i>Amaranthus viridis</i> L. | Amaranthaceae | Kuppaikeerai | Green amaranth | Leaf | Herb | Root decoction is used twice a day to control excess bleeding during menstruation. |
| <i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson | Araceae | Chenaikilangu | Elephant foot yam | Rhizome | Herb | Intake of cooked rhizome cures piles. |
| <i>Anisomeles malabarica</i> (L.) R. Br. ex. Sims | Lamiaceae | Perumthumbai | Malabar catmint | Leaf | Shrub | Leaves are boiled with water to cure rheumatic swelling and smoke inhaled to cure cough. |
| <i>Annona squamosa</i> L. | Annonaceae | Chethapalam | Custard apple | Leaf and Seed | Tree | Crushed leaf juice taken orally to heal stomach ulcers. Seed paste mixed with oil used to destroy lice from hair. |
| <i>Areca catechu</i> L. | Arecaceae | Pakkumaram | Areca nut | Seed | Palm | Seed paste is applied on infected parts to cure wounds. |
| <i>Aristolochia bracteolata</i> Lam. | Aristolochiaceae | Karudakodi | Ductman' s pipe | Leaf | Herb | Leaf paste is used applied topically to cure wounds and heals skin rashes. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|-----------------|--------------------|----------------------------|---------------|-----------|---|
| <i>Artocarpus heterophyllus</i> Lam. | Moraceae | Palamaram | Jack fruit tree | Fruit | Tree | Fruits used to cure skin diseases and reduce cough. |
| <i>Artocarpus hirsutus</i> Lam. | Moraceae | Ayenissakai | Anjili | Fruit | Tree | An infusion of the bark is applied to cure small pimples and cracks on the skin. |
| <i>Azadirachta indica</i> A. Juss. | Meliaceae | Veppamaram | Neem | Leaf bark | Tree | Leaf paste used to cure skin diseases and bark powder used to promote tooth strengthening. |
| <i>Azima tetracantha</i> Lam. | Salvadoraceae | Esanku | Needle brush | Leaf | Tree | Leaves are used to cure cough. |
| <i>Basella alba</i> L. | Basellaceae | Pasalikeerai | Indian spinach | Leaf | Herb | Cooked leaves are edible cures fungal infection in stomach. |
| <i>Bauhinia tomentosa</i> L. | Caesalpiniaceae | Eruvachi | Bauhinia | Flower | Tree | Juice of flower is used to cure diarrhoea, dysentery and paste to cure skin diseases. |
| <i>Beta vulgaris</i> L. | Chenopodiaceae | Beetroot | Beet root | Root | Herb | Root paste applied on infected area to cure burning sensation. |
| <i>Boerhavia diffusa</i> L. | Nyctaginaceae | Mukkuurataik eerai | Pigweed | Whole plant | Herb | Whole plant decoction along with jaggery taken once a day used to cure stomachache and fever. |
| <i>Borassus flabellifer</i> L. | Aracaceae | Panaimaram | Palmyra palm | Young fruit | Tall palm | Pulpy kernel water of palmara applied on the eyes to cure eye ache. |
| <i>Calotropis gigantea</i> (L.) Dryand. | Asclepiadaceae | Erukku | Crown flower, milk weed | Root and bark | Shrub | Root and bark decoction along with palm sugar taken for 21 day's cures elephantiasis. |
| <i>Canna indica</i> L. | Cannaceae | Kalvalai | Indian shot | Rhizome | Shrub | Rhizomes extract acts as diuretic and taken three day's to cure fever. |
| <i>Capsicum frutescens</i> L. | Solanaceae | Kantharimilagu | Red chilly | Fruit | Shrub | Fruits are edible and reduce blood cholesterol. |
| <i>Capsicum annum</i> L. | Solanaceae | Milagai | Long chilly | Fruit | Shrub | Daily intake of fruit enhances blood circulation. |
| <i>Cardiospermum halicacabum</i> L. | Sapindaceae | Mudakathhan | Balloon vine | Leaf | Climber | Decoction of leaves are used to cure rheumatism. |
| <i>Carica papaya</i> L. | Caricaceae | Pappali | Papaya or melon like fruit | Fruit | Tree | Fruits are edible and increases eye vision. |
| <i>Cassia auriculata</i> L. | Caesalpinaceae | Avarpoo | Tannres cassia | Leaf | Shrub | Leaf paste taken orally to cure gas trouble problems. |
| <i>Casuarina litorea</i> (L.) Diss. Forest. | Casurinaceae | Chavukku | Casurina | Bark | Tree | Bark decoction taken orally cures fever. |
| <i>Catharanthus roseus</i> (L.) G. Don. | Apocynaceae | Nithayakalyani | Periwinkle | Whole plant | Herb | Whole plant paste taken orally are used to cure leukemia and hypertension. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|---------------|----------------|-----------------------|---------------|---------|--|
| <i>Centella asiatica</i> (L.) Urb. | Apiaceae | Vallarai | Water pennywort | Leaf | Herb | Handful of leaves applied on skin to cure skin infection. It increases a memory power. |
| <i>Chrysanthemum indicum</i> L. | Asteraceae | Sevanthi | Chrysanthus | Flower | Shrub | Flower extract is drunk to cure fever, head ache and hypertension. |
| <i>Cissus quadrangularis</i> (L.) | Vitaceae | Pirandai | Adament creeper | Stem | Climber | Cooked stem is taken orally to cure stomach aches. |
| <i>Citrullus colocynthis</i> (L.) Schrad. | Cucurbitaceae | Kumattikkai | Bitter apple fruit | Root | Herb | Root paste applied on head before bath used to promote hair growth. |
| <i>Citrus aurantifolia</i> (Christm.) Swingle | Rutaceae | Narthakkai | Bitter orange tree | Leaf, fruit | Shrub | Leaves and fruit extract used to cure vomiting, fever and diabetic problems. |
| <i>Citrus limon</i> (L.) Osbeck | Rutaceae | Elumichai | Lemon | Fruit | Shrub | Fruit juice is taken to cure indigestion and jaundice. |
| <i>Cleome gynandra</i> L. | Capparidaceae | Thivalai | African spider flower | Leaf | Herb | Juice of leaf used to cure rheumatism, head ache and ear ache. |
| <i>Clerodendrum phlomidis</i> L. F | Verbenaceae | Vathamadaki | Arni | Leaf | Shrub | Leaf paste is applied on the forehead to cure headache and also cures rheumatic pain |
| <i>Clitoria ternatea</i> L. | Fabaceae | Sangupuhpam | Butterfly pea | Leaf | Shrub | Leaf paste applied topically over affected area to cure wounds. |
| <i>Coccinia grandis</i> (L.) Voigt. | Cucurbitaceae | Kovaikkai | Ivy-Gourd | Fruit | Climber | Raw fruits taken orally are used to cure stomach ulcer. |
| <i>Cocos nucifera</i> L. | Arecaceae | Thengu | Coconut | Whole plant | Tree | Coconut milk is used to cure administrated for 30 days jaundice, chickenpox. |
| <i>Colocasia esculenta</i> (L.) Schott. | Arecaceae | Chembukilangu | Taro, Elephant ear | Rhizome | Herb | Daily intake of cooked rhizome cures piles. |
| <i>Coriandrum sativum</i> L. | Apiaceae | Kothamalli | Coriander | Leaf | Herb | Leaves are used to cure jaundice and vomiting. |
| <i>Crataeva magna</i> (L.) DC. | Capparidaceae | Mavilingam | Three-lived caper | Root and Bark | Tree | Root and bark are used to treat skin inflammation. |
| <i>Crotalaria retusa</i> L. | Fabaceae | Killukilluppai | Devil bean | Leaf | Shrub | Leaf paste applied topically cures skin diseases. |
| <i>Cucumis sativus</i> L. | Cucurbitaceae | Vellerikkai | Cucumber | Fruit Seed | Climber | Fruits used as edible and powdered seeds are applied on infected area to cure burning sensation. |
| <i>Cucurbita maxima</i> Duchesne. | Cucurbitaceae | Pusanikai | Squash winter | Fruit | Climber | Fruits are edible and acts as coolant. |
| <i>Curcuma longa</i> L. | Zingiberaceae | Manjal | Turmeric | Rhizome | Herb | Rhizome paste applied topically cures skin infection. |
| <i>Cynbopogon citratus</i> (DC.) Stapf. | Poaceae | Vasanaipullu | Lemon grass | Leaf | Herb | Juice of wholeplant is drunk to cure head ache and |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|----------------|----------------|-----------------------------|----------------|---------|--|
| | | | | | | rheumatism. |
| <i>Cynodon dactylon</i> (L.) Pers. | Poaceae | Arukampullu | Bermuda grass | Leaf | Herb | Leaf juice taken orally to controls blood sugar level. |
| <i>Datura innoxia</i> Mill. | Solanaceae | Umathai | Devil's trumpet | Flower | Herb | Dried flowers are burnt and smoked to cure asthma. |
| <i>Dendrocalamus strictus</i> (Roxb.) Cor | Poaceae | Kalmungil | Bamboo | Leaf | Herb | Leaf juice taken for three days cures cough in children. |
| <i>Eclipta prostrata</i> (L.) Mant. | Asteraceae | Karisalangani | Trailing eclipta | Root | Herb | Root paste is applied to heal wounds. |
| <i>Erythrina variegata</i> L. | Fabaceae | Mullu murungai | Indian coral tree | Leaf | Tree | Leaves are used to cure leprosy. |
| <i>Euphorbia heterophylla</i> L. | Euphorbiaceae | Palperuki | Mole plant | Leaf | Herb | Cooked leaves taken orally cures diarrhoea. |
| <i>Euphorbia hirta</i> L. | Euphorbiaceae | amanpacharsi | Snake weed | Herb | Herb | Herb extract used as a medicine for cold and cough. |
| <i>Evolvulus alsinoides</i> L. | Convolvulaceae | Vishnukranthi | Slender dwarf morning glory | Leaf | Herb | Leaf paste applied over head before bathing promote growth of hair. |
| <i>Ficus benghalensis</i> L. | Moraceae | Alamaram | Baniyan tree | Root | Tree | Root boiled with coconut oil applied over head before bath used to cure dandruff and heals cracks on the foot. |
| <i>Ficus racemosa</i> L. | Moraceae | Athimaram | Athi tree | Leaf | Tree | Leaf juice given orally three times per day for three days cures brain fever. |
| <i>Ficus religiosa</i> L. | Moraceae | Arasu | Peepal tree | Bark | Tree | Bark paste applied topically is used to cure rheumatism. |
| <i>Gomphrena globosa</i> L. | Amaranthaceae | Vadammali | Globe amaranthus | Root | Herb | Root extract are used to cure cough. |
| <i>Helianthus annuus</i> L. | Asteraceae | suryakanthi | Sun flower | Seeds | Shrub | Seed powdered and taken orally reduce cholesterol and cure diabetics. |
| <i>Heliotropium indicum</i> L. | Boraginaceae | Thelkodukai | Indian turn sole | Leaf | Herb | Leaf paste used to cure ring worm infection. |
| <i>Hibiscus rosa-sinensis</i> L. | Malvaceae | Chembaruthi | Shoe flower | Leaf & flowers | Shrub | Leaf and flower boiled along with the coconut oil applied over head before bath enhance hair growth. |
| <i>Ipomoea quamoclit</i> L. | Convolvulaceae | Mayilmanikam | Cypress vine | Leaf | Climber | Leaf paste applied topically cures elephantsis diseases. |
| <i>Ixora coccinea</i> L. | Rubiaceae | Thettichedi | Sacred ixora | Leaf | Shrub | Leaf paste are used to cure skin infection and itching diseases. |
| <i>Jasminum angustifolium</i> (L.) Willd. | Oleaceae | kattupichi | Wild jasmine | Leaf | Shrub | Leaf paste applied topically cures skin diseases. |
| <i>Jasminum sambac</i> (L.) Aiton. | Oleaceae | Malligai | Jasmine | Flower | Shrub | Flower powder used to cure skin diseases. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|---------------|------------------|--------------------|---------------|---------|---|
| <i>Jatropha curcas</i> L. | Euphorbiaceae | Katamanaku | purging nut | Leaf | Shrub | Pasted leaves used to cure skin infection and eczema. |
| <i>Jatropha glandulifera</i> Roxb. | Euphorbiaceae | Adathalai | Glandular jatropa | Seed and root | Shrub | Seed oil applied topically cures rheumatism and root decoction used to cure abdominal pain. |
| <i>Justicia adhatoda</i> L.. | Acanthaceae | Adhatoda | Malabar nut | Leaf | Shrub | Leaf juice taken orally cures cough and heals bronchitis problem. |
| <i>Lantana camara</i> L. | Verbanaceae | Unnichi | Lantana weed | Leaf and Root | Shrub | Leaf paste used to cure ulcer and root decoction cures cough and cold. |
| <i>Lawsonia inermis</i> L. | Lythraceae | Maruthani | Henna | Leaf | Shrub | Leaf juice is used as cooling agent and its promote hair growth. |
| <i>Leucas aspera</i> (Willd.) Link. | Lamiaceae | Thumbai | Thumbai | Leaf | Herb | Leaf paste applied topically on forehead to cure head ache. |
| <i>Limonia acidissima</i> Groff. | Rutaceae | Vilankai | Wood apple | Fruit | Tree | Fruit pulp mixed with honey taken orally are used against heart diseases. |
| <i>Luffa acutangula</i> (L.) Roxb. | Cucurbitaceae | Peerkkangai | Ridged gourd | Fruit | creeper | Fruits are eaten to cure skin diseases. |
| <i>Lycopersicon esculentum</i> Mill. | Solanaceae | Thakkali | Tomato | Fruit | Herb | Intake of fruits effective in reducing cholesterol levels and lowering blood pressure. |
| <i>Madhuca longifolia</i> (J.Koenig) J.f. | Sapotaceae | Illupai | Indian butter tree | Root | Tree | Boil the root along with coconut oil applied topically in legs used to cure rheumatism |
| <i>Mangifera indica</i> L. | Anacardiaceae | Mangai | Mango tree | Flower | Tree | Flower decoction taken orally cures chronic dysentery. |
| <i>Manihot esculenta</i> Crantz. | Euphorbiaceae | Marchinikilangu | Tapioca | Tuber | Shrub | Cooked tubers are rich in starch. |
| <i>Manilkara zapota</i> (L.) P.Royen | Sapotaceae | Sapota | Sapota tree | Fruit | Shrub | Root powder is taken orally for three days to cure cough. |
| <i>Marsilea quadrifolia</i> L. | Verbenaceae | Aarakeerai | Frog fruit | Leaf | Shrub | Paste of leaf juice are applied over head to cure dandruff problem. |
| <i>Mentha arvensis</i> L. | Lamiaceae | Puthina | Mint | Leaf | Herb | Leaf decoction given orally cures diarrhoea. |
| <i>Mimosa pudica</i> L. | Mimosaceae | Thottal churungi | Touch- me- not | Leaf | Herb | Pasted leaves applied for cuts and wounds. |
| <i>Mirabilis jalapa</i> L. | Nyctaginaceae | Anthimantharai | Four'o clock | Root | Herb | Pasted roots applied topically twice a day to cure sebaceous cysts. |
| <i>Momordica charantia</i> L. | Cucurbitaceae | Pavaikkai | Bitter gourd | Fruit | Herb | Fruits taken orally controls blood sugar level. |
| <i>Morinda pubescens</i> Sm. | Rubiaceae | Manjanathi | Morinda tree nuna | Leaf | Tree | Juice of leaves are used to cure diarrhoea, dysentery and fever. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|----------------|----------------------|-------------------------|-------------------------------|-----------|---|
| <i>Moringa oleifera</i> Lam. | Moringaceae | Murungai | Drumstick tree | Leaf | Tree | Leaf extract cures stomach ache and constipation. |
| <i>Mukia maderaspatana</i> (L.) M. Roem. | Cucurbitaceae | Musumusukai | Madras pea pumpkin | Leaf | Climber | Roasted leaves are cures respiratory problems. |
| <i>Murraya koenigii</i> (L.) Spreng. | Rutaceae | Kariveppilai | Curry leaf | Leaf | Herb | Leaves boiled with coconut oil applied on the hair to promote hair growth. |
| <i>Musa sapidisiaca</i> L. | Musaceae | Vazhai | Banana | Fruit, flowers and pseudostem | Tall herb | Half cup of Pseudostem juice taken orally for a week used to cure kidney stone. Intake of ripe banana used to reduce constipation. Flowers used to control blood sugar level. |
| <i>Nelumbiumnucifera</i> Willd. | Nymphaeaceae | Thammarai | Lotus flower | Flower | Herb | Flower juice used to cure rheumatism and regulate the blood circulation. |
| <i>Nerium oleander</i> L. | Apocyanaceae | Arali | Indian-oleander | Flower | Shrub | Flower paste applied topically are used to heal foot cracks. |
| <i>Nyctanthes arbor-tristis</i> L. | Oleaceae | Pavalamalli | Night jasmine | Leaves | Shrub | Leaf juice are used to cure rheumatism and fever. |
| <i>Ocimum basilicum</i> L. | Lamiaceae | Thiruneetru pachalai | Sweet basil | Leaf | Herb | Powdered leaves taken orally once a day to cure giddiness. |
| <i>Ocimum tenuiflorum</i> L. | Lamiaceae | Thulasi | Holy basil | Leaves | Herb | Leaf decoction is taken twice a day to cure cough and cold. |
| <i>Opuntia stricta</i> (Haw.) Haw. | Cactaceae | Sapathikalli | Prickly pear | Fruit | Shrub | Fruits are edible. It acts as a coolant, diuretic and laxative. |
| <i>Oryza sativa</i> L. | Poaceae | Nellu | Rice | Grains | Herb | Rice powder is applied to cure inflamed surface. |
| <i>Pandanus fascicularis</i> Lam. | Pandanaceae | Thalampoo | Screw pine | Root | Shrub | Root paste is applied daily on legs to cure rheumatism. |
| <i>Pergularia daemia</i> (Forssk.) Chiov. | Asclepiadaceae | Veliparuthi | Pergularia | Leaf | Herb | Decoction of leaves taken orally once a day to cure asthma. |
| <i>Phoenix sylvestris</i> Roxb. | Areaceae | Ichanmaram | Wild date palm | Leaf | Palm | Crushed fresh leaves are soaked in water overnight, the water is taken next morning in empty stomach to expel worms, fruits act as nerve tonic |
| <i>Phyla nodiflora</i> L. | Verbenaceae | Poduthalai | Turkey tangle fog fruit | Leaf | Herb | Paste of leaf is applied on head before bath to cure dandruff problem. |
| <i>Phyllanthus acidus</i> (L.) Skeels | Euphorbiaceae | Ari nelli | Carry me seed | Root | Herb | Root extract is drunk once a day in empty stomach to cure jaundice. |
| <i>Phyllanthus amarus</i> Schumacher & Thonn. | Euphorbiaceae | Keelanelli | Keelanelli | Whole plant | Herb | Plant juice given orally once a day for 21 days cures jaundice. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|---------------|----------------|---------------|------------------------|---------|--|
| <i>Phyllanthus emblica</i> L. | Euphorbiaceae | Nellikai | Goose berry | Fruits | Tree | Boil the fruits along with coconut oil applied externally cures scabies. |
| <i>Piper betle</i> L. | Piperaceae | Vetrillai | Betal pepper | Leaf | Creeper | Leaf juice used to cure cough, cold. |
| <i>Pithecellobium dulce</i> (Roxb.) Benth | Mimosaceae | Kodukkapuli | Madras thorn | Leaf, | Tree | Leaf extract taken twice a day are used to cure diarrhoea and dysentery. |
| <i>Plectranthus amboinicus</i> (Lour.) Spreng | Lamiaceae | Karpuravalli | Indian borage | Leaf | Herb | Leaf juice mixed with jiggery taken orally for once in three days used to cure cough. |
| <i>Polyalthia longifolia</i> (Sonn).Th waites | Annonaceae | Nettilingam | False asoka | Bark | Tree | Bark paste applied on the infected part to cure skin diseases. |
| <i>Polygala arvensis</i> Willd. | Polygalaceae | Sirianangai | Snake root | Leaf | Herb | Leaves extract is used to cure skin diseases. |
| <i>Pongamia pinnata</i> Pierre. | Fabaceae | Punka maram | Indian beech | Bark | Tree | Bark paste is applied externally to heal ring worm infection. |
| <i>Psidium guajava</i> L. | Myrtaceae | Koyya | Guava tree | Leaf | Tree | Leaf juice used to cure diarrhoea and diabetics. |
| <i>Punica granatum</i> L. | Punicaceae | Mathulai | Pomegranate | Leaf, flower and fruit | Shrub | Decoction of leaf, flower and fruits are drunk orally used to cure stomach and dysentery. |
| <i>Raphanus sativus</i> L. | Brassicaceae | Mullanki | Radish | Tuber | Herb | Cooked tuber are edible and are used to cure cough and paralysis. |
| <i>Ricinus communis</i> L. | Euphorbiaceae | Amanaku | Castor seed | Leaf | Tree | Leaf paste applied externally used to cure leg pain, cracks and leaf juice taken once a day cures constipation. |
| <i>Rosa indica</i> L. | Rosaceae | Rose | Rose | Flower | Shrub | Flowers soaked with honey for 2 weeks. Infusion drunk increases iron content in our body. |
| <i>Sesbania grandiflora</i> (L.) Poir. | Fabaceae | Akathikeerai | Sesban | Flowers | Tree | Flowers cooked and taken orally to treat headache. |
| <i>Sida rhombifolia</i> L. | Malvaceae | Kurunthottiver | Flannel weed | Root and Leaf | Shrub | Root extract taken orally used to cure gas troubles and leaf paste applied externally to cure headache. |
| <i>Solanum melongena</i> L. | Solanaceae | Kaththiri | Brinjal | Fruit | Herb | Fruit extract reduces upper gastrointestinal inflammation such as gastritis, eosinophilic gastroenteritis, peptic ulcer disease, |
| <i>Solanum nigrum</i> L. | Solanaceae | Manathakali | Black | Leaf | Herb | Leaf decoction taken orally for a week to cure ulcer. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|---|-----------------|--------------------|---|--------------------|---------|--|
| <i>Solanum surattense</i> Burm.f. | Solanaceae | Kandankathri | Yellow-berried-night shade | Roots Fruits | Shrub | Fruits and roots infusion taken orally twice a day used to cure stomach ache and fever. |
| <i>Solanum torvum</i> Sw. | Solanaceae | Sundakkai | Thorn apple | Root and Fruits | Shrub | Infusion of root is useful for skin diseases, Fruits sauted with gingelly oil taken orally to cure piles |
| <i>Solanum trilobatum</i> L. | Solanaceae | Thuthuvalai | Purple fruited pea egg plant | Leaf | Shrub | Decoction of leaves taken with jaggery to get from cough and cold. |
| <i>Stachytarpheta indica</i> (L.) Vahl. | Verbenaceae | Seemai naiyurvi | Pink rat tail | Root | Shrub | Infusion of root bark is taken twice a day for 3 days to cure diarrhoea and dysentery. |
| <i>Syzygium cumini</i> (L.) Skeels. | Myrtaceae | Naval | Jambolan, javaplum | Seeds | Tree | Seed powder mixes with milk taken twice a day orally to treat Diabetes |
| <i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem. & Schult. | Apocyanaceae | Nanthiavatam | East Indian rose bay wax flower plant | Flower Fruit | Shrub | Flower and fruit extract applied topically to cure tooth ache. |
| <i>Tamarindus indica</i> L. | Caesalpiniaceae | Puliamaram | Tamarind | Leaf | Tree | Leaf paste used to cure swelling in the body and legs. |
| <i>Tectona grandis</i> L.f. | Verbenaceae | Thekku | Teak | Leaf, Bark | Tree | Leaf Oil used as a hair tonic and it promote hair growth, bark astringent used in bronchitis. |
| <i>Tephrosia purpurea</i> (L.) Pers. | Fabaceae | Kozhunji | Purple tephorsia | Root | Herb | Decoction of root is to cure urinary disorders. |
| <i>Terminalia catappa</i> L. | Combretaceae | Vallankotai | Indian almond | Seeds | Tree | Powdered seed used to cure cough, ulcer and skin rashes. |
| <i>Thespesia populnea</i> (L.) Sol. ex Correa | Malvaceae | Poovarasu | Willd indigo | Bark | Tree | Bark paste applied externally which heals leprosy and scabies. |
| <i>Thevetianeriifolia</i> Juss. ex Steud. | Apocyanaceae | Manjalarali | Yellow oleander | Root | Shrub | Root paste is applied topically to cure boils. |
| <i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. & Thomson. | Menispermaceae | Seenthilkodi | Tinospora, heavenly elixir | Leaf | Climber | Leaf extract is drunk orally to cure jaundice. |
| <i>Tribulus terrestris</i> L. | Zygophyllaceae | Nerungil | Land-caltrops | Leaf | Herb | Leaf paste is taken orally to cure stomach- ache. |
| <i>Trichosanthes cucumerina</i> L. | Cucurbitaceae | Pudalangai | Snake gourd | Fruit | Cimber | Dried fruit powder decoction are given orally with sugar to assist digestion. |
| <i>Tridax procumbens</i> L. | Asteraceae | Muriyanpachalai | Tridax daisy | Leaf | Herb | Leaf juice is applied over affected place to cure cuts . |
| <i>Tylophora zeylanica</i> Decne. | Asclepiadaceae | Palaikeerai | Indian lpecac | Leaf | Climber | Powdered leaves are used to heal respiratory problem. |
| <i>Vigna mungo</i> (L.) Hepper. | Fabaceae | Ulundhu | Black gram | Seed | Twiner | Seeds are used as a protein food supplement. |





Jayakumar et al.,

| Botanical name | Family | Local name | Common name | Useful parts | Habit | Medicinal uses/ Mode of usage |
|----------------------------------|---------------|------------|-------------|--------------|-------|--|
| <i>Vitex negundo</i> L. | Verbenaceae | Nochi | Chaste tree | Leaf | Shrub | Leaf paste applied over affected places to cure cuts. |
| <i>Zingiber officinale</i> Rosc. | Zingiberaceae | Inchi | Ginger | Rhizome | Herb | Rhizome juice is used to cure indigestion and gas troubles. |
| <i>Ziziphus mauritiana</i> Lam. | Rhamnaceae | Illanthai | Jackal jube | Fruit Bark | Tree | Fruits are edible and bark decoction taken once in three day is used to cure uterus disorders. |

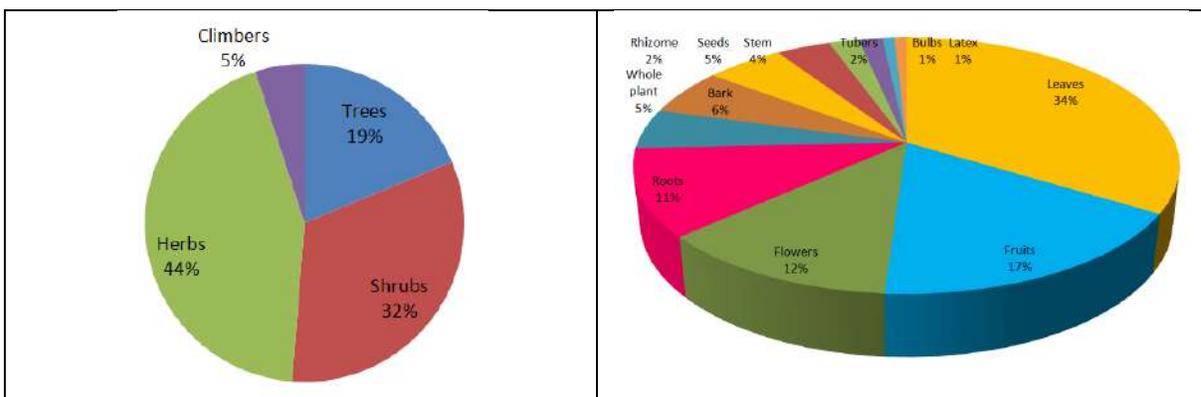


Figure 1. Habit wise distribution of ethnomedicinal plants

Figure 2. Plant parts used for the preparation of herbal medicines by Vetans

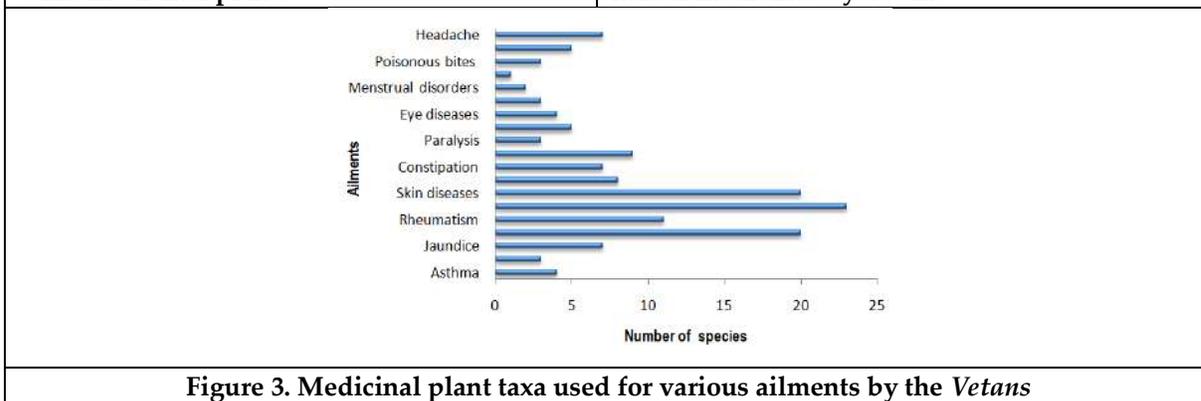


Figure 3. Medicinal plant taxa used for various ailments by the Vetans





Comparative Analysis of the Various Biochemical Compounds in Fresh and Dry Form of *Labeo rohita*, *Mystus tengara*, *Amblypharyngodon mola* in NE India with Special Reference to the Osazone Formation

Ritismita Devi¹, Tumpa Kuri², Jyotchna Gogoi^{3*} and Manash P. Sarma⁴

¹Assistant Professor, Department of Biochemistry, Assam down town University, Panikhaiti, Guwahati, Assam, India.

²M.Sc Biochemistry, Department of Biochemistry, Assam down town University, Panikhaiti, Guwahati, Assam, India.

³Associate Professor, Department of Biochemistry, Assam down town University, Panikhaiti, Guwahati, Assam India.

⁴Associate Professor, Department of Biotechnology, Assam down town University, Panikhaiti, Guwahati, Assam, India.

Received: 29 Apr 2022

Revised: 30 May 2022

Accepted: 05 July 2022

*Address for Correspondence

Jyotchna Gogoi

Associate Professor,
Department of Biochemistry,
Assam down town University,
Panikhaiti, Guwahati, Assam, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Fish an excellent source of protein and other essential nutrient are consumed by a large percentage of population in Assam and India. Since fresh fish deteriorates faster, fish drying has become a common practice in India especially in the North Eastern region of India. Nutritional analysis of fresh and dry fish namely *Labeo rohita*, *Mystus tengara*, *Amblypharyngodon mola* were obtained from locally available markets in Assam and analyzed using qualitative and quantitative test. Results shows the presence of protein, fats and carbohydrates with certain variation in total protein content (mg/ml). Lowry's estimation method for dry fish and fresh fish samples showed 0.86mg/ml/0.94mg/ml for *Labeo rohita*, 0.73mg/ml/0.86mg/ml for *Mystus tengara*, and 0.73mg/ml/0.89mg/ml for *Amblypharyngodon mola* respectively. Bradford's estimation method conducted for both dry and fresh fish showed 0.90mg/ml/0.93mg/ml for *Labeo rohita*, 0.75mg/ml/0.90mg/ml for *Mystus tengara* and 0.76mg/ml/0.95mg/ml for *Amblypharyngodon mola* respectively. The quantitative test for carbohydrate by Anthrone method also revealed variation in the carbohydrate content (mg/ml) in fresh and dry fishes that showed 0.54mg/ml /0.21mg/ml for *Labeo rohita*, 0.54mg/ml/0.21mg/ml for *Mystus tengara* and 0.62mg/ml/0.43mg/ml for *Amblypharyngodon mola* respectively. Similarly results Bradford's method showed. Determination of acid value for fats showed 137.1mg/g/161.56mg/g for *Labeo rohita*, 121.88mg/g/132.6mg/g for *Mystus tengara* and 150.91mg/g/161.8mg/g for *Amblypharyngodon mola* respectively. Osazone test conducted for dry and fresh fish revealed striking presence of reducing monosaccharides, glucosazone. The overall investigation revealed that these fresh fish shows more protein and fat content as compared to the dry fish and





Ritismita Devi *et al.*,

less carbohydrate content as compared to the dry fish which indicate that various drying techniques of fish may lead to degradation process like proteolysis or denaturation.

Keywords: Lowry Method, Bradford Method, Osazone, glucosazone.

INTRODUCTION

Fish and aquaculture products supply an important amount of animal protein as well as valuable nutrition to the diet. Fishes contain good quality, balanced and digestible protein. Protein content in fish meat varied between 16% to 21%. According to the Food and Agricultural Organization (FAO) report "The State of World Fisheries and Aquaculture 2018" apparent per capita fish consumption in India lies between a range of 5-10kg. The consumption of fish has long been associated with several health benefits. Fishes are an important source of many nutrients including protein and long chain omega-3 polyunsaturated fatty acids (n-3 PUFAs), as well as several vitamins and minerals including selenium, iodine, potassium, vitamin D and B vitamins and minerals. Dietary patterns that typically include good amount of fish are generally associated with lower risk of diseases like obesity and overweight, cardiovascular disease including stroke, type-2- diabetes, cancer, asthma, eczema and other atopic conditions, cognitive development and function, bone health, rheumatoid arthritis report symptom relief with supplements of long chain n-3 PUFAs. However, evidence on fish intake and risk of developing rheumatoid arthritis is too limited to draw conclusions (Weichselbaum E, Coe S, Buttriss J and Stanner S., 'Review of fish in the diet' in *Nutrition Bulletin*, 2013). Fresh fish rapidly deteriorates unless some way can be found to preserve it. Drying is a method of food preservation that works by removing water from the food, which inhibits the growth of microorganisms. Open air drying using sun and wind has been practised since ancient times to preserve food. Water is usually removed by evaporation (air drying, sun drying, smoking or wind drying) but in the case of freeze drying, food is first frozen and then the water is removed by sublimation. Bacteria, yeast and moulds need the water in the food to grow, and drying effectively prevents from surviving in the food. Due to the diversity and topographic and climatic features of northeast India, this region is rich in endemic fish and is an important in view of large scale production from capture fishery underlined by the existence of innumerable rivers, rivulets and lentic water bodies, which harbor plenty of diverse fish fauna (Bishal Dhar and Sankar., 2015). There are about 267 species belonging India (Ponniah *et al.*, 2009) out of which, 52.32% possess either of the three values as food for humans, component in angling tourism or aquarism fish trade, and are thus potential recourse for the growth of economy. Fish growth is influenced by number factors including food, space, salinity, season and physical activity (M.Ali *et al.*, 2005). Since fish are poikilothermic and live permanently immersed in water, they are directly affected by the changes in ambient medium (Weatherly and GILL, 1987). Assam is the highest fish producing state in the North-Eastern region of India. During Monsoon season in the North Eastern Region, different species of fresh water species is caught from the rivers and Beels (a natural bounded body). A bulk amount of such catch are traditionally dried by different method (Sharma *et al.*, 2013). In the North Eastern Region dried fish constitutes a dominant portion of the standard diet in a given population supplying a significant fraction of the protein source. Fish protein contain the essential amino acids in the required proportion and thus, improve the overall protein quality of mixed diet. Nutrient profiling of fish shows that fishes are superior nutrients and umpteem number of health benefits are believed to be associated with regular fish consumption. Fish and aquaculture product supply an important amount of animal proteins as well as valuable nutrition to the human diet. In addition fishing is a source of income for millions of people in the world (Jayashree and Arunachalam, 2000.) Adequate consumption of high quality protein and calories is to be essentially induced in daily diet for the proper healthy growth and development of children and their deficiency may lead to protein-calorie malnutrition (PCM). Kwashiorkor and Marasmus, the severe stage of PCM mainly observed in children are caused by chronic deficiency of protein and energy, respectively (Mohanty *et al.*, 2014). Majority of the trace elements such as Fe, Se, Zn, and Mn play a considerable role in the physiological functioning of our body as brain development, and their deficiency may direct to stunted growth (Chowanadesai *et al.*, 2005). Much of the carbohydrates that enter the diets of animals, including fish, is of plant origin. Carnivorous fish like the Atlantic Salmon and the Japanese yellow tail, therefore, deal with little carbohydrate. Indeed, experiments have shown that these species are ill-equipped to handle significant quantities of raw carbohydrates in the diets. The monosaccharide's





Ritismita Devi *et al.*,

which results from carbohydrate digestion consist primarily of glucose, fructose, galactose, mannose, xylose and arabinose. Although the rate of absorption of these sugars have been determined for many land animals, similar information for fish is not available. Glucose does not appear to be a superior energy source for fish over protein or fat although digestible carbohydrate do spare protein for tissue building. The more efficient metabolism of amino acid for glucose for energy could be due to the ability of fish to excrete nitrogenous waste as Ammonia from their gills without the high cost of energy in converting the waste to urea Acclimation in fish, in essence, reflects enzyme acclimation, since the animal's ability to survive depends largely upon its ability to carry out normal metabolic functions. Some enzymes for metabolic acclimation show good compensation while others do not. The enzyme associated with energy liberation (enzyme of glycolysis, pentose, shunt, tri-carboxylic acid cycle, electron transport and fatty acid oxidation) exhibit temperature compensation whereas, those enzymes dealing largely with the degradation of metabolic products show poor or reverse compensation (Prosser, C.L. (ed.), 1973). Triacylglycerols (fats and oils) are the concentrated dietary source of fuel, contributing 15-20% of the body energy requirements. Phospholipids and cholesterol (from animal sources) are also important in nutrition. Dietary lipids have two major nutritive functions – they supply triacylglycerols that normally constitute about 90% of dietary lipids which is a concentrated source of fuel to the body and they provide essential fatty acids and fat soluble vitamins (A, D, E and K). The essential fatty acids more frequently called polyunsaturated fatty acids (PUFA) are predominantly present in vegetable oils and fish oils.

Nutritionists recommend that at least 30% of dietary fat should contain PUFA. Fish , an excellent low fat source of protein, provides many health benefits, such as omega-3 (n-3) fatty acids that reduces cholesterol levels and the incidence of stroke, heart diseases, and pre-term delivery, and enhance cognitive development (Bouzan *et al.*, 2005; Cohen *et al.*, 2005a, b; Daviglus *et al.*, 2002; Koniget *et al.*, 2005; McMichael and Butler, 2005; Patterson, 2002; Willet 2005). Fish consumption studies examining dietary habits have revealed the health benefits of seafood. Seafood contains functional components that are not present in terrestrial organisms. These components include n-3 polyunsaturated fatty acids such as eicosapentaenoic acid (EPA) and docosahexanoic acid (DPA), which aid in the prevention of arteriosclerotic and thrombotic disease. Seafood is currently accepted as an essential food for humans (FAO 2007). Fish oil contains abundant EPA and DHA and is sold as a functional food that can promote superior health, many other bioactive components derived from seafood are also sold and are underdevelopment as functional foods (Harris 2004). The total content of EPA and DHA in fish varies depending on the type of fish and their habitat. The proportion of PUFAs in fish muscle is higher in fatty fish, such as mackerel, herring, and salmon, than in lean fish such as cod, haddock, and halibut. In addition, shellfish such as crab, shrimp, and lobster have low levels of n-3 PUFAs (Shahidi, 2011). In this investigation the saponification number and acid number was estimated for both the dry and fresh fishes. The term saponification is the hydrolysis of triacylglycerols by alkali to produce glycerol and soaps and the saponification number is defines as the mg (number) of KOH required to hydrolyze 9saponify) one gram of fat or oil. It is the measure of the average molecular size of the fatty acids present. Since fish contains all the needed nutrition and sources of vitamins and minerals, a healthy diet must include fish. According to Government dietary guidelines it is recommended that people must include fish in their diet at least twice a week

BIOLOGY OF THE SAMPLES

Labeo rohita,

| | |
|---------|---------------|
| Kingdom | Anamalia |
| Phylum | Chordata |
| Class | Actinoterygil |
| Order | Cypriniformes |
| Family | Ciprinidae |
| Genus | <i>Labeo</i> |
| Species | <i>Rohita</i> |





Ritismita Devi *et al.*,

Mystus tengara.

Taxonomical Classification of *Mystys tengara*

| | |
|---------|-------------------|
| Kingdom | Animalia |
| Phylum | Chordata |
| Class | Actinoptergii |
| Order | Siluriformes |
| Family | Bagridae |
| Genus | <i>Mystus</i> |
| Species | <i>M. tengara</i> |

Amblypharyngodon mola

Taxonomical Classification of *Amblypharyngodon mola*.

| | |
|---------|-------------------------|
| Kingdom | Animalia |
| Phylum | Chordata |
| Class | Actinopterygii |
| Order | Cypriniformes |
| Family | Cyprinidae |
| Genus | <i>Amblypharyngodon</i> |
| Species | <i>A.mola</i> |

OBJECTIVES

In the present investigation an attempt would be done for:

1. Qualitative screening and quantitative analysis for the presence of biochemical components.
2. Osazonepreparation.
3. Comparative analysis of protein(s) expression in the fish extract.

MATERIALS AND METHADODOLOGY

STUDY AREA

Assam is a state in India, situated south of the eastern Himalayas, along the Brahmaputra and Barak River valleys. Assam covers an area of 78,438 km² (30,285 sq mi). the state has total 5.59 lakhs hectares of fishery resources in the form of river, beels, ponds, low laying areas and paddy fields (*Budhin Gogoi et al., 2015*). Fish market infrastructure in Assam includes wholesale market, retail markets and fish retail outlets. In wholesale markets, large quantities of fishes are collected from the surrounding places sold to other wholesalers and retailers (*Biswa,2006*). Fish in Assam is marketed in three major forms viz., fresh fish, dried fish and fish seed (*Arup kumar das*).

MATERIALS REQUIRED

GLASSWARES

Beakers, conical flask, cylinder, test tubes. Eppendroff, spirit lamp, test tube holders.

EQUIPMENTS

Spectrophotometer, Centrifuge, Vortex, Spinner, TLC chamber and plates, electrophoresis medium, Burette, Burette stand, Hot air oven, Incubator, hot plate, pH meter, weighing balance machine.





Ritishmita Devi *et al.*,

COLLECTION OF SAMPLES

The fish samples of *Labeo rohita*, *Mystus tengara*, *Ambly* (dry and fresh) was purchased from Guwahati, Assam and was brought to the laboratory of department of biochemistry.

PREPARATION OF THE EXTRACT

The collected samples was transported to the Biochemistry laboratory of Assam down town university packed tightly in a polythene bag and kept at refrigerator (-4 degree). It was then washed with deionise water. The fish were boiled and 20gm of boiled muscle tissue was crushed with mortar and pestle in 100ml of phosphate buffer (Ph 6.5). The crushed tissue muscle was centrifuge at 1000rpm for 10min. The supernatant so collected was used for further investigation (Blanchard JS 1984)

Qualitative test for carbohydrates

Molisch test

1ml of the sample solution treated with Molisch Reagent and sulphuric acid (H₂SO₄) (*AmalAlmari qualitative analysis of carbohydrate*)

Iodine Test

1ml of the sample and few drops of iodine added to it. (*Amal Almari qualitative analysis of carbohydrate.*)

Benedict's Test

Sample solution treated with Benedict Reagent . (*AmalAlmari qualitative analysis of carbohydrates.*)

Picric Acid Test

Sample was treated with picric acid followed by 0.5ml 10% sodium carbonate and heated in a boiling water bath (*S.K. Sawhney and Randhirsingh, Introductory practical biochemistry*)

Barfoed's Test

2ml of Barfoed solution and 21 ml of sample solution added to it and kept at boiling water bath (*S.K. Sawhney and Randhirsingh, Introductory practical biochemistry*). BIAL'S TEST: 2ml of Bial's reagent and 4-5 drops of sample solution was added to it and heated in boiling water bath. (*S.K. Sawhney and Randhirsingh, Introductory practical biochemistry*)

Seliwanoff's Test

1ml of the sample solution added to 2ml of Seliwanoff's reagent and warmed at boiling water bath for 10minutes (*S.K. Sawhney and Randhirsingh, Introductory practical biochemistry*)

Qualitative test for proteins

Biuret's test

1ml of supernatant was treated with 40% NaOH and 1% CuSO₄ for the presence of peptide linkages. (*Concept of Biochemistry, theory and practical by Dr. A.C. Deb 1999*).

Ninhydrin's Test

1ml of supernatant was treated with 0.2% of Ninhydrin solution (*Concept of Biochemistry, Dr. A.C. Deb*)

Xanthoproteic Test

1ml of the supernatant was treated with concentrated HNO₃ (Nitric acid) and boil after which make it alkaline WITH 20% NaOH (*Concept of Biochemistry, Dr. A.C. Deb*).

Coagulation Test

1ml of supernatant was treated with concentrated HNO₃ (Nitric acid) and heat (*Concept of Biochemistry, Dr. A.C. Deb*).





Ritismita Devi et al.,

Precipitation Test

1ml of supernatant was treated with few ml of alcohol (*Concept of Biochemistry, Dr.A.C.Deb*).

Qualitative test for lipids

Emulsification test for lipids

Sample solution is dissolved in ethanol and this solution is dissolved in water (*Lieberman Barchard, qualitative test for protein*)

Quantitative Test for Carbohydrates

Standard quantitative test was done for the estimation of total carbohydrates content present in fishes.

Anthrone Test for Carbohydrates

0.2 to 1 ml of standard solution of atleast five different test tubes were take and water was added to each test tube to make three final volume to 1ml. 4ml of Anthrone Reagent was added to each test tube and the test tubes were shaken well. The test tubes were kept at water bath for 10 minutes. The test tubes were cooled and read at 620nm. Simultaneously blank was prepared with 1ml of distilled water and 4ml of Anthrone Reagent (*Sahar Al-subaie, general colour test for carbohydrates*).

Quantitative Test for Proteins

Standard quantitative analysis was done for the estimation of the total protein content present in the fish samples.

Lowry Estimation of Protein

The principle of Lowry method lies in the reactivity of peptide nitrogen with alkaline copper sulphate solution and folin's reagent giving blue color according to the concentration of protein. The absorbance is read at 660nm (Gary L. Peterson, 1977). This method is sensitive enough to give a moderate constant volume. The blue color developed by the reduction of the phosphomolybdic phosphotungstic component in the Folin's reagent by amino acids tyrosine and tryptophan present in the protein plus the color developed by biuret reaction of protein with the alkaline cupric tartarate are measured in this method.

Reagents and Chemicals

Reagent 1

2% sodium carbonate in 0.1% sodium hydroxide.

Bradford Estimation of Protein

The procedure is conducted following standard protocol.

Quantitative test for lipids

Determination of acid value of fats

The acid value is the number of milligrams of KOH required to neutralize the free fatty acid present in 1 gm of fat (*S.K. Sawhney and Randhirsingh, Introductory practical biochemistry*)





Ritishmita Devi et al.,

RESULTS AND DISCUSSION

Qualitative assay of proteins

Table no. 1- Qualitative Assay of Protein

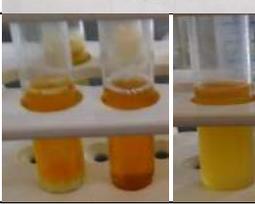
| TESTS PERFORMED | OBSERVATION (DRY FISH) | OBSERVATION (FRESH FISH) | RESULTS |
|---------------------------|---|--|-----------|
| Heat and Coagulation test |  |  | Positive. |
| Precipitation test |  |  | Positive. |
| Heller's Test |  |  | Positive. |
| Biuret Test |  |  | Positive. |
| Ninhydrin Test |  |  | Positive |
| Xanthoprotic Test |  |  | Positive. |

Fig. 4: Image of the Various Qualitative test of Proteins.

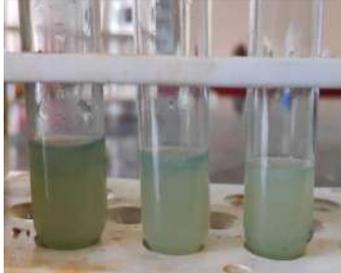
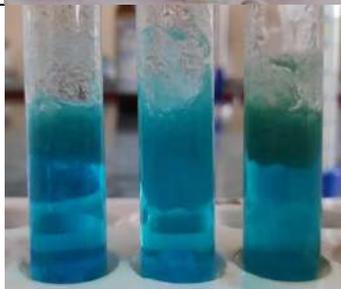
Qualitative Assay of Carbohydrates





Ritismita Devi et al.,

Table no.2- Qualitative assay of Carbohydrates

| TESTS PERFORMED | OBSERVATION (DRY FISH) | OBSERVATION (FRESH FISH) | RESULT. |
|---|---|--|-----------|
| Molisch Test (for the presence of carbohydrates) |  |  | Positive. |
| Iodine Test (for the presence of polysaccharide) |  |  | Negative. |
| Benedict's Test (for the presence of reducing sugar) |  |  | Negative |
| Picric acid Test (for the presence of reducing sugar) |  |  | Positive. |
| Barfoed's Test (for the presence of monosaccharides) |  |  | Positive. |





Ritishmita Devi et al.,



Fig 5: Image of the Various Qualitative Test for Carbohydrates.

Table no. 3 - Qualitative Assay for Fats

Table no. 3 - Qualitative Assay For Fats

| TEST PERFORMED | OBSERVATION (DRY FISH) | OBSERVATION (FRESH FISH) | RESULT |
|----------------------------|------------------------|--------------------------|------------------|
| <p>Emulsification Test</p> | | | <p>Positive.</p> |

Fig 6: Image of the Emulsification Test for Fats.

For proteins

Lowry's estimation

Table no.4- Variation of total protein content (mg/ml) shown as standard deviation.

Bradford Estimation

Table no 5: Variation of total protein content (mg/ml) shown as standard deviation. As shown in the above table no.4 , both the dry and fresh fish showed variation of total protein (mg/ml) in the body muscle of the selected fishes namely *Labeo rohita*, *Mystus tengara*, *Amblypharyngodon*. Highest protein content was observed in the fresh fish sample of *Labeo rohita*, *Mystus tengara*, *Amblypharyngodon mola*.

For carbohydrates

Anthrone estimation of sugar

Table no.6: variation of carbohydrate content (mg/ml) shown as standard deviation. The dried fish samples showed highest carbohydrate content in comparison to the fresh fishes.

Osazone Test

Appearance of needle shaped structures when observed under the microscope for all the samples (dry and fresh) proves the presence of glucose.

For fats

Fatty acid value

The acid value of dried fish *Labeo rohita* was found to be 161.568±17.30 whereas the fresh sample showed 137.1±17.30 indicating highest fatty acid value in the fresh fish sample. Similarly dried *Mystus tengara* showed value of





Ritismita Devi et al.,

121.88±7.58 whereas fresh fish sample showed value of 132.6±7.58 and for dried *Amblypharyngodon mola* acid value was found to be 150.91±7.70 whereas in fresh fish it was found to be 161.8±7.70.

CONCLUSION

The study shows that the fresh fishes are high in nutritional content as compared to the dried fishes with negligible variation. Intake of fish to overcome deficiencies such as Kwashiorkor and Marasmus should be incorporated in diet. As there seems to be slightest variation in fresh and dry samples of fish, people can incorporate either of them accordingly for a healthy life.

ACKNOWLEDGEMENTS

This authors acknowledge the support from the Department of Biochemistry, Assam down town university

Conflict of Interest; None

Financial disclosure: None

REFERENCES

1. Bhaskar Chakravarty, A.K Tamuli, Simanku Borah and Kapil Deb Nath, 'Economic analysis of fish farmers and fishes in Kamrup district, Assam, India'. Asian journal of agricultural extension, economics and society. 2017 ISSN;2320-7027, vol:20, issue:1.
2. D.D Radtke sample preservation, p:89-94.
3. Dr. A.C. Deb. Concept of Biochemistry (theory and practical) 1999 part 3 p: 10-12
4. Evolutionary relationship of fish protein profiling, adapted from Bio-RAD biotechnology explorer protein fingerprinting instruction manual.
5. Gary L Peterson. A simplification of the protein assay method of Lowry which is more genetically applicable. July 29 1997, Department of pharmacology, university of Wisconsin, Madison, p:5-119.
6. Gogoi B., Das R., Kumar Abujam, and Das Debangshu Narayan. 2015. Enumeration of fish from Dulakhoijiyabeel (wetland) of Lakhimpur district Assam. 1. Department of zoology, Rajiv Gandhi University, Arunachal Pradesh, 2. Department of zoology, North Bank college, Lalimpur.
7. Hames BD and Rickwood. Gel electrophoresis of protein – a practical approach, 1990 2nd edition, IRL press at Oxford University press Oxford London.
8. Jayahree, B and S. Arunachalam; Mapping Fish Research in India. Current Science, 79(5): 613-620, 2000.
9. K.G. Kenrick and J. Margolis. Isoelectric focusing and gradient gel electrophoresis: a two dimensional technique. 1970 Analytical Biochemistry 33(1): 204-207.
10. K.M. Clegg. The application of the anthrone reagent to the estimation of starch in cereals, 1956 p:40-44.
11. Mrinomoy Das. Primary study of fish fauna found in Brahmaputra river and its tributaries in Assam 2010. Student, Christ University, Bangalore.
12. Niamke, Sebastian, Patrice, Kouame Parfait Kouadio, Jean, Koffi, Didier. Effect of some chemicals on the accuracy of protein estimation by the Lowry Method. Biochemistry. 2016 (ISSN:0795-8080) VOL 17 NUM.2).
13. Almari A, qualitative analysis of carbohydrates.
14. Burchard Liieberman, qualitative test for protein.
15. Clegg K M. 1956, the application of the Anthrone Reagent to the estimation of Starch in cereals, 1956 p:40-44.
16. S.K. Sawhney and Randhirsingh, Introductory practical biochemistry.
17. David T., An introduction to Practical biochemistry.
18. Mohanty, B., Mahanty, A., Ganguly, S., Sankar, T.V., Chakraborty, K., Anandan, R., Pau, B., Sarma, D., Mathew, S., Asha, K.K., Behera, B., Aftabuddin, M., Debnath, D., Vijayagopal, P., Sridhar, N., Akhtar, M.S., Sahi, N.,





Ritismita Devi et al.,

- Mitra, T., Banarjee, S., Paria, P., Das, D., Das, P., Vijayan, K.K., Laxmanan, P.T., Sharma, A.P., 2014. Amino acid composition of 27 food fish and their importance in clinical nutrition. *J. Amino Acids*, 1-7.
19. Mohanty, B.P., Ganguly, S., Mahanty, A., Sankar, T.V., Anandan, R. Chakraborty, K., Paul, B.N., Sarma, D., Dayal, J.S., Venkateshwar, G., Mathew, S., Asha, K.K., Karunakaran, D., Mitra, T., Banarjee, S., Chanda, S., Shahi, N., Das, P., Akhtar, M.S., Vijayagopal, P., Sridhar, N. 2016. DHA, EPA content and Fatty acid profile of 39 foods fishes from India Biomedical Research International. Doi. 10. 115/2016/4027437 Morris.
20. Sample collectors handbook Illinois Environmental Protection Agency.
21. FAO, 2015. IFAD and WFP. The State of Food Insecurity in the World. The Multiple Dimensions of Food Security.
22. Kumar, D. 1992. Fish culture in Un- Drainable ponds. A manual for extension FAO Fisheries Technical paper, No. 235:239.
23. Dhar Bishal and Sankar 2015. Identifying ornamental fishes of North East India through DNA barcoding. Department of biotechnology, Assam University, Silchar. Article June 2015
24. Aberoumad A., and Pourshafi K., 2010. Chemical and proximate composition properties in different fish species obtained from Iran. *World J.*
25. Arivu, Muniyan, Muthulingam, Parthiban, Ambedkar, Kamalanth and Anbarasan, 2015. Effects of 2,4-dichlorophenoxyacetic acid on protein change on freshwater fingerlings under SDS-PAGE gel separation. *International journal of Toxicology and applied pharmacology*. P:7-12
26. A.Krogdahl, G-1. Hemre and T.P. Mommsen., 2004. Carbohydrate in fish nutrition: digestion and absorption in postlarval stages.
27. Aberoumand A, Department of Fisheries, Natural Resources College, Behbahan Khatam Alanbia University of Technology, Behbahan, Iran., 2012. Preliminary comparison of nutritional and processed seafood.
28. Weichselbaum E, Coe S, Buttriss J and Stanner S, 2013. Nutrients, Food and Ingredients Fish in the diet: A review.
29. Banrie, 2013. Principles of Fish Nutrition.

Table no.4- Variation of total protein content (mg/ml) shown as standard deviation.

| SAMPLE NAME | Conc. Mg/ml of dry fish sample. | Conc. Mg/ml of fresh fish sample. | MEAN | STANDARD DEVIATION |
|------------------------------|---------------------------------|-----------------------------------|-------|--------------------|
| <i>Labeo rohita</i> | 0.86 | 0.94 | 0.9 | 0.056 |
| <i>Mystus tengara</i> | 0.73 | 0.86 | 0.81 | 0.11 |
| <i>Amblypharyngodon mola</i> | 0.73 | 0.89 | 0.835 | 0.14 |

Table no 5: Variation of total protein content (mg/ml) shown as standard deviation

| SAMPLE NAME | Conc. Mg/ml of Dry fish sample. | Conc. Mg/ml of Fresh fish sample. | MEAN | STANDARD DEVIATION |
|------------------------------|---------------------------------|-----------------------------------|-------|--------------------|
| <i>Labeo rohita</i> | 0.90 | 0.93 | 0.915 | 0.02 |
| <i>Mystus tengara</i> | 0.75 | 0.90 | 0.825 | 0.10 |
| <i>Amblypharyngodon mola</i> | 0.76 | 0.95 | 0.855 | 0.13 |

Table no.6: variation of carbohydrate content (mg/ml) shown as standard deviation.

| SAMPLE NAME | Conc. mg/ml of dry fish sample | Conc. Mg/ml of fresh fish sample | MEAN | STANDARD DEVIATION. |
|-----------------------------|--------------------------------|----------------------------------|-------|---------------------|
| <i>Labeo rohita</i> | 0.54 | 0.21 | 0.375 | 0.233 |
| <i>Mystus tengara</i> | 0.54 | 0.21 | 0.375 | 0.233 |
| <i>Amblypharogodon mola</i> | 0.62 | 0.26 | 0.43 | 0.240 |





Ritismita Devi et al.,

Table no 7: Variation of acid value number

| SAMPLE NAME | DRY | FRESH | MEAN | Std. dev |
|------------------------------|--------|--------|--------|----------|
| <i>Labeo rohita</i> | 137.1 | 161.56 | 149.33 | 17.30 |
| <i>Mystus tengara</i> | 121.88 | 132.6 | 127.24 | 7.58 |
| <i>Amblypharyngodon mola</i> | 150.91 | 161.8 | 156.35 | 7.70 |



Fig 1: Image of Fresh *Labeo rohita*

Fig 2: Image of Fresh *Mystus tengara*



Fig 3: Image of Fresh *Amblypharyngodon mola*

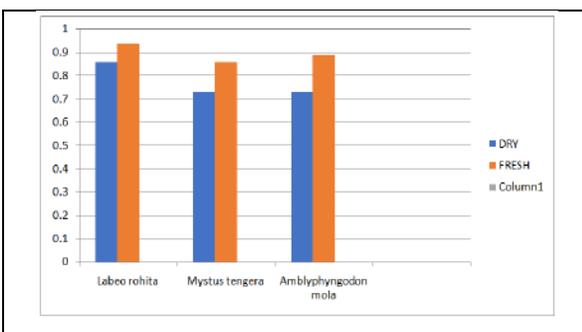


Fig 7: Concentration variation of protein by Lowry's Method.

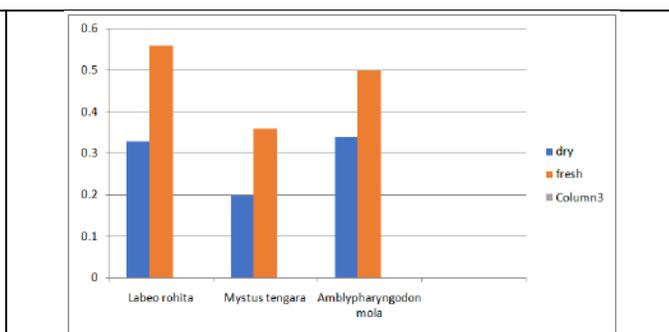


Fig 8: concentration variation of protein by Bradford method

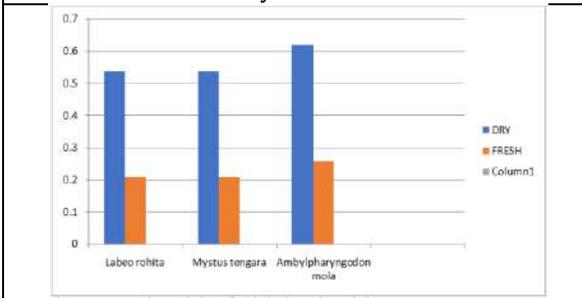


Fig 9 : Concentration variation of carbohydrates in mg/ml

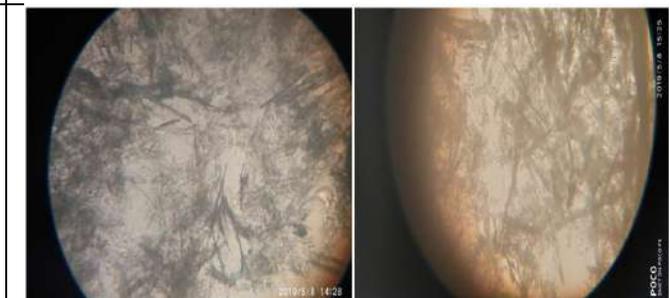


Fig 10 : Appearance of glucosazone in dry and fresh *Labeo rohita*





Ritismita Devi et al.,



Fig 11: Appearance of glucosazone in both Dry and Fresh *Mystus tengara*

Fig12: Appearance of glucosazone in both Dry and Fresh *Amblypharngodon mola*

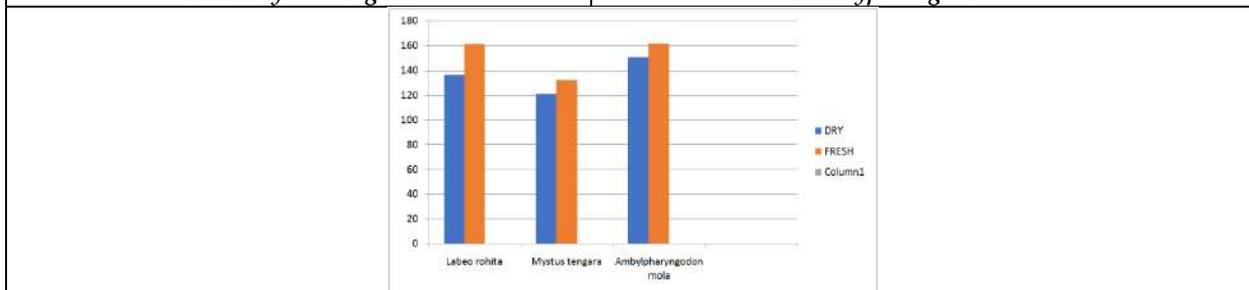


Fig 13: variation in acid value for fats.





Preformulation and Validation of UV Spectrophotometric Method for the Estimation of Canagliflozin

Rajib Lochan Dutta^{1*}, Vishal Soni¹ and Ankit Anand Kharia¹

Department of Pharmacy, Mandasur University, Mandasur, Madhya Pradesh, India.

Received: 10 June 2022

Revised: 01 July 2022

Accepted: 30 July 2022

*Address for Correspondence

Rajib Lochan Dutta

Department of Pharmacy,
Mandasur University, Mandasur,
Madhya Pradesh, India.

Email: rajivl.dutta@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

To study the Preformulation parameters and develop, validate simple, sensitive, precise, rapid and cost effective method for determination of Canagliflozin in bulk and pharmaceutical formulations as per ICH Guidelines. A simple double beam UV Spectrophotometric method has been developed and validated with different parameters such as Linearity, Precision, Repeatability, Accuracy, Robustness and Ruggedness. Canagliflozin in phosphate buffer shows maximum absorbance at 289 nm. Beer's law was obeyed in the concentration range of 1-6 mcg ml⁻¹. A recovery of Canagliflozin was observed in the range of 80-120%. Percentage assay of Canagliflozin was found to be more than 98%. The proposed method is precise, accurate and reproducible and can be used for routine analysis of Canagliflozin in bulk and pharmaceutical dosage form.

Keywords: Canagliflozin, Ultraviolet Spectroscopy, Preformulation study, Method Development and Validation.

INTRODUCTION

In recent years about 40% of drugs with high therapeutic values are found to be poorly soluble, due to which their therapeutic efficiency is reduced. The bioavailability of these orally administered drugs needs newer strategies to enhance its pharmacological activity and sustain its therapeutic effects. For poorly water-soluble compounds, even the preliminary toxicological testing using animal models become impossible owing to its poor absorption in the body. The bioavailability of a drug is mainly influenced by its solubility and permeability, and so there is a need to increase their bioavailability [1].

Canagliflozin (CFZ) belongs to a novel class of sodium glucose co-transporter (SGLT II) inhibitors and has been widely used for the management of type 2 diabetes mellitus (T2DM) through insulin independent mechanism.





Rajib Lochan Dutta et al.,

Canagliflozin is chemically (2S,3R,4R,5S,6R)-2-[3-[5-(4-fluorophenyl)-thiophen-2-ylmethyl]-4-methyl-phenyl] 6hydroxymethyltetrahydro-pyran-3,4,5-triol. It is white to off white solid with melting point of 95-105°C [2]. Literature review revealed that they were several analytical methods like HPLC, LS-MS, HPTLC and RP-HPLC and only few UV-Spectroscopic methods were reported for the estimation of canagliflozin in bulk and pharmaceutical dosage forms. Hence the present work aimed at the development and validates a simple, precise, sensitive UV spectro photometric method for the estimation of Canagliflozin in its bulk and pharmaceutical dosage form [3].

The major limitation of the drug is its low solubility and permeability leading to poor bioavailability, which necessitates higher doses and thereby, hindered its clinical use.

MATERIAL AND METHODS

Instrumentation

A double beam UV-visible spectrophotometer (Shimadzu 1800) consisting of two matched quartz cells with 1 cm light path and loaded with UV Solutions software (UV Probe) was used for recording and measuring of spectra and absorbance. Electronic analytical weighing balance 0.1 mg sensitivity and a sonicator (Sonica, model 1900 MH) were used in this study.

Chemicals and reagents

Analytically pure sample of Canagliflozin was obtained from Hetero drugs, Hyderabad and marketed tablet formulation (Invokana) was procured from Johnson & Johnson, Mumbai, India with label claim 100 mg.

Selection of analytical Wavelength [4]

Canagliflozin is soluble in organic solvents like phosphate buffer, Methanol and Dim ethyl sulfoxide (DMSO) so Phosphate buffer was selected throughout the study. Canagliflozin 10 µg/ml of working standard solution was scanned in between 200 nm to 400 nm and showed maximum absorption at 289nm by UV spectrophotometer figure 2.

Solubility

Solubility of Canagliflozine was determined in solvents: water, methanol, chloroform and acetonitrile. Excess amount of sample were added in 20 ml of solvent with stirring (300 rpm), at temperature 25 ± 0.5°C for 48 h and sonicated using sonicator (Electrolab™) for 2 h. Samples were filtered through 0.45 µm filters and assayed spectro photo metrically for drug content at 280nm for Canagliflozine⁵. The solubility of the canagliflozine are given in table 1.

Bulk density, tap density, Carr's index and Hausner's ratio

$$\text{Bulk Density} = \frac{\text{Weight of the powder}}{\text{Bulk volume}}$$

$$\text{Tap Density} = \frac{\text{Weight of the powder}}{\text{Tapped volume}}$$

$$\text{Hausner's ratio} = \frac{\text{Tap density}}{\text{Bulk density}}$$

$$\text{Carr's Index} = \frac{(\text{Tap density} - \text{Bulk density})}{\text{Tap density}} \times 100$$



**Rajib Lochan Dutta et al.,**Angle of repose = $\tan^{-1} h/r$ **Calibration curve of Canaglifozine****Preparation pH 7.4 phosphate buffer**

Dissolve 2.38 g of disodium hydrogen phosphate, 0.19 g of potassium dihydrogen phosphate and 8.0 g of sodium chloride in sufficient water to produce 1000 ml. Adjust the pH of the solution to 2 by 0.1N HCl or 0.1N NaOH if necessary.

Calibration curve

10 mg of Canaglifozine was dissolved in 100 ml of pH 7.4 phosphate buffer separately in 100ml volumetric cylinder and sonicated for 1 hour in bath sonicator. From the stock solution 1/2/3/4/5/6/7 ml of the solution was again diluted to 10 ml of pH 7.4 phosphate buffer separately to prepare the solutions with concentration 10/20/30/40/50/60/70 µg/ml. Absorbances of the all prepared solutions were taken on UV-Visible spectrophotometer at wavelength 289 nm [6]. The calibration curve is given in figure 3 and table 2.

Linearity

The linearity of an analytical procedure is its ability (within a given range) to obtain test results which are directly proportional to the concentration of the analyte in sample. A linear relationship should be evaluated across the range of analytical procedure [7]. It may be demonstrated directly on the active substance (by dilution of stock solution) and/or separate weighing of synthetic mixtures of the product component using the proposed procedure.

Procedure for Canaglifozine

10 mg of Canaglifozine was dissolved in 100 ml of pH 7.4 phosphate buffer separately in 100ml volumetric cylinder and sonicated for 1 hour in bath sonicator. From the stock solution 1/2/3/4/5/6/7/8/9/10 ml of the solution was again diluted to 10 ml of pH 7.4 phosphate buffer separately to prepare the solutions with concentration 10/20/30/40/50/60/70/80/90/100 µg/ml. Absorbances of the all prepared solutions were taken on UV-Visible spectrophotometer at wavelength 289 nm [8]. The linearity curve of Canaglifozine was as shown in figure 16 and the values were as given in table 3. The results have indicated that method is linear.

Range

The range of analytical procedure is the interval between the upper and lower concentration of analyte in the sample for which it has been demonstrated that the analytical procedure has a suitable level of precision, accuracy and linearity. The specified range is normally derived from linearity studies and depends on the intended application of the procedure. It is established by confirming that the analytical procedure provides an acceptable degree of linearity, accuracy and precision when applied to samples containing amount of analyte with in or at the extremes of the analytical procedure⁹⁻¹¹. The λ_{max} , concentration range and R^2 values of calibration curve of Canaglifozine, were determined as per procedure given in linearity and are given in table 4. The R^2 value of all curves were closer to one (0.999) indicated the linearity of concentration range

Specificity

Specificity is the ability to assess unequivocally the analyte in the presence of components which may be expected to be present. Typically these might include impurities, degradants, matrix etc. Specificity test is done by measuring the absorbance of placebo solution, standard solution and mixing of placebo and standard solution.

Procedure

For Canaglifozine, standard solution used was pH 7.4 phosphate buffer, pH 8 phosphate buffer and pH 7.4 phosphate buffer respectively. Stock solution was prepared by dissolving 10 mg of the drug in respective standard solution. Placebo solution was prepared by adding the 1 mg of all the excipients (without drug) in 100 ml of standard solution. Sample solutions were prepared by diluting 1ml of stock solution with 10 ml of placebo solution¹².



**Rajib Lochan Dutta et al.,**

Absorbance of placebo, standard and sample solution was taken at respective λ_{\max} . From the results it was concluded that the placebo shows very negligible absorbance and there is no significant difference between absorbance of standard and sample solution. The results of the specificity test were shown no any interference of placebo at above specified λ_{\max} for Canagliflozine.

Precision

The precision of an analytical procedure express the closeness of agreement (degree of scatter) between a series of measurements obtained from multiple sampling of the same homogenous sample under the prescribed conditions. Precision may be considered at three levels: repeatability, intermediate and reproducibility. Precision should be investigated using homogenous, authentic samples. However; if it is not possible to obtain a homogeneous sample it may be investigated using artificially prepared samples or a sample solution. The precision of an analytical procedure is usually expressed as a variance, standard deviation or coefficient of variation of series of measurements [12]. Precision test were performed by measuring the absorbance of the target solution of concentration: 10 $\mu\text{g/ml}$ prepared as per procedure given in linearity and its absorbance was taken at its λ_{\max} . For intra day variation absorbance was taken at 3 different times within a same day and for inter day variation absorbance was taken for 3 different day. The results were as given in table 6. As percent relative standard deviation for intra-day and inter-day variation study was less than 1.5% the method was precise.

Accuracy

The accuracy of analytical procedure expresses the closeness of agreement between the values which is Prepared the blend of placebo and the active by mixing the active drug into the placebo powder at 25%, 50%, 75%, 100% accepted either as conventional true value or an accepted reference value and the value found. This is sometimes termed as trueness[13]. Accuracy should be established across the specified range of the analytical.

Procedure

Different concentrations of sample (2/4/6/8 mg/ml) of Canagliflozine, glibenclamide and pioglitazone were prepared using placebo and standard solutions as per the procedure given in linearity. Levels of target concentrations were prepared in triplicate and analyzed for the recovery of samples ¹⁴. The accuracy parameters of the method were as given in table 7 for Canagliflozine. As the difference between the individual recovery and the average recovery at each level was less than $\pm 2\%$, the recovery was NLT 98% and NMT 102%.The %RSD for the triplicate at each spick level shall be NMT 2%.

Robustness test

The robustness of an analytical procedure is measure of its capacity to remain unaffected by small but deliberate variation in the method parameters and provide an indication of its reliability during normal usage ¹⁴⁻¹⁶. Robustness test were done by measuring the solution stability for 8 hours. Sample solutions of concentration 10 $\mu\text{g/ml}$ were prepared as per procedure given in linearity and at 1, 2, 4, 6, and 8 hours. The robustness data for the method of Canagliflozine, were as given in table 8. The obtained results showed that there is no significant difference in absorbance of specific concentration at different time intervals from 1-8 hrs. The obtained %RSD was NMT 2.0%.

CONCLUSION

Canagliflozin is an anti diabetic drug used to improve glycemic control in patients with type 2 diabetes. A sensitive UV spectro photometric method was developed for the estimation of canagliflozin in bulk and pharmaceutical dosage form. Validation of the developed method was done as per the ICH guidelines.





Rajib Lochan Dutta *et al.*,

ACKNOWLEDGEMENTS

The authors are thankful to the authorities of Mandsur University, Mandhya Pradesh, Hetero drugs, Hyderabad for providing bulk drug sample and marketed tablet provided from Johnson and Johnson private limited, Mumbai Invokana 100mg.

REFERENCES

1. Bailey C.J. Renal glucose reabsorption inhibitors to treat diabetes. Trends Pharmacological Sciences, 2011;32(2): 63-71.
2. Devineni D, Curtin CR, Polidori D, Gutierrez MJ, Murphy J, Rusch S. Pharmacokinetics and pharmacodynamics of canagliflozin a sodium glucose co transporter 2 inhibitor in subjects with type 2 diabetes mellitus. Journal of Clinical Pharmacology, 2013; 53(6): 601-610.
3. Bossunia MTI, Urmi KF, Shaha CK. Quality-By-Design Approach to Stability Indicating RP-HPLC Analytical Method Development for Estimation of Canagliflozin API and Its Validation. Pharmaceutical Methods, 2017; 8(2): 92-101.
4. Deepak G, Patil RN, Mangesh H. A Validated Stability Indicating RP-HPLC Method for Simultaneous Determination of Metformin and Canagliflozin in Pharmaceutical Formulation. World Journal Pharmacy and Pharmaceutical Sciences, 2015; 4(12): 631-640.
5. Dudhe PB, Kamble MC. RP-HPLC Method Development and Validation for the Determination of Canagliflozin in Human Plasma. International Journal of Pharm Tech Research, 2016; 9(8): 174-181.
6. Nomura S, Sakamaki S, Hongu M, Kawanishi E, Koga Y, Sakamoto T. Discovery of canagliflozin a novel C-glucoside with thiophene ring as sodium-dependent glucose co transporter 2 inhibitor for the treatment of type 2 diabetes mellitus. Journal of medicinal chemistry, 2010; 53(17): 6355-6360.
7. Strojek K, Yoon KH, Hrubá V, Elze M, Langkilde AM, Parikh S. Effect of dapagliflozin in patients with type 2 diabetes who have inadequate glycaemic control with glimepiride a randomized 24-week double-blind placebo-controlled trial. Diabetes Obesity Metabolism, 2011; 13(10): 928-938
8. D'souza S, Krishna M, Sushmitha GS, Vasantharaju SG. Stability indicating assay method development and validation to simultaneously estimate metformin hydrochloride and canagliflozin by RP-HPLC. Current Trends in Biotechnology and Pharmacy, 2016; 10(4): 334-342.
9. Maddu S, Manasa K, Rajakumari Ch, Lakshmaiah B. RP-HPLC Method Development and Validation for the Estimation of Canagliflozin in Tablet Dosage Form. International Journal Pharmaceutics, 2014; 5(4): 1288- 1292.
10. Inagaki N, Kondo K, Yoshinari T, Ishii M, Sakai M, Kuki H, Furihata K. Pharmacokinetic and Pharmacodynamic Profiles of Canagliflozin in Japanese Patients with Type 2 Diabetes Mellitus and Moderate Renal Impairment. Clinical Drug Investigation, 2014; 34: 731– 742.
11. Plosker GL. Canagliflozin a review of its use in patients with type 2 diabetes mellitus. Drugs, 2014; 74(7): 807– 824.
12. Uttam PP, Sunil KR. A Novel Validated RP-HPLC-DAD Method for the Simultaneous Estimation of Metformin Hydrochloride and Canagliflozin in Bulk and Pharmaceutical Tablet Dosage form with Forced Degradation Studies. Oriental Journal of Chemistry, 2015; 31(3): 1489-1507.
13. Nar eddy PR, Naga TC. RP-HPLC Method development and validation for the Simultaneous Estimation of Metformin and Canagliflozin in Tablet Dosage Form. Indian Journal of Pharmaceutical Sciences, 2015; 5(4):1155- 1159.
14. Suneetha, Sharmila .D. A Validated Stability Indicating RP-HPLC Method for Estimation of Canagliflozin in Dosage Form. Research Journal of Pharmaceutical Biological and Chemical Sciences, 2015; 6(5): 1186-1194.
15. Ishpreet K, Sharad W, Harsharan PS, Satish M. Development and Validation of a Stability Indicating Reverse Phase HPLC-PDA Method for Determination of Canagliflozin in Bulk and Pharmaceutical Dosage Form. Pharmaceutical Methods, 2016; 7(1): 54-62.





Rajib Lochan Dutta et al.,

16. Marella VL, Syed A, Prasanna ML, Buchi Naidu N. A novel validated RP-HPLC method for the estimation of canagliflozin in bulk and pharmaceutical dosage forms. International Journal of Advances in Pharmaceutical Analysis, 2017; 7(3): 24-27.

Table 1. Preformulation study report of Canaglifozine in Bulk.

| Sr. No | Parameters | | Observations |
|--------|------------------------------------|---|---------------------|
| | | | Canaglifozine |
| 1 | A | Solubility in water ($\mu\text{g/ml}$) | Insoluble |
| | B | Solubility in methanol (mg/ml) | 121 ± 3.6 |
| | C | Solubility in chloroform (mg/ml) | 87 ± 3.6 |
| | D | Solubility in acetonitrile (mg/ml) | 65 ± 5.7 |
| 3 | Bulk density (gm/cc) | | 0.322 ± 0.007 |
| 4 | Tapped density (gm/cc) | | 0.476 ± 0.006 |
| 5 | Carr's Index (%) | | 32.35 ± 0.5 |
| 6 | Hausner's Ratio | | 1.42 ± 0.04 |
| 7 | Angle of Repose ($^\circ$) | | 42.23 ± 1.5 |
| 9 | Melting Point ($^\circ\text{C}$) | | 108°C |

Table 2: Concentration-absorbance data of Canaglifozine, for calibration curve.

| Sr. No | Canaglifozine | |
|--------|----------------------------|------------|
| | Conc. ($\mu\text{g/ml}$) | Absorbance |
| 1 | 0 | 0 |
| 2 | 10 | 0.5715 |
| 3 | 20 | 1.143 |
| 4 | 30 | 1.714 |
| 5 | 40 | 2.286 |
| 6 | 50 | 2.857 |
| 7 | 60 | 3.4295 |
| 8 | 70 | 3.9675 |

Table 3. Concentration absorbance data of Canaglifozine

| Sr. No | Canaglifozine | |
|--------|----------------------------|------------|
| | Conc. ($\mu\text{g/ml}$) | Absorbance |
| 1 | 0 | 0 |
| 2 | 10 | 0.5715 |
| 3 | 20 | 1.143 |
| 4 | 30 | 1.714 |
| 5 | 40 | 2.286 |
| 6 | 50 | 2.857 |
| 7 | 60 | 3.4295 |
| 8 | 70 | 3.9675 |
| 9 | 80 | 4.386 |
| 10 | 90 | 5.101 |
| 11 | 100 | 5.711 |





Rajib Lochan Dutta et al.,

Table 4: λ_{\max} , concentration range and R^2 value of calibration curve of Canaglifozine.

| Sr. No. | Name of the drug | λ_{\max} | Concentration Range | R^2 |
|---------|------------------|------------------|----------------------------|-------|
| 1 | Canaglifozine | 289 nm | 10 to 100 $\mu\text{g/ml}$ | 0.999 |

Table 5: Absorbance of placebo, standard and sample solutions of Canaglifozine.

| Sr. No. | Name of the drug | Absorbance of solutions | | |
|---------|------------------|-------------------------|----------|--------|
| | | Placebo | Standard | Sample |
| 1 | Canaglifozine | 0.004 | 0.514 | 0.517 |

Table 6: Results of precision of analytical method for Canaglifozine.

| Sr. No. | Sample | Absorbance of Canaglifozine |
|---------|-------------|-----------------------------|
| 1 | Intra-day 1 | 0.514 |
| 2 | Intra-day 2 | 0.516 |
| 3 | Intra-day 3 | 0.519 |
| Average | | 0.746 |
| SD | | 0.00404 |
| % RSD | | 0.542 |
| 4 | Inter-day 1 | 0.514 |
| 5 | Inter-day 2 | 0.517 |
| 6 | Inter-day 3 | 0.522 |
| Average | | 0.755 |
| SD | | 0.006 |
| % RSD | | 0.795 |

SD: Standard deviation, RSD: Relative standard Deviation

Table 7: Accuracy parameters for analytical method of Canaglifozine.

| Recovery level (%) | Recovered Drug (mg) | Drug Added (mg) | % Recovery | Average | S.D | %RSD |
|--------------------|---------------------|-----------------|------------|---------|-------|------|
| 25 | 1.96 | 2 | 98 | 98 | 0.02 | 1 |
| | 1.98 | 2 | 99 | | | |
| | 1.94 | 2 | 97 | | | |
| 50 | 3.94 | 4 | 98.5 | 98.75 | 0.01 | 0.25 |
| | 3.96 | 4 | 99 | | | |
| | 3.95 | 4 | 98.75 | | | |
| 75 | 5.95 | 6 | 99.16 | 98.88 | 0.037 | 0.63 |
| | 5.96 | 6 | 99.33 | | | |
| | 5.89 | 6 | 98.16 | | | |
| 100 | 7.96 | 8 | 99.5 | 99.12 | 0.043 | 0.54 |
| | 7.88 | 8 | 98.5 | | | |
| | 7.95 | 8 | 99.37 | | | |

SD: Standard deviation, RSD: Relative standard Deviation





Rajib Lochan Dutta et al.,

Table 8: Robustness data for the method of Canagliflozine,

| Time (h) | Absorbance of Canagliflozine |
|----------|------------------------------|
| 1 | 0.514 |
| 2 | 0.516 |
| 4 | 0.515 |
| 6 | 0.517 |
| 8 | 0.519 |
| Average | 0.516 |
| SD | 0.00192 |
| % RSD | 0.372 |
| 1 | 0.514 |
| 2 | 0.515 |
| 4 | 0.517 |
| 6 | 0.519 |
| 8 | 0.518 |
| Average | 0.5166 |
| SD | 0.00207 |
| % RSD | 0.401 |

SD: Standard deviation, RSD: Relative standard Deviation

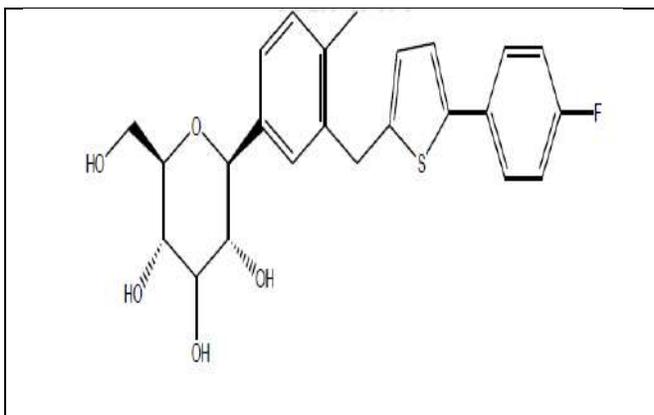


Figure :1 Structure of canagliflozine.

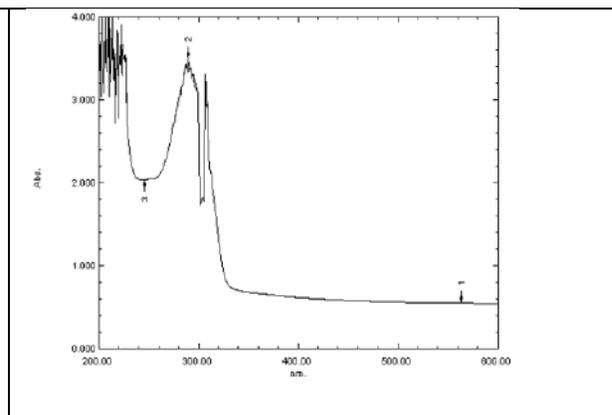


Figure 2. Maximum absorbance detected at 289nm.

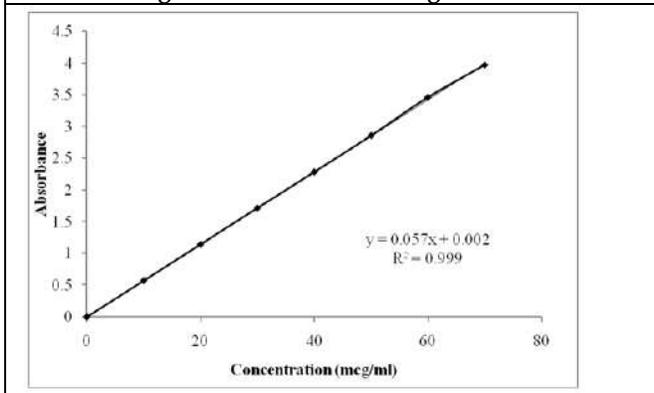


Figure 3: Calibration curve of Canagliflozine

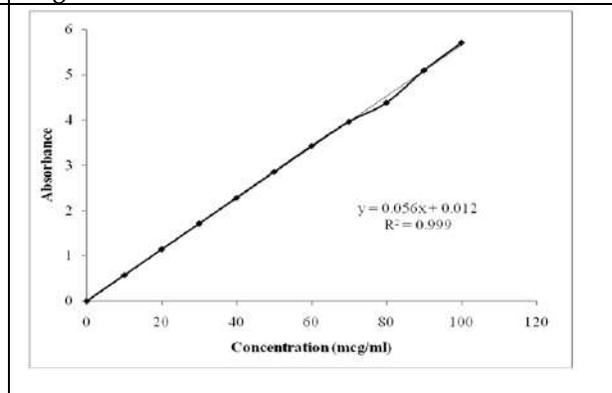


Figure 4. Linearity curve of Canagliflozine





Optimization of Formulation and Process Parameters using Factorial Design for Omeprazole Pellets

Sagar Muley^{1*}, Rahul Trivedi² and Tanaji Nandgude³

¹Research Scholar, Faculty of Pharmacy, B R Nahata College of Pharmacy, Mandsaur University, Mandsaur, Madhya Pradesh, India.

²Professor, Faculty of Pharmacy, B R Nahata College of Pharmacy, Mandsaur University, Mandsaur, Madhya Pradesh, India.

³Associate Professor, Department of Pharmaceutics, Dr. D Y Patil Institute of Pharmaceutical Science and Research, Pimpri, Pune, Maharashtra, India.

Received: 16 June 2022

Revised: 29 June 2022

Accepted: 09 July 2022

*Address for Correspondence

Sagar Muley

Research Scholar, Faculty of Pharmacy,
B R Nahata College of Pharmacy,
Mandsaur University, Mandsaur -458 001,
Madhya Pradesh, India.
Email: sagarsmuley@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In this study, the extrusion-spheronization technique was used to make Omeprazole pellets from carboxymethylated form of tamarind kernel powder. Several research initiatives have been conducted using tamarind kernel powder in past few decades. Some essential formulation and process factors were found through preformulation experiments, and the impact of those parameters on responses such as yield, drug content, particle size, hardness, disintegration time, and drug release was investigated using a 3² factorial design. OMZ25 was found to be the optimized batch after analyzing formulation and process parameter batches, with yield and drug content of 88.50 and 86.59%, respectively. The average particle size in this batch was 1.96 mm, with a hardness of 0.277 kg/cm². These pellets disintegrated in about 262 seconds on average. In phosphate buffer 6.8, drug release comparison of OMZ25 and marketed formulation revealed that 93.23% of the drug in the optimized batch and 88.23% of the drug in the marketed formulation was released after 60 minutes. After testing in an accelerated stability condition, the batch was found to be stable.

Keywords: Pellets, Extrusion-spheronization, Omeprazole, Carboxymethyl Tamarind Kernel powder, Factorial design.



Sagar Muley *et al.*,

INTRODUCTION

In 1943 as a replacement to some of very crucial components of Indian textile market, Tamarind kernel powder came into commercial production. It is obtained from seeds of Tamarind, commonly known as Imli [1]. It is mainly carbohydrate containing polymer additionally having proteins, amino acids, minerals, vitamins and fatty acids in it [2]. GRAS (Generally Recognized as Safe) Monograph have already confirmed the safety of tamarind seed polysaccharide for human consumptions if it is manufactured as per the specification [3]. To achieve various goals sometimes various modifications are done in TKP like, *Carboxymethylation* results in greater microbial resistance and higher viscosity as compared to the original TKP. *De-galactosylation* for formation of microgel at dilute concentrations. *Thiolation* improves bio-adhesion and drug permeation of the polymer. *Grafting* transfers natural product to a form which has less side effects that to without losing its original properties [2,4]. Tamarind kernel powder is a versatile excipient that can be used to formulate dosage forms such as sustained release tablets, biphasic liquids, gel, patches, and targeted drug delivery [5]. Some of the investigated formulations of tamarind kernel powder include suspension of Nimesulide [6], sustained release tablet of Aceclofenac [7], mucoadhesive tablet of Ciprofloxacin HCl [8], Diclofenac sodium [9], mucoadhesive patches of Metronidazole [10] and In situ gel of Ketorolac tromethamine [11]. Pellets are spherical and free-flowing units prepared using various pelletization techniques. Pellets as a dosage form has advantages like less discomfort to gastro-intestinal tract, particle size, and low risk of dose dumping when compared to dosage forms like tablets. The extrusion-spheronization is among the most common method for preparing pellets, which involves granulation, extrusion, spheronization, and drying [12-15]. Omeprazole (OMZ) is a proton pump inhibitor (PPI) that works at gastric parietal cell to inhibit gastric acid production by inhibiting the (H⁺, K⁺)-ATPase enzyme system [16]. In this study, pellets of Omeprazole (OMZ) were prepared using carboxymethylated form of tamarind kernel powder (CMTKP) to investigate its utility in pellet formulation via extrusion-spheronization. For formulation and process parameters, pellet formulations were optimised using factorial design

MATERIAL AND METHOD

MATERIALS

OMZ was purchased from BLD Pharma, Hyderabad. CMTKP was purchased from LR Industries, Jodhpur. Avicel-PH 101 (Microcrystalline cellulose), Lactose and Isopropyl alcohol (IPA) were purchased from Research-lab, Mumbai.

METHODS

Characterization of OMZ

λ_{max} and calibration curve of OMZ in phosphate buffer pH 6.8

In 50 mL volumetric flask, 50 mg OMZ was dissolved in 30 mL of methanol and then final volume was made up with methanol. In a 100 mL volumetric flask from above solution 10 mL was taken and further diluted up to 100 mL with phosphate buffer. From final solution 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5 and 6 mL was measured separately in 10 mL volumetric flasks which were further diluted with phosphate buffer to obtain the solutions of concentrations 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 and 60 $\mu\text{g/mL}$ respectively. The λ_{max} was determined and the absorbance of all concentrations was measured at the λ_{max} in the UV/Visible spectrophotometer [17, 18].

Differential scanning calorimetry (DSC) (Ta Instruments, Q 20)

OMZ was assessed by carrying out the thermal analysis [19, 20]. Crimped aluminum pan was used in which 2 mg of sample was transferred and heated carefully. The heating began at 40°C and increased at a rate of 10°C/min until it reached 400°C, while an inert atmosphere was maintained using nitrogen gas.



Sagar Muley *et al.*,**Infra-Red spectroscopy**

To remove moisture from OMZ, it was dried in a dryer, then mixed with potassium bromide and its infrared spectra was recorded using a Fourier Transform Infrared Spectrophotometer (Agilent, Cary630, USA) [20, 21].

Characterization of CMTKP

Micromeritic properties, true density, solubility, pH of 1% aqueous solution, surface tension, water retention capacity and swelling index of CMTKP were measured. 2.5% w/v solution of CMTKP was tested for microbial growth using nutrient agar [22]. The viscosity of 1, 3, and 5% aqueous solution of CMTKP was measured using a viscometer (DV-E viscometer, Brookfield Engineering Labs) using spindle numbers S61, S62, and S64. The prepared concentration's viscosities were measured at 5, 10, 20, 30, 50, 60, and 100 rpm [23].

X-ray diffraction (XRD)

The X-ray diffraction spectrums of TKP and CMTKP were obtained using an X-ray diffractometer (Make- Rigaku Japan; Model-Smart lab Cu 1.5 KV). Scanning was done in the range of 5 to 90° with scan speed of 0.35deg/min at room temperature (25°C).

Scanning electron microscopy (SEM)

CMTKP was examined using a scanning electron microscope (Make-Carl Zeiss Germany; Model-Supra 55). The sample to be analyzed was coated with a thin layer of gold under a vacuum and then the images were captured at different magnifications like 2, 10, 50 and 100KX.

Compatibility testing of the OMZ and Excipients

To test the compatibility of drug and other excipients a physical mixture containing drug and excipients was analyzed through DSC and IR spectroscopy.

Formulation of OMZ loaded Pellets containing CMTKP

All of the excipients listed in table 1 were accurately weighed, mixed thoroughly, and passed through a sieve to ensure uniform mixing before adding solvent (water and IPA) to prepare damp mass. To obtain extrudates, the prepared mass was passed through a sieve with 1 mm apertures. To prepare pellets, the obtained extrudates were spheronized in a spheronizer using 2 and 4 mm friction plates with cross-hatch grooves. Pellets were dried in a hot air oven at 50°C for 1 hr. Optimization of OMZ loaded pellets using factorial design for both formulation and process parameters was done. From pre-formulation studies most important factors were identified and accordingly factorial design was applied. In case of formulation; concentration of CMTKP and ratio of solvent IPA and water were very crucial parameters and for process parameters; RPM of friction plate and time for which the spheronization was carried out were the parameters. Considering above parameters firstly 9 batches of formulation parameters were prepared and evaluated and then best batch from formulation parameters was selected, on which process parameters were applied and further 9 batches were prepared. Composition of all the batches is given in table 1.

Evaluation of OMZ Loaded Batches**Yield**

For calculating yield following formula was used;

$$\text{Yield (\%)} = \frac{\text{Actual weight of pellets}}{\text{Theoretical weight of pellets}} \times 100$$

Hardness and Particle Size

Digital pellet hardness tester of Veeco was used to measure the hardness of pellets. The average particle size of the pellets from each batch was analyzed using ImageJ software [22].



**Sagar Muley et al.,****Drug content**

100 mg of the pellets were weighed and crushed to get a fine powder from which 30 mg of powder was dissolved in 25 mL phosphate buffer pH 6.8 and sonicated for 5 min. In 10 mL volumetric flask from above solution 1 mL solution was taken which was further diluted with phosphate buffer up to the mark. The absorbance of obtained solution was measured at 301 nm using the UV/Visible spectrophotometer and the concentration of drug in solution was calculated[18]. After knowing the total concentration of drug in a batch following formula was used to determine percent drug content;

$$\text{Drug content (\%)} = \frac{\text{Actual amount of drug found in pellets}}{\text{Theoretical amount of drug in pellets}} \times 100$$

Disintegration Time

Time required for breakdown of pellets in phosphate buffer pH 6.8 of pellets was determined by using a Veego's disintegration test apparatus.

In vitro Drug Release

For the drug release study, a sample containing 30 mg equivalence of OMZ was weighed and placed in the Veego's USP dissolution apparatus 1 (basket type). The basket was immersed in a vessel containing 900 mL of pH 6.8 phosphate buffer. The temperature of the vessel was maintained at $37^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$, and the baskets were rotated at a speed of 75 rpm. Every 10 minutes for the next 60 minutes, 10 mL was removed from the vessel and replaced with the same amount of fresh dissolution medium. The collected 10 mL samples were filtered using Whatman filter paper, and the absorbance of all samples was measured at 301 nm[24, 25].

Comparison between drug release of OMZ25 and marketed formulation

The drug release profile of OMZ25 and marketed capsule formulation (OMEZ) in phosphate buffer pH 6.8 was compared to find the effectiveness of prepared formulation.

Stability Studies of Optimized Batch

To know that over the time dose the product remains stable or not accelerated stability studies were conducted as per the ICH guidelines. The optimized formulation was tested at 40°C and 75% relative humidity for 3 months and then it was analyzed for some of the parameters like its appearance, drug content and drug release.

RESULT AND DISCUSSION**Characterization and compatibility studies of OMZ and excipients** **λ_{max} and calibration curve of OMZ in phosphate buffer pH 6.8**

λ_{max} for OMZ in phosphate buffer was found to be 301 nm. Straight line equation and R^2 value were $y = 0.0254x + 0.005$ and 0.9914 respectively.

Differential scanning calorimetry (DSC)

The DSC thermogram of pure Omeprazole is shown in Fig.2A which shows endothermic peak at 161.94°C and exothermic peak at 180.17°C . The obtained thermogram was compared with other studies also for confirmation[25]. In Fig.2B (DSC thermogram of Physical mixture of OMZ and other excipients) the endothermic and exothermic peak were observed at 162.41°C and 182.31°C respectively, hence from both the thermogram it can be concluded that there was no interaction between OMZ and other excipients.



Sagar Muley *et al.*,

Infra-Red spectroscopy

In Infra-Red spectrum of OMZ (Fig.3A) main functional groups; Aromatic C–H stretch (3056.40 cm^{-1}), C–H stretch (2970.70 cm^{-1}), C=C stretch (1625.10 cm^{-1}), C=N stretch (1585.50 cm^{-1}), CH₂ bending (1509.60 cm^{-1}), CH bending (1405.20 and 1312.0 cm^{-1}), C=O stretch (1159.20 cm^{-1}), C=S stretch (1073.50 cm^{-1}), and C–H bending (965.40 , 883.40 and 808.80 cm^{-1}) were observed. The obtained spectrum and frequencies confirmed that the analyzed sample contained all of Omeprazole's functional groups. Thus, the spectrum confirmed that the sample tested was Omeprazole[25]. Almost all of the characteristic peaks of OMZ were observed in Fig. 3B (IR spectra of Physical mixture of OMZ and other excipients), indicating that there was no interaction between OMZ and other excipients.

Characterization of CMTKP

Some of the results for characterization of CMTKP are given in table 2. The solubility study indicated that CMTKP was soluble in normal distilled water and warm distilled water. Further CMTKP was found to be very slightly soluble in acetone, n-hexane, petroleum ether and isopropyl alcohol. In ethanol and benzene it was insoluble. Values are expressed as mean \pm SD (n=3) When 2.5% w/v solution of CMTKP was tested for microbial growth using nutrient agar, no microbial growth was observed. Results suggested that CMTKP would prove to be safer for use. The results clearly supported or justified the carboxymethylation of tamarind kernel powder that improves its microbial resistance. Fig. 4 depicts a graph of the viscosities (cPS; shear stress) of CMTKP solutions (1, 3, and 5%) versus RPM (shear rate). The graphs show that as the concentration increased, so did the viscosity and it demonstrated non-Newtonian behaviour. Based on the swelling index, water retention capacity, and viscosity study of CMTKP, it can be concluded that this powder can be used as a release modifier in dosage forms [26].

X-ray diffraction (XRD)

Overlay X-ray diffraction graph of TKP and CMTKP is shown in Fig.5. From these diffraction patterns of TKP and CMTKP, it is clear that both have similar diffraction patterns. Additional two diffraction patterns or peaks at around 32 and 46 were might be due to carboxymethylation of TKP. As there are sharp peaks in both TKP and CMTKP X-ray diffraction graph it indicated that these powders might be semi-crystalline [27].

Scanning electron microscopy (SEM)

CMTKP was characterised using SEM. Fig.6 depicts SEM images at various magnifications. Agglomerated shapes and irregular particle sizes were observed. The surface of the CMTKP particle was smooth according to SEM photomicrographs. Both small and bigger particles were seen in the images. This could be attributed to the manufacturer's specific grinding technique. These parameters must be considered when developing pharmaceutical dosage forms containing these excipients, especially when the surface morphology of the material is critical. Because of the irregular particle size, uniform mixing may be hampered. This can be rectified by passing these powders through a suitable sieve to aid in uniform mixing.

Evaluation of OMZ Pellets

Optimization of OMZ loaded pellets using factorial design for both formulation and process parameters was done and the results are given in table 3. Values are expressed as Mean \pm SD, \$ n=50, #n=3 In case of results of formulation optimization it was clearly evident that hardness, particle size, disintegration time and drug release of the batches were having close relation with each other. Batches with relatively more hardness like in OMZ7, OMZ8 and OMZ9 were having higher disintegration time and accordingly lesser drug release after 60 minutes. On the other hand batches with relatively less hardness like in OMZ1, OMZ2 and OMZ3 were showing lesser disintegration time and accordingly higher drug release after 60 minutes. These observed results can be directly correlated with the concentration of CMTKP. As the concentration of CMTKP was increasing relatively hard pellets were produced which were taking more time in disintegrating and accordingly drug release was also on lower side. Hence the study indicated that 2.5% concentration of CMTKP was proven optimum for the formulation of pellets. IPA and water as solvent were also has significance in these results, as it was clearly evident that more the water and CMTKP in the formulation, harder pellets were obtained. Response surface 3D graphs showing the impact of amount of CMTKP and IPA:Water on the Yield, Drug content, Particle size, Hardness, time taken of disintegrating pellets and Drug



**Sagar Muley et al.,**

release for OMZ formulation optimization batches is shown in Fig. 8. OMZ2 was the most ideal batch with hardness of 0.325kg/cm², particle size of 1.16 mm, disintegration time of 288 seconds and 89.21% of drug release. OMZ2 was selected for further optimization of process parameters on the basis of above results. The drug release graphs for formulation optimization batches of OMZ pellets are shown in Fig. 7. It was clear that as the concentration of CMTKP was increasing the drug release was decreasing. Maximum of 89.21% drug release was seen for batch OMZ2 containing 2.5 % CMTKP whereas minimum of 57.83% was observed for OMZ7 which contain 7.5 % of CMTKP. As from formulation optimization it was clear that less the hardness of pellets less would be the disintegration time, which results in higher drug release. Similar trend was also seen in case of process optimization batches. Average speed of 750 RPM and average time 450 sec were proven to be ideal parameters to achieve above results. Response surface 3D graphs highlighting the impact of speed (RPM) and time on the Yield, Drug content, Particle size, Hardness, time taken of disintegrating pellets and Drug release for OMZ process optimization batches is shown in Fig. 10. OMZ25 was the most ideal batch with hardness of 0.277kg/cm², particle size of 1.96 mm, disintegration time of 262 seconds and 93.23% of drug release. There was no specific trend observed in process optimization as it was seen in formulation optimization but, with RPM of 500 the pellets with relatively larger particle size and with RPM of 1000 more amounts of fines were produced. The Drug release profiles of process optimization batches of OMZ pellets are shown in Fig.9. Maximum of 93.23% drug release was seen for batch OMZ25 which was processed at 750 RPM for 450 seconds, whereas minimum of 72.95% was observed for OMZ21 which was processed at 500 RPM for 300 seconds. From these observations it was clear that at relatively lower speed and time, produced pellets showed lesser drug release. Comparison of drug release patterns of optimized batch OMZ25 and OMEZ is shown in Fig. 11. From results it was observed that in initial 10 minutes drug release from marketed formulation was relatively lower which was clearly because of enteric coating layer on the marketed pellets formulation. It took some time to break that coating and then only it might have started to release the drug. Whereas in case of optimized formulation drug release was not affected in first 10 minutes as there was no enteric coating on pellets. Once enteric coating on these pellets will be done, it should affect drug release in first 10 minutes. Keeping aside first 10 minutes at every level optimized batch showed better drug release with 93.23% drug getting released within 60 minutes whereas in case of marketed formulation it was 88.23%.

Stability studies

When the samples from stability studies were analyzed it showed no changes or very minor changes such as there was no change observed in color, drug content showed minor change of 86.03% with 86.59% being the drug content before stability results. Where as drug release was affected by 1.06% as it decreased from 93.23% to 92.17%. Above all results suggested no significant difference in before and after data, indicated stability of formulation was maintained during the accelerated stability condition for 3 months.

CONCLUSION

From present study it was observed that in pellet formulation, CMTKP can be utilized in specific concentration so as to get desired results in terms of drug release and other parameters as per the official standards. Concentration of CMTKP was very crucial and one needs to be very careful about it. One can also vary the concentration of CMTKP as per the desired release profile from the formulation. CMTKP is very promising excipient which can be explored further for its various functionalities and there is lots of scope in this field where different excipients from natural sources can be utilized for formulating different dosage forms.

ACKNOWLEDGEMENT

The authors are very much thankful to B R Nahata College of Pharmacy, Mandsaur, Madhya Pradesh, India for allowing utilizing the facilities for research work.



Sagar Muley *et al.*,**CONFLICT OF INTEREST**

The authors have no conflicts of interest regarding this investigation.

REFERENCES

1. G.V.Radha, Naidu MS. An overview study on Tamarind seed polysaccharide as a novel excipient in pharmaceutical formulations. *Int J Invent Pharm Sci.* 2013;1(2):140-148.
2. Shaikh SS, Shivsharan KJ, Pawar RK, Misal NS, Mene HR, More BA. Tamarind seed polysaccharide : A versatile pharmaceutical excipient and its modification. *Int J Pharm Sci Rev Res.* 2015;33(1):157-164.
3. Heimbach JT. Determination of the GRAS Status of the Addition of Tamarind Seed Polysaccharide to Conventional Foods as a Stabilizer and Thickener.; 2014.
4. Katiyar N, Malviya R, Sharma PK. Pharmaceutical applications and formulation based patents of tamarindusindica seed polysaccharide and their modified derivatives. *AdvBiol Res (Rennes).* 2014;8(6):274-281.
5. Dey S, Chandra Nandy B, Narayan De J, Hasnain MS, Nayak AK. Tamarind Gum in Drug Delivery Applications. Elsevier Inc.; 2019. doi:10.1016/B978-0-12-817055-7.00012-1
6. Deveswaran R, Bharath S, Furtado S, Abraham S, Basavaraj B V, Madhavan V. Isolation and Evaluation of Tamarind Seed Polysaccharide as a Natural Suspending Agent. *Int J Pharm Biol Arch.* 2010;1(4):360-363.
7. Basavaraj, Rao BS, Kulkarni S V, Patil P, Surpur C. Design and Characterization of Sustained Release Aceclofenac Matrix Tablets Containing Tamarind Seed Polysaccharide. *Asian J Pharm Technol.* 2011;1(1):17-21.
8. Chandramouli Y, Firoz S, Vikram A, Venkata T, Yasmeen BR, Mahitha B. Evaluation of Tamarind seed polysaccharide (TSP) as a mucoadhesive and controlled release component of Ciprofloxacin HClmucoadhesive matrix tablet & comparison with HPMC K-100 and Xanthan gum. *Int J Curr Pharm Clin Res.* 2012;2(2):90-98.
9. Jangdey MS, Gupta A, Sah AK. Development and evaluation of mucoadhesive sustained release tablet using tamarindusindica gum. *Asian J Res Pharm Sci.* 2014;4(2):77-82.
10. Jana S, Lakshman D, Sen KK, Basu SK. Development and evaluation of epichlorohydrin cross-linked mucoadhesive patches of tamarind seed polysaccharide for buccal application. *Int J Pharm Sci Drug Res* 2010. 2010;2(3):193-198.
11. Gupta SK, Arora P, Yadav R. Sustained ophthalmic delivery of ketorolac tromethamine from an ion activated in situ gelling system. *Int J Pharm LIFE Sci.* 2014;5(12):4063-4073.
12. Ghebre-sellassie I. Pellets: A general overview. In: Ghebre-sellassie I, ed. *Pharmaceutical Pelletization Technology.* New York: Marcel Dekker; 1989:1-15.
13. Yadav HKS, Usman S, Ramesh KVRNS, Islam Q. Formulation and evaluation of pellets of natural Okra gum prepared by extrusion and spheronization. *Res J Pharm Technol.* 2021;14(6):3290-3294.
14. Manoharan K, Bhaskaran NA, Kumar L. Pellets and techniques of pelletization. *Res J Pharm Technol.* 2019;12(12):6157-6164.
15. Vervaet C, Baert L, Remon JP. Extrusion-spheronisation A literature review. *Int J Pharm.* 1995;116(2):131-146.
16. Tripathi KD. Drugs for Peptic ulcer. In: *Essentials of Medical Pharmacology.* 6th ed. New Delhi: Jaypee publishers; 2006:627-629.
17. Venkateswarlu P. Formulation and In Vitro Evaluation of Lansoprazole Delayed Release Capsules. *Int J Innov Pharm Res.* 2013;4(3):328-336.
18. Kumar AA, Ramana KV, Raju CN, Rao GS. A simple UV spectrophotometric method for determination of lansoprazole in bulk and pharmaceutical dosage forms. *Int J Pharm ChemBiol Sci.* 2012;2(4):524-528.
19. Humboldt University of Berlin. *Advanced Lab: DSC Investigation of Polymers.*
20. A V Kasture KRM. *Pharmaceutical Analysis. Volume II.* Pune: NiraliPrakashan; 2010.
21. Stuart BH. *Infrared Spectroscopy: Fundamentals and Applications.* Vol8.; 2004.
22. Phani Kumar GK, Battu G, LovaRaju KNS. Isolation and evaluation of tamarind seed polysaccharide being used as a polymer in pharmaceutical dosage forms. *Res J Pharm BiolChem Sci.* 2011;2(2):274-290.
23. Razavi M, Nyamathulla S, Karimian H, Moghadamtousi SZ, Noordin MI. Hydrogel polysaccharides of tamarind and xanthan to formulate hydrodynamically balanced matrix tablets of famotidine. *Molecules.* 2014;19(9):13909-



Sagar Muley *et al.*,

13931.

24. United State Pharmacopoeia. USP30-NF25 ed. The United States Pharmacopoeial Convention; 2007.
25. Al-Badr AA. Omeprazole. Profiles Drug SubstExcipRelatMethodol. 2010;35:151-262.
26. Neil John Alderman. Non-Newtonian Fluids: Introduction and Guide To Classification and Characteristics. EngSci Data Unit, Data Items. 2016;(January):1-33.
27. Sumathi S, Ray AR. Release behaviour of drugs from tamarind seed polysaccharide tablets. J Pharm Pharm Sci. 2002;5(1):12-18.

Table 1. Composition of batches for formulation and process optimization

| Optimization | Batch code | MCC (% w/w) | OMZ (% w/w) | Lactose (% w/w) | CMTKP (% w/w) | Water:IPA (% v/v) | Time (sec) | RPM |
|----------------------------------|------------|-------------|-------------|-----------------|---------------|-------------------|------------|------|
| Formulation Optimization batches | OMZ1 | 25 | 2.5 | 70 | 2.5 | 30:70 | 600 | 1000 |
| | OMZ2 | 25 | 2.5 | 70 | 2.5 | 20:80 | 600 | 1000 |
| | OMZ3 | 25 | 2.5 | 70 | 2.5 | 10:90 | 600 | 1000 |
| | OMZ4 | 25 | 2.5 | 67.5 | 5 | 30:70 | 600 | 1000 |
| | OMZ5 | 25 | 2.5 | 67.5 | 5 | 20:80 | 600 | 1000 |
| | OMZ6 | 25 | 2.5 | 67.5 | 5 | 10:90 | 600 | 1000 |
| | OMZ7 | 25 | 2.5 | 65 | 7.5 | 30:70 | 600 | 1000 |
| | OMZ8 | 25 | 2.5 | 65 | 7.5 | 20:80 | 600 | 1000 |
| | OMZ9 | 25 | 2.5 | 65 | 7.5 | 10:90 | 600 | 1000 |
| Process Optimization batches | OMZ21 | 25 | 2.5 | 70 | 2.5 | 20:80 | 300 | 500 |
| | OMZ22 | 25 | 2.5 | 70 | 2.5 | 20:80 | 450 | 500 |
| | OMZ23 | 25 | 2.5 | 70 | 2.5 | 20:80 | 600 | 500 |
| | OMZ24 | 25 | 2.5 | 70 | 2.5 | 20:80 | 300 | 750 |
| | OMZ25 | 25 | 2.5 | 70 | 2.5 | 20:80 | 450 | 750 |
| | OMZ26 | 25 | 2.5 | 70 | 2.5 | 20:80 | 600 | 750 |
| | OMZ27 | 25 | 2.5 | 70 | 2.5 | 20:80 | 300 | 1000 |
| | OMZ28 | 25 | 2.5 | 70 | 2.5 | 20:80 | 450 | 1000 |
| | OMZ29 | 25 | 2.5 | 70 | 2.5 | 20:80 | 600 | 1000 |

Table 2: Basic properties of CMTKP

| Parameters | CMTKP | USP specification |
|------------------------------|--------------|-------------------------------|
| Bulk density (g/ml) | 0.5034±0.003 | |
| Tapped density (g/ml) | 0.6238±0.008 | |
| True density (g/ml) | 1.3801±0.007 | |
| Hausner ratio | 1.24±0.013 | 1.19-1.25; fair flow property |
| Carr's index (%) | 19.30±0.86 | 16- 20 % ; fair flow property |
| Angle of repose (degree) | 44.5±1.01 | 41-45° passable flow property |
| pH | 9.5±0.08 | |
| Swelling index (%) | 223.3±2.4 | |
| Water retention capacity (%) | 65±0.8 | |
| Surface tension (dynes/cm) | 47.27±1.31 | |





Sagar Muley *et al.*,

Table 3. Responses of various evaluations for formulation and process optimization batches

| Batch code | Yield (%) | Hardness (kg/cm ²) [#] | Particle Size (mm) [§] | Drug Content (%) [#] | Disintegration Time (sec) [#] | Drug Release (%) After 60 min [#] |
|------------|-----------|---|---------------------------------|-------------------------------|--|--|
| OMZ1 | 68.90 | 0.330±0.060 | 0.96±0.27 | 60.64±0.73 | 320±4 | 83.98±0.26 |
| OMZ2 | 73.00 | 0.325±0.082 | 1.16±0.20 | 60.79±0.28 | 288±6 | 89.21±0.20 |
| OMZ3 | 71.50 | 0.337±0.062 | 1.07±0.18 | 51.52±1.08 | 312±2 | 87.60±0.43 |
| OMZ4 | 90.00 | 0.409±0.089 | 1.08±0.30 | 63.03±1.06 | 373±2 | 67.99±0.24 |
| OMZ5 | 73.70 | 0.378±0.089 | 1.31±0.29 | 54.51±0.67 | 355±4 | 70.71±0.29 |
| OMZ6 | 72.70 | 0.369±0.089 | 1.32±0.27 | 52.51±0.75 | 343±2 | 73.62±0.06 |
| OMZ7 | 83.30 | 0.477±0.088 | 1.14±0.23 | 64.28±0.57 | 535±4 | 57.83±0.24 |
| OMZ8 | 72.35 | 0.467±0.076 | 0.99±0.34 | 60.32±0.29 | 508±2 | 61.10±0.15 |
| OMZ9 | 85.00 | 0.481±0.093 | 1.21±0.24 | 63.34±0.62 | 520±4 | 59.80±0.29 |
| OMZ21 | 89.60 | 0.334±0.088 | 2.95±0.54 | 78.77±0.46 | 327±2 | 72.95±0.15 |
| OMZ22 | 89.00 | 0.345±0.088 | 1.84±0.26 | 70.08±0.38 | 322±2 | 75.59±0.26 |
| OMZ23 | 61.50 | 0.325±0.086 | 3.12±0.36 | 47.30±0.13 | 315±1 | 76.30±0.29 |
| OMZ24 | 86.50 | 0.298±0.070 | 1.78±0.25 | 83.36±0.24 | 308±2 | 89.84±0.31 |
| OMZ25 | 88.50 | 0.277±0.005 | 1.96±0.36 | 86.59±0.34 | 262±2 | 93.23±0.24 |
| OMZ26 | 92.30 | 0.289±0.010 | 2.23±0.38 | 80.77±0.26 | 283±2 | 91.77±0.10 |
| OMZ27 | 68.00 | 0.266±0.007 | 2.70±0.44 | 60.19±0.22 | 318±2 | 82.60±0.06 |
| OMZ28 | 81.10 | 0.271±0.005 | 2.77±0.32 | 72.25±0.44 | 323±2 | 83.78±0.06 |
| OMZ29 | 87.00 | 0.289±0.002 | 1.36±0.44 | 74.78±0.28 | 332±2 | 83.58±0.20 |

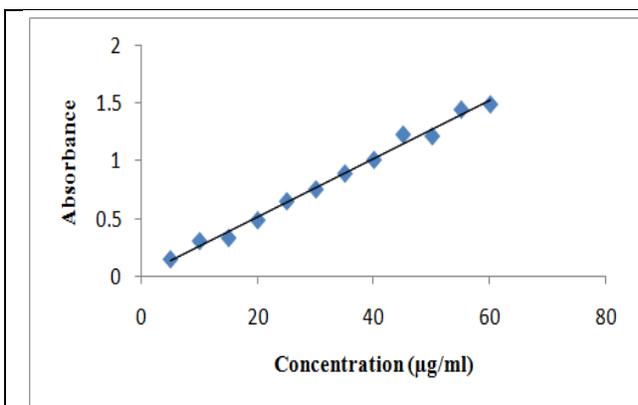


Fig. 1: Calibration curve of OMZ in phosphate buffer pH 6.8

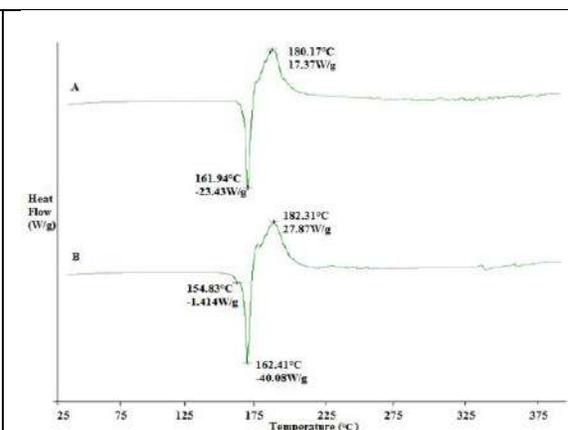


Fig. 2: (A) DSC thermogram of OMZ, and (B) DSC of Physical mixture of OMZ and other excipients





Sagar Muley *et al.*,

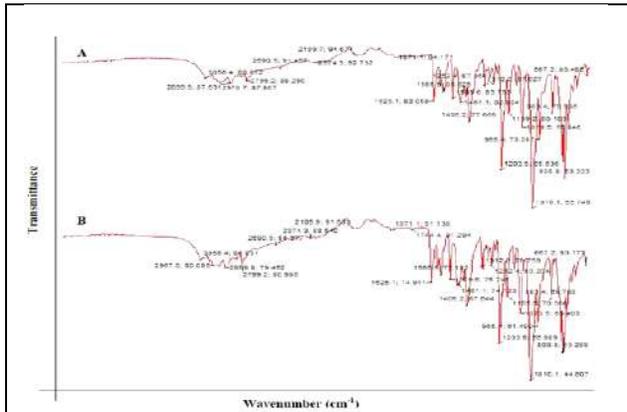


Fig. 3: (A) IR spectra of OMZ, and (B) IR spectra of Physical mixture of OMZ and other excipients

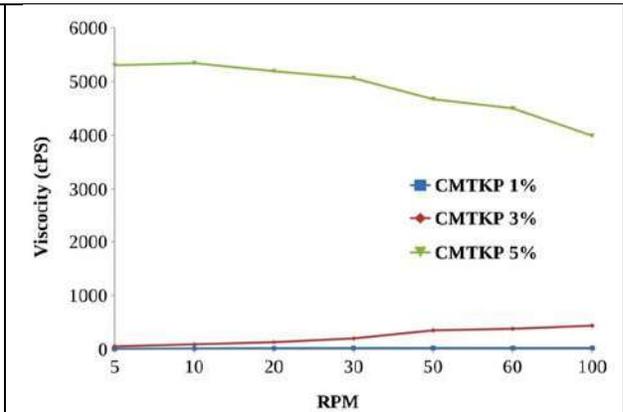


Fig. 4: Graphs for Viscosity (cPS) vs RPM of CMTKP dispersions (1%, 3% and 5%)

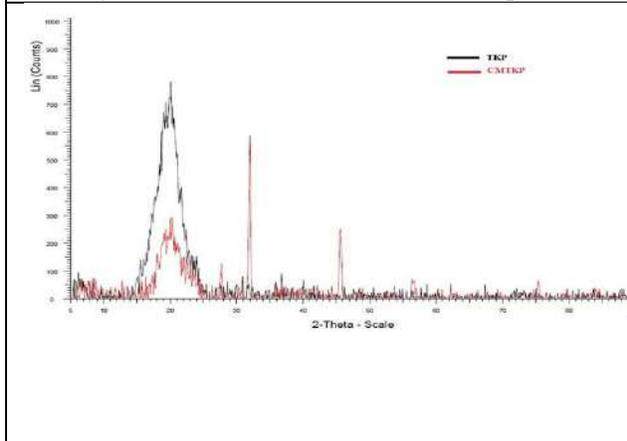


Fig. 5: Overlay XRD graph of TKP and CMTKP

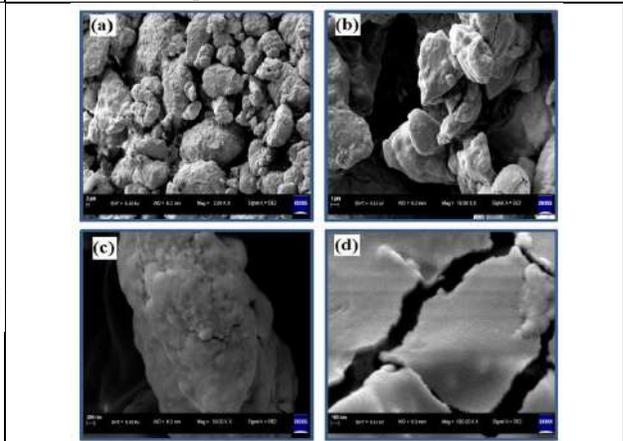


Fig. 6: SEM images at different magnifications for CMTKP; (a) 2KX, (b) 10KX, (c) 50KX, (d) 100KX

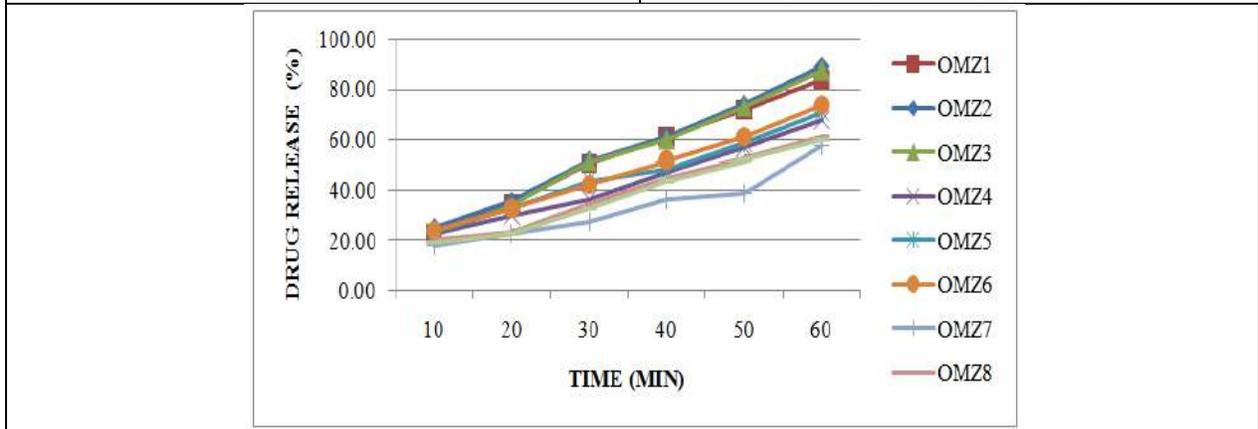
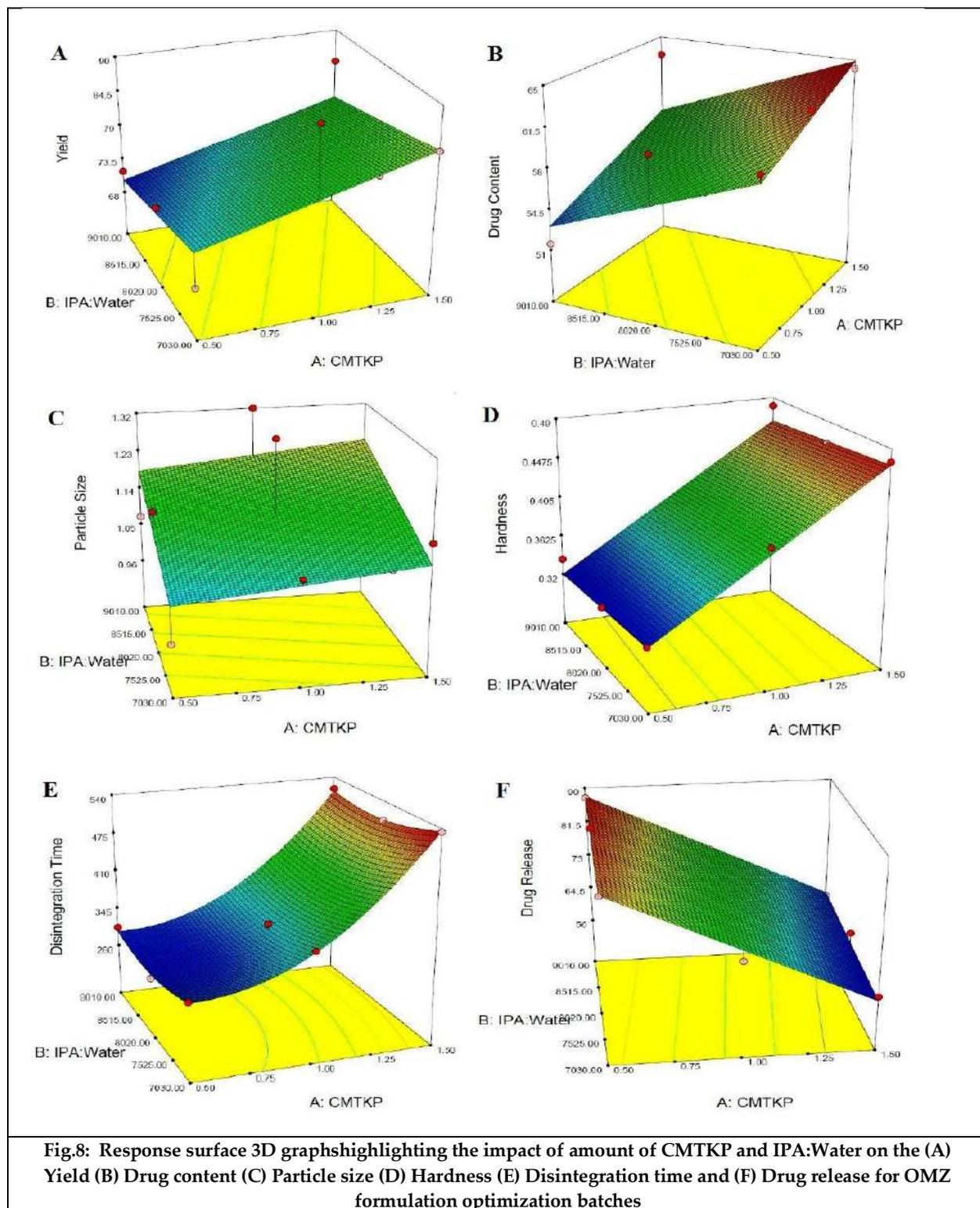


Fig.7: Drug release graphs for formulation optimization batches of OMZ pellets





Sagar Muley *et al.*,





Sagar Muley *et al.*,

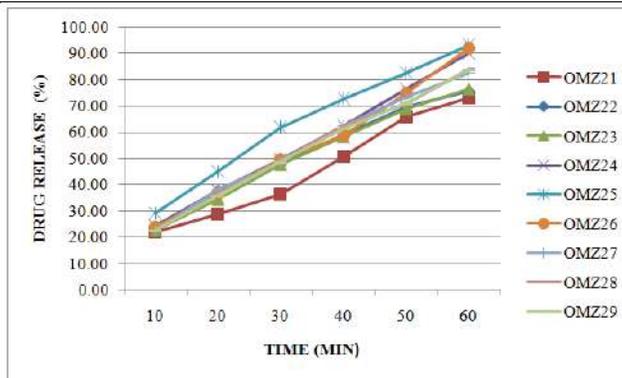


Fig. 9: Drug release graphs for process optimization batches of OMZ pellets

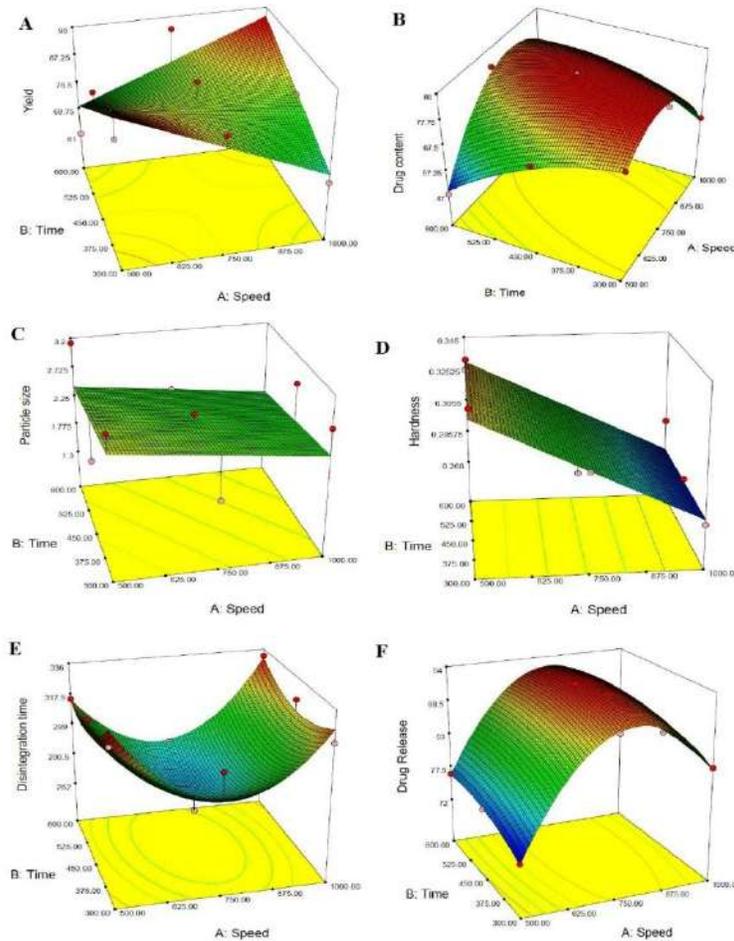


Fig.10: Response surface 3D graphs highlighting the impact of Speed (RPM) and Time on the (A) Yield (B) Drug content (C) Particle size (D) Hardness (E) Disintegration time and (F) Drug release for OMZ process optimization batches





Sagar Muley *et al.*,

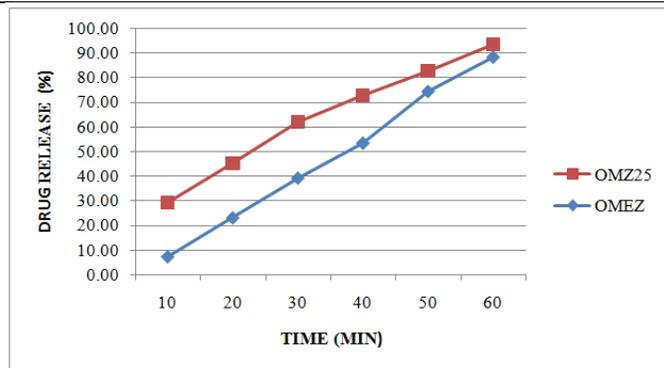


Fig. 11: Drug release patternsfor optimized batch OMZ25 and OMEZ in Phosphate Buffer 6.8 pH





On $(1, 2)^*$ - $\alpha\omega$ -Irresolute Maps in Bitopological Spaces

S. Mukesh Parkavi^{1*} and A. Arivu Chelvam²

¹Research Scholar, PG and Research Department of Mathematics, Mannar Thirumalai Naicker College, Madurai, Tamil Nadu, India.

²Assistant Professor, PG and Research Department of Mathematics, Mannar Thirumalai Naicker College, Madurai, Tamil Nadu, India.

Received: 30 May 2022

Revised: 15 June 2022

Accepted: 18 July 2022

*Address for Correspondence

S. Mukesh Parkavi

Research Scholar,

PG and Research Department of Mathematics,

Mannar Thirumalai Naicker College,

Madurai, Tamil Nadu, India.

Email: mukeshparkavi98@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

R.S.Wali and Prabhavati S Mandalgeri studied the concept of $\alpha\omega$ -continuous and $\alpha\omega$ -irresolute maps in topology in 2014. Recently the authors introduced $(1,2)^*$ - $\alpha\omega$ -continuous maps, $(1,2)^*$ -perfectly $\alpha\omega$ -continuous maps in bitopological spaces. In this paper a new type of functions on bitopological spaces called a $(1,2)^*$ - $\alpha\omega$ -irresolute maps is introduced and its various properties are discussed. $(1,2)^*$ -strongly $\alpha\omega$ -continuous function is defined and its results are studied. Also, comparative study has been done with the existing functions.

Keywords: $(1,2)^*$ - $\alpha\omega$ -open sets, $(1,2)^*$ - $\alpha\omega$ -closed sets, $(1,2)^*$ - $\alpha\omega$ -irresolute maps, $(1,2)^*$ -strongly $\alpha\omega$ -continuous.

INTRODUCTION

The concept of a bitopological space (X, τ_1, τ_2) was first initiated by J.C.Kelly [1], Where X is a nonempty set and τ_1, τ_2 are topologies on X . Arya.S.P and Gupta.R [2] was introduced the concept of regular continuous and completely continuous. S.G.Crossly, and S.K.Hildebrand [14] studied the concept of semi topological properties. R.S.Wali et al [4] was introduced a new type of functions called $\alpha\omega$ -continuous maps, $\alpha\omega$ -irresolute maps in topological space. Recently the authors [13] introduced $(1,2)^*$ - $\alpha\omega$ -continuous maps in bitopological spaces. The purpose of the paper is to study about a new class of functions, namely $(1,2)^*$ - $\alpha\omega$ -irresolute functions, $(1,2)^*$ -strongly- $\alpha\omega$ -continuous functions. Also, we obtain some of the characterization of this function and investigate the basic properties of $(1,2)^*$ - $\alpha\omega$ -irresolute functions.





Mukesh Parkavi and Arivu Chelvam

Preliminaries

Throughout this paper, (X, τ_1, τ_2) and (Y, σ_1, σ_2) (or simply X and Y) represent a bitopological spaces on which no separation axioms are assumed unless otherwise mentioned. For a subset A of a space X , $cl(A)$ and $int(A)$ denote the closure of A and the interior of A respectively. X/A or A^c denotes the complement of A in X . We recall the following definitions and results.

Definition 2.1

A subset A of a bitopological space (X, τ_1, τ_2)

- $(1,2)^*$ -semiopen set [7] if $A \subseteq \tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(A))$ and $(1,2)^*$ -semiclosed set if $\tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(A)) \subseteq A$
- $(1,2)^*$ -preopen set [10] if $A \subseteq \tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(A))$ and $(1,2)^*$ -preclosed set if $\tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(A)) \subseteq A$
- $(1,2)^*$ - α -open set [5] if $A \subseteq \tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(A)))$ and $(1,2)^*$ - α -closed set if $\tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(A))) \subseteq A$
- $(1,2)^*$ -semi-preopen set [6] ($=\beta$ -open) if $A \subseteq \tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(A)))$ and $(1,2)^*$ -semi-preclosed set ($=\beta$ -closed) if $\tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(A))) \subseteq A$
- $(1,2)^*$ -regular open set [5] if $A = \tau_{1,2}\text{-int}(\tau_{1,2}\text{-cl}(A))$ and $(1,2)^*$ -regular closed set if $A = \tau_{1,2}\text{-cl}(\tau_{1,2}\text{-int}(A))$
- $(1,2)^*$ -regular semi open set [12] if there is a $(1,2)^*$ -regular open set U such that $U \subseteq A \subseteq \tau_{1,2}\text{-cl}(U)$
- $(1,2)^*$ -regular α -open set (briefly, $(1,2)^*$ - $r\alpha$ -open) if there is a $(1,2)^*$ -regular open set U such that $U \subseteq A \subseteq (1,2)^*\text{-}\alpha\text{cl}(U)$

Definition 2.2

- $(1,2)^*$ - ω -closed set [11] if $\tau_{1,2}\text{-cl}(A) \subseteq U$ whenever $A \subseteq U$ and U is $(1,2)^*$ -semi-open in X .
- $(1,2)^*$ -regular ω -closed (briefly $(1,2)^*$ - $r\omega$ -closed) [8] if $(1,2)^*\text{-cl}(A) \subseteq U$ whenever $A \subseteq U$ and U is $(1,2)^*$ -regular semiopen in X .
- $(1,2)^*$ - α regular ω -closed (briefly $(1,2)^*$ - $\alpha r\omega$ -closed) set [16] if $(1,2)^*\text{-}\alpha\text{cl}(A) \subseteq U$ whenever $A \subseteq U$ and U is $(1,2)$ - $r\omega$ -open in X .

Definition 2.3

- $(1,2)^*$ -continuous [9] if $f^{-1}(V)$ is $\tau_{1,2}$ in X for every $\sigma_{1,2}$ closed subset V of Y .
- $(1,2)^*$ -regular continuous ($(1,2)^*$ - r -continuous) [8] if $f^{-1}(V)$ is $(1,2)^*$ - r -closed in X for every $\sigma_{1,2}$ closed subset V of Y .
- $(1,2)^*$ -strongly-continuous if $f^{-1}(V)$ is $\tau_{1,2}$ -clopen (both closed and open) in X for every $\sigma_{1,2}$ closed subset V of Y .
- $(1,2)^*$ - $r\omega$ -continuous [8] if $f^{-1}(V)$ is $(1,2)^*$ - $r\omega$ -closed in X for every $\sigma_{1,2}$ closed subset V of Y .
- $(1,2)^*$ -strongly α -continuous if $f^{-1}(V)$ is $(1,2)^*$ - α -closed in X for every $\sigma_{1,2}$ semi-closed subset V of Y .
- $(1,2)^*$ - α regular ω continuous ($(1,2)^*$ - $\alpha r\omega$ -Continuous) [13] if $f^{-1}(V)$ is $(1,2)^*$ - $\alpha r\omega$ -closed set in X for every $\sigma_{1,2}$ closed set V in Y .
- $(1,2)^*$ -perfectly α regular ω continuous (briefly $(1,2)^*$ -perfectly $\alpha r\omega$ -continuous) [13] if $f^{-1}(V)$ is $\tau_{1,2}$ -clopen (closed and open) set in X for Every $(1,2)^*$ - $\alpha r\omega$ -open set V in Y .





Mukesh Parkavi and Arivu Chelvam

Definition 2.4

A map $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ is said to be

- $(1,2)^*$ - α -irresolute [3] if $f^{-1}(V)$ is $(1,2)^*$ - α -closed in X for every $(1,2)^*$ - α -closed subset V of Y .
- $(1,2)^*$ -irresolute [14] if $f^{-1}(V)$ is $(1,2)^*$ -semi-closed in X for every $(1,2)^*$ -semi closed subset V of Y .
- $(1,2)^*$ -contra irresolute if $f^{-1}(V)$ is $(1,2)^*$ -semi open in X for every $(1,2)^*$ -semi closed subset V of Y .
- $(1,2)^*$ -contra continuous [15] if $f^{-1}(V)$ is $\tau_{1,2}$ -open in X for every $\sigma_{1,2}$ closed subset V of Y .

$(1, 2)^*$ - $\alpha\omega$ -Irresolute and Strongly $(1, 2)^*$ - $\alpha\omega$ -Continuous Functions

Definition 3.1

A function f from a bitopological space (X, τ_1, τ_2) into a bitopological space (Y, σ_1, σ_2) is called $(1,2)^*$ - α regular ω irresolute ($(1,2)^*$ - $\alpha\omega$ -irresolute) map if $f^{-1}(V)$ is $(1,2)^*$ - $\alpha\omega$ -closed set in X for every $(1,2)^*$ - $\alpha\omega$ -closed set V in Y .

Definition 3.2

A function f from bitopological space (X, τ_1, τ_2) into a bitopological space (Y, σ_1, σ_2) is called $(1,2)^*$ -strongly α regular ω continuous ($(1,2)^*$ -strongly $\alpha\omega$ -continuous) map if $f^{-1}(V)$ is $\tau_{1,2}$ -closed set in X for every $(1,2)^*$ - $\alpha\omega$ -closed set V in Y .

Theorem 3.3

If A map $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ is $(1,2)^*$ - $\alpha\omega$ -irresolute, then it is $(1,2)^*$ - $\alpha\omega$ -continuous but not conversely.

Proof

Let $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ be $(1,2)^*$ - $\alpha\omega$ -irresolute. Let F be any $\sigma_{1,2}$ -closed set in Y . Then F is $(1,2)^*$ - $\alpha\omega$ -closed in Y . Since f is $(1,2)^*$ - $\alpha\omega$ -irresolute, the inverse image $f^{-1}(F)$ is $(1,2)^*$ - $\alpha\omega$ -closed set in X . Therefore f is $(1,2)^*$ - $\alpha\omega$ -continuous. The converse of the above theorem need not be true as seen from the following example.

Example 3.4

Let $X=Y=\{a,b,c\}$, $\tau_1=\{X, \emptyset, \{a\}, \{a,b\}\}$ and $\tau_2=\{X, \emptyset, \{b\}\}$, $\sigma_1=\{Y, \emptyset, \{b\}\}$ and $\sigma_2=\{Y, \emptyset, \{b,c\}\}$, Let map $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ defined by, $f(a)=b$, $f(b)=c$, $f(c)=a$, then f is $(1,2)^*$ - $\alpha\omega$ -continuous but f is not $(1,2)^*$ - $\alpha\omega$ -irresolute, as $(1,2)^*$ - $\alpha\omega$ -closed set $F=\{c\}$ in Y , then $f^{-1}(F)=\{b\}$ in X , which is not $(1,2)^*$ - $\alpha\omega$ -closed in X .

Theorem 3.5

If A map $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ is $(1,2)^*$ - $\alpha\omega$ -irresolute, then for every subset A of X , $f((1,2)^*\text{-}\alpha\omega\text{-cl}(A)) \subseteq (1,2)^*\text{-}\alpha\text{-cl}(f(A))$.

Proof

If $A \subseteq X$ then consider $(1,2)^*\text{-}\alpha\text{-cl}(f(A))$ which is $(1,2)^*$ - $\alpha\omega$ -closed in Y . since f is $(1,2)^*$ - $\alpha\omega$ -irresolute, $f^{-1}((1,2)^*\text{-}\alpha\text{-cl}(f(A)))$ is $(1,2)^*$ - $\alpha\omega$ -closed in X . Furthermore $A \subseteq f^{-1}(f(A)) \subseteq f^{-1}((1,2)^*\text{-}\alpha\text{-cl}(f(A)))$. Therefore by $(1,2)^*$ - $\alpha\omega$ -closure, $(1,2)^*\text{-}\alpha\omega\text{-cl}(A) \subseteq f^{-1}((1,2)^*\text{-}\alpha\text{-cl}(f(A)))$, consequently, $f((1,2)^*\text{-}\alpha\omega\text{-cl}(A)) \subseteq f(f^{-1}((1,2)^*\text{-}\alpha\text{-cl}(f(A)))) \subseteq (1,2)^*\text{-}\alpha\text{-cl}(f(A))$.

Theorem 3.6

Let $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ is $(1,2)^*$ -strongly $\alpha\omega$ -continuous then it is $(1,2)^*$ -continuous.





Mukesh Parkavi and Arivu Chelvam

Proof

Assume that $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly $\alpha\omega$ -continuous, Let F be $\sigma_{1,2}$ -closed set in Y . As every $\tau_{1,2}$ closed is $(1,2)^*$ - $\alpha\omega$ -closed, F is $(1,2)^*$ - $\alpha\omega$ -closed in Y . since f is $(1,2)^*$ -strongly $\alpha\omega$ -continuous then $f^{-1}(F)$ is $\tau_{1,2}$ -closed set in X . Therefore f is $(1,2)^*$ -continuous.

Theorem 3.7

Let $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly $\alpha\omega$ -continuous then it is $(1,2)^*$ -strongly α -continuous but not conversely.

Proof

Assume that $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly $\alpha\omega$ -continuous, Let F be $(1,2)^*$ - α -closed set in Y . As every $(1,2)^*$ - α -closed is $(1,2)^*$ - $\alpha\omega$ -closed, F is $(1,2)^*$ - $\alpha\omega$ -closed in Y . since f is $(1,2)^*$ -strongly $\alpha\omega$ -continuous then $f^{-1}(F)$ is $\tau_{1,2}$ -closed set in X . Therefore f is $(1,2)^*$ -strongly α -continuous. The converse of the above theorem need not be true as seen from the following example.

Example 3.8

Let $X=\{a,b,c,d\}$ and $Y=\{a,b,c\}$, $\tau_1=\{X,\emptyset,\{a\},\{a,b\}\}$ and $\tau_2=\{X,\emptyset,\{b\},\{a,b,d\}\}$, $\sigma_1=\{Y,\emptyset,\{c\}\}$ and $\sigma_2=\{Y,\emptyset,\{a,c\}\}$, Let map $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ defined by $f(a)=c$, $f(b)=c$, $f(c)=a$, $f(d)=b$, then f is $(1,2)^*$ -strongly α -continuous but not $(1,2)^*$ -continuous and not $(1,2)^*$ -strongly- $\alpha\omega$ -continuous, as closed set $F=\{b\}$ in Y , then $f^{-1}(F)=\{d\}$ in which is not $\tau_{1,2}$ -closed set in X .

Theorem 3.9

Let $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly continuous then it is $(1,2)^*$ -strongly $\alpha\omega$ -continuous.

Proof

Assume that $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly continuous. Let G be $(1,2)^*$ - $\alpha\omega$ -open in Y and also it is any subset of Y . since f is $(1,2)^*$ -strongly continuous, $f^{-1}(G)$ is $\tau_{1,2}$ -open (and also closed) in X . $f^{-1}(G)$ is $\tau_{1,2}$ -open in X . Therefore f is $(1,2)^*$ -strongly $\alpha\omega$ -continuous.

Theorem 3.10

Let $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly $\alpha\omega$ -continuous then it is $(1,2)^*$ - $\alpha\omega$ -continuous.

Proof

Let G be open in Y , every $\tau_{1,2}$ -open is $(1,2)^*$ - $\alpha\omega$ -open, G is $(1,2)^*$ - $\alpha\omega$ -open in Y , since f is $(1,2)^*$ -strongly $\alpha\omega$ -continuous, $f^{-1}(G)$ is $\tau_{1,2}$ -open in X . and therefore $f^{-1}(G)$ is $(1,2)^*$ - $\alpha\omega$ -open in X . Hence f is $(1,2)^*$ - $\alpha\omega$ -continuous.

Theorem 3.11

In discrete space, a map $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly $\alpha\omega$ -continuous then it is $(1,2)^*$ -strongly continuous.

Proof

Let F be any subset of Y , in discrete space, Every subset of F in Y is both $\sigma_{1,2}$ -open and $\sigma_{1,2}$ -closed, then subset F is both $(1,2)^*$ - $\alpha\omega$ -open or $(1,2)^*$ - $\alpha\omega$ -closed, i) let F is $(1,2)^*$ - $\alpha\omega$ -closed in Y , since f is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous, then $f^{-1}(F)$ is $\tau_{1,2}$ -closed in X . ii) let F is $(1,2)^*$ - $\alpha\omega$ -open in Y , since f is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous, then $f^{-1}(F)$ is $\tau_{1,2}$ -open in X . Therefore $f^{-1}(F)$ is $\tau_{1,2}$ -closed and $\tau_{1,2}$ -open in X . Hence f is $(1,2)^*$ -strongly continuous.

Theorem 3.12

If A map $f:(X,\tau_1,\tau_2)\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous and A is $\tau_{1,2}$ -open subset of (X,τ_1,τ_2) then the restriction $f/A: A\rightarrow(Y,\sigma_1,\sigma_2)$ is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous.

Proof



Mukesh Parkavi and Arivu Chelvam

Let V be any $(1,2)^*$ - $\alpha\omega$ -open set of Y , since f is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous, then $f^{-1}(V)$ is $\tau_{1,2}$ -open in X . since A is $\tau_{1,2}$ -open in X , $(f/A)^{-1} = A \cap f^{-1}(V)$ is $\tau_{1,2}$ -open in A . hence f/A is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous.

Theorem 3.13

Let (X, τ_1, τ_2) be a discrete bitopological space and (Y, σ_1, σ_2) be any bitopological space and $f: (X, \tau_1, \tau_2) \rightarrow (Y, \sigma_1, \sigma_2)$ be a map. Then the following statements are equivalent:

- (i) f is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous.
- (ii) f is $(1,2)^*$ -perfectly- $\alpha\omega$ -continuous.

Proof

(i)→(ii) Let U be any $(1,2)^*$ - $\alpha\omega$ -open set in (Y, σ_1, σ_2) . By hypothesis $f^{-1}(U)$ is $\tau_{1,2}$ -open in (X, τ_1, τ_2) . Since (X, τ_1, τ_2) is discrete space, $f^{-1}(U)$ is also closed in (X, τ_1, τ_2) . $f^{-1}(U)$ is both $\tau_{1,2}$ -open and $\tau_{1,2}$ -closed in (X, τ_1, τ_2) . Hence f is $(1,2)^*$ -perfectly- $\alpha\omega$ -continuous.

(ii)→(i) Let U be any $(1,2)^*$ - $\alpha\omega$ -open set in (Y, σ_1, σ_2) . Then $f^{-1}(U)$ is both $\tau_{1,2}$ -open and $\tau_{1,2}$ -closed in (X, τ_1, τ_2) . Hence f is $(1,2)^*$ -strongly- $\alpha\omega$ -continuous.

CONCLUSION

Recently, we introduced $(1,2)^*$ - $\alpha\omega$ -continuous maps, $(1,2)^*$ - perfectly $\alpha\omega$ -continuous maps in bitopological spaces. Using above concepts of this paper we learned a new type of $(1,2)^*$ - $\alpha\omega$ -irresolute maps and its various properties. And also we developed $(1,2)^*$ -strongly $\alpha\omega$ -continuous functions and its results.

REFERENCES

1. J.C. Kelly, Bitopological spaces, proc. London Math. Soc. (3) 13 (1963), pp.71 - 89.
2. S.P. Arya and R. Gupta, On strongly continuous functions, Kyungpook Math. J.14:131:143,(1974).
3. S.N. Maheswari and R. Prasad, On α -irresolute maps, Tamkang J. Math., 11 (1980), pp. 209-214.
4. R.S. Waliand Prabhavati S Mandalgeri, on $\alpha\omega$ -continuous and $\alpha\omega$ -irresolute maps in Topological space, Int. J. of Math Archive, Vol.10, (2014), pp.14 - 24
5. M. Lellis Thivagar, O. Ravi, On stronger forms of $(1,2)^*$ -quotient mapping in bitopological space, Internet. J. Math. Game theory and Algebra, Vol.4, No.6, (2004), pp.481 -492.
6. O. Ravi and M. Lellis Thivagar, Remarks on λ -irresolute functions via $(1,2)^*$ -sets, Advanced in App. Math. Analysis, 5(1) (2010), pp.1 - 15.
7. O. Ravi and M. Lellis Thivagar, $(1,2)^*$ -semi -generalized continuous maps, Bull. Malayas. Math. Sci. Soc., 29(1) (2006), pp.79 - 88.
8. K. Balasubramaniyan, $(1,2)^*$ - $r\omega$ -open functions and $(1,2)^*$ - $r\omega$ -continuous functions, The international journal of analytical and experimental modal analysis. Vol.11, (2019), pp.2174 -2179.
9. M. Lellis Thivagar, O.Ravi, E.Hatir, Decomposition of $(1,2)^*$ -continuity and $(1,2)^*$ - α -Continuity, Miskolc Mathematical notes, 10(2), (2009), 163-171.
10. D. Sreeja, Juane P. Sinthya, On $(1,2)^*$ - $rg\alpha$ -closed sets in bitopological spaces, Malaya J Mat S. (2015); (1): pp.27 - 41.
11. O. Ravi and M. Lellis Thivagar and Jinjinli, Remarks on extensions of $(1,2)^*$ - g -closed maps, Archimedes J. Math., 1(2) (2011), pp.177 - 187
12. Renu Thomas, C. Janaki, Separation Axioms on $(1,2)^*$ - R^* -closed sets in bitopological spaces, ijsrp, Vol.7, (2017), pp.310 - 313.
13. S. Mukesh Parkavi, A. Arivu Chelvam, On $(1,2)^*$ - $\alpha\omega$ -continuous maps in bitopological Spaces.
14. S.G. Crossly, and S.K. Hildebrand, Semi topological properties, Fund. Math., 74(1972), pp.233-254.
15. J. Dontchev, Contra continuous functions and strongly S-closed space, Interet J. Math. Sci., (1986), 19, 303.
16. R.S. Waliand Prabhavati S Mandalgeri, On α regular ω sets in Topological spaces, Int. J. of Math Archive 5(10) (2014), pp.68 - 76.





Phosphatase and Tensin Homolog (PTEN) as a Suppressor of Cell Cycle and Tumorigenesis

Mukta Raghav¹, Sushil Kumar Upadhyay¹, Varruchi Sharma², Poonam Bansal¹, Vasu Punj³ and Anil K. Sharma^{1*}

¹Department of Biotechnology, Maharishi Markandeshwar (Deemed to be University), Mullana (Ambala), Haryana, India

²Department of Biotechnology & Bioinformatics, Sri Guru Gobind Singh College Sector-26, Chandigarh (UT), India.

³Department of Medicine, Keck School of Medicine, NRT G511, Health Sciences Campus, University of Southern California, Los Angeles, US.

Received: 17 May 2022

Revised: 08 June 2022

Accepted: 11 July 2022

*Address for Correspondence

Anil K. Sharma

Department of Biotechnology,

Maharishi Markandeshwar

(Deemed to be University),

Mullana (Ambala), Haryana, India

Email: anibiotech18@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Phosphatase and Tensin Homolog (PTEN) as tumour suppressor is a common target in negative regulation of cell cycle and somatic cancers showing dominant nature of MDM2, BRCA1, P53 with PTEN. Therefore, the divergent activity of PTEN as a suppressor relies on other enzymes or on the intrinsic regulation of PTEN activity by other molecules. In this review, authors have tried to highlight the pessimistic regulatory role of PTEN in cell cycle regulation, tumorigenesis, cancer and other associated diseases. Best probable novel activities of PTEN especially in context with regulatory processes have also been emphasized; making PTEN mediated information transduction as an important and efficient therapeutic target for cancer.

Keywords: PTEN, Cell Cycle, Tumorigenesis, Tumor suppressor, Cancer.

INTRODUCTION

Phosphatase and Tensin Homolog deleted on chromosome 10 (PTEN) is a dual phosphatase with both protein and lipid phosphatase activities. PTEN was first discovered as a tumor suppressor with growth and survival regulatory functions [1]. Irregular stimulated episodes targeting PI3K/AKT may result in significant disturbance of the process,





Mukta Raghav et al.,

leading to tumorigenesis, metastasis, tumor development and therapeutic blockage [2-4]. Tuberous sclerosis I and II (TSC1/TSC2), and liver kinase B1 (LKB1) lead to the indirect inactivation of AKT [5] which is in contrast to the negative regulation of mTORC1 and PIP3 (phosphatidylinositol-3,4,5-trisphosphate) activity by PTEN. Loss of PTEN activity results in abnormal cell growth, survival, and proliferation with subsequent stable activation of the PI3K/AKT signalling [6]. The tumor suppressor role is reportedly outside the PI3K/AKT axis [7].

Development and induction of breast cancer through a number of mechanisms has been associated with PTEN along with loss of heterozygosity, germline and somatic mutations in the PTEN gene locus, epigenetic silencing by methylation of the PTEN promoter, protein degradation, post-translational modifications and down-regulation of PTEN [8-11]. PTEN protein is the largest member of the protein tyrosine phosphatase family with a molecular mass of 55kDa having 403 amino acids [12]. Phosphatidylinositol-3,4,5-triphosphate is an important lipid second messenger in tumorigenesis which help in activation of AKT and other signalling molecules involved in a variety of cellular functions like survival, proliferation, cell motility and invasion [13]. PTEN extensively interconnects with other tumor suppressors; oncogenic signalling pathways (involving p53 and RAS). In contrary to this, PTEN network does not perform function in isolation. PTEN and p53 not only participate in the similar cellular processes, but they also physically interact and regulate each other. DNA binding ability and acetylation state is affected by physical association between p53 and PTEN [14-16].

Amount of DNA damage is positively related to the variation in the levels of p53. High levels of p53 may activate apoptosis and low level of p53 may activate cell cycle arrest. Progression of cell cycle supported by AKT signalling has been shown to be activated by the growth factor. On the other hand, it also acts on several other factors involved in G1/S or G2/M cell cycle transitions. The p53 activates cell cycle arrest or apoptosis which could be aggravated by cell cycle survival signal that includes AKT pathway and cell growth signal resulting in breakage of p53 by producing its negative regulator. Both *in vitro* and *in vivo* BRCA1 transcription is also regulated by p53 protein. Breast cancer and ovarian cancer may get accelerated by BRCA1 mutant and MDM2 acts upon it as a modifier. At the transcription and protein level, p53 and PTEN are known to interact and regulate each other, acting as important machinery for switching between cell survival and cell death. Therefore, the role of PTEN in cell cycle regulation of p53, MDM2, BRCA1 became more significant (Fig. 1).

Expression of key genes involved in cell cycle and carcinogenesis have an additional regulatory effect served by combination of reciprocal antagonistic pathway. The regulation between p53 and PTEN brought by genistein (a soy isoflavone) to support the cell cycle arrest [17]. PTEN expression and nuclear accumulation activated by genistein bring about the arrangement of PTEN dependent nuclear p53 accumulation and placement of p53/PTEN complex to the p53 binding site, followed by decrease in expression of cell proliferative genes. Molecules of p53, PTEN, BRCA1 and MDM2 and their genetic variants play a role in tumor suppressor network of p53, PTEN, BRCA1 and MDM2 signal. It has been shown that zinc deficiency modulates the p53, PTEN, MDM2, BRCA1 network signalling in normal cells. Expression of these tumour suppressor genes are regulated by genetic, epigenetic, and transcriptional changes, which may result in DNA repair and cell cycle regulation in a cell.

PTEN AS A TUMOR SUPPRESSOR

Canonical Signal pathway regulated by PTEN and PIP3 accumulation serves as a major signal for stimulation of growth factor. Lipid moiety provided by PIP3 binds to the pleckstrin homology (ph) domain of downstream proteins (AKT) resulting in recruitment of these proteins to the plasma membrane [18]. Confirmation of these proteins may change by binding of PIP3 to the ph domain which can be later activated by phosphorylation. Activation of downstream proteins of the PI3K pathway occurs which includes serine/threonine kinase AKT and the protein kinase C (pkc) inhibited by PTEN by reducing the intracellular levels of PIP3 [19]. Critical role in regulating a number of cellular activities like cell growth, survival, migration, differentiation, cell, organ size control, metabolism has been played by well-known downstream effector of protein signal AKT of PTEN [20]. Protein kinase B (PKB) is also known as AKT (a serine/threonine kinase). Accumulation of PIP3 allows the recruitment of the AKT to the plasma membrane through direct interaction with its ph domain followed by PI3K activation [21]. In this way





Mukta Raghav *et al.*,

binding of AKT to PIP3 exposes site on AKT where it can be further modified and allow AKT to move to the membrane. At Thr 308, Akt is phosphorylated by another ph domain which also contains kinase 3 phosphoinositide dependent protein kinase-1(PDK1) [22,23]. Maximum activation cum phosphorylation of ser473 by mTORc2 is required whereas the phosphorylation on Thr 308 is important for initial activation of AKT [24] (Fig. 1). Kinases such as glycogen synthase (GSK3 α and β) [25], I κ B (IKK α and IKK β) [26] apoptotic factors such as BAD [27] MDM2, a ubiquitin ligase for p53 [28], GT Pases like Rac and Rho [29], cell cycle inhibitors p21 and p27 [30], and transcription factors such as fork head transcription family (FoxO) members (Fig. 3) [31-33] are regulated when activated AKT phosphorylate the plethora of downstream factors.

Functions of these molecules that are important for multiple cellular processes are regulated by phosphorylation of AKT. For example proapoptotic factor BAD, caspases 3 and 9 by AKT were distributed inactively and promoted cell survival by phosphorylation. Nuclear exclusion was resulted by phosphorylation of p21 on T145, P27 on T157 and the inability of these cell cycle inhibitors to inhibit cell proliferation [34,35]. MDM2 and MDMX were directly phosphorylated by AKT [36,37]. Stabilization of MDM2 and MDMX complexes which start the degradation of p53 to keep the level of p53 low in the cells due to phosphorylated MDM2 and MDMX that binds to 14-3-3 proteins. Fork head transcriptional factors also phosphorylated by AKT and activate their binding to 14-3-3 proteins [38]. Translocation to the nucleus was blocked by this process. AKT including FOXO1 and FOXO3 are target for several members of fork head transcriptional factors. Genes that regulate cell proliferation, survival, metabolic changes are widely spread on the promoter regions of binding elements of these fork head transcriptional factors [39].

Apoptosis initiated when FOXO3 a binds to the promoter of BIM and PUMA and they also activated the transcription of these death genes [40,41]. P21 and P27 were transcriptionally activated by FOXO1 and stopped the cell proliferation through these actions [42,43]. Metabolic effects were activated by insulin signalling through the PI3K/AKT signalling pathway subject to the fork head transcription factor additionally [44]. Fork head transcriptional factors may play an important role in the feedback regulation of the Insulin/PI3K/AKT signalling pathway [45]. Important roles in mediating cross talks between PI3K/AKT signaling pathway and other signaling pathways) have been played by two substrates of AKT, GSK3 β and tuberous sclerosis complex TSC1/2. AKT phosphorylates the GSK3 β which stops its activity on Serine21/9 [46]. In wnt signalling, GSK3 β is considered to be an important regulator. Ubiquitin-mediated degradation is due to the phosphorylation of β -catenin, by GSK3 β . Some of the effects of PTEN on the regulation of stem cell maintenance [47-49] and G0-G1 cell cycle regulation may be controlled by the crosstalk between PTEN and Wnt signalling [50-54]. TSC1/2, TSC1/2 is another substrate of AKT which plays an important role in cell growth and proliferation regulation together with cell size control and also include metabolism [55]. For suppressing the function of mTOR, the heterodimer of TSC1 and TSC2 is important [56]. TSC2 activity is stopped when phosphorylated by AKT [57]. Therefore, by acting on TSC2, AKT activates the activity of mTOR and the downstream events of mTOR activation that incorporate metabolic changes, protein translation as well as cell proliferation. The crosstalk of PTEN with another tumor suppressor, LKB1 [58] occurs by the regulation of mTOR by AKT-TSC mediated signal.

SPECIFIC PATTERNS OF PTEN VERSUS TUMORIGENESIS

In tumours, stark changes have been seen in PTEN activity that display changes in the PTEN gene, deleting or mutating the gene in many cases leading to complete loss of activity or of expression. In different tumour types, PTEN shows different patterns of loss as has been shown in Table 1. Sources of uncertainty within datasets analysing PTEN loss is attributed to the use of poor antibodies in immunohistochemistry (IHC) as well as difficulties in standardizing IHC data [59]. PTEN 6H2.1 mouse monoclonal was the first of the monoclonal antibodies used and validated in the Charis Eng laboratory [60]. Further, 138G6 rabbit monoclonal antibody known for its selectivity along with the other validated antibodies emerged recently [61,62].

PTEN AND BREAST CANCER

Breast cancer is the leading cause of cancer death among women worldwide as well as the most commonly diagnosed malignancy [63,64]. Breast cancer has been classified into different subtypes, each of them displaying





Mukta Raghav et al.,

different clinical and pathological features. In breast cancer main molecular classification is based on the expression of immune-histochemistry markers namely estrogen receptor (ER), progesterone receptor (PR) and human epidermal growth factor receptor 2 (HER2), which respond differently to anti-estrogen therapy. PTEN loss is common in breast cancer which has been confirmed by the multiple studies [65-67], although in this particular tumour type the frequency and clinical relevance of PTEN alteration has not been fully elucidated.

Expression of the PTEN protein is either lost or reduced in 40% of primary breast carcinomas as revealed by the immunohistochemistry (IHC) analysis of patient-derived samples (Table 1). The foreboding value of PTEN loss in breast cancer has been studied comprehensively. An association between PTEN loss and a more aggressive behaviour of the disease as assessed by the analysis of several clinical and pathological parameters results from the detailed meta-analysis pooling results from 27 studies including a total of 10,231 cases taking into consideration the tumour size, lymph node metastasis and cell differentiation. Moreover, PTEN loss was associated with negative ER and PR expression while positively correlated with triple negative phenotypes displayed by the pooled results [68-72]. PTEN expression in breast cancer was reduced which was attributed to multiple mechanisms although their contribution to PTEN inactivation is still unclear. In breast carcinomas, Homozygous deletion of the PTEN gene locus is a common event encountered, particularly in case of an aggressive disease [13,65,73].

In sporadic breast carcinomas sequence variants in the PTEN coding region have rarely been documented. PTEN mutation frequencies reported in literature is <5% which is in concordance with the mutation frequency of 4.43% (318/7176 samples) reported by the COSMIC database. The loss of protein expression and discrepancy observed between homozygous mutations may point towards the fact that other non-genetic mechanisms may contribute to PTEN inactivation. Epigenetic silencing of the PTEN promoter is a major mechanism leading to PTEN inactivation in breast cancer as proposed by the growing body of evidence. The promoter hypermethylation observed have been reported in Table 1. Garcia et al. found that the PTEN promoter was hypermethylated in 48% of the analysed samples and those other diagnostic factors were correlated with PTEN promoter hypermethylation, such as ERBB2 over expression, larger size and higher histological grade [74]. Aberrant methylation of the promoter is a major contributor to PTEN loss during the early stages of breast cancer. Although, during the progression of the disease it does not seem to play a role as tumour grade ER, PR or HER2 status showed no correlation with the presence of promoter hypermethylation [75-78].

CONCLUSION

PTEN as a tumor suppressor has been proven to be quite significant in its role in regulation of cell cycle and tumorigenesis. The disruption in the regulators of PTEN may have a deeper impact in other oncogenic pathways besides that of PI3K-AKT pathway. PTEN and its emergence at functional level may influence the progression of various cancers. The incorporation of various functions, functional level changes, makes PTEN as a central inhibitory node having an impact in cell cycle regulation and tumorigenesis.

CONFLICT OF INTEREST

There exists no conflict of interest amongst authors regarding publication of this manuscript.

ACKNOWLEDGEMENTS

Authors greatly acknowledge Maharishi Markandeshwar (Deemed to be University), Mullana–Ambala (Haryana), India for providing the requisite platform for this collaborative research work.





Mukta Raghav et al.,

REFERENCES

1. Chen CY, Chen J, He L, Stiles BL. PTEN: Tumor suppressor and metabolic regulator. *Frontiers in Endocrinology*. 2018;https://doi.org/10.3389/fendo.2018.00338.
2. Chan CH, Jo U, Kohrman A, Rezaeian AH, Chou PC, Logothetis C, Lin HK. Posttranslational regulation of Akt in human cancer. *Cell and Bioscience*. 2014;4(1):1-9.
3. Grizzi G, Ghidini M, Botticelli A, Tomasello G, Ghidini A, Grossi F, Fusco N, Cabiddu M, Savio T, Petrelli F. Strategies for increasing the effectiveness of aromatase inhibitors in locally advanced breast cancer: an evidence-based review on current options. *Cancer Management and Research*. 2020;12:675.
4. Zbuk KM, Eng C. Cancer phenomics: RET and PTEN as illustrative models. *Nature Reviews Cancer*. 2007;(1):35-45.
5. Papa A, Pandolfi PP. The PTEN–PI3K axis in cancer. *Biomolecules*. 2019;9(4):153.
6. Song MS, Salmena L, Pandolfi PP. The functions and regulation of the PTEN tumour suppressor. *Nature reviews Molecular Cell Biology*. 2012;13(5):283-296.
7. Leslie NR, Spinelli L, Tibarewal P, Zilidis G, Weerasinghe N, Lim JC, Maccario H, Downes CP. Indirect mechanisms of carcinogenesis via down regulation of PTEN function. *Advances in Enzyme Regulation*. 2010;50(1):112-118.
8. Okahara F, Ikawa H, Kanaho Y, Maehama T. Regulation of PTEN Phosphorylation and Stability by a Tumor Suppressor Candidate Protein. *Journal of Biological Chemistry*. 2004;279(44):45300-45303.
9. Shetty PJ, Pasupuleti N, Chava S, Nasaruddin K, Hasan Q. Altered transcription and expression of PTEN in breast tumors: is it regulated by hypermethylation?. *Breast Disease*. 2012;33(1):27-33.
10. Sharma V, Sharma N, Sheikh I, Kumar V, Sehrawat N, Yadav M, Ram G, Sankhyan A, Sharma AK. Probiotics and prebiotics having broad spectrum anticancer therapeutic potential: Recent trends and future perspectives. *Current Pharmacology Reports*. 2021;7(2):67-79.
11. Singh B, Ittmann MM, Krolewski JJ. Sporadic breast cancers exhibit loss of heterozygosity on chromosome segment 10q23 close to the Cowden disease locus. *Genes, Chromosomes and Cancer*. 1998;21(2):166-171.
12. Garcia JM, Silva JM, Dominguez G, Gonzalez R, Navarro A, Carretero L, Provencio M, España P, Bonilla F. Allelic loss of the PTEN region (10q23) in breast carcinomas of poor patho phenotype. *Breast cancer research and treatment*. 1999;57(3):237-243.
13. Freeman DJ, Li AG, Wei G, Li HH, Kertesz N, Lesche R, Whale AD, Martinez-Diaz H, Rozengurt N, Cardiff RD, Liu X. PTEN tumor suppressor regulates p53 protein levels and activity through phosphatase-dependent and-independent mechanisms. *Cancer Cell*. 2003;3(2):117-130.
14. Li AG, Piluso LG, Cai X, Wei G, Sellers WR, Liu X. Mechanistic insights into maintenance of high p53 acetylation by PTEN. *Molecular Cell*. 2006;23(4):575-587.
15. Chang CJ, Mulholland DJ, Valamehr B, Mosessian S, Sellers WR, Wu H. PTEN nuclear localization is regulated by oxidative stress and mediates p53-dependent tumor suppression. *Molecular and Cellular Biology*. 2008;28(10):3281-3289.
16. Sheikh I, Sharma V, Tuli HS, Aggarwal D, Sankhyan A, Vyas P, Sharma AK, Bishayee A. Cancer chemoprevention by flavonoids, dietary poly phenols and terpenoids. *Biointerface Research in Applied Chemistry*. 2020;11(1):8502-8537.
17. Di Nitto JP, Cronin TC, Lambright DG. Membrane recognition and targeting by lipid-binding domains. *Science's STKE*. 2003;2003(213):16-20.
18. Stiles B, Gilman V, Khanzenzon N, Lesche R, Li A, Qiao R, Liu X, Wu H. Essential role of AKT-1/protein kinase B α in PTEN-controlled tumorigenesis. *Molecular and Cellular Biology*. 2002;22(11):3842-3851.
19. Manning BD, Cantley LC. AKT/PKB signaling: navigating downstream. *Cell*. 2007;129(7):1261-1274.
20. Coursaris CK, Kim DJ. A meta-analytical review of empirical mobile usability studies. *Journal of Usability Studies*. 2011;6(3):117-171.
21. Knowles MA, Platt FM, Ross RL, Hurst CD. Phosphatidylinositol 3-kinase (PI3K) pathway activation in bladder cancer. *Cancer and Metastasis Reviews*. 2009;28(3):305-316.



**Mukta Raghav et al.,**

22. Hresko RC, Mueckler M. mTOR· RICTOR is the Ser473 kinase for Akt/protein kinase B in 3T3-L1 adipocytes. *Journal of Biological Chemistry*. 2005;280(49):40406-40416.
23. Waterman-Storer CM, Salmon ED. Microtubule dynamics: Treadmilling comes around again. *Current Biology*. 1997;7(6):R369-R372.
24. Pap M, Cooper GM. Role of translation initiation factor 2B in control of cell survival by the phosphatidylinositol 3-kinase/Akt/glycogen synthase kinase 3 β signaling pathway. *Molecular and Cellular Biology*. 2002;22(2):578-586.
25. Gustin JA, Ozes ON, Akca H, Pincheira R, Mayo LD, Li Q, Guzman JR, Korgaonkar CK, Donner DB. Cell type-specific expression of the I κ B kinases determines the significance of phosphatidylinositol 3-kinase/Akt signaling to NF- κ B activation. *Journal of Biological Chemistry*. 2004;279(3):1615-20.
26. Datta SR, Dudek H, Tao X, Masters S, Fu H, Gotoh Y, Greenberg ME. Akt phosphorylation of BAD couples survival signals to the cell-intrinsic death machinery. *Cell*. 1997;91(2):231-241.
27. Ashcroft M, Ludwig RL, Woods DB, Copeland TD, Weber HO, MacRae EJ, Vousden KH. Phosphorylation of HDM2 by Akt. *Oncogene*. 2002;21(13):1955-1962.
28. Liliental J, Moon SY, Lesche R, Mamillapalli R, Li D, Zheng Y, Sun H, Wu H. Genetic deletion of the Pten tumor suppressor gene promotes cell motility by activation of Rac1 and Cdc42 GTPases. *Current Biology*. 2000;10(7):401-404.
29. Collado M, Medema RH, García-Cao I, Dubuisson ML, Barradas M, Glassford J, Rivas C, Burgering BM, Serrano M, Lam EW. Inhibition of the phosphoinositide 3-kinase pathway induces a senescence-like arrest mediated by p27Kip1. *Journal of Biological Chemistry*. 2000;275(29):21960-21968.
30. Biggs WH, Meisenhelder J, Hunter T, Cavenee WK, Arden KC. Protein kinase B/Akt-mediated phosphorylation promotes nuclear exclusion of the winged helix transcription factor FKHR1. *Proceedings of the National Academy of Sciences*. 1999;96(13):7421-7426.
31. Brunet A, Bonni A, Zigmond MJ, Lin MZ, Juo P, Hu LS, Anderson MJ, Arden KC, Blenis J, Greenberg ME. Akt promotes cell survival by phosphorylating and inhibiting a Forkhead transcription factor. *Cell*. 1999;96(6):857-868.
32. Guo S, Rena G, Cichy S, He X, Cohen P, Unterman T. Phosphorylation of serine 256 by protein kinase B disrupts transactivation by FKHR and mediates effects of insulin on insulin-like growth factor-binding protein-1 promoter activity through a conserved insulin response sequence. *Journal of Biological Chemistry*. 1999;274(24):17184-17192.
33. Zhou BP, Liao Y, Xia W, Zou Y, Spohn B, Hung MC. HER-2/neu induces p53 ubiquitination via Akt-mediated MDM2 phosphorylation. *Nature Cell Biology*. 2001;3(11):973-982.
34. Fujita N, Sato S, Katayama K, Tsuruo T. AKT-dependent phosphorylation of p27Kip1 promotes binding to 14-3-3 and cytoplasmic localization. *Journal of Biological Chemistry*. 2002;277(32):28706-287013.
35. Feng J, Tamaskovic R, Yang Z, Brazil DP, Merlo A, Hess D, Hemmings BA. Stabilization of Mdm2 via decreased ubiquitination is mediated by protein kinase B/Akt-dependent phosphorylation. *Journal of Biological Chemistry*. 2004;279(34):35510-35517.
36. Lopez-Pajares V, Kim MM, Yuan ZM. Phosphorylation of MDMX mediated by Akt leads to stabilization and induces 14-3-3 binding. *Journal of Biological Chemistry*. 2008;283(20):13707-13713.
37. Cardone MH, Roy N, Stennicke HR, Salvesen GS, Franke TF, Stanbridge E, Frisch S, Reed JC. Regulation of cell death protease caspase-9 by phosphorylation. *Science*. 1998;282(5392):1318-1321.
38. Hedrick SM. The cunning little vixen: FoxO and the cycle of life and death. *Nature Immunology*. 2009;10(10):1057-1063.
39. Dijkers PF, Medema RH, Lammers JW, Koenderman L, Coffey PJ. Expression of the pro-apoptotic Bcl-2 family member Bim is regulated by the forkhead transcription factor FKHR-L1. *Current Biology*. 2000;10(19):1201-1204.
40. Sharma AK, Sharma VR, Gupta GK, Ashraf GM, Kamal MA. Advanced glycation end products (AGEs), glutathione and breast cancer: Factors, mechanism and therapeutic interventions. *Current Drug Metabolism*. 2019;20(1):65-71.



**Mukta Raghav et al.,**

41. Stahl M, Dijkers PF, Kops GJ, Lens SM, Coffers PJ, Burgering BM, Medema RH. The forkhead transcription factor FoxO regulates transcription of p27Kip1 and Bim in response to IL-2. *The Journal of Immunology*. 2002;168(10):5024-5031.
42. Liu R, Wang L, Chen G, Katoh H, Chen C, Liu Y, Zheng P. FOXP3 up-regulates p21 expression by site-specific inhibition of histone deacetylase 2/histone deacetylase 4 association to the locus. *Cancer Research*. 2009;69(6):2252-2259.
43. Gross DN, Wan M, Birnbaum MJ. The role of FOXO in the regulation of metabolism. *Current Diabetes Reports*. 2009;9(3):208-214.
44. Marr MT, D'Alessio JA, Puig O, Tjian R. IRES-mediated functional coupling of transcription and translation amplifies insulin receptor feedback. *Genes and Development*. 2007;21(2):175-183.
45. Cross DA, Alessi DR, Cohen P, Andjelkovich M, Hemmings BA. Inhibition of glycogen synthase kinase-3 by insulin mediated by protein kinase B. *Nature*. 1995;378(6559):785-789.
46. Rountree CB, Ding W, He L, Stiles B. Expansion of CD133-expressing liver cancer stem cells in liver-specific phosphatase and tensin homolog deleted on chromosome 10-deleted mice. *Stem Cells*. 2009;27(2):290-299.
47. Ding W, You H, Dang H, LeBlanc F, Galicia V, Lu SC, Stiles B, Rountree CB. Epithelial-to-mesenchymal transition of murine liver tumor cells promotes invasion. *Hepatology*. 2010;52(3):945-953.
48. Debebe A, Medina V, Chen CY, Mahajan IM, Jia C, Fu D, He L, Zeng N, Stiles BW, Chen CL, Wang M. Wnt/ β -catenin activation and macrophage induction during liver cancer development following steatosis. *Oncogene*. 2017;36(43):6020-6029.
49. Groszer M, Erickson R, Scripture-Adams DD, Lesche R, Trumpp A, Zack JA, Kornblum HI, Liu X, Wu H. Negative regulation of neural stem/progenitor cell proliferation by the PTEN tumor suppressor gene in vivo. *Science*. 2001;294(5549):2186-2189.
50. Kwon CH, Zhu X, Zhang J, Knoop LL, Tharp R, Smeyne RJ, Eberhart CG, Burger PC, Baker SJ. PTEN regulates neuronal soma size: a mouse model of Lhermitte-Duclos disease. *Nature Genetics*. 2001;29(4):404-411.
51. Bachman ES, Dhillon H, Zhang CY, Cinti S, Bianco AC, Kobilka BK, Lowell BB. β AR signaling required for diet-induced thermogenesis and obesity resistance. *Science*. 2002;297(5582):843-845.
52. Yilmaz ÖH, Valdez R, Theisen BK, Guo W, Ferguson DO, Wu H, Morrison SJ. PTEN dependence distinguishes haematopoietic stem cells from leukaemia-initiating cells. *Nature*. 2006;441(7092):475-482.
53. Weatherhead EC, Andersen SB. The search for signs of recovery of the ozone layer. *Nature*. 2006;441(7089):39-45.
54. Leung AK, Robson WL. Tuberous sclerosis complex: a review. *Journal of Pediatric Health Care*. 2007;21(2):108-114.
55. Sehrawat N, Yadav M, Singh M, Kumar V, Sharma VR, Sharma AK. Probiotics in microbiome ecological balance providing a therapeutic window against cancer. *Seminars in Cancer Biology*. 2021;70:24-36.
56. Li Y, Corradetti MN, Inoki K, Guan KL. TSC2: filling the GAP in the mTOR signaling pathway. *Trends in Biochemical Sciences*. 2004;29(1):32-8.
57. Jia C, Medina V, Liu C, He L, Qian D, Tu T, Okamoto CT, Stiles BL. Crosstalk of LKB1-regulated and PTEN-regulated signals in liver morphogenesis and tumor development in mice. *Hepatology Communications*. 2017;1(2):153-167.
58. Pallares J, Bussaglia E, Martínez-Guitarte JL, Dolcet X, Llobet D, Rue M, Sanchez-Verde L, Palacios J, Prat J, Matias-Guiu X. Immunohistochemical analysis of PTEN in endometrial carcinoma: a tissue microarray study with a comparison of four commercial antibodies in correlation with molecular abnormalities. *Modern Pathology*. 2005;18(5):719-727.
59. Perren A, Weng LP, Boag AH, Ziebold U, Thakore K, Dahia PL, Komminoth P, Lees JA, Mulligan LM, Mutter GL, Eng C. Immunohistochemical evidence of loss of PTEN expression in primary ductal adenocarcinomas of the breast. *The American Journal of Pathology*. 1999;155(4):1253-1260.
60. Castillo-Martin M, Thin TH, Lorduy AC, Cordon-Cardo C. Immunopathologic assessment of PTEN expression. In: *PTEN*. Humana Press, New York, NY. 2016:23-37
61. Zhu G, Baker SJ. Detecting PTEN and PI3K signaling in brain. In: *PTEN*. Humana Press, New York, NY. 2016:53-62.



**Mukta Raghav et al.,**

62. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*. 2018;68(6):394-424.
63. Sharma V, Sharma AK. An In-Silico approach for designing a potential antagonistic molecule targeting β 2-adrenoreceptor having therapeutic significance. *Letters in Applied NanoBioScience*. 2021;10:2063-2069.
64. Bose S, Wang SI, Terry MB, Hibshoosh H, Parsons R. Allelic loss of chromosome 10q23 is associated with tumor progression in breast carcinomas. *Oncogene*. 1998;17(1):123-127.
65. Depowski PL, Rosenthal SI, Ross JS. Loss of expression of the PTEN gene protein product is associated with poor outcome in breast cancer. *Modern Pathology*. 2001;14(7):672-676.
66. Sharma VR, Sharma DK, Navnit Mishra AK, Batra N. New and potential therapies for the treatment of Breast Cancer: An update for oncologists. *Breast Cancer*. 2010;2:3.
67. Li S, Shen Y, Wang M, Yang J, Lv M, Li P, Chen Z, Yang J. Loss of PTEN expression in breast cancer: Association with clinicopathological characteristics and prognosis. *Oncotarget*. 2017;8(19):32043.
68. Sharma VR, Singh M, Kumar V, Yadav M, Sehrawat N, Sharma DK, Sharma AK. Microbiome dysbiosis in cancer: Exploring therapeutic strategies to counter the disease. *Seminars in Cancer Biology*. 2021;70:61-70.
69. Singh M, Kumar V, Sehrawat N, Yadav M, Chaudhary M, Upadhyay SK, Kumar S, Sharma V, Kumar S, Dilbaghi N, Sharma AK. Current paradigms in epigenetic anticancer therapeutics and future challenges. *Seminars in Cancer Biology*. 2021; <https://doi.org/10.1016/j.semcancer.2021.03.013>.
70. Tuli HS, Mittal S, Aggarwal D, Parashar G, Parashar NC, Upadhyay SK, Barwal TS, Jain A, Kaur G, Salva R, Sak K, Kumar M, Varol, M, Iqbal A, Sharma AK. Path of silibinin from diet to medicine: A dietary polyphenolic flavonoid having potential anti-cancer therapeutic significance. *Seminars in Cancer Biology*. 2021;73:196-218.
71. Aggarwal D, Upadhyay SK, Singh R, Tuli HS. Recent patents on therapeutic activities of xanthohumol: A prenylated chalconoid from hops (*Humulus lupulus* L.). *Pharmaceutical Patent Analyst*. 2021;10(1):37-49.
72. Zhou XP, Hoang JM, Li YJ, Seruca R, Carneiro F, Sobrinho-Simoes M, Lothe RA, Gleeson CM, Russell SH, Muzeau F, Fléjou JF. Determination of the replication error phenotype in human tumors without the requirement for matching normal DNA by analysis of mononucleotide repeat microsatellites. *Genes, Chromosomes and Cancer*. 1998;21(2):101-107.
73. Zhang HY, Liang F, Jia ZL, Song ST, Jiang ZF. PTEN mutation, methylation and expression in breast cancer patients. *Oncology letters*. 2013;6(1):161-168.
74. García JM, Silva J, Peña C, Garcia V, Rodríguez R, Cruz MA, Cantos B, Provencio M, España P, Bonilla F. Promoter methylation of the PTEN gene is a common molecular change in breast cancer. *Genes, Chromosomes and Cancer*. 2004;41(2):117-124.
75. Lu YM, Cheng F, Teng LS. The association between phosphatase and tensin homolog hypermethylation and patients with breast cancer, a meta-analysis and literature review. *Scientific Reports*. 2016;6(1):1-9.
76. Kumar SA, Indu S, Gautami D, Sharma VR. Oral squamous cell carcinoma (OSCC) in humans: Etiological Factors, diagnostic and therapeutic relevance. *Research Journal of Biotechnology*. 2020;15:10.
77. Dan S, Upadhyay SK, Girdhar M, Mandal M, Sakshi. Oral carcinoma and therapeutic approaches of nanotechnology: From fundamental concept, incidence, molecular mechanism to emerging treatment techniques. *Biointerface Research in Applied Chemistry*. 2021;12(3):3900-3937.
78. Upadhyay SK, Dan S, Pant M, Shaloo. Synergistic approach of graphene oxide-silver-titanium nanocomposite film in oral and dental studies: A new paradigm of infection control in dentistry. *Biointerface Research in Applied Chemistry*. 2021;11(2):9680-9703.





Mukta Raghav et al.,

Table 1. Pattern based PTEN loss in different tumor types.

| Tumour Type | % Frequency of PTEN loss by: | | | |
|-----------------------------|------------------------------|----------|-----------------------|----------------------|
| | Mutation | Deletion | Loss of Protein (IHC) | Promoter Methylation |
| Breast | 3 | 27 | 40 | 35 |
| Colon | 7 | 12 | 40 | 17 |
| Lung | 8 | 34 | 56 | 38 |
| Prostate (Primary) | 3 | 26 | 29 | <5 |
| Prostate (Metastatic) | 13 | 51 | 54 | <5 |
| Glioblastoma | 30 | 78 | 65 | 6 |
| Endometrial | 41 | 48 | 45 | 19 |
| Ovarian (High Grade Serous) | 1 | 30 | 34 | 10 |
| Ovarian (Endometrioid) | 16 | 48 | 44 | 10 |

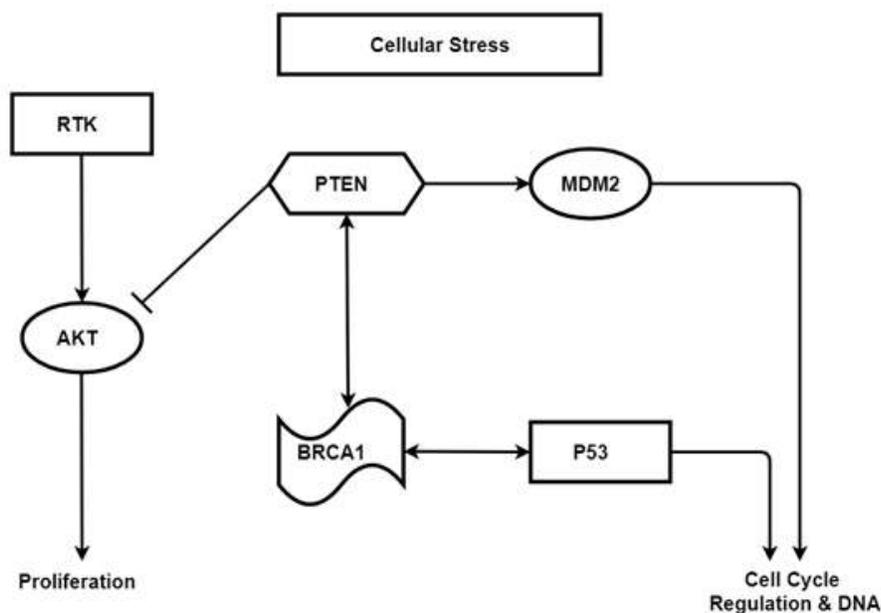


Fig. 1. Cell cycle regulation showing dominant nature of MDM2, BRCA1, P53 with PTEN.





Physicochemical, Thermal, Spectral and Biological Investigation of Mixed Ligand Lanthanum Complexes

Asmitak A. Bhagat¹, Sunil S. Patil¹, Bhushan P. Langi², Vishal S. Kamble¹, Digambar K. Patil¹ and Jitendra M. Pawara^{1*}

¹Department of Chemistry, Changu Kana Thakur Arts Commerce and Science College (Autonomous), New Panvel, Maharashtra, India

²Department of Chemistry, Dnyanasadhana College, Thane, Maharashtra, India

Received: 05 May 2022

Revised: 15 June 2022

Accepted: 18 July 2022

*Address for Correspondence

Jitendra M. Pawara

Department of Chemistry,
Changu Kana Thakur Arts
Commerce and Science College (Autonomous),
New Panvel, Maharashtra, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License (CC BY-NC-ND 3.0)** which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The mixed ligand lanthanum complexes were synthesized from N- and O- donor ligands. The 2-amino-6-methyl pyridine-4-ol (HP) was used as a primary ligand and L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine (HL) were used as secondary ligands for synthesis. The physicochemical and spectral methods, viz. elemental analysis, molar conductance, magnetic susceptibility measurements, UV-Visible spectroscopy, IR spectroscopy, thermal analysis and XRD were used for the characterization of synthesized complexes. The metal ion, primary ligand and secondary ligand were reacted and the complex was formed in a 1:2:1 ratio which was confirmed by elemental analysis. The molar conductance data of synthesized complexes concludes their non-electrolytic behavior. The data from studies of magnetic susceptibility measurements conclude the diamagnetic properties of the synthesized complexes. The coordination of metal ions with 2-amino-6-methyl pyridine-4-ol (HP) and amino acids was confirmed by UV-Visible and IR spectroscopy. The presence of metal ion, primary ligand and secondary ligand was confirmed by thermal and XRD studies. The synthesized lanthanum complexes were screened and studied against selective micro-organisms.

Keywords: Lanthanum complexes, physicochemical, thermal, spectral, biological studies.

INTRODUCTION

Coordination chemistry is an interesting branch of chemistry for its numerous applications in kinetics, pharmaceuticals, paints, etc. (1-3). Several inner transition metal ions form chelates with N- and O- donor ligands and





Asmitak A. Bhagat et al.,

are studied for various biological activities (4-5). Lanthanide complexes were also reported for antimicrobial activities (6-7). Research scholars also studied the synthesis and characterization of mixed ligand complexes with 2-amino-6-methyl pyridine-4-ol(8). Amino acids also form complexes with metal ions and are studied for different antimicrobial activities (9-10). Anti-malarial and anti-allergic activities of the complexes have been studied by some research scholars (11-12). By considering the importance of mixed ligand complexes in a biological system, the authors have decided to synthesize mixed ligand lanthanum complexes using 2-amino-6-methyl pyridine-4-ol as primary ligand and L-alanine, L-arginine and L-hydroxy proline as secondary ligands.

EXPERIMENTAL

MATERIALS

Lanthanum chloride heptahydrate (metal salt), 2-amino-6-methyl pyridine-4-ol (primary ligand) and L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine (secondary ligands) used during study were of analytical grade. The solvents used for the study were distilled and purified (13-15).

Synthesis of Mixed Ligand Complexes

The mixed ligand lanthanum complexes were synthesized using lanthanum chloride heptahydrate as a metal salt, 2-amino-6-methyl pyridine-4-ol as primary ligand and L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine as secondary ligands. Initially, 10 cm³ of 1 mmol aqueous solution of lanthanum salt was prepared. In the lanthanum salt solution, 10 cm³ of 2 mmol alcoholic solutions of 2-amino-6-methyl pyridine-4-ol were added with constant stirring. The resultant solution was heated in a water bath for about 20 minutes. The solution was removed from the water bath and kept on an asbestos sheet. The 10 cm³ of 1 mmol aqueous solution of amino acid was added drop by drop to the same hot solution. The mixture was again heated in a boiling water bath for 10 minutes. The resultant mixture was removed from the boiling water bath and kept on the asbestos sheet for cooling. To the cooled solution, a 1:1 ammonia solution was added drop-wise to increase its pH. At pH 7, the solid was formed in the mixture. It was cooled and filtered with a 1:1 ethanolic solution. The filtered solid was dried under a vacuum.

Instrumentation

The synthesized lanthanum complexes were characterized by various physicochemical and spectral methods. The conductance of all complexes was measured to conclude the electrolytic nature of the complexes on the Labtronics LT- 26 Deluxe Conductivity Meter. The 10⁻³ M solutions of complexes were prepared in DMSO to determine their conductance. Stoichiometry of complexes was concluded by elemental analysis. The analysis was carried out on ThermoFinnigan Elemental Analyzer. The magnetic moment of all complexes was measured to conclude the magnetic nature of the complexes on the Gouy balance. The electronic spectral study of 10⁻³ M solutions of complexes in DMSO was carried out on Shimadzu UV/Visible spectrophotometer. FTIR spectra of metal salt, 2-amino-6-methyl pyridine-4-ol (HP), amino acids and all complexes were obtained from the Shimadzu FTIR spectrophotometer. thermogravimetric and differential thermogravimetric curves of all synthesized complexes were taken from Perkin Elmer Diamond TG-DTA instrument in a nitrogen atmosphere and the X-ray diffraction study was carried out on Siemens X-ray Diffractometer.

Antibacterial Screening

Synthesized complexes were screened against the gram positive (*Staphylococcus aureus*, *Corynebacterium diphtheriae*) and gram-negative bacteria (*Salmonella typhi* and *Pseudomonas aeruginosa*) to see their antibacterial potential. The tube dilution method was adapted to find the minimum inhibitory concentration (MIC) and the agar cup method was followed to see the zone of inhibition.





Asmitak A. Bhagat et al.,

Tube dilution method

The synthesized complexes were dissolved in DMSO to make a stock solution of 1mg/cm³ and diluted to make the concentrations of 20, 40, 60, 80.....300 µg/cm³ with sterile Mueller Hinton broth. The 18 hrs. The old cultures were diluted with broth to get the initial concentration of 10⁶/cm³ using sterile Mueller Hinton broth. In a set of sterile tubes, 5 cm³ of each of the concentrations of the synthesized complexes were taken. To each tube, 0.1 cm³ of diluted culture was added. 5 cm³ sterile Mueller Hinton broth inoculated with 0.1 cm³ of diluted culture was kept as a positive control. The test control of DMSO of respective dilution made using sterile Mueller Hinton Broth was also kept. For standard control tetracycline of 10µg/cm³ was used. The tubes were kept in the incubator at 37°C for 24 hrs. The minimum inhibitory concentration was noted by observing the turbidity.

Agar cup method

The Agar cup method was adapted to see the zone of inhibition by the respective complexes. The 0.001 M concentration of the complexes was used to see the zone of inhibition by the respective complexes. The sterile borosilicate plates were poured with 20 cm³ nutrient agar with 1 cm³ of bacterial culture having a cell density of 10⁶/cm³. The plates were allowed to cool. The wells were bored using a cork borer of 5 mm diameter. The wells were assigned to the respective concentration of the complexes and 0.1 cm³ of the sample was placed in each of them. The 0.1 cm³ tetracycline of 10 µg/cm³ concentration was used as standard control. The control of DMSO was not considered since there was no significant inhibition in the growth of bacteria shown in the MIC.

RESULTS AND DISCUSSION

Synthesis of mixed ligand complexes

The synthesis of the mixed ligand complexes is represented by following reaction.



Where, HP 2-amino-6-methyl pyridine-4-ol HL: Amino acid such as L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine

Colour, Solubility, Hygroscopic Nature and Decomposition Temperature

The synthesized complexes with L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine were found in white colour. The range of decomposition temperature of all complexes was found in 277-280 °C. This high range of temperature indicates the strong bond between metal ion, primary ligand and secondary ligand in the complexes. The physicochemical study also revealed that all complexes were solid, insoluble in water, partially soluble in DMF and DMSO and non-hygroscopic in nature(16)(Table No. 1 and 2).

Conductance Measurement

The conductance of solutions of synthesized lanthanum complexes was measured on digital conductometer and it was found less than 1 mhos cm² mol⁻¹. As the data of conductance measurement was found less than 1, it is concluded that all synthesized complexes are non-electrolytic in nature (17) (Table No. 3).

Elemental Studies

The data of elemental analysis is mentioned in Table No. 3. The study of data revealed that the general formula of all synthesized lanthanum complexes is 1:2:1. It also confirms the reaction stated above (18) (Table No.3).

Magnetic Studies

The effective magnetic moments of all synthesized complexes were measured on Gouy balance using diamagnetic corrections and these values are mentioned in Table No. 4. The data revealed diamagnetic nature of the lanthanum complexes (19).





Asmitak A. Bhagat *et al.*,

Electronic Absorption Spectra

The spectra of all lanthanum complexes were taken in the UV-Visible region. All complexes show similar behavior. In all spectra, 3 peaks are observed. The peaks observed in the range of 270-275 nm, 332-339 nm and 391-395 nm confirm the transition of electrons from ligands to metal ion for $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ and charge-transfer transitions respectively. The data concludes the coordination of ligands with metal ion through the transition of electrons (Table No. 5).

Infra-red Spectra

All complexes show complex FTIR spectra (21-23). The spectra were recorded over the range 4000-400 cm^{-1} in KBr discs. The FTIR data does not show the band at 3430 cm^{-1} which may confirm deprotonation of the hydroxyl group of 2-amino-6-methyl pyridine-4-ol molecules in the formation of complexes. The spectra show strong band in the range of 1020-1013 cm^{-1} for C-O stretching vibration. The free 2-amino-6-methyl pyridine-4-ol molecule shows the same band at 1100 cm^{-1} . By comparing these two values, it is concluded that the same band of the complexes is shifted to a lower wave number which confirms the coordination of 2-amino-6-methyl pyridine-4-ol with lanthanum metal ion through the oxygen atom of C-O. The spectra show a weak band in the range of 1580-1482 cm^{-1} for C=N stretching vibration. The free 2-amino-6-methyl pyridine-4-ol molecule shows same band at 1650 cm^{-1} . By comparing these two values it is concluded that the same band of the complexes is shifted to a lower wave number which confirms the coordination of nitrogen of 2-amino-6-methyl pyridine-4-ol molecule with lanthanum metal ion. It also shows the medium band at 3294-3281 cm^{-1} for -OH stretching vibration which confirms the free oxime -OH group present in the 2-amino-6-methyl pyridine-4-ol moiety of the lanthanum complexes. The spectra show a weak band in the range of 814-821 cm^{-1} for M-N vibration (M stands for metal ion). The free 2-amino-6-methyl pyridine-4-ol molecule shows the same band at ~780 cm^{-1} .

By comparing these two values, it is concluded that the same band of the complexes is shifted to a higher wave number which confirms N atom of 2-amino-6-methyl pyridine-4-ol coordinated with lanthanum metal ion during complexation. The FTIR spectra also show weak bands in the range of 3140-3135 cm^{-1} and 2989-2980 cm^{-1} for N-H asymmetric and N-H symmetric vibrations respectively. The free amino acid molecule shows the same bands at ~3050 cm^{-1} and ~2960 cm^{-1} . By comparing these wave numbers it is concluded that the same bands are shifted to lower wave number which confirms N atom of amino acid coordinated with lanthanum metal ion. The spectra show strong band in the range 1617-1614 cm^{-1} and 1381-1372 cm^{-1} for COO- asymmetric vibration and COO- symmetric vibration respectively. The free amino acid molecule shows same band at ~1595 cm^{-1} and ~1410 cm^{-1} respectively. By comparing these wave numbers it is concluded that same bands are shifted to lower wave numbers which confirm carboxylic acid group of amino acid coordinated with lanthanum metal ion through its oxygen atom. The spectra show medium band in the range of 3366-3321 cm^{-1} and weak band in the range of 1598-1583 cm^{-1} for O-H asymmetric and O-H symmetric vibrations respectively in the complexes. These bands indicate presence of coordinated water molecules in the complexes. The spectra show medium band in the range of 404-401 cm^{-1} and 622-617 cm^{-1} for M-N and M-O vibrations respectively in the complexes. These bands indicate the bonding between central metal ion and O and N atoms of ligands (21-23) (Table No. 6).

Thermal Studies

The controlled nitrogen atmosphere was used to study thermal behaviour of lanthanum complexes. The thermogravimetric and differential thermogravimetric curves of synthesized complexes were obtained by heating the complex in TG-DTA instrument. The heating rate was 10°C per minute. All the complexes show same type of thermogravimetric curves. The gradual weight loss is observed with increase in the temperature. The first weight loss is observed in the range of 140-183°C, second is observed in the range of 265-419°C and the final loss is observed in the range of 640-830°C. All the complexes show straight line in TG-DTA above 840°C. The straight line indicates completion of reaction. The first weight loss in the thermogram is due to loss of two water molecules, the second weight loss is due to loss of amino acids and the last weight loss is due to two 2-amino-6-methyl pyridine-4-ol molecules from the complex. The curves in DTA show endothermic peak in the range of 140-183°C conclude two coordinated water molecules present in complexes. It shows a small exotherm in the range of 265-419°C indicates presence of amino acid moiety in the complexes and broad exotherm in the range 640-830°C indicates presence of two 2-amino-6-methyl





Asmitak A. Bhagat et al.,

pyridine-4-ol molecule moieties in the complexes. The final product of reaction is the lanthanum powder which is then converted into lanthanum oxide. The oxide formed by reaction of trace oxygen present in nitrogen atmosphere with lanthanum powder. The XRD studies also conclude formation of lanthanum oxide after decomposition of complexes(24) (Table No. 7).

Antibacterial Studies

Tube dilution method

The complexes were found inhibiting the activity of the selected bacterial strains. The MIC for [La(P)₂(Ala)·2H₂O] ranged between 80 and 100 µg/cm³ having more efficiency for *S. aureus*. For [La(P)₂(Arg)·2H₂O], [La(P)₂(Hpro)·2H₂O] and [La(P)₂(Val)·2H₂O] the MIC recorded was between 80 and 200 µg/cm³ with same trend exhibiting its effectiveness towards *S. aureus*. The MIC for [La(P)₂(Pro)·2H₂O] ranged between 80 and 100 µg/cm³ having more efficiency for *S. aureus*(25-26) (Table No. 8 and 9)

Agar cup method

The result showed the similar trend as that of MIC showing a maximum zone of inhibition for *S. aureus* by all the complexes. The zone of inhibition for gram negative bacteria viz. *S. typhi* and *P. aeruginosa* was minimal compared to the gram positive bacteria viz. *S. aureus* and *C. diphtheria*. *P. aeruginosa* was found to be more resistant to the complexes (27-29) (Table No. 10).

CONCLUSIONS

The decomposition temperature of complexes shows high values. The high values confirm the strong bond formed between metal ions and ligands during the formation of complexes. The conductance of the complexes is reported as less than 1 mhos cm² mol⁻¹, it is concluded that all the metal complexes are non-electrolytic. Elemental analysis studies reveal the general formula of the complexes, 1:2:1. The Gouy method confirms the diamagnetic nature of all synthesized complexes. Electronic absorption studies conclude the transformation of electrons from ligands to lanthanum metal ions. The bonding between metal ions and ligands is confirmed by FTIR spectral studies. The thermal and XRD studies confirm the presence of coordinated water molecules, amino acid moiety and 2-amino-6-methyl pyridine-4-ol molecules moieties in the complexes. In regards to the above conclusions, coordination number 8 may be proposed for all complexes. The complexes are found to be more active against *S. aureus*, *C. diphtheriae* compared to activity of *S. Typhi* and *P. aerruginosa*.

The proposed structures for the complexes are -

REFERENCES

1. Altun, Ö. and Şuözer, M., "Synthesis, spectral analysis, stability constants, antioxidant and biological activities of Co (II), Ni (II) and Cu (II) mixed ligand complexes of nicotinamide, theophylline and thiocyanate", *Journal of Molecular Structure*, 1149, 307–314, July 2017.
2. Shaikh, I., Jadeja, R. N. and Patel, R., "Three Mixed Ligand Mononuclear Zn(II) Complexes of 4-Acyl Pyrazolones: Synthesis, Characterization, Crystal Study and Anti-Malarial Activity", *Polyhedron*, 183, 114528, June 2020.
3. Fan, C., Zong, Z., Zhang, X., Xu, C., Zhu, Z., Meng, X., Shuangyu, B. and Fan, Y., "Rational assembly of functional Co-MOFs via a mixed-ligand strategy: synthesis, structure, topological variation, photodegradation properties and dye adsorption", *CrystEngComm*, 20, 4973-4988, July 2018.
4. Sakr, S., Elshafie, H., Camele, I. and Sadeek, S., "Synthesis, Spectroscopic, and Biological Studies of Mixed Ligand Complexes of Gemifloxacin and Glycine with Zn(II), Sn(II), and Ce(III)", *Molecules*, 23(5), 1182-1198, May 2018.
5. Huang, H., Zhang, P., Yu, B., Jin, C., Ji, L. and Chao, H., "Synthesis, characterization and biological evaluation of mixed-ligand ruthenium(II) complexes for photodynamic therapy", *Dalton Transactions*, 44(39), 17335-17345, September 2015.



**Asmitak A. Bhagat et al.,**

6. Taha, Z. A., Ajlouni, A. M., Al Momani, W. and Al-Ghzawi, A. A., "Syntheses, characterization, biological activities and photophysical properties of lanthanides complexes with a tetradentate Schiff base ligand", *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 81(1), 570–577, June 2011.
7. Hegazy, W. H. and Al-Motawaa, I. H., "Lanthanide Complexes of Substituted -DiketoneHydrazone Derivatives: Synthesis, Characterization, and Biological Activities", *Bioinorganic Chemistry and Applications*, 2011, 1-10, April 2011.
8. Chavan, M.C., Deshpande, V.D. and Vaidya, P.V., "Synthesis and characterization of lanthanide mixed complexes using benzoin- α -oxime thiourea and phenylthioureas as ligands", *Asian J. Chem.* 4(2), 246-250, June 1992.
9. Abdelkarim, A.T., Mahmoud, W.H. and El-Sherif A. A., "Potentiometric, thermodynamics and coordination properties for binary and mixed ligand complexes of copper(II) with cephradine antibiotic and some N- and O-bound amino acids (α -alanine and β -alanine)", *Journal of Molecular Liquids*, 328, 115334, April 2021.
10. Shebl, M., "Synthesis, spectral studies, and antimicrobial activity of binary and ternary Cu(II), Ni(II), and Fe(III) complexes of new hexadentate Schiff bases derived from 4,6-diacetylresorcinol and amino acids", *Journal of Coordination Chemistry*, 62(19), 3217–3231. August 2009.
11. Adediji, J.F., Olayinka, E.T., Adebayo, M. A. and Babatunde O., "Antimalarial mixed ligand metal complexes: Synthesis, physicochemical and biological activities", *International Journal of Physical Sciences*, 4 (9), 529-534, September 2009.
12. Katouah, H. A., Al-Fahemi, J. H., Elghalban, M. G., Saad, F. A., Althagafi, I. A., El-Metwaly, N. M., and Khedr, A. M., "Synthesis of new Cu(II)-benzohydrazide nanometer complexes, spectral, modeling, CT-DNA binding with potential anti-inflammatory and anti-allergic theoretical features", *Materials Science and Engineering: C*, 96, 740-756 March 2019.
13. Vogel A.I., *Quantitative Inorganic Analysis*, 4th ed., ELBS and Longman, New York 1985.
14. Vogel A. I., *Textbook of Practical Organic Chemistry*, 5th Ed., Longmans Green and Co. Ltd., London, 1989.
15. Vogel A I, *Textbook of Quantitative Inorganic Analysis*, 5th Ed., Longmans Green and Co. UK Ltd., 1989.
16. Thakkar, J. R. and Thakkar, N. V., "Synthesis and characterization of chiral mixed ligand Co(II) complexes of isonitrosopropiophenone and amino acids," *Synthesis and Reactivity in Inorganic and Metal-Organic Chemistry*, 30(10), 1871–1887, July 2000.
17. Geary, W. J., "The use of conductivity measurements in organic solvents for the characterisation of coordination compounds," *Coordination Chemistry Reviews*, 7(1), 81–122, October 1971.
18. Kekare, M., Vaidya, V.V., Thakur J., "Studies and Synthesis of Biologically Active Mixed Ligand Cerium (III) Complexes", *International Journal of Science and Research (IJSR)*, 4 (1), 1361-1366, January 2015.
19. Thakur, G. A. and Shaikh, M. M., "Synthesis, characterization, antibacterial and cytotoxicity studies on some mixed ligand Th(IV) complexes," *Acta Polonicae Pharmaceutica*, 63(2), 95–100, March 2006.
20. Shivankar, V. S. and Thakkar, N.V., "Synthesis, characterization and antimicrobial activity of some mixed ligand Co(II) and Ni(II) complexes," *Acta Polonicae Pharmaceutica*, 60(1), 45–50, April 2003.
21. Charles, R.C., Freiser, H., Friedel, R., Hillard, L.E. and Johnson, W.D. "Infra-red absorption spectra of metal chelates derived from 8-hydroxyquinoline, 2-methyl-8-hydroxyquinoline, and 4-methyl-8-hydroxyquinoline," *Spectrochim Acta*, 8(1), June 1956.
22. Gandhi, J.B. and Kulkarni, N.D., "Synthesis, characteristics and redox properties of uranyl complexes with diamine ligands having ONNO and ONNNO donor groups," *Indian Journal of Chemistry A*, 39(4), 461–464, April 2000.
23. Nakamoto, K., *Infrared and Raman Spectra of Inorganic and Coordination Compounds*, 4th edition, John Wiley and Sons, New York, NY, USA, 1986.
24. Thakur, G.A. and Shaikh, M.M., "Synthesis, characterization, antibacterial and cytotoxicity studies on some mixed ligand Th (IV) complexes", *Acta Polonicae Pharmaceutica*, 63(2), 95-100, April 2006
25. Prasad, R.V. and Thakkar, N.V., "Study of cobalt complexes as catalysts in the decomposition of hydrogen peroxide," *Journal of Molecular Catalysis*, 92(1), 9–20, August 1994.
26. Chohan, Z.H., Misbahul, A.K. and Moazzam, M., "Synthesis, characterization and antimicrobial studies of Co(II) and Ni(II) complexes with some pyrazoles," *Indian Journal of Chemistry A*, 27A(12), 1102-1104, December 1988.





Asmitak A. Bhagat et al.,

27. Jitendra M. Pawara, Sunil S. Patil. An Innovative Method Designed for the Synthesis of Some New Mixed Ligand Ni(II) Complexes Its Characterization and Applications. World Journal of Chemical Education. 9(2), 50-56, May 2021.
28. Pawara, J., &Patil, S. (2021). SYNTHESIS OF NIO NANOPARTICLES BY THERMAL DECOMPOSITION AT LOW-TEMPERATURE OF NEW AQUA (2-AMINO-6-METHYL PYRIMIDINE-4-OL AND ISOLEUCINE)NI(II) COMPLEX AND ITS ANTIMICROBIAL STUDY. Journal of Advanced Scientific Research, 12(03), 113-118 August 2021.
29. Pawara, Jitendra&Patil, Sunil. (2021). Microwave-Assisted Synthesis of Some New Mixed Ligand Ni(II) Complexes Its Characterization and Its Antimicrobial Study. Journal of Pharmaceutical Research International. 143-152 June 2021.

Table 1: Empirical Formula, Molecular Weight and Colour of the Complexes

| Complex | Empirical Formula | Molecular Weight | Colour |
|---|--|------------------|--------|
| [La(P) ₂ (Ala)·2H ₂ O] | C ₁₃ H ₁₉ LaN ₇ O ₆ | 715.52 | White |
| [La(P) ₂ (Arg)·2H ₂ O] | C ₁₆ H ₂₈ LaN ₁₀ O ₅ | 800.63 | White |
| [La(P) ₂ (Hpro)·2H ₂ O] | C ₁₄ H ₃₆ LaN ₇ O ₅ | 757.56 | White |
| [La(P) ₂ (Pro)·2H ₂ O] | C ₁₂ H ₃₆ LaN ₇ O ₅ | 741.56 | White |
| [La(P) ₂ (Val)·2H ₂ O] | C ₁₃ H ₃₈ LaN ₇ O ₅ | 743.57 | White |

Table 2: Decomposition Temperature and pH of the Complexes

| Complex | Decomposition Temperature (°C) | pH |
|---|--------------------------------|------|
| [La(P) ₂ (Ala)·2H ₂ O] | 280 | 6.96 |
| [La(P) ₂ (Arg)·2H ₂ O] | 278 | 6.92 |
| [La(P) ₂ (Hpro)·2H ₂ O] | 277 | 6.96 |
| [La(P) ₂ (Pro)·2H ₂ O] | 276 | 6.98 |
| [La(P) ₂ (Val)·2H ₂ O] | 280 | 6.99 |

Table 3: Elemental Analysis Data and Molar Conductance of the Complexes

| Complex | Elemental Analysis Found (Calculated) | | | | Molar Conductance |
|---|---------------------------------------|---------------|-------------|---------------|-------------------|
| | % M | % C | % H | % N | |
| [La(P) ₂ (Ala)·2H ₂ O] | 19.38 (19.41) | 52.00 (52.04) | 4.75 (4.79) | 5.84 (5.87) | 0.0011 |
| [La(P) ₂ (Arg)·2H ₂ O] | 17.32 (17.35) | 51.00 (51.01) | 5.12 (5.16) | 10.48 (10.50) | 0.0015 |
| [La(P) ₂ (Hpro)·2H ₂ O] | 18.34 (18.34) | 52.30 (52.32) | 4.73 (4.79) | 5.51 (5.55) | 0.0013 |
| [La(P) ₂ (Pro)·2H ₂ O] | 18.76 (18.73) | 53.49 (53.44) | 4.94 (4.90) | 5.68 (5.66) | 0.0015 |
| [La(P) ₂ (Val)·2H ₂ O] | 18.68 (18.68) | 53.33 (53.30) | 5.18 (5.16) | 5.68 (5.65) | 0.0013 |

Table 4: Magnetic Susceptibility data of the Complexes (- 10⁻⁶ c.g.s. units)

| Complex | X _g | X _m | μ _{eff} |
|---|---------------------------|---------------------------|------------------|
| [La(P) ₂ (Ala)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.47 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Arg)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.87 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Hpro)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.84 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Pro)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.47 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Val)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.87 × 10 ⁻⁴ | Diamagnetic |





Asmitak A. Bhagat et al.,

Table 5: Electronic Absorption Spectra of the Complexes

| Sr. No. | Complex | λ (nm) | ν (cm ⁻¹) | Proposed Assignments |
|---------|---|----------------|---------------------------|-------------------------|
| 1 | [La(P) ₂ (Ala)·2H ₂ O] | 270 | 37037 | $\pi \rightarrow \pi^*$ |
| | | 339 | 29498 | $n \rightarrow \pi^*$ |
| | | 395 | 25316 | Charge-transfer |
| 2 | [La(P) ₂ (Arg)·2H ₂ O] | 271 | 36900 | $\pi \rightarrow \pi^*$ |
| | | 332 | 30120 | $n \rightarrow \pi^*$ |
| | | 392 | 25510 | Charge-transfer |
| 3 | [La(P) ₂ (Hpro)·2H ₂ O] | 275 | 36363 | $\pi \rightarrow \pi^*$ |
| | | 337 | 29673 | $n \rightarrow \pi^*$ |
| | | 391 | 25575 | Charge-transfer |
| 4 | [La(P) ₂ (Pro)·2H ₂ O] | 275 | 36363 | $\pi \rightarrow \pi^*$ |
| | | 337 | 29673 | $n \rightarrow \pi^*$ |
| | | 391 | 25575 | Charge-transfer |
| 5 | [La(P) ₂ (Val)·2H ₂ O] | 271 | 36900 | $\pi \rightarrow \pi^*$ |
| | | 332 | 30120 | $n \rightarrow \pi^*$ |
| | | 392 | 25510 | Charge-transfer |

Table 6: FTIR Data of the Complexes

| Complex | ν (C-O) | ν (C=N) | ν (-OH) (Oxime) | ν (M-N) | ν (N-H) (Asym) | ν (N-H) (Sym) | ν (COO-) (Asym) | ν (COO-) (Sym) | ν (HOH) (Asym) | ν (HOH) (Sym) | ν (M-N) | ν (M-O) |
|---|-------------|-------------|---------------------|-------------|--------------------|-------------------|---------------------|--------------------|--------------------|-------------------|-------------|-------------|
| | (Cup) | (Cup) | (Cup) | (Cup) | (A.a.) | (A.a.) | (A.a.) | (A.a.) | (HOH) | (HOH) | (Complex) | (Complex) |
| [La(P) ₂ (Ala)·2H ₂ O] | 1012 (s) | 1482 (w) | 3281 (m) | 814 (w) | 3138 (w) | 2980 (w) | 1617 (s) | 1372 (w) | 3277 (m) | 1598 (w) | 402 (m) | 622 (w) |
| [La(P) ₂ (Arg)·2H ₂ O] | 1015 (s) | 1580 (w) | 3290 (m) | 813 (w) | 3140 (w) | 2982 (w) | 1616 (s) | 1381 (w) | 3366 (m) | 1593 (w) | 404 (m) | 618 (w) |
| [La(P) ₂ (Hpro)·2H ₂ O] | 1019 (s) | 1512 (w) | 3294 (m) | 812 (w) | 3135 (w) | 2989 (w) | 1614 (s) | 1380 (w) | 3321 (m) | 1583 (w) | 401 (m) | 617 (w) |
| [La(P) ₂ (Pro)·2H ₂ O] | 1015 (s) | 1580 (w) | 3290 (m) | 813 (w) | 3140 (w) | 2982 (w) | 1616 (s) | 1381 (w) | 3366 (m) | 1593 (w) | 404 (m) | 618 (w) |
| [La(P) ₂ (Val)·2H ₂ O] | 1019 (s) | 1512 (w) | 3294 (m) | 812 (w) | 3135 (w) | 2989 (w) | 1614 (s) | 1380 (w) | 3321 (m) | 1583 (w) | 401 (m) | 617 (w) |

Table 7: Thermal Data of the Complexes

| Sr. No. | Complex | Temperature Range (°C) | Weight Loss Due to the Loss of | % Weight Loss | |
|---------|---|------------------------|--------------------------------|---------------|------------|
| | | | | Found | Calculated |
| 1. | [La(P) ₂ (Ala)·2H ₂ O] | 140-180 | Two water molecules | 5.00 | 5.04 |
| | | 265-418 | Amino acid | 12.29 | 12.31 |
| | | 640-826 | Two HP molecules | 63.21 | 63.24 |
| 2. | [La(P) ₂ (Arg)·2H ₂ O] | 145-183 | Two water molecules | 4.48 | 4.50 |
| | | 272-419 | Amino acid | 21.61 | 21.64 |
| | | 648-830 | Two HP molecules | 56.49 | 56.51 |
| 3. | [La(P) ₂ (Hpro)·2H ₂ O] | 141-182 | Two water molecules | 4.74 | 4.76 |
| | | 268-417 | Amino acid | 17.15 | 17.18 |
| | | 650-827 | Two HP molecules | 59.72 | 59.73 |
| 4. | [La(P) ₂ (Pro)·2H ₂ O] | 145-183 | Two water molecules | 4.48 | 4.50 |
| | | 272-419 | Amino acid | 21.61 | 21.64 |
| | | 648-830 | Two HP molecules | 56.49 | 56.51 |
| 5. | [La(P) ₂ (Val)·2H ₂ O] | 141-182 | Two water molecules | 4.74 | 4.76 |
| | | 268-417 | Amino acid | 17.15 | 17.18 |
| | | 650-827 | Two HP molecules | 59.72 | 59.73 |





Asmitak A. Bhagat et al.,

Table 8: MIC Data of the Complexes by Tube Dilution Method

| Sr. No. | Complex | MIC ($\mu\text{g}/\text{cm}^3$) | | | |
|---------|---|-----------------------------------|-----------------------|-----------------|----------------------|
| | | <i>S. aureus</i> | <i>C. diphtheriae</i> | <i>S. typhi</i> | <i>P. aeruginosa</i> |
| 1. | [La(Cup) ₂ (Ala)·2H ₂ O] | 60 | 80 | 100 | 120 |
| 2. | [La(Cup) ₂ (Arg)·2H ₂ O] | 80 | 120 | 140 | 200 |
| 3. | [La(Cup) ₂ (Hpro)·2H ₂ O] | 80 | 120 | 140 | 200 |
| 4. | [La(P) ₂ (Pro)·2H ₂ O] | 60 | 80 | 100 | 120 |
| 5. | [La(P) ₂ (Val)·2H ₂ O] | 80 | 120 | 140 | 200 |

Table 9: MIC Data of Metal Salts, Ligand and Tetracycline by Tube Dilution Method

| Salt / Ligand / Tetracycline | MIC ($\mu\text{g}/\text{cm}^3$) | | | |
|--------------------------------------|-----------------------------------|-----------------------|-----------------|----------------------|
| | <i>S. aureus</i> | <i>C. diphtheriae</i> | <i>S. typhi</i> | <i>P. aeruginosa</i> |
| LaCl ₃ ·7H ₂ O | 100 | 150 | 150 | 200 |
| HP | 110 | 200 | 160 | 140 |
| Tetracycline | 1.5 | 2.0 | 1.5 | 8.0 |

Table 10: Antibacterial Activity (mm) of the Complexes by Agar Cup Method

| Sr. No. | Complex | Antibacterial Activity (mm) with | | | |
|---------|---|----------------------------------|-----------------------|-----------------|----------------------|
| | | <i>S. aureus</i> | <i>C. diphtheriae</i> | <i>S. typhi</i> | <i>P. aeruginosa</i> |
| 1. | [La(Cup) ₂ (Ala)·2H ₂ O] | 16 | 14 | 10 | 07 |
| 2. | [La(Cup) ₂ (Arg)·2H ₂ O] | 16 | 08 | 09 | 06 |
| 3. | [La(Cup) ₂ (Hpro)·2H ₂ O] | 15 | 08 | 08 | 06 |
| 4. | [La(P) ₂ (Pro)·2H ₂ O] | 16 | 14 | 10 | 07 |
| 5. | [La(P) ₂ (Val)·2H ₂ O] | 16 | 08 | 09 | 06 |
| 6. | Tetracycline | 30 | 25 | 26 | 18 |

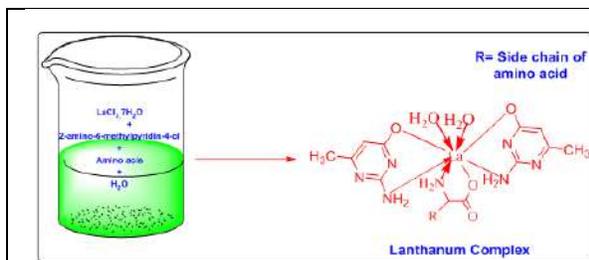


Figure 1. Experimental Method

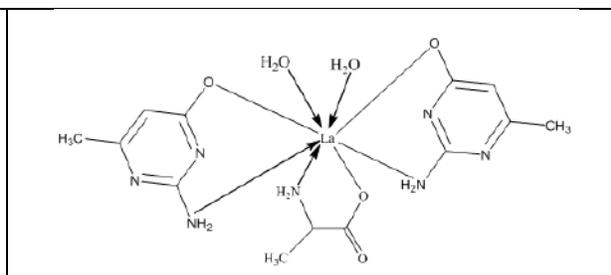


Figure 2: Proposed Structure of [La(P)₂(Ala)·2H₂O]

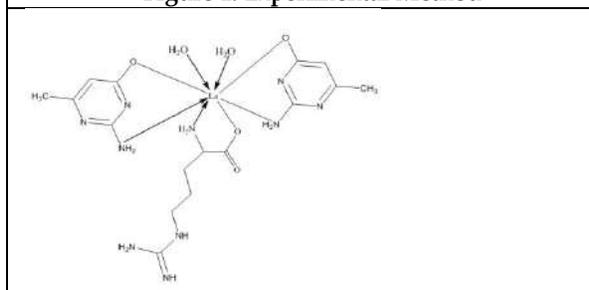


Figure 3. Proposed Structure of [La(P)₂(Arg)·2H₂O]

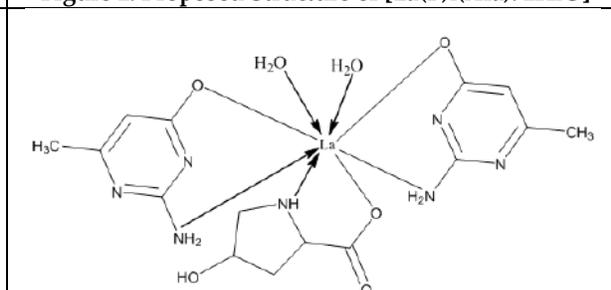


Figure 4. Proposed Structure of [La(P)₂(Hpro)·2H₂O]





Asmitak A. Bhagat *et al.*,

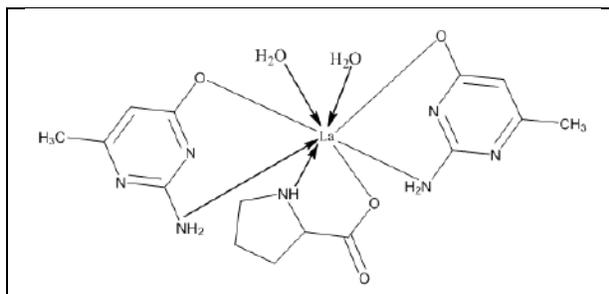


Figure 5. Proposed Structure of [La(P)₂(Pro)·2H₂O]

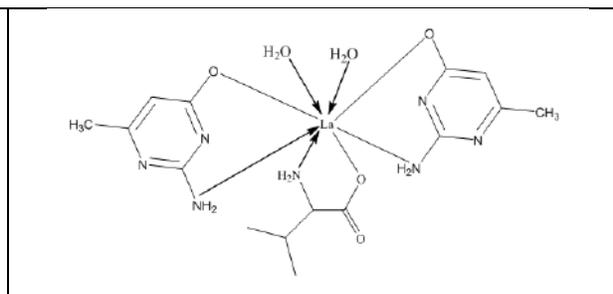


Figure 6. Proposed Structure of [La(P)₂(Val)·2H₂O]





A Study on Screening of Bioactive Compounds and *In-vitro* Evaluation of Antiarthritic Activity of *Cassia roxburghii* Leaves Extract

Suriya P^{1*}, Shalini R², Amargeetha A³ and Antony Thangadurai T⁴

¹Head and Assistant Professor, Department of Biochemistry, Annai College of Arts and Science (Affiliated to Bharathidasan University), Kovilacheri, Kumbakonam, Tamil Nadu, India

²Assistant Professor, Department of Biochemistry, Annai College of Arts and Science (Affiliated to Bharathidasan University), Kovilacheri, Kumbakonam, Tamil Nadu, India

³Assistant professor, Department of Chemistry, Bon Secours College for Women (Affiliated to Bharathidasan University), Vilar Bypass, Thanjavur, Tamil Nadu, India

⁴Director, Rontgen Medical Centre, Thanjavur, Tamil Nadu, India.

Received: 14 Apr 2022

Revised: 16 May 2022

Accepted: 26 Jun 2022

*Address for Correspondence

Suriya P

Head and Assistant Professor,
Department of Biochemistry,
Annai College of Arts and Science,
(Affiliated to Bharathidasan University),
Kovilacheri, Kumbakonam,
Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Arthritis is a disease condition that affects the musculoskeletal system, causing painful inflammation and stiffness around joints. Rheumatoid arthritis (RA) is considered the most common chronic inflammatory autoimmune disease, occurring in 1 to 2% of the worldwide population. A number of natural products are used in the traditional medical systems in many countries. Alternative medicine for treatment of various diseases is getting more popular. Making medicinal plants provide relief of symptoms comparable to that obtained from allopathic medicines. The medicinal value of the chosen *Cassia roxburghii* leaves extract has not been extensively worked out. Therefore, the present study was to investigate the phytochemical screening and anti-arthritics activity of *Cassia roxburghii* leaves extract. The phytochemical screening *Cassia roxburghii* leaves extract showed that the presence of tannin, saponins, terpenoids, flavonoids, steroids, alkaloids triterpenoids, polyphenol, anthroquinone and glycosides. Overall, it can be concluded from the present study that *Cassia roxburghii* leaves extract contains rich sources of phytochemicals and anti-arthritics activity evidence for the relevance of *Cassia roxburghii* leaves extract.

Keywords: *Cassia roxburghii* leaves extract, Anti-arthritics, Phytochemicals.



Suriya *et al.*,

INTRODUCTION

Arthritis is a disease condition that affects the musculoskeletal system, causing painful inflammation and stiffness around joints. In Greek “artho” means joint and “itis” means inflammation and so arthritis is a form of joint disorder that involves inflammation of joints. Arthritis is an umbrella term describing more than 100 recognized condition that collectively affects approximately 70 million adults and 3,00,000 children (Arthritis Foundation, 2005). Arthritis can affect individuals of any age but is more predominant in the age range of 25 and 50 years with a peak in the age range of 40-50years (Kaur *et al.*, 2013). India (and South Asia more generally) is an important region in which to pursue humoral constructions of arthritis and joint disorders. Many Indians suffer from joint pain and rheumatic problems: osteoarthritis is widespread and rheumatoid arthritis, the far less prevalent but more incapacitating form of the disease, affects an estimated ten million Indians, 80% of which are women (Times of India, 1999). Rheumatoid arthritis (RA) is considered the most common chronic inflammatory autoimmune disease, occurring in 1 to 2% of the worldwide population (Firestein *et al.*, 2005). Rheumatoid arthritis (RA) is one of the commonest autoimmune diseases, is a chronic, progressive, systemic inflammatory disorder affecting the synovial joints and typically produces symmetrical arthritis that leads to joint destruction, which is responsible for the deformity and disability. The consequent morbidity and mortality have a substantial socio-economic impact (Buch and Emery, 2002).

The normal use of available prevailing therapies constantly induces harmful consequences, which with time may neutralize valuable outcomes. Plant drugs are favoured over conventional medicines by patients because of unremitting quality of malady, fear of surgery, terrible morbidity, ever-growing medicinal cost, trivial reaction to established drugs and disadvantages of novel drugs. These herbal remedies diminish the manifestations of illness and raise the worth of life (Patil *et al.*, 2011). In India, many Ayurvedic practitioners are using various indigenous plants for the treatment of different types of arthritic conditions. The present study investigates phytochemicals and *in vitro* anti-arthritis activity of *Cassia roxburghii* (Family: Leguminosae, Tamil name: Vakai) leaves extract.

MATERIALS AND METHODS

Collection of Plant Materials

The leaves of *Cassia roxburghii* were collected in December 2020 from Thanjavur, Tamil Nadu, India. The *Cassia roxburghii* leaves were washed several times with distilled water to remove the traces of impurities from the leaves. Leaves were spread out in plain paper and shade dried at room temperature for about 10 days and made a fine powder using a grinder mixture. The powder materials were used for further studies.

Preparation for extract

One gram of the powder of *Cassia roxburghii* leaves were transferred in to conical flask (250ml) containing 100ml of ethanol. The conical flask containing *Cassia roxburghii* leaves were shaken it well for 30 minutes by free hand. After 24 hrs, the extracts were filtered using whatman filter paper No.1 and filtrate used for further analysis.

Phytochemical screening

Chemical tests were carried out on the extract using standard procedures to identify the constituents as described by Sofowara (1993), Trease and Evans (1989) and Harborne (1973 and 1984).

In-vitro Anti-Arthritis Activity

Inhibition of albumin denaturation

In vitro anti-inflammatory activity was carried out by the method of Sangita Chandra *et al.* (2012)

Assay of Membrane stabilizing activity

Anti-inflammatory activity was evaluated by Membrane stabilizing activity as described by Divya Singh *et al.*, (2013).





Suriya et al.,

RESULTS AND DISCUSSION

Qualitative analysis

In the present study was carried out on the *Cassia roxburghii* leaves extract revealed the presence of medicinally active constituents. The phytochemical characters of the *Cassia roxburghii* leaves extract are investigated and summarized in Table 1. The phytochemical screening *Cassia roxburghii* leaves extract showed that the presence of tannin, saponins, terpenoids, flavonoids, steroids, alkaloids triterpenoids, polyphenol, anthroquinone and glycosides whereas coumarins were absent in aqueous extracts. Hassain *et al.* (2011) screened phytochemical constituents from methanol leaf extract of *Bombax malabaricum*. Various organic 11 solvent extracts of *Pedaliium murex* were subjected to preliminary phytochemical screenings by Thamizh mozhi *et al.* (2011). Selected 53 traditionally used medicinal plants from the western region of India for their qualitative phytochemical screenings, total phenol and flavonoids contents. Kumar *et al.*, (2013) investigated the preliminary phytochemical screening of the leaves of the plant *Lasia spinosa* (Lour) Thwaites. The phytochemical screening showed that the methanol and aqueous extracts contained alkaloid, the carbohydrates and phenolic compounds were present in all of the solvent extracts except petroleum ether extract. The chloroform, ethyl acetate and the aqueous extract contained glycosides whereas the saponins present in methanol and aqueous extract. The ethyl acetate extract contains only flavonoids.

In vitro anti-arthritis activity of *Cassia roxburghii* leaves extract

There are certain problems in using animals in experimental pharmacological research, such as ethical issues and the lack of rationale for their use when other suitable methods are available or could be investigated. Hence, in the present study, the protein denaturation bioassay was selected for *in vitro* assessment of anti-arthritis property *Cassia roxburghii* leaves extract. Denaturation of tissue proteins is one of the well-documented cases of inflammatory and arthritic diseases. Production of autoantigens in certain inflammatory diseases may be due to *in vivo* denaturation of proteins. The mechanism of denaturation probably involves alteration in electrostatic, hydrogen, hydrophobic and disulphide bonding (Grant *et al.*, 1970). Agents that can prevent protein denaturation, therefore, would be worthwhile for anti-inflammatory drug development. The increments in absorbance of test samples with respect to control indicated stabilization of protein (Egg albumin) denaturation by and reference diclofenac sodium. *Cassia roxburghii* leaves extract exhibited anti-arthritis activities in dose-dependent manner (Table 2 and 3, fig 1, 2).

Sangita Chandra *et al.*, (2012) evaluated the *in vitro* anti-inflammatory effect of aqueous extract of coffee (*Coffea arabica*) against the denaturation of protein. The extract at different concentrations was incubated with egg albumin in controlled experimental conditions and subjected to determination of absorbance and viscosity to assess the anti-inflammatory property. Diclofenac sodium was used as the reference drug. The present findings exhibited a concentration dependent inhibition of protein (albumin) denaturation by the coffee extract. The effect of diclofenac sodium was found to be less when compared with the test extract. He concluded that coffee possessed marked *in vitro* anti-inflammatory effect against the denaturation of protein

Divya Singh *et al* (2013) examined Anti-inflammatory and Anti-arthritic Activity of seed extract of *Pongamia pinnata* (L.) Pierre by *in vitro* model. The anti-arthritic and anti-inflammatory activity of *P. pinnata* hydroalcoholic extract was done by Inhibition of protein denaturation and Human red blood cell membrane stabilization (HRBC) *in vitro* methods. The hydro alcoholic extract of *P. pinnata* was subjected to *in vitro* Inhibition of protein denaturation in various concentrations i.e. 10, 50, 100, 200, 400, 800, 1000 and 2000µg/ml. HRBC method was also used for the estimation of anti-inflammatory activity from in various concentrations 100, 200, 400, 800 and 1600 µg/ml. *P. pinnata* hydroalcoholic extract exhibited a concentration dependent inhibition of protein (albumin) denaturation. The stabilization of HRBC membrane showed a concentration dependent anti-inflammatory activity, and the protection percent increased with increase in the concentration of the *P. pinnata* hydroalcoholic extract. The present study is support to the isolation and use of phytoconstituents from seed of *P. pinnata* in treatment of inflammation and arthritis.





Suriya et al.,

Amar et al (2014) reported that the *in vitro* anti-arthritic activity of *Cassia tora* Linn. Leaves using effect of membrane stabilization and protein denaturation using different concentration. The results are compared with standard drug. The aqueous extract of the selected medicinal plant showed significant activity. Anti-arthritic effect of *Cassia tora* Linn. Leaves were studied by testing various *in vitro* studies. The effect of the selected plant on inhibition of protein denaturation and effect of membrane stabilization was 87.22 % and 87.25% respectively for the aqueous extract of the selected plant leaves. He concluded that *Cassia tora* possessed marked *in vitro* anti-inflammatory effect against the denaturation of protein. Susmitha Sudevan et al., (2015) investigation exposed that the extracts of *Acmella Oleracea* have potent phytochemical and antimicrobial activity which explains its use in traditional system of medicines. The qualitative analysis of the extracts from the leaf sample of *Acmella oleracea* showed the presence of phytochemical constituents such as tannins, saponin, flavonoids, steroid, lipids, amino acids and terpenoids. Hence, *Acmella oleracea* can source of natural antimicrobials that can serve as a substitute to conventional medicines.

CONCLUSION

Overall, it can be concluded from the present study that *Cassia roxburghii* leaves extract contains rich source of phytochemicals. This study is the first scientific report that provides convincing phytochemicals and anti-arthritics activity evidence for the relevance of *Cassia roxburghii* leaves extract thus providing scientific validity to its traditional consumption by the local populace of south India.

REFERENCES

1. Amar P, Patil, Ajinkya Chavan, Tohid Alias, Navaj Baxu and Satyajit Sathe. (2014) In Vitro Anti-Arthritic Activity of *Cassia tora* Linn. Leaves. International Journal of Pharmaceutical Research and Bio Science, 3(1): 60-64.
2. Arthritis foundation (2005). The facts about arthritis. (Available [http://24.104.35.44/resources/Getting started / default asp](http://24.104.35.44/resources/Getting%20started/default.asp)).
3. Buch M and Emery P. (2002) The etiology and pathogenesis of rheumatoid arthritis. Hospital pharmacist. 9: 5-10.
4. Divya Singh, Rahul Nainwani, Tripta Sharma, Rupesh K and Gautam. (2013) *In-vitro* anti-inflammatory and anti-arthritic activity of hydroalcoholic extract of *Pongamia Pinnata* (L.) Pierre Seed. International Journal of Pharma Research & Review, 2(12):20-25.
5. Firestein GS . (2005) Firestein GS . (2005) Rheumatoid Arthritis. In: Firestein GS, Budd RC, Harris Jr, ED, et al,eds. *Kelley's Textbook o Rheumatology*. 8th ed. Philadelphia PA. Saunders/ Elsevier.
6. Grant NH, Alburn HE and Kryzanasuskas C. (1970) Stabilization of serum albumin by anti-inflammatory drugs. Biochem Pharmacol, 19: 715-722.
7. Harborne JB. (1973) Phytochemical Methods; A guide to modern techniques of plant Analysis.2nd Edition, London New York. pp. 49-188.
8. Harborne JB. (1984) Phytochemical Methods. A Guide to Modern Technique of Plant analysis. London: Chapman and Hall, pp.78-210.
9. Hassain E, Mandal SC and Gupta JK. (2011) Phytochemical screening and *in vitro* antipyretic activity of the methanol leaf extract of *Bombax malabaricum* DC (Bombacaceae). Trop. J. Pharmaceut. Res, 10: 55-60.
10. Kaur DHP, Sawant GH and Deshmukh P. (2013) Herbal Medicine-A nature cure to arthritis. Indian journal of natural products and resource. 4(1): 27-35.
11. Kumar M, Mondal P, Borah S and Mahato K. (2013) Physico- chemical evaluation, preliminary phytochemical investigation, fluorescence and TLC analysis of leaves of the plant *Lasia spinosa* (Lour) Thwaites. Int J Pharm Pharm Sci, 5 (2):306-310.
12. Sangita Chandra, Priyanka Chatterjee, Protapaditya Dey and Sanjib Bhattacharya. (2012) Evaluation of *in vitro* anti-inflammatory activity of coffee against the denaturation of protein. Asian Pacific Journal of Tropical Biomedicine, 178-180.





Suriya et al.,

13. Sofowara A. (1993) Medicinal plants and Traditional medicine in Africa. Spectrum Books Ltd, Ibadan, Nigeria. p. 289.
14. Susmitha Sudevan, Shalini Sundar, Ranganayaki P, Aswathy Guptha, Shafina J and Vijayaraghavan Ramasamy. (2015) Studies on in-vitro Antiinflammatory activity of *Acmella oleracea* metabolic compounds. Journal of Chemical and Pharmaceutical Sciences, 8(2): 227-232.
15. Thamizh Mozhi M, Mulaicharam AR and Murugesh S. (2011) Phytochemical and Pharmacognostical studies on *Pedalium murex* Linn. Inter J. Res, Ayurveda and Pharmacy, 2: 253-258.
16. Times of India. 1999, 2 December . P4.
17. Trease GE, Evans WC (1989). Pharmacognsy. 11th edn. Brailliar Tiridel Can. Macmillian publishers.
18. Patil KR, Patil CR, Jadhav RB, Mahajan VK, Patil PR, Gaikwad PS. Anti-arthritic activity of Bartogenic acid isolated from fruits of *Barringtonia racemosa* Roxb. (Lecythidaceae). Evid Based Complement Alternat Med. 2011; (2011): 785245.

Table 1: Qualitative analysis of Phytochemicals in *Cassia roxburghii* leaves extract

| S. No | Phytochemicals | Aqueous extract |
|-------|----------------|-----------------|
| 1 | Tannin | + |
| 2 | Saponin | + |
| 3 | Flavonoids | + |
| 4 | Steroids | + |
| 5 | Terpenoids | + |
| 6 | Triterpenoids | + |
| 7 | Alkaloids | + |
| 8 | Antroquinone | + |
| 9 | Polyphenol | + |
| 10 | Glycoside | + |
| 11 | Coumarins | - |

(-) Indicates Absence; (+) Indicates Presence

Table 2: *In vitro* anti-arthritics activity of *Cassia roxburghii* leaves extract (Egg albumin)

| Concentration ($\mu\text{g/ml}$) | <i>Cassia roxburghii</i> leaves extract | Standard (Diclofenac sodium) |
|------------------------------------|---|------------------------------|
| 100 | 17.50 \pm 1.22 | 21.34 \pm 1.49 |
| 200 | 30.21 \pm 2.11 | 36.45 \pm 2.55 |
| 300 | 56.97 \pm 3.98 | 65.94 \pm 4.61 |
| 400 | 77.14 \pm 5.39 | 83.45 \pm 5.84 |
| 500 | 92.09 \pm 6.44 | 93.45 \pm 6.54 |

Values are expressed as Mean \pm SD for triplicates**Table 3: *In vitro* anti-arthritics activity of *Cassia roxburghii* leaves extract (Membrane stability)**

| Concentration ($\mu\text{g/ml}$) | <i>Cassia roxburghii</i> leaves extract | Standard (Diclofenac sodium) |
|------------------------------------|---|------------------------------|
| 100 | 18.64 \pm 1.30 | 23.28 \pm 1.62 |
| 200 | 36.99 \pm 2.58 | 42.75 \pm 2.99 |
| 300 | 44.33 \pm 3.10 | 51.25 \pm 3.58 |
| 400 | 59.01 \pm 4.13 | 75.42 \pm 5.27 |
| 500 | 81.06 \pm 5.67 | 90.68 \pm 6.34 |

Values are expressed as Mean \pm SD for triplicates



Suriya et al.,

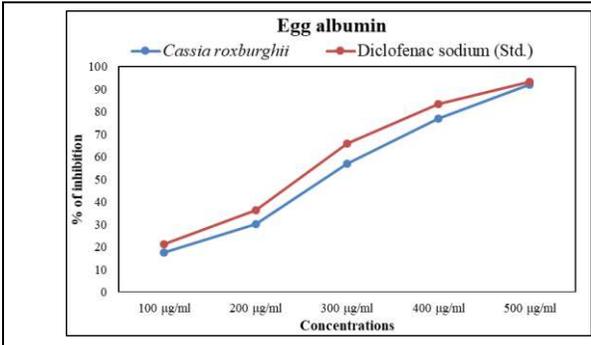


Figure 1: *In vitro* anti-arthritis activity of *Cassia roxburghii* leaves extract

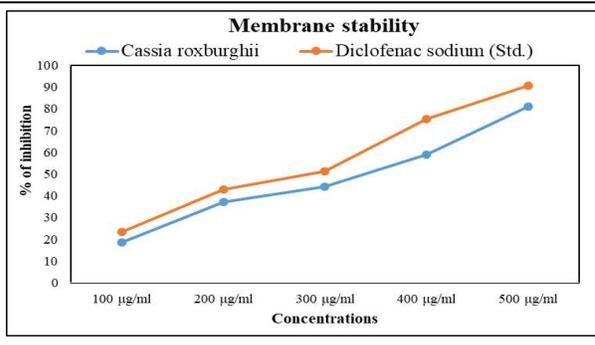


Figure 2: *In vitro* anti-arthritis activity of *Cassia roxburghii* leaves extract





Physicochemical, Thermal, Spectral and Biological Investigation of Mixed Ligand Lanthanum Complexes

Asmitak A. Bhagat¹, Sunil S. Patil¹, Bhushan P. Langi², Vishal S. Kamble¹, Digambar K. Patil¹ and Jitendra M. Pawara^{1*}

¹Department of Chemistry, Changu Kana Thakur Arts Commerce and Science College (Autonomous), New Panvel, Maharashtra, India

²Department of Chemistry, Dnyanasadhana College, Thane, Maharashtra, India

Received: 05 May 2022

Revised: 15 June 2022

Accepted: 18 July 2022

*Address for Correspondence

Jitendra M. Pawara

Department of Chemistry,
Changu Kana Thakur Arts
Commerce and Science College (Autonomous),
New Panvel, Maharashtra, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The mixed ligand lanthanum complexes were synthesized from N- and O- donor ligands. The 2-amino-6-methyl pyridine-4-ol (HP) was used as a primary ligand and L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine (HL) were used as secondary ligands for synthesis. The physicochemical and spectral methods, viz. elemental analysis, molar conductance, magnetic susceptibility measurements, UV-Visible spectroscopy, IR spectroscopy, thermal analysis and XRD were used for the characterization of synthesized complexes. The metal ion, primary ligand and secondary ligand were reacted and the complex was formed in a 1:2:1 ratio which was confirmed by elemental analysis. The molar conductance data of synthesized complexes concludes their non-electrolytic behavior. The data from studies of magnetic susceptibility measurements conclude the diamagnetic properties of the synthesized complexes. The coordination of metal ions with 2-amino-6-methyl pyridine-4-ol (HP) and amino acids was confirmed by UV-Visible and IR spectroscopy. The presence of metal ion, primary ligand and secondary ligand was confirmed by thermal and XRD studies. The synthesized lanthanum complexes were screened and studied against selective micro-organisms.

Keywords: Lanthanum complexes, physicochemical, thermal, spectral, biological studies.

INTRODUCTION

Coordination chemistry is an interesting branch of chemistry for its numerous applications in kinetics, pharmaceuticals, paints, etc. (1-3). Several inner transition metal ions form chelates with N- and O- donor ligands and





Asmitak A. Bhagat et al.,

are studied for various biological activities (4-5). Lanthanide complexes were also reported for antimicrobial activities (6-7). Research scholars also studied the synthesis and characterization of mixed ligand complexes with 2-amino-6-methyl pyridine-4-ol(8). Amino acids also form complexes with metal ions and are studied for different antimicrobial activities (9-10). Anti-malarial and anti-allergic activities of the complexes have been studied by some research scholars (11-12). By considering the importance of mixed ligand complexes in a biological system, the authors have decided to synthesize mixed ligand lanthanum complexes using 2-amino-6-methyl pyridine-4-ol as primary ligand and L-alanine, L-arginine and L-hydroxy proline as secondary ligands.

EXPERIMENTAL

MATERIALS

Lanthanum chloride heptahydrate (metal salt), 2-amino-6-methyl pyridine-4-ol (primary ligand) and L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine (secondary ligands) used during study were of analytical grade. The solvents used for the study were distilled and purified (13-15).

Synthesis of Mixed Ligand Complexes

The mixed ligand lanthanum complexes were synthesized using lanthanum chloride heptahydrate as a metal salt, 2-amino-6-methyl pyridine-4-ol as primary ligand and L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine as secondary ligands. Initially, 10 cm³ of 1 mmol aqueous solution of lanthanum salt was prepared. In the lanthanum salt solution, 10 cm³ of 2 mmol alcoholic solutions of 2-amino-6-methyl pyridine-4-ol were added with constant stirring. The resultant solution was heated in a water bath for about 20 minutes. The solution was removed from the water bath and kept on an asbestos sheet. The 10 cm³ of 1 mmol aqueous solution of amino acid was added drop by drop to the same hot solution. The mixture was again heated in a boiling water bath for 10 minutes. The resultant mixture was removed from the boiling water bath and kept on the asbestos sheet for cooling. To the cooled solution, a 1:1 ammonia solution was added drop-wise to increase its pH. At pH 7, the solid was formed in the mixture. It was cooled and filtered with a 1:1 ethanolic solution. The filtered solid was dried under a vacuum.

Instrumentation

The synthesized lanthanum complexes were characterized by various physicochemical and spectral methods. The conductance of all complexes was measured to conclude the electrolytic nature of the complexes on the Labtronics LT- 26 Deluxe Conductivity Meter. The 10⁻³ M solutions of complexes were prepared in DMSO to determine their conductance. Stoichiometry of complexes was concluded by elemental analysis. The analysis was carried out on ThermoFinnigan Elemental Analyzer. The magnetic moment of all complexes was measured to conclude the magnetic nature of the complexes on the Gouy balance. The electronic spectral study of 10⁻³ M solutions of complexes in DMSO was carried out on Shimadzu UV/Visible spectrophotometer. FTIR spectra of metal salt, 2-amino-6-methyl pyridine-4-ol (HP), amino acids and all complexes were obtained from the Shimadzu FTIR spectrophotometer. thermogravimetric and differential thermogravimetric curves of all synthesized complexes were taken from Perkin Elmer Diamond TG-DTA instrument in a nitrogen atmosphere and the X-ray diffraction study was carried out on Siemens X-ray Diffractometer.

Antibacterial Screening

Synthesized complexes were screened against the gram positive (*Staphylococcus aureus*, *Corynebacterium diphtheriae*) and gram-negative bacteria (*Salmonella typhi* and *Pseudomonas aeruginosa*) to see their antibacterial potential. The tube dilution method was adapted to find the minimum inhibitory concentration (MIC) and the agar cup method was followed to see the zone of inhibition.





Asmitak A. Bhagat et al.,

Tube dilution method

The synthesized complexes were dissolved in DMSO to make a stock solution of 1mg/cm³ and diluted to make the concentrations of 20, 40, 60, 80.....300 µg/cm³ with sterile Mueller Hinton broth. The 18 hrs. The old cultures were diluted with broth to get the initial concentration of 10⁶/cm³ using sterile Mueller Hinton broth. In a set of sterile tubes, 5 cm³ of each of the concentrations of the synthesized complexes were taken. To each tube, 0.1 cm³ of diluted culture was added. 5 cm³ sterile Mueller Hinton broth inoculated with 0.1 cm³ of diluted culture was kept as a positive control. The test control of DMSO of respective dilution made using sterile Mueller Hinton Broth was also kept. For standard control tetracycline of 10µg/cm³ was used. The tubes were kept in the incubator at 37°C for 24 hrs. The minimum inhibitory concentration was noted by observing the turbidity.

Agar cup method

The Agar cup method was adapted to see the zone of inhibition by the respective complexes. The 0.001 M concentration of the complexes was used to see the zone of inhibition by the respective complexes. The sterile borosilicate plates were poured with 20 cm³ nutrient agar with 1 cm³ of bacterial culture having a cell density of 10⁶/cm³. The plates were allowed to cool. The wells were bored using a cork borer of 5 mm diameter. The wells were assigned to the respective concentration of the complexes and 0.1 cm³ of the sample was placed in each of them. The 0.1 cm³ tetracycline of 10 µg/cm³ concentration was used as standard control. The control of DMSO was not considered since there was no significant inhibition in the growth of bacteria shown in the MIC.

RESULTS AND DISCUSSION

Synthesis of mixed ligand complexes

The synthesis of the mixed ligand complexes is represented by following reaction.



Where, HP 2-amino-6-methyl pyridine-4-ol HL: Amino acid such as L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine

Colour, Solubility, Hygroscopic Nature and Decomposition Temperature

The synthesized complexes with L-alanine, L-arginine, L-hydroxy proline, L-Proline and Valine were found in white colour. The range of decomposition temperature of all complexes was found in 277-280 °C. This high range of temperature indicates the strong bond between metal ion, primary ligand and secondary ligand in the complexes. The physicochemical study also revealed that all complexes were solid, insoluble in water, partially soluble in DMF and DMSO and non-hygroscopic in nature(16)(Table No. 1 and 2).

Conductance Measurement

The conductance of solutions of synthesized lanthanum complexes was measured on digital conductometer and it was found less than 1 mhos cm² mol⁻¹. As the data of conductance measurement was found less than 1, it is concluded that all synthesized complexes are non-electrolytic in nature (17) (Table No. 3).

Elemental Studies

The data of elemental analysis is mentioned in Table No. 3. The study of data revealed that the general formula of all synthesized lanthanum complexes is 1:2:1. It also confirms the reaction stated above (18) (Table No.3).

Magnetic Studies

The effective magnetic moments of all synthesized complexes were measured on Gouy balance using diamagnetic corrections and these values are mentioned in Table No. 4. The data revealed diamagnetic nature of the lanthanum complexes (19).





Asmitak A. Bhagat *et al.*,

Electronic Absorption Spectra

The spectra of all lanthanum complexes were taken in the UV-Visible region. All spectra show similar behavior. In all spectra, 3 peaks are observed. The peaks observed in the range of 270-275 nm, 332-339 nm and 391-395 nm confirm the transition of electrons from ligands to metal ion for $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ and charge-transfer transitions respectively. The data concludes the coordination of ligands with metal ion through the transition of electrons (Table No. 5).

Infra-red Spectra

All complexes show complex FTIR spectra (21-23). The spectra were recorded over the range 4000-400 cm^{-1} in KBr discs. The FTIR data does not show the band at 3430 cm^{-1} which may confirm deprotonation of the hydroxyl group of 2-amino-6-methyl pyridine-4-ol molecules in the formation of complexes. The spectra show strong band in the range of 1020-1013 cm^{-1} for C-O stretching vibration. The free 2-amino-6-methyl pyridine-4-ol molecule shows the same band at 1100 cm^{-1} . By comparing these two values, it is concluded that the same band of the complexes is shifted to a lower wave number which confirms the coordination of 2-amino-6-methyl pyridine-4-ol with lanthanum metal ion through the oxygen atom of C-O. The spectra show a weak band in the range of 1580-1482 cm^{-1} for C=N stretching vibration. The free 2-amino-6-methyl pyridine-4-ol molecule shows same band at 1650 cm^{-1} . By comparing these two values it is concluded that the same band of the complexes is shifted to a lower wave number which confirms the coordination of nitrogen of 2-amino-6-methyl pyridine-4-ol molecule with lanthanum metal ion. It also shows the medium band at 3294-3281 cm^{-1} for -OH stretching vibration which confirms the free oxime -OH group present in the 2-amino-6-methyl pyridine-4-ol moiety of the lanthanum complexes. The spectra show a weak band in the range of 814-821 cm^{-1} for M-N vibration (M stands for metal ion). The free 2-amino-6-methyl pyridine-4-ol molecule shows the same band at ~780 cm^{-1} .

By comparing these two values, it is concluded that the same band of the complexes is shifted to a higher wave number which confirms N atom of 2-amino-6-methyl pyridine-4-ol coordinated with lanthanum metal ion during complexation. The FTIR spectra also show weak bands in the range of 3140-3135 cm^{-1} and 2989-2980 cm^{-1} for N-H asymmetric and N-H symmetric vibrations respectively. The free amino acid molecule shows the same bands at ~3050 cm^{-1} and ~2960 cm^{-1} . By comparing these wave numbers it is concluded that the same bands are shifted to lower wave number which confirms N atom of amino acid coordinated with lanthanum metal ion. The spectra show strong band in the range 1617-1614 cm^{-1} and 1381-1372 cm^{-1} for COO- asymmetric vibration and COO- symmetric vibration respectively. The free amino acid molecule shows same band at ~1595 cm^{-1} and ~1410 cm^{-1} respectively. By comparing these wave number it is concluded that same bands are shifted to lower wave numbers which confirm carboxylic acid group of amino acid coordinated with lanthanum metal ion through its oxygen atom. The spectra show medium band in the range of 3366-3321 cm^{-1} and weak band in the range of 1598-1583 cm^{-1} for O-H asymmetric and O-H symmetric vibrations respectively in the complexes. These bands indicate presence of coordinated water molecules in the complexes. The spectra show medium band in the range of 404-401 cm^{-1} and 622-617 cm^{-1} for M-N and M-O vibrations respectively in the complexes. These bands indicate the bonding between central metal ion and O and N atoms of ligands (21-23) (Table No. 6).

Thermal Studies

The controlled nitrogen atmosphere was used to study thermal behaviour of lanthanum complexes. The thermogravimetric and differential thermogravimetric curves of synthesized complexes were obtained by heating the complex in TG-DTA instrument. The heating rate was 10°C per minute. All the complexes show same type of thermogravimetric curves. The gradual weight loss is observed with increase in the temperature. The first weight loss is observed in the range of 140-183°C, second is observed in the range of 265-419°C and the final loss is observed in the range of 640-830°C. All the complexes show straight line in TG-DTA above 840°C. The straight line indicates completion of reaction. The first weight loss in the thermogram is due to loss of two water molecules, the second weight loss is due to loss of amino acids and the last weight loss is due to two 2-amino-6-methyl pyridine-4-ol molecules from the complex. The curves in DTA shows endothermic peak in the range of 140-183°C conclude two coordinated water molecules present in complexes. It shows a small exotherm in the range of 265-419°C indicates presence of amino acid moiety in the complexes and broad exotherm in the range 640-830°C indicates presence of two 2-amino-6-methyl





Asmitak A. Bhagat et al.,

pyridine-4-ol molecule moieties in the complexes. The final product of reaction is the lanthanum powder which is then converted into lanthanum oxide. The oxide formed by reaction of trace oxygen present in nitrogen atmosphere with lanthanum powder. The XRD studies also conclude formation of lanthanum oxide after decomposition of complexes(24) (Table No. 7).

Antibacterial Studies

Tube dilution method

The complexes were found inhibiting the activity of the selected bacterial strains. The MIC for $[\text{La}(\text{P})_2(\text{Ala})\cdot 2\text{H}_2\text{O}]$ ranged between 80 and 100 $\mu\text{g}/\text{cm}^3$ having more efficiency for *S. aureus*. For $[\text{La}(\text{P})_2(\text{Arg})\cdot 2\text{H}_2\text{O}]$, $[\text{La}(\text{P})_2(\text{Hpro})\cdot 2\text{H}_2\text{O}]$ and $[\text{La}(\text{P})_2(\text{Val})\cdot 2\text{H}_2\text{O}]$ the MIC recorded was between 80 and 200 $\mu\text{g}/\text{cm}^3$ with same trend exhibiting its effectiveness towards *S. aureus*. The MIC for $[\text{La}(\text{P})_2(\text{Pro})\cdot 2\text{H}_2\text{O}]$ ranged between 80 and 100 $\mu\text{g}/\text{cm}^3$ having more efficiency for *S. aureus*(25-26) (Table No. 8 and 9)

Agar cup method

The result showed the similar trend as that of MIC showing a maximum zone of inhibition for *S. aureus* by all the complexes. The zone of inhibition for gram negative bacteria viz. *S. typhi* and *P. aeruginosa* was minimal compared to the gram positive bacteria viz. *S. aureus* and *C. diphtheria*. *P. aeruginosa* was found to be more resistant to the complexes (27-29) (Table No. 10).

CONCLUSIONS

The decomposition temperature of complexes shows high values. The high values confirm the strong bond formed between metal ions and ligands during the formation of complexes. The conductance of the complexes is reported as less than 1 mhos $\text{cm}^2 \text{mol}^{-1}$, it is concluded that all the metal complexes are non-electrolytic. Elemental analysis studies reveal the general formula of the complexes, 1:2:1. The Gouy method confirms the diamagnetic nature of all synthesized complexes. Electronic absorption studies conclude the transformation of electrons from ligands to lanthanum metal ions. The bonding between metal ions and ligands is confirmed by FTIR spectral studies. The thermal and XRD studies confirm the presence of coordinated water molecules, amino acid moiety and 2-amino-6-methyl pyridine-4-ol molecules moieties in the complexes. In regards to the above conclusions, coordination number 8 may be proposed for all complexes. The complexes are found to be more active against *S. aureus*, *C. diphtheriae* compared to activity of *S. Typhi* and *P. aerruginosa*.

The proposed structures for the complexes are -

REFERENCES

1. Altun, Ö. and Şuözer, M., "Synthesis, spectral analysis, stability constants, antioxidant and biological activities of Co (II), Ni (II) and Cu (II) mixed ligand complexes of nicotinamide, theophylline and thiocyanate", *Journal of Molecular Structure*, 1149, 307–314, July 2017.
2. Shaikh, I., Jadeja, R. N. and Patel, R., "Three Mixed Ligand Mononuclear Zn(II) Complexes of 4-Acyl Pyrazolones: Synthesis, Characterization, Crystal Study and Anti-Malarial Activity", *Polyhedron*, 183, 114528, June 2020.
3. Fan, C., Zong, Z., Zhang, X., Xu, C., Zhu, Z., Meng, X., Shuangyu, B. and Fan, Y., "Rational assembly of functional Co-MOFs via a mixed-ligand strategy: synthesis, structure, topological variation, photodegradation properties and dye adsorption", *CrystEngComm*, 20, 4973-4988, July 2018.
4. Sakr, S., Elshafie, H., Camele, I. and Sadeek, S., "Synthesis, Spectroscopic, and Biological Studies of Mixed Ligand Complexes of Gemifloxacin and Glycine with Zn(II), Sn(II), and Ce(III)", *Molecules*, 23(5), 1182-1198, May 2018.
5. Huang, H., Zhang, P., Yu, B., Jin, C., Ji, L. and Chao, H., "Synthesis, characterization and biological evaluation of mixed-ligand ruthenium(II) complexes for photodynamic therapy", *Dalton Transactions*, 44(39), 17335-17345, September 2015.



**Asmitak A. Bhagat et al.,**

6. Taha, Z. A., Ajlouni, A. M., Al Momani, W. and Al-Ghzawi, A. A., "Syntheses, characterization, biological activities and photophysical properties of lanthanides complexes with a tetradentate Schiff base ligand", *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 81(1), 570–577, June 2011.
7. Hegazy, W. H. and Al-Motawaa, I. H., "Lanthanide Complexes of Substituted -DiketoneHydrazone Derivatives: Synthesis, Characterization, and Biological Activities", *Bioinorganic Chemistry and Applications*, 2011, 1-10, April 2011.
8. Chavan, M.C., Deshpande, V.D. and Vaidya, P.V., "Synthesis and characterization of lanthanide mixed complexes using benzoin- α -oxime thiourea and phenylthioureas as ligands", *Asian J. Chem.* 4(2), 246-250, June 1992.
9. Abdelkarim, A.T., Mahmoud, W.H. and El-Sherif A. A., "Potentiometric, thermodynamics and coordination properties for binary and mixed ligand complexes of copper(II) with cephradine antibiotic and some N- and O-bound amino acids (α -alanine and β -alanine)", *Journal of Molecular Liquids*, 328, 115334, April 2021.
10. Shebl, M., "Synthesis, spectral studies, and antimicrobial activity of binary and ternary Cu(II), Ni(II), and Fe(III) complexes of new hexadentate Schiff bases derived from 4,6-diacetylresorcinol and amino acids", *Journal of Coordination Chemistry*, 62(19), 3217–3231. August 2009.
11. Adediji, J.F., Olayinka, E.T., Adebayo, M. A. and Babatunde O., "Antimalarial mixed ligand metal complexes: Synthesis, physicochemical and biological activities", *International Journal of Physical Sciences*, 4 (9), 529-534, September 2009.
12. Katouah, H. A., Al-Fahemi, J. H., Elghalban, M. G., Saad, F. A., Althagafi, I. A., El-Metwaly, N. M., and Khedr, A. M., "Synthesis of new Cu(II)-benzohydrazide nanometer complexes, spectral, modeling, CT-DNA binding with potential anti-inflammatory and anti-allergic theoretical features", *Materials Science and Engineering:C.*, 96, 740-756 March 2019.
13. Vogel A.I., *Quantitative Inorganic Analysis*, 4th ed., ELBS and Longman, New York 1985.
14. Vogel A. I., *Textbook of Practical Organic Chemistry*, 5th Ed., Longmans Green and Co. Ltd., London, 1989.
15. Vogel A I, *Textbook of Quantitative Inorganic Analysis*, 5th Ed., Longmans Green and Co. UK Ltd., 1989.
16. Thakkar, J. R. and Thakkar, N. V., "Synthesis and characterization of chiral mixed ligand Co(II) complexes of isonitrosopropiophenone and amino acids," *Synthesis and Reactivity in Inorganic and Metal-Organic Chemistry*, 30(10), 1871–1887, July 2000.
17. Geary, W. J., "The use of conductivity measurements in organic solvents for the characterisation of coordination compounds," *Coordination Chemistry Reviews*, 7(1), 81–122, October 1971.
18. Kekare, M., Vaidya, V.V., Thakur J., "Studies and Synthesis of Biologically Active Mixed Ligand Cerium (III) Complexes", *International Journal of Science and Research (IJSR)*, 4 (1), 1361-1366, January 2015.
19. Thakur, G. A. and Shaikh, M. M., "Synthesis, characterization, antibacterial and cytotoxicity studies on some mixed ligand Th(IV) complexes," *Acta Polonicae Pharmaceutica*, 63(2), 95–100, March 2006.
20. Shivankar, V. S. and Thakkar, N.V., "Synthesis, characterization and antimicrobial activity of some mixed ligand Co(II) and Ni(II) complexes," *Acta Polonicae Pharmaceutica*, 60(1), 45–50, April 2003.
21. Charles, R.C., Freiser, H., Friedel, R., Hillard, L.E. and Johnson, W.D. "Infra-red absorption spectra of metal chelates derived from 8-hydroxyquinoline, 2-methyl-8-hydroxyquinoline, and 4-methyl-8-hydroxyquinoline," *Spectrochim Acta*, 8(1), June 1956.
22. Gandhi, J.B. and Kulkarni, N.D., "Synthesis, characteristics and redox properties of uranyl complexes with diamine ligands having ONNO and ONNNO donor groups," *Indian Journal of Chemistry A*, 39(4), 461–464, April 2000.
23. Nakamoto, K., *Infrared and Raman Spectra of Inorganic and Coordination Compounds*, 4th edition, John Wiley and Sons, New York, NY, USA, 1986.
24. Thakur, G.A. and Shaikh, M.M., "Synthesis, characterization, antibacterial and cytotoxicity studies on some mixed ligand Th (IV) complexes", *Acta Polonicae Pharmaceutica*, 63(2), 95-100, April 2006
25. Prasad, R.V. and Thakkar, N.V., "Study of cobalt complexes as catalysts in the decomposition of hydrogen peroxide," *Journal of Molecular Catalysis*, 92(1), 9–20, August 1994.
26. Chohan, Z.H., Misbahul, A.K. and Moazzam, M., "Synthesis, characterization and antimicrobial studies of Co(II) and Ni(II) complexes with some pyrazoles," *Indian Journal of Chemistry A*, 27A(12), 1102-1104, December 1988.





Asmitak A. Bhagat et al.,

27. Jitendra M. Pawara, Sunil S. Patil. An Innovative Method Designed for the Synthesis of Some New Mixed Ligand Ni(II) Complexes Its Characterization and Applications. World Journal of Chemical Education. 9(2), 50-56, May 2021.
28. Pawara, J., &Patil, S. (2021). SYNTHESIS OF NIO NANOPARTICLES BY THERMAL DECOMPOSITION AT LOW-TEMPERATURE OF NEW AQUA (2-AMINO-6-METHYL PYRIMIDINE-4-OL AND ISOLEUCINE)NI(II) COMPLEX AND ITS ANTIMICROBIAL STUDY. Journal of Advanced Scientific Research, 12(03), 113-118 August 2021.
29. Pawara, Jitendra&Patil, Sunil. (2021). Microwave-Assisted Synthesis of Some New Mixed Ligand Ni(II) Complexes Its Characterization and Its Antimicrobial Study. Journal of Pharmaceutical Research International. 143-152 June 2021.

Table 1: Empirical Formula, Molecular Weight and Colour of the Complexes

| Complex | Empirical Formula | Molecular Weight | Colour |
|---|--|------------------|--------|
| [La(P) ₂ (Ala)·2H ₂ O] | C ₁₃ H ₁₉ LaN ₇ O ₆ | 715.52 | White |
| [La(P) ₂ (Arg)·2H ₂ O] | C ₁₆ H ₂₈ LaN ₁₀ O ₅ | 800.63 | White |
| [La(P) ₂ (Hpro)·2H ₂ O] | C ₁₄ H ₃₆ LaN ₇ O ₅ | 757.56 | White |
| [La(P) ₂ (Pro)·2H ₂ O] | C ₁₂ H ₃₆ LaN ₇ O ₅ | 741.56 | White |
| [La(P) ₂ (Val)·2H ₂ O] | C ₁₃ H ₃₈ LaN ₇ O ₅ | 743.57 | White |

Table 2: Decomposition Temperature and pH of the Complexes

| Complex | Decomposition Temperature (°C) | pH |
|---|--------------------------------|------|
| [La(P) ₂ (Ala)·2H ₂ O] | 280 | 6.96 |
| [La(P) ₂ (Arg)·2H ₂ O] | 278 | 6.92 |
| [La(P) ₂ (Hpro)·2H ₂ O] | 277 | 6.96 |
| [La(P) ₂ (Pro)·2H ₂ O] | 276 | 6.98 |
| [La(P) ₂ (Val)·2H ₂ O] | 280 | 6.99 |

Table 3: Elemental Analysis Data and Molar Conductance of the Complexes

| Complex | Elemental Analysis Found (Calculated) | | | | Molar Conductance |
|---|---------------------------------------|---------------|-------------|---------------|-------------------|
| | % M | % C | % H | % N | |
| [La(P) ₂ (Ala)·2H ₂ O] | 19.38 (19.41) | 52.00 (52.04) | 4.75 (4.79) | 5.84 (5.87) | 0.0011 |
| [La(P) ₂ (Arg)·2H ₂ O] | 17.32 (17.35) | 51.00 (51.01) | 5.12 (5.16) | 10.48 (10.50) | 0.0015 |
| [La(P) ₂ (Hpro)·2H ₂ O] | 18.34 (18.34) | 52.30 (52.32) | 4.73 (4.79) | 5.51 (5.55) | 0.0013 |
| [La(P) ₂ (Pro)·2H ₂ O] | 18.76 (18.73) | 53.49 (53.44) | 4.94 (4.90) | 5.68 (5.66) | 0.0015 |
| [La(P) ₂ (Val)·2H ₂ O] | 18.68 (18.68) | 53.33 (53.30) | 5.18 (5.16) | 5.68 (5.65) | 0.0013 |

Table 4: Magnetic Susceptibility data of the Complexes (- 10⁻⁶ c.g.s. units)

| Complex | X _g | X _m | μ _{eff} |
|---|---------------------------|---------------------------|------------------|
| [La(P) ₂ (Ala)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.47 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Arg)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.87 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Hpro)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.84 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Pro)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.47 × 10 ⁻⁴ | Diamagnetic |
| [La(P) ₂ (Val)·2H ₂ O] | - 1.04 × 10 ⁻⁶ | - 7.87 × 10 ⁻⁴ | Diamagnetic |





Asmitak A. Bhagat et al.,

Table 5: Electronic Absorption Spectra of the Complexes

| Sr. No. | Complex | λ (nm) | ν (cm ⁻¹) | Proposed Assignments |
|---------|---|----------------|---------------------------|-------------------------|
| 1 | [La(P) ₂ (Ala)·2H ₂ O] | 270 | 37037 | $\pi \rightarrow \pi^*$ |
| | | 339 | 29498 | $n \rightarrow \pi^*$ |
| | | 395 | 25316 | Charge-transfer |
| 2 | [La(P) ₂ (Arg)·2H ₂ O] | 271 | 36900 | $\pi \rightarrow \pi^*$ |
| | | 332 | 30120 | $n \rightarrow \pi^*$ |
| | | 392 | 25510 | Charge-transfer |
| 3 | [La(P) ₂ (Hpro)·2H ₂ O] | 275 | 36363 | $\pi \rightarrow \pi^*$ |
| | | 337 | 29673 | $n \rightarrow \pi^*$ |
| | | 391 | 25575 | Charge-transfer |
| 4 | [La(P) ₂ (Pro)·2H ₂ O] | 275 | 36363 | $\pi \rightarrow \pi^*$ |
| | | 337 | 29673 | $n \rightarrow \pi^*$ |
| | | 391 | 25575 | Charge-transfer |
| 5 | [La(P) ₂ (Val)·2H ₂ O] | 271 | 36900 | $\pi \rightarrow \pi^*$ |
| | | 332 | 30120 | $n \rightarrow \pi^*$ |
| | | 392 | 25510 | Charge-transfer |

Table 6: FTIR Data of the Complexes

| Complex | ν (C-O) | ν (C=N) | ν (-OH) (Oxime) | ν (M-N) | ν (N-H) (Asym) | ν (N-H) (Sym) | ν (COO-) (Asym) | ν (COO-) (Sym) | ν (HOH) (Asym) | ν (HOH) (Sym) | ν (M-N) | ν (M-O) |
|---|-------------|-------------|---------------------|-------------|--------------------|-------------------|---------------------|--------------------|--------------------|-------------------|-------------|-------------|
| | (Cup) | (Cup) | (Cup) | (Cup) | (A.a.) | (A.a.) | (A.a.) | (A.a.) | (HOH) | (HOH) | (Complex) | (Complex) |
| [La(P) ₂ (Ala)·2H ₂ O] | 1012 (s) | 1482 (w) | 3281 (m) | 814 (w) | 3138 (w) | 2980 (w) | 1617 (s) | 1372 (w) | 3277 (m) | 1598 (w) | 402 (m) | 622 (w) |
| [La(P) ₂ (Arg)·2H ₂ O] | 1015 (s) | 1580 (w) | 3290 (m) | 813 (w) | 3140 (w) | 2982 (w) | 1616 (s) | 1381 (w) | 3366 (m) | 1593 (w) | 404 (m) | 618 (w) |
| [La(P) ₂ (Hpro)·2H ₂ O] | 1019 (s) | 1512 (w) | 3294 (m) | 812 (w) | 3135 (w) | 2989 (w) | 1614 (s) | 1380 (w) | 3321 (m) | 1583 (w) | 401 (m) | 617 (w) |
| [La(P) ₂ (Pro)·2H ₂ O] | 1015 (s) | 1580 (w) | 3290 (m) | 813 (w) | 3140 (w) | 2982 (w) | 1616 (s) | 1381 (w) | 3366 (m) | 1593 (w) | 404 (m) | 618 (w) |
| [La(P) ₂ (Val)·2H ₂ O] | 1019 (s) | 1512 (w) | 3294 (m) | 812 (w) | 3135 (w) | 2989 (w) | 1614 (s) | 1380 (w) | 3321 (m) | 1583 (w) | 401 (m) | 617 (w) |

Table 7: Thermal Data of the Complexes

| Sr. No. | Complex | Temperature Range (°C) | Weight Loss Due to the Loss of | % Weight Loss | |
|---------|---|------------------------|--------------------------------|---------------|------------|
| | | | | Found | Calculated |
| 1. | [La(P) ₂ (Ala)·2H ₂ O] | 140-180 | Two water molecules | 5.00 | 5.04 |
| | | 265-418 | Amino acid | 12.29 | 12.31 |
| | | 640-826 | Two HP molecules | 63.21 | 63.24 |
| 2. | [La(P) ₂ (Arg)·2H ₂ O] | 145-183 | Two water molecules | 4.48 | 4.50 |
| | | 272-419 | Amino acid | 21.61 | 21.64 |
| | | 648-830 | Two HP molecules | 56.49 | 56.51 |
| 3. | [La(P) ₂ (Hpro)·2H ₂ O] | 141-182 | Two water molecules | 4.74 | 4.76 |
| | | 268-417 | Amino acid | 17.15 | 17.18 |
| | | 650-827 | Two HP molecules | 59.72 | 59.73 |
| 4. | [La(P) ₂ (Pro)·2H ₂ O] | 145-183 | Two water molecules | 4.48 | 4.50 |
| | | 272-419 | Amino acid | 21.61 | 21.64 |
| | | 648-830 | Two HP molecules | 56.49 | 56.51 |
| 5. | [La(P) ₂ (Val)·2H ₂ O] | 141-182 | Two water molecules | 4.74 | 4.76 |
| | | 268-417 | Amino acid | 17.15 | 17.18 |
| | | 650-827 | Two HP molecules | 59.72 | 59.73 |





Asmitak A. Bhagat et al.,

Table 8: MIC Data of the Complexes by Tube Dilution Method

| Sr. No. | Complex | MIC ($\mu\text{g}/\text{cm}^3$) | | | |
|---------|---|-----------------------------------|-----------------------|-----------------|----------------------|
| | | <i>S. aureus</i> | <i>C. diphtheriae</i> | <i>S. typhi</i> | <i>P. aeruginosa</i> |
| 1. | [La(Cup) ₂ (Ala)·2H ₂ O] | 60 | 80 | 100 | 120 |
| 2. | [La(Cup) ₂ (Arg)·2H ₂ O] | 80 | 120 | 140 | 200 |
| 3. | [La(Cup) ₂ (Hpro)·2H ₂ O] | 80 | 120 | 140 | 200 |
| 4. | [La(P) ₂ (Pro)·2H ₂ O] | 60 | 80 | 100 | 120 |
| 5. | [La(P) ₂ (Val)·2H ₂ O] | 80 | 120 | 140 | 200 |

Table 9: MIC Data of Metal Salts, Ligand and Tetracycline by Tube Dilution Method

| Salt / Ligand / Tetracycline | MIC ($\mu\text{g}/\text{cm}^3$) | | | |
|--------------------------------------|-----------------------------------|-----------------------|-----------------|----------------------|
| | <i>S. aureus</i> | <i>C. diphtheriae</i> | <i>S. typhi</i> | <i>P. aeruginosa</i> |
| LaCl ₃ ·7H ₂ O | 100 | 150 | 150 | 200 |
| HP | 110 | 200 | 160 | 140 |
| Tetracycline | 1.5 | 2.0 | 1.5 | 8.0 |

Table 10: Antibacterial Activity (mm) of the Complexes by Agar Cup Method

| Sr. No. | Complex | Antibacterial Activity (mm) with | | | |
|---------|---|----------------------------------|-----------------------|-----------------|----------------------|
| | | <i>S. aureus</i> | <i>C. diphtheriae</i> | <i>S. typhi</i> | <i>P. aeruginosa</i> |
| 1. | [La(Cup) ₂ (Ala)·2H ₂ O] | 16 | 14 | 10 | 07 |
| 2. | [La(Cup) ₂ (Arg)·2H ₂ O] | 16 | 08 | 09 | 06 |
| 3. | [La(Cup) ₂ (Hpro)·2H ₂ O] | 15 | 08 | 08 | 06 |
| 4. | [La(P) ₂ (Pro)·2H ₂ O] | 16 | 14 | 10 | 07 |
| 5. | [La(P) ₂ (Val)·2H ₂ O] | 16 | 08 | 09 | 06 |
| 6. | Tetracycline | 30 | 25 | 26 | 18 |

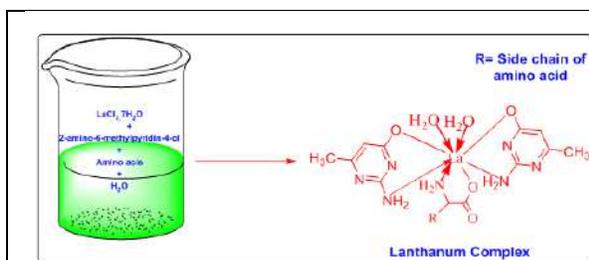


Figure 1. Experimental Method

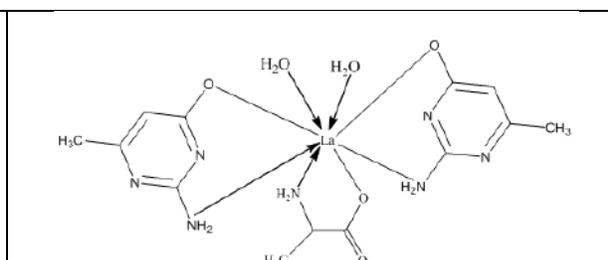


Figure 2: Proposed Structure of [La(P)₂(Ala). 2H₂O]

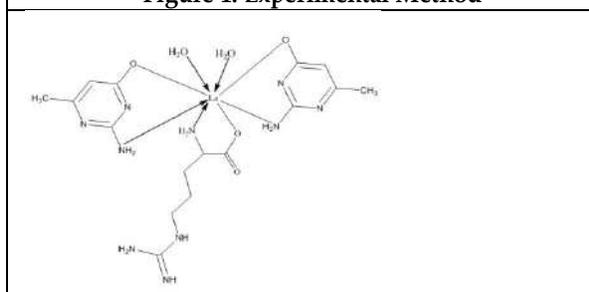


Figure 3. Proposed Structure of [La(P)₂(Arg). 2H₂O]

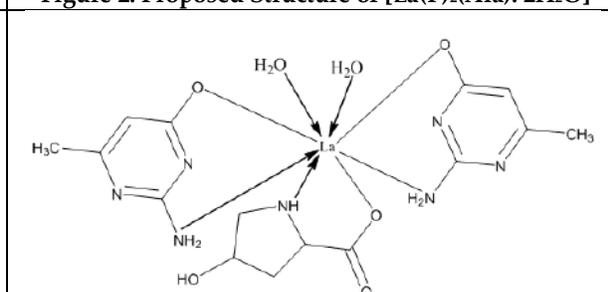


Figure 4. Proposed Structure of [La(P)₂(Hpro). 2H₂O]





Asmitak A. Bhagat et al.,

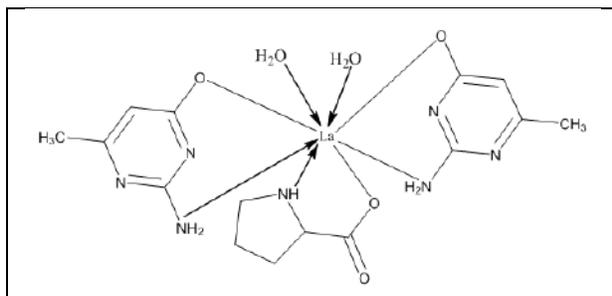


Figure 5. Proposed Structure of [La(P)₂(Pro)·2H₂O]

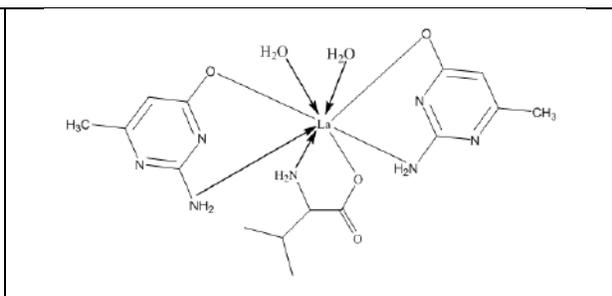


Figure 6. Proposed Structure of [La(P)₂(Va)·2H₂O]





A Study on Screening of Bioactive Compounds and *In-vitro* Evaluation of Antiarthritic Activity of *Cassia roxburghii* Leaves Extract

Suriya P^{1*}, Shalini R², Amargeetha A³ and Antony Thangadurai T⁴

¹Head and Assistant Professor, Department of Biochemistry, Annai College of Arts and Science (Affiliated to Bharathidasan University), Kovilacheri, Kumbakonam, Tamil Nadu, India

²Assistant Professor, Department of Biochemistry, Annai College of Arts and Science (Affiliated to Bharathidasan University), Kovilacheri, Kumbakonam, Tamil Nadu, India

³Assistant professor, Department of Chemistry, Bon Secours College for Women (Affiliated to Bharathidasan University), Vilar Bypass, Thanjavur, Tamil Nadu, India

⁴Director, Rontgen Medical Centre, Thanjavur, Tamil Nadu, India.

Received: 14 Apr 2022

Revised: 16 May 2022

Accepted: 26 Jun 2022

*Address for Correspondence

Suriya P

Head and Assistant Professor,
Department of Biochemistry,
Annai College of Arts and Science,
(Affiliated to Bharathidasan University),
Kovilacheri, Kumbakonam,
Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Arthritis is a disease condition that affects the musculoskeletal system, causing painful inflammation and stiffness around joints. Rheumatoid arthritis (RA) is considered the most common chronic inflammatory autoimmune disease, occurring in 1 to 2% of the worldwide population. A number of natural products are used in the traditional medical systems in many countries. Alternative medicine for treatment of various diseases is getting more popular. Making medicinal plants provide relief of symptoms comparable to that obtained from allopathic medicines. The medicinal value of the chosen *Cassia roxburghii* leaves extract has not been extensively worked out. Therefore, the present study was to investigate the phytochemical screening and anti-arthritics activity of *Cassia roxburghii* leaves extract. The phytochemical screening *Cassia roxburghii* leaves extract showed that the presence of tannin, saponins, terpenoids, flavonoids, steroids, alkaloids triterpenoids, polyphenol, anthroquinone and glycosides. Overall, it can be concluded from the present study that *Cassia roxburghii* leaves extract contains rich sources of phytochemicals and anti-arthritics activity evidence for the relevance of *Cassia roxburghii* leaves extract.

Keywords: *Cassia roxburghii* leaves extract, Anti-arthritics, Phytochemicals.



Suriya *et al.*,

INTRODUCTION

Arthritis is a disease condition that affects the musculoskeletal system, causing painful inflammation and stiffness around joints. In Greek “artho” means joint and “itis” means inflammation and so arthritis is a form of joint disorder that involves inflammation of joints. Arthritis is an umbrella term describing more than 100 recognized condition that collectively affects approximately 70 million adults and 3,00,000 children (Arthritis Foundation, 2005). Arthritis can affect individuals of any age but is more predominant in the age range of 25 and 50 years with a peak in the age range of 40-50years (Kaur *et al.*, 2013). India (and South Asia more generally) is an important region in which to pursue humoral constructions of arthritis and joint disorders. Many Indians suffer from joint pain and rheumatic problems: osteoarthritis is widespread and rheumatoid arthritis, the far less prevalent but more incapacitating form of the disease, affects an estimated ten million Indians, 80% of which are women (Times of India, 1999). Rheumatoid arthritis (RA) is considered the most common chronic inflammatory autoimmune disease, occurring in 1 to 2% of the worldwide population (Firestein *et al.*, 2005). Rheumatoid arthritis (RA) is one of the commonest autoimmune diseases, is a chronic, progressive, systemic inflammatory disorder affecting the synovial joints and typically produces symmetrical arthritis that leads to joint destruction, which is responsible for the deformity and disability. The consequent morbidity and mortality have a substantial socio-economic impact (Buch and Emery, 2002).

The normal use of available prevailing therapies constantly induces harmful consequences, which with time may neutralize valuable outcomes. Plant drugs are favoured over conventional medicines by patients because of unremitting quality of malady, fear of surgery, terrible morbidity, ever-growing medicinal cost, trivial reaction to established drugs and disadvantages of novel drugs. These herbal remedies diminish the manifestations of illness and raise the worth of life (Patil *et al.*, 2011). In India, many Ayurvedic practitioners are using various indigenous plants for the treatment of different types of arthritic conditions. The present study investigates phytochemicals and *in vitro* anti-arthritis activity of *Cassia roxburghii* (Family: Leguminosae, Tamil name: Vakai) leaves extract.

MATERIALS AND METHODS

Collection of Plant Materials

The leaves of *Cassia roxburghii* were collected in December 2020 from Thanjavur, Tamil Nadu, India. The *Cassia roxburghii* leaves were washed several times with distilled water to remove the traces of impurities from the leaves. Leaves were spread out in plain paper and shade dried at room temperature for about 10 days and made a fine powder using a grinder mixture. The powder materials were used for further studies.

Preparation for extract

One gram of the powder of *Cassia roxburghii* leaves were transferred in to conical flask (250ml) containing 100ml of ethanol. The conical flask containing *Cassia roxburghii* leaves were shaken it well for 30 minutes by free hand. After 24 hrs, the extracts were filtered using whatman filter paper No.1 and filtrate used for further analysis.

Phytochemical screening

Chemical tests were carried out on the extract using standard procedures to identify the constituents as described by Sofowara (1993), Trease and Evans (1989) and Harborne (1973 and 1984).

In-vitro Anti-Arthritis Activity

Inhibition of albumin denaturation

In vitro anti-inflammatory activity was carried out by the method of Sangita Chandra *et al.* (2012)

Assay of Membrane stabilizing activity

Anti-inflammatory activity was evaluated by Membrane stabilizing activity as described by Divya Singh *et al.*, (2013).





Suriya et al.,

RESULTS AND DISCUSSION

Qualitative analysis

In the present study was carried out on the *Cassia roxburghii* leaves extract revealed the presence of medicinally active constituents. The phytochemical characters of the *Cassia roxburghii* leaves extract are investigated and summarized in Table 1. The phytochemical screening *Cassia roxburghii* leaves extract showed that the presence of tannin, saponins, terpenoids, flavonoids, steroids, alkaloids triterpenoids, polyphenol, anthroquinone and glycosides whereas coumarins were absent in aqueous extracts. Hassain *et al.* (2011) screened phytochemical constituents from methanol leaf extract of *Bombax malabaricum*. Various organic 11 solvent extracts of *Pedaliium murex* were subjected to preliminary phytochemical screenings by Thamizh mozhi *et al.* (2011). Selected 53 traditionally used medicinal plants from the western region of India for their qualitative phytochemical screenings, total phenol and flavonoids contents. Kumar *et al.*, (2013) investigated the preliminary phytochemical screening of the leaves of the plant *Lasia spinosa* (Lour) Thwaites. The phytochemical screening showed that the methanol and aqueous extracts contained alkaloid, the carbohydrates and phenolic compounds were present in all of the solvent extracts except petroleum ether extract. The chloroform, ethyl acetate and the aqueous extract contained glycosides whereas the saponins present in methanol and aqueous extract. The ethyl acetate extract contains only flavonoids.

In vitro anti-arthritis activity of *Cassia roxburghii* leaves extract

There are certain problems in using animals in experimental pharmacological research, such as ethical issues and the lack of rationale for their use when other suitable methods are available or could be investigated. Hence, in the present study, the protein denaturation bioassay was selected for *in vitro* assessment of anti-arthritis property *Cassia roxburghii* leaves extract. Denaturation of tissue proteins is one of the well-documented cases of inflammatory and arthritic diseases. Production of autoantigens in certain inflammatory diseases may be due to *in vivo* denaturation of proteins. The mechanism of denaturation probably involves alteration in electrostatic, hydrogen, hydrophobic and disulphide bonding (Grant *et al.*, 1970). Agents that can prevent protein denaturation, therefore, would be worthwhile for anti-inflammatory drug development. The increments in absorbance of test samples with respect to control indicated stabilization of protein (Egg albumin) denaturation by and reference diclofenac sodium. *Cassia roxburghii* leaves extract exhibited anti-arthritis activities in dose-dependent manner (Table 2 and 3, fig 1, 2).

Sangita Chandra *et al.*, (2012) evaluated the *in vitro* anti-inflammatory effect of aqueous extract of coffee (*Coffea arabica*) against the denaturation of protein. The extract at different concentrations was incubated with egg albumin in controlled experimental conditions and subjected to determination of absorbance and viscosity to assess the anti-inflammatory property. Diclofenac sodium was used as the reference drug. The present findings exhibited a concentration dependent inhibition of protein (albumin) denaturation by the coffee extract. The effect of diclofenac sodium was found to be less when compared with the test extract. He concluded that coffee possessed marked *in vitro* anti-inflammatory effect against the denaturation of protein

Divya Singh *et al* (2013) examined Anti-inflammatory and Anti-arthritic Activity of seed extract of *Pongamia pinnata* (L.) Pierre by *in vitro* model. The anti-arthritic and anti-inflammatory activity of *P. pinnata* hydroalcoholic extract was done by Inhibition of protein denaturation and Human red blood cell membrane stabilization (HRBC) *in vitro* methods. The hydro alcoholic extract of *P. pinnata* was subjected to *in vitro* Inhibition of protein denaturation in various concentrations i.e. 10, 50, 100, 200, 400, 800, 1000 and 2000µg/ml. HRBC method was also used for the estimation of anti-inflammatory activity from in various concentrations 100, 200, 400, 800 and 1600 µg/ml. *P. pinnata* hydroalcoholic extract exhibited a concentration dependent inhibition of protein (albumin) denaturation. The stabilization of HRBC membrane showed a concentration dependent anti-inflammatory activity, and the protection percent increased with increase in the concentration of the *P. pinnata* hydroalcoholic extract. The present study is support to the isolation and use of phytoconstituents from seed of *P. pinnata* in treatment of inflammation and arthritis.





Suriya et al.,

Amar et al (2014) reported that the *in vitro* anti-arthritic activity of *Cassia tora* Linn. Leaves using effect of membrane stabilization and protein denaturation using different concentration. The results are compared with standard drug. The aqueous extract of the selected medicinal plant showed significant activity. Anti-arthritic effect of *Cassia tora* Linn. Leaves were studied by testing various *in vitro* studies. The effect of the selected plant on inhibition of protein denaturation and effect of membrane stabilization was 87.22 % and 87.25% respectively for the aqueous extract of the selected plant leaves. He concluded that *Cassia tora* possessed marked *in vitro* anti-inflammatory effect against the denaturation of protein. Susmitha Sudevan et al., (2015) investigation exposed that the extracts of *Acmella Oleracea* have potent phytochemical and antimicrobial activity which explains its use in traditional system of medicines. The qualitative analysis of the extracts from the leaf sample of *Acmella oleracea* showed the presence of phytochemical constituents such as tannins, saponin, flavonoids, steroid, lipids, amino acids and terpenoids. Hence, *Acmella oleracea* can source of natural antimicrobials that can serve as a substitute to conventional medicines.

CONCLUSION

Overall, it can be concluded from the present study that *Cassia roxburghii* leaves extract contains rich source of phytochemicals. This study is the first scientific report that provides convincing phytochemicals and anti-arthritics activity evidence for the relevance of *Cassia roxburghii* leaves extract thus providing scientific validity to its traditional consumption by the local populace of south India.

REFERENCES

1. Amar P, Patil, Ajinkya Chavan, Tohid Alias, Navaj Baxu and Satyajit Sathe. (2014) In Vitro Anti-Arthritic Activity of *Cassia tora* Linn. Leaves. International Journal of Pharmaceutical Research and Bio Science, 3(1): 60-64.
2. Arthritis foundation (2005). The facts about arthritis. (Available [http://24.104.35.44/resources / Getting started / default asp](http://24.104.35.44/resources/Getting%20started/default.asp)).
3. Buch M and Emery P. (2002) The etiology and pathogenesis of rheumatoid arthritis. Hospital pharmacist. 9: 5-10.
4. Divya Singh, Rahul Nainwani, Tripta Sharma, Rupesh K and Gautam. (2013) *In-vitro* anti-inflammatory and anti-arthritic activity of hydroalcoholic extract of *Pongamia Pinnata* (L.) Pierre Seed. International Journal of Pharma Research & Review, 2(12):20-25.
5. Firestein GS . (2005) Firestein GS . (2005) Rheumatoid Arthritis. In: Firestein GS, Budd RC, Harris Jr, ED, et al,eds. *Kelley's Textbook o Rheumatology*. 8th ed. Philadelphia PA. Saunders/ Elsevier.
6. Grant NH, Alburn HE and Kryzanasuskas C. (1970) Stabilization of serum albumin by anti-inflammatory drugs. Biochem Pharmacol, 19: 715-722.
7. Harborne JB. (1973) Phytochemical Methods; A guide to modern techniques of plant Analysis.2nd Edition, London New York. pp. 49-188.
8. Harborne JB. (1984) Phytochemical Methods. A Guide to Modern Technique of Plant analysis. London: Chapman and Hall, pp.78-210.
9. Hassain E, Mandal SC and Gupta JK. (2011) Phytochemical screening and *in vitro* antipyretic activity of the methanol leaf extract of *Bombax malabaricum* DC (Bombacaceae). Trop. J. Pharmaceut. Res, 10: 55-60.
10. Kaur DHP, Sawant GH and Deshmukh P. (2013) Herbal Medicine-A nature cure to arthritis. Indian journal of natural products and resource. 4(1): 27-35.
11. Kumar M, Mondal P, Borah S and Mahato K. (2013) Physico- chemical evaluation, preliminary phytochemical investigation, fluorescence and TLC analysis of leaves of the plant *Lasia spinosa* (Lour) Thwaites. Int J Pharm Pharm Sci, 5 (2):306-310.
12. Sangita Chandra, Priyanka Chatterjee, Protapaditya Dey and Sanjib Bhattacharya. (2012) Evaluation of *in vitro* anti-inflammatory activity of coffee against the denaturation of protein. Asian Pacific Journal of Tropical Biomedicine, 178-180.





Suriya et al.,

13. Sofowara A. (1993) Medicinal plants and Traditional medicine in Africa. Spectrum Books Ltd, Ibadan, Nigeria. p. 289.
14. Susmitha Sudevan, Shalini Sundar, Ranganayaki P, Aswathy Guptha, Shafina J and Vijayaraghavan Ramasamy. (2015) Studies on in-vitro Antiinflammatory activity of *Acmella oleracea* metabolic compounds. Journal of Chemical and Pharmaceutical Sciences, 8(2): 227-232.
15. Thamizh Mozhi M, Mulaicharam AR and Murugesh S. (2011) Phytochemical and Pharmacognostical studies on *Pedalium murex* Linn. Inter J. Res, Ayurveda and Pharmacy, 2: 253-258.
16. Times of India. 1999, 2 December . P4.
17. Trease GE, Evans WC (1989). Pharmacognsy. 11th edn. Brailliar Tiridel Can. Macmillian publishers.
18. Patil KR, Patil CR, Jadhav RB, Mahajan VK, Patil PR, Gaikwad PS. Anti-arthritis activity of Bartogenic acid isolated from fruits of *Barringtonia racemosa* Roxb. (Lecythidaceae). Evid Based Complement Alternat Med. 2011; (2011): 785245.

Table 1: Qualitative analysis of Phytochemicals in *Cassia roxburghii* leaves extract

| S. No | Phytochemicals | Aqueous extract |
|-------|----------------|-----------------|
| 1 | Tannin | + |
| 2 | Saponin | + |
| 3 | Flavonoids | + |
| 4 | Steroids | + |
| 5 | Terpenoids | + |
| 6 | Triterpenoids | + |
| 7 | Alkaloids | + |
| 8 | Antroquinone | + |
| 9 | Polyphenol | + |
| 10 | Glycoside | + |
| 11 | Coumarins | - |

(-) Indicates Absence; (+) Indicates Presence

Table 2: *In vitro* anti-arthritis activity of *Cassia roxburghii* leaves extract (Egg albumin)

| Concentration ($\mu\text{g/ml}$) | <i>Cassia roxburghii</i> leaves extract | Standard (Diclofenac sodium) |
|------------------------------------|---|------------------------------|
| 100 | 17.50 \pm 1.22 | 21.34 \pm 1.49 |
| 200 | 30.21 \pm 2.11 | 36.45 \pm 2.55 |
| 300 | 56.97 \pm 3.98 | 65.94 \pm 4.61 |
| 400 | 77.14 \pm 5.39 | 83.45 \pm 5.84 |
| 500 | 92.09 \pm 6.44 | 93.45 \pm 6.54 |

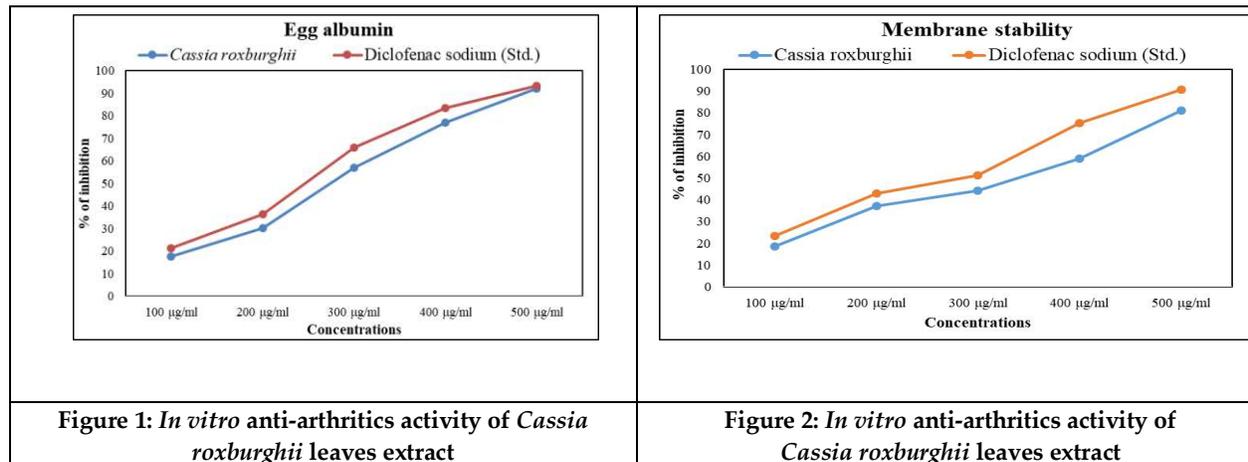
Values are expressed as Mean \pm SD for triplicates**Table 3: *In vitro* anti-arthritis activity of *Cassia roxburghii* leaves extract (Membrane stability)**

| Concentration ($\mu\text{g/ml}$) | <i>Cassia roxburghii</i> leaves extract | Standard (Diclofenac sodium) |
|------------------------------------|---|------------------------------|
| 100 | 18.64 \pm 1.30 | 23.28 \pm 1.62 |
| 200 | 36.99 \pm 2.58 | 42.75 \pm 2.99 |
| 300 | 44.33 \pm 3.10 | 51.25 \pm 3.58 |
| 400 | 59.01 \pm 4.13 | 75.42 \pm 5.27 |
| 500 | 81.06 \pm 5.67 | 90.68 \pm 6.34 |

Values are expressed as Mean \pm SD for triplicates



Suriya et al.,





A Study on Business Development and Client Engagement Activities of JCRE Skill Solutions, Imphal, Manipur

Sharald Ahongsangbam^{1*} and Sitaram Vikram Sujir²

¹Final Year MBA Student, Brindavan College, Bengaluru, Karnataka, India.

²Assistant Professor, Department of Management Studies, Brindavan College, Bengaluru, Karnataka, India

Received: 04 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Sharald Ahongsangbam

Final Year MBA Student,
Brindavan College, Bengaluru
Karnataka, India.

Email: sharald.ahongsangbam@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License (CC BY-NC-ND 3.0)** which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Business development tries to answer all the crucial questions that are essential for any company's operation like: identifying potential customers and market, their spending capacity, supply chain, structure of business and the best plan of action. It also helps in enhancing the financial pool and resources of the business through proper scrutiny and balances. For a business to grow and attain new heights, retaining customers and creating an ecosystem of brand conscious following is also important. Client engagement ensures that the company understands the trends, keeps track on client preferences, enables them to make selective improvements and helps keep customers in touch with any new developments. It begins with the identification of the client's preferences and establishing a connection with them. The strategy revolves around the intention of evaluating and assessing client satisfaction to ensure positive experience so that engagement continues. Once the communication or contact is established, it becomes imperative to maintain contact about a service or a product by providing incentives and new appealing developments. The study is focus on understanding of business development and client engagement activities in JCRE skill solutions where given training to refine and increase their knowledge, skills and abilities in doing a particular job and Organization development which plans effort initiated by an expert who has both knowledge and skill in the given organization. In a multifaceted institution such as JCRE, Client engagement is done in multiple forms. Engaging clients through emails, social media, customer care/support. Creating a custom content to engage and nurture existing clients as well as content marketing to drive leads and acquire new customers. JCRE skill solutions is a leading skill development Institution, first NSDC funded partner institute of Manipur and second in the entire North-East India. The intention of this study is to understand how and what method JCRE used to engage and lure the clients.





Keywords: Customer satisfaction, Business development, Client engagement, Brand awareness, Business strategy.

INTRODUCTION

By business development we mean the analytical assessment and compositing of potential clients or opportunities to facilitate development of any business. It can also mean the initiation and maintenance of strategic relationship with other businesses to enhance its growth. To improve brand consciousness among the masses through multiple platforms and agencies, devising ways to build a sustainable business model also constitutes business development. They ensure the survival and continuous growth of a company by identifying and assessing ideal clients or buyer to figure out where their advantage lies. Such qualification are normally done through interaction via calls, emails, or social media. BDRs are also tasked with keeping in touch with market trends in order to enable themselves in figuring out strategies to outgrow competitors. Business development, in brief, constitutes the nurturing of ideas and plans through, research, consultations, communication and calculated assessments which can propagate, and facilitate the growth of a business.

Learning about a client's preference and interest can also be considered an important part of business development whereby the growth of a business is linked closely with client satisfaction. In order to ensure continuous and lasting relationship with clients, effective and sustained client engagement is vital since it retains clients through loyalty, positive experiences and emotional connection. Paul Greenberg defines client engagement as "the ongoing interactions between company and customer, offered by the company, chosen by the customer." Client engagement therefore can be defined as the ways through which a brand or an institution establishes a lasting relationship with its clients and customers to promote brand awareness and loyalty. Client engagement can be done through multiple means like text messages, emails or social media platforms. Even though this can happen in more traditional way through in person meetings and interaction, customer or client engagement gained immense value in the digital age.

REVIEW OF LITERATURE

Business development, as we understand, constitutes any strategy, analysis, or actions that aids the growth of the company. In our increasingly competitive business environment, any business needs to stay on top of the game to not only survive but grow and prosper. Competent business development knowledge helps in acquiring information with the help of which businesses can make realistic market assessments of the status of the existing market. It can help built confident and reliable models based on verified data. For a business to grow and attain new heights, retaining customers and creating an ecosystem of brand conscious following is also important. Client engagement ensures that the company understands the trends, keeps tract on client preferences, enables them to make selective improvements, and helps keep customers in touch with any new developments. Living in a post pandemic world where services had been rendered less physical, there has been a preferential shift to a more digital mode of communication among business operators. Multiple communication channels have opened up in hopes of maintaining connection with the customers and manage experiences. The global pandemic ensured the accelerated development of some of the revolutionary capabilities that will guide modern customer engagement in the future. Recent developments have indicated a shift from in-person engagements to a more digital mode of communications compelling companies to adopt more effective channels to handle the increasing volume of conversations. Studying this trend will help us understand present engagement tactics and predict future trends. Working remotely in place of face-to-face interactions also brings forth the need for a new management strategy. Recent advancements in the field of automation and artificial intelligence has also affected industries to opt for a more automated form of engagement. New developments such as these helps form new business development strategies and also make sure companies stay attuned to the latest trend in customer engagement. The topic of study which is to examine the



**Sharald Ahongsangbam and Sitaram Vikram Sujir**

business development and client engagement activities of JCRE skill solutions holds significance on multiple fronts since it helps one understand the mode of operation and adaptive tactics of a multifaceted brand like JCRE. By answering questions on which business strategy, it adopts, how it maintains customer relation and client satisfaction, the study aims to provide a comprehensive understanding of the subject.

NEED OF THE STUDY

Business development helps strengthening the thread that ties all the company's functions, departments. Business development strategies are important in finding new areas of expansion and in figuring out opportunities. It also helps in optimizing the number of clients existence, improving the reputation of the organization as well as expanding their target market, identifying the clients wants and establishing a connection with them. A shift from in-person engagements to a more digital mode of communications compels companies to adopt more effective channels to handle the increasing volume of conversations.. Studying this trend will help us understand present engagement tactics and predict future trends.

OBJECTIVES OF THE STUDY

- To study the JCRE ability to deliver different and effective training programs.
- To analyze the unique characteristic which makes them stand out from its competitor
- To understand the way JCRE establishes brand awareness through campaigns
- To study the communication tools that are being used for customer engagement in JCRE skill solutions.

RESEARCH METHODOLOGY

- Both primary and secondary data of information are taken in to account the data collection.
- Primary data:
 - Data that are being collected from primary source which are the clients and trainers through questionnaire, interview schedule, Observations, Surveys .
- Secondary data:
 - Data that are being collected through JCRE website, social media, Broachers, Newsletters

DATA ANALYSIS AND INTERPRETATION

The data of analysis was purely through data collection of the study. The data is to be represented in the form of graphs, tables and charts etc. The statistical tool like chi- square analysis and percentage analysis will be used to analyze the data of the study.

FINDINGS

As per the data acquired from the clients and trainees of JCRE during my research on the business development and client engagement in JCRE, I have reached upon some concrete and credible findings on the subject matter. The following results were detected from the data acquired: From the interaction with the trainees and clients at JCRE, I have come to know that: The target clients JCRE aims to acquire are not gender specific. They must be educated yet they also accept School or College dropouts for their training programmed which is commendable because providing skill to the young generation who has little academic background will give them a chance to be employed or run a business thereby contributing to the nation. Business Development strategy includes finding ways to spread brand awareness. According to the data, JCRE adopts multiple means to ensure the brand is known by all and remains up to date. Mobilization, word of mouth, collaboration, and advertisement are some of the brand awareness tactics JCRE adopts. The mode of communication through which footfall is created in JCRE is mainly mobilization followed by advertising and website interaction. All the means are used but mobilization works best. In order to ensure quality in its services, JCRE monitors the quality of their training diligently. It conducts periodic assessment



**Sharald Ahongsangbam and Sitaram Vikram Sujir**

of its services and uses practical knowledge, final assessment and certification, on the job training opportunity. JCRE skill solution also ensures its clients to have proper employment opportunities after the course is completed. Findings indicate that above 60% of its clients got placements through various departments of the JCRE. The most preferred means of engagement opted by clients appears to be in person interaction through office visits; while interaction through calls and text messages comes after to it. Interaction through social media handle takes the third position with only some clients choosing to communicate through it.

CONCLUSION

Business development, as we understand, constitutes any strategy, analysis, or actions that aid the growth of the company. In our increasingly competitive business environment, any business needs to stay on top of the game to not only survive but grow and prosper. Competent business development knowledge helps in acquiring information with the help of which, businesses can make realistic market assessments of the status of the existing market. It can help built confident and reliable models based on verified data. Business development tries to answer all the crucial questions that are essential for any company's operation like: identifying potential customers and market, their spending capacity, supply chain, structure of business and the best plan of action. It also helps in enhancing the financial pool and resources of the business through proper scrutiny and balances. For a business to grow and attain new heights, retaining customers and creating an ecosystem of brand conscious following is also important. Client engagement ensures that the company understands the trends, keeps tract on client preferences, enables them to make selective improvements, and helps keep customers in touch with any new developments. It begins with the identification of the client's preferences and establishing a connection with them. The strategy revolves around the intention of evaluating and assessing client satisfaction to ensure positive experience so that engagement continues. Once the communication or contact is established, it becomes imperative to maintain contact about a service or a product by providing incentives and new appealing developments. The topic of study which is to examine the business development and client engagement activities of JCRE skill solutions holds significance on multiple fronts since it helps one understand the mode of operation and adaptive tactics of a multifaceted brand like JCRE. By answering questions on which business strategy, it adopts, how it maintains customer relation and client satisfaction, the study aims to provide a comprehensive understanding of the subject.

SUGGESTIONS

Adoption of more efficient and competitive business model through the employment of competent business development executives. Planning and policy making of the company which are suitable and conducive to the region. Harnessing the complete potential of the region through a holistic and extensive study of its demography and socio-economic structure. Increase association and partnership with multiple brands and institutions to increase network and placement opportunities. Foster engagement through a more responsive help desk. Advertisement of activities through multiple channels to increase brand awareness. Maintaining a friendly and inclusive experience to aid customer retention and promote positive relationships.

REFERENCES

1. BLOWFIELD, M. Business and development: making sense of business as a development agent 2012 - Corporate Governance: The international journal of business in society In-text: (Blowfield, 2012)
2. What Is Business Development and What Are The Top 3 Skills? by Lucia Pissedu Dec 10, 2020 <https://www.saleshacker.com/what-is-business-development/> | Sales Hacker
3. Client Engagement: Model & Strategies Expert Contributor- Steven Scalia , Instructor- Allison Tanner
4. CUSTOMER ENGAGEMENT – A LITERATURE REVIEW -October 2016 Authors: Rohit Bansal





Sharald Ahongsangbam and Sitaram Vikram Sujir

5. Erat, P., Desouza, K., Schäfer-Jugel, A. and Kurzawa, M., 2006. Business customer communities and knowledge sharing: exploratory study of critical issues. *European Journal of Information Systems*, 15(5), pp.511-524.
6. D. Kaltcheva, V., Patino, A., V. Laric, M., A. Pitta, D. and Imparato, N., 2014. Customers' relational models as determinants of customer engagement value. *Journal of Product & Brand Management*, 23(1), pp.55-61.
7. JCRE SKILL SOLUTIONS <http://jcre.co.in/>





Poverty in India: Policy Discourse, Challenges and the Way Ahead

Monika Kashyap*

Assistant Professor, Department of Business Management, School of Management H.N.B. Garhwal University (A Central University), Chauras Campus, P.O: Kilkileswar Via: Kirtinagar Dist: Tehri, Uttarakhand (India)

Received: 04 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Monika Kashyap

Assistant Professor, Department of Business Management, School of Management H.N.B.Garhwal University(A Central University), Chauras Campus, P.O: Kilkileswar Via: Kirtinagar Dist: Tehri, Uttarakhand ,India
Email: monikakash@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

While India is making new strides in addressing the issues related to poverty and bringing down the poverty figures significantly, it is pertinent to look at another side of the coin. India consists of 30.3 per cent of extremely poor children living across the world, and it is second only to sub-Saharan Africa in how many poor children live in the country, states a joint report released by UNICEF and International Labour Organization (ILO). Moreover despite a huge fall, still there is considerable level of population in India in poor conditions. This indicates the existence of poverty in a different format and reminds us of the stark reality that, the challenges still remain on the front of fighting poverty and what is more worrisome is that they are becoming chronic as the time passes. It is in this context it is pertinent to understand the policy discourse on poverty, in order to look forward by looking back. This gives a deeper understanding into the challenges that are confronting the policy makers in tackling poverty and helps find solutions to them. It is in this backdrop, the present study attempts to realize the modest objective of understanding the discourse on poverty in India and suggest ways to tackle poverty in a better way. The present study attempts to throw light upon the work done by academia and at the policy level to understand 'poverty'. It brings forward some important studies related that offered key insights by bringing in new dimensions to the subject, there by influenced the policy discourse on poverty. It also brings in challenges faced by the policy makers in fighting the poverty and provides policy suggestions and concludes.

Keywords: Poverty, Economic Reforms, Policy discourse, Policy suggestions.



**Monika Kashyap**

INTRODUCTION

When India attained freedom from the Colonial rule of the British, the first generation of independent India inherited a desperately poor nation which was economically exploited and politically divided. The economic growth was abysmally low and a large chunk of population was illiterate. In the post independent India, an insular, mixed economic model of development was adapted, but it could not foster economic growth. In fact, the growth potential of the country could not be realized fully, thanks to the tight regulatory control over the economy. While the size of the economy grew slowly, there was a bigger challenge of bring out millions poor, out of the poverty. The concept of poverty alleviation entered the policy discourse at a large level, with the slogan of 'GariboHatao', given nearly fifty years ago. Since then India has been relentlessly fighting poverty and in fact achieved solid results on this front. In the last decade of the 20th century, India trekked the path of economic reforms and they had a positive fallout on Indian economy, in the form of higher growth rate, enhanced employment in service sector, and rise in standard of living. As a logical derivate of this whole process, poverty in India also got reigned in and according to the census data of 2011, 21.9 percent of India's population lives below the poverty line. This is a significant improvement when compared to 37 percent in 2004-05. In the subsequent period, after the census data got released, India's performance on the front of poverty reduction kept improving, which is clear from the findings of the 2018 Global Multidimensional Poverty Index (MPI) released by the United Nations Development Programmed (UNDP) and the Oxford Poverty and Human Development Initiative (OPHI). The MPI looks beyond the people's income, in order to understand how they experience poverty in multiple ways, simultaneously. This index identifies how people are being left behind across three key dimensions like living standards, health and education, and attempts to understand how people are lacking basic services like adequate nutrition, sanitation, clean water, and primary education. Those who are deprived in at least of a third of the components of MPI's are considered to be multi-dimensionally poor. This report found that, India could successfully bring out 271 million people from poverty during the decade of 2005-06 and 2015-16. The report also revealed that the country's poverty rate got almost halved, falling from 55 per cent to 28 per cent over this decade. On the other hand, India is also a signatory to the global Sustainable Development Goals (SDGs) and is committed to achieving them. SDG1 aims to "end poverty in all its forms everywhere" by 2030.

Objective of the Study

While the country is making new strides in addressing the issues related to poverty and bringing down the poverty figures significantly, it is pertinent to look at another side of the coin. India consists of 30.3 per cent of extremely poor children living across the world, and it is second only to sub-Saharan Africa in how many poor children live in the country, states a joint report released by UNICEF and International Labour Organization (ILO). Moreover despite a huge fall, still there is considerable level of population in India in poor conditions. This indicates the existence of poverty in a different format and remember us the stark reality that, the challenges still remain on the front of fighting poverty and what is more worrisome is that they are becoming chronic as the time passes. It is in this context it is pertinent to understand the policy discourse on poverty, in order to look forward by looking back. This gives a deeper understanding into the issues and challenges that are confronting the policy makers and helps find solutions to them. It is in this backdrop, the present study attempts to realize the modest objective of understanding the discourse on poverty in India and suggest ways to tackle poverty in a better way.

METHODOLOGY

The present study is basically descriptive in nature. It attempts to throw light upon the work done by academia and at the policy level to understand 'poverty' and brings forward some important studies related that offered key insights by bringing in new dimensions to the subject, there by influenced the policy discourse on poverty. This helps the enthusiastic researchers in this area to get the concise package of review of important studies related to this area of research. The present study is in fact a modest attempt to bring together the pertinent studies related to



**Monika Kashyap**

poverty that ranges from issues related to estimation of poverty to its relationship with economic inequalities. Once these studies are reviewed, an attempt is made to find out the challenges faced by the policy makers in fighting the poverty. This will be discussed in the findings section. The last section is devoted for policy suggestions and concludes.

Review of Studies: The Discourse on Poverty in India

Ever since India became independent, there has been consistent policy interventions to reduce poverty in the country. Both the academia and the policy makers have been striving to understand and address this issue. In fact there have been many significant contributions from both the sides to bring down the poverty levels in the country. While there is a vast body of literature, that had contributed to the enrichment of the policy making in India towards addressing issues related to poverty, some of the key studies are highlighted in this paper. Studies like Bardhan (1974, 1988) provided a holistic treatment of the subject at hand. After the introduction of economic reforms in India, a large section of the academia focused on the impact of economic reforms on poverty reduction and tried to dwell upon the question of whether the poverty levels have changed in the post reform India. Tendulkar (1998), Deaton and Dreze (2002), Bhalla (2002) and Deaton and Kozel (2005). Panagariya (2008), Bhagwati and Panagariya (2012a, 2012b), Cain, Hasan and Rana (2012), Mukim and Panagariya (2012), Dehejia and Panagariya (2012) are some of the key studies that dwelled upon various aspects of poverty in India.

By taking the definition based upon the consumption expenditure of poverty, by the planning commission (1962) and the calorie criteria (1977) as a basis, many studies came up by making attempts to define and measure poverty in India. For instance the study of Minhas(1970) estimated poverty for the period between 1956-57 and 1967-68, depending upon the planning commission definition, while studies like Dandekar and Rath (1971), Bardhan (1973), Rudra (1974) and Ahluwalia (1978) defined poverty by taking calories intake as the basis. However, in the post reform India this scope has been extended and for the first time, Ravallion and Datt (1996) estimated the poverty for the period 1950-90, by taking poverty gap index, squared poverty gap index and head count ratio. The study by Mehta and Venkaraman (2000) brought forward the issue of changing food preferences in to the debate on poverty estimates. They found that the people on "Official Poverty Line" in India were having means just sufficient enough to acquire 2100 calories per capita per day in the urban areas and 2400 calories per capita per day in the rural areas. In the later period, studies attempted to address the criticism that surround the poverty estimates, that they do not consider the non-income variables. For example, deprivation indices for three parameters namely, per capita state domestic product, per capita expenditure on education, per capita expenditure on medical and public health were used by the study by Gaur (2005), which helped to compile inter-state human poverty indices for the twenty major states of India. In the same year, a study by Gupta (2005) argued that consumption and income measures failed to cover important aspects related to deprivation, that the poor population experience and hence applied the Capability Poverty Index and Human Poverty Index to estimate poverty across various states of the country. On the other hand some studies used alternate definitions of poverty line based on nutrients to estimate poverty. One such study is the study by Ray and Lancaster (2005). The novelty of this study was that it considered both the food and non-food expenditure to construct the poverty line and moreover the poverty line projected by this study covers differences in the preferences of food due to the influence of varied factors like caste, class, region and other factors that are non-demographic in nature. An attempt was made by Sen and Chakarborty (2005) to calculate capability poverty index and human poverty for 1993-94 and 1999-2000. The study found that the rank co-efficient of correlation between the two variables- income poverty and capability poverty was very high.

Later on, the studies on poverty attempted to touch new dimensions like poverty across various social groups in the country and the relationship between economic inequalities and poverty. For instance Cain, Hasan and Rana (2012) studied the possible impact of openness on poverty, while Mukim and Panagariya (2012) had documented the decline in poverty across social groups over a period of time. On the other hand, studies like Dehejia and Panagariya (2012) provided an evidence about the growth in entrepreneurship in services sectors among the socially disadvantaged groups, and Hnatkovska and Lahiri (2012) came up with reasons for narrowing wage inequality between the socially disadvantaged groups and the upper castes. While this vast literature had provided enough



**Monika Kashyap**

scaffolding for the policy makers to fight against poverty over a period of time, the Government of India has been putting its endeavors in estimating poverty in the country since the decade of 1960s, under the erstwhile Planning Commission. However, it has been revising the methodology of estimation, by taking into account, the glitches that arise in this process, over a period of time. Although the first estimates of poverty were released in 1962, based on a consumption basket, it only focused on the calories requirements for survival. Later on attempts were made to express the poverty line in terms of monetary equivalents of a consumption basket, based on the data for the year 1973-74. In the later years poverty line estimation was done simply by updating the poverty line for 1973-74, by adjusting to the price changes, however, the consumption basket remained the same (Nayyar&Nayyar, 2016).

With the research over the estimation of poverty line and the issues pertaining to it deepened further, a consensus emerged, that the states differ in their price differentials and hence the national poverty line does not necessarily reflect them in reality. As a result, state specific poverty lines, by taking the interstate price differentials came has been brought forward by the Lakdawala Committee in 1993. These estimates were continuously updated by the price deflators and the erstwhile planning commission used the same until January 2011. However, there has been a growing criticism in the academia and the policy circles about the way the poverty line is determined in the country. The main criticism on this approach was that it did not take the issue of changing consumption basket into consideration. To address these issues, Suresh Tendulkar Committee was appointed in 2005 and its biggest mandate was to re-examine the alternate methods to measure poverty in India. The committee estimated that 269.3 million Indians were poor in 2011-12 based on a poverty line of just Rs.27.2 per person per day in rural and Rs.33.3 per person per day in urban areas. According to this committee's report, only 22 per cent of India's population was in poverty in 2011-12. Later on, the Rangarajan committee was appointed for the same. It came out with a Poverty Line Basket (PLB), which has been used for the population in both the urban and rural areas in all states of the country, after adjusting the price differentials. But this method for measurement of poverty was restricted to the updating of the prices only in the context of goods and services, for which meaningful quantities have been provided by the NSSO data. This in turn had left a lacuna in the calculation of the unit values for aspects such as education and health, which changes dynamically with the time. The Committee used higher poverty lines (Rs.32.4 and R.46.9 per person per day for rural and urban areas, respectively) and arrived at a poverty ratio of 29.5 per cent (362.99 million) for 2011-12. The committee submitted its report in July 2014 to the Government of India in 2014 and the report made substantial points, which could potentially bring in a qualitative change in the poverty estimation methodology in India. The committee suggested that there is a need to define the normative level of adequate nourishment, in terms of fats, calorie and protein, according to the norms of the Indian Council of Medical Research (ICMR) and in fact any food basket should meet the nutritional requirements. It also suggested that a particular amount need to be included for housing, clothing, education, transport, and other basic non-food items. The Government of India had setup a group under the vice chairman, NITI Aayog, to re-examine the issue of poverty measurement and the report is awaited. Hence there is still an ambiguity over the poverty estimates in India, which makes it increasingly difficult to precisely decide on the fiscal allotments and designing schemes to alleviate poverty in the country. There is an urgent need to draw upon consensus on defining 'who is poor' and 'what is poverty' in India, so as to take up the focused implementation of schemes at Centre and State levels.

Findings of the Study

After thoroughly reviewing the studies discussed above and understanding the contemporary developments, we could make certain important findings in the form of challenges that the policy makers are confronted. In fact these challenges hinder their efforts to bring down poverty levels in the country. They are discussed here under. While the issues related to poverty estimates is increasingly complex, there are other challenges that need to be confronted by the policy makers in fighting poverty. The first challenge is related to the approach to be adapted towards poverty and its alleviation. Largely economists and policy makers view it from the prism of 'income poverty' and try to address to reduce poverty by attempting to improve incomes of the people by improving their State GDPs and resorting to redistribution mechanisms. Even the election manifestos of major political parties in the country, during the recently concluded General elections and different assembly elections, were largely aimed at increasing the income of individuals. However, the pertinent aspect that majority of the policy makers miss out is the fact that



**Monika Kashyap**

'income poverty' is only one symptom of poverty and it is not the actual problem. This is not to say that improvement in GDP and redistributing it is not important. It is to emphasize that this is a necessary condition, but not a sufficient condition to address poverty. To put it simply, trying to improve people's incomes without addressing the structural and institutional issues that cause poverty is like mopping a wet floor with the taps on.

The other challenge is to deal with the Centre-State relations. Given the Constitutional structure of India, Centre and States share powers and responsibilities and have defined functions. In the context of dealing with poverty, Southern and Western States of India are far better than the Northern and Eastern States. This only indicates that the States have larger role to play in poverty reduction, with the cooperation of the Union Government, with a consensual and focused approach towards poverty.

Contribution of the Study

The present study makes a pertinent contribution by emphasizing and reiterating the fact through an extensive review of related studies, that poverty is a dynamic variable. To put it simply, poverty level of a person keeps changing. At times people come out of the poverty lines due to their increase productivity levels or due to the initiatives of Government and other welfare schemes. At the same time many people slips from above poverty line to below poverty line levels due to different circumstances like job losses or economic failures or at times due to policy induced side effects. However the agencies that implement poverty alleviation programmes keeps targeting those people who are falling in the bracket of their definition of poverty. In the process, the deserved goes missing and the many undeserving comes into the beneficiary lists of Government schemes. The study envisages that it could be the underlying reason why while India had grown economically in the post reform period, the number of poor people is still considerably large in number. In fact this could itself become a topic of research for further studies, which could be helpful in understanding the dynamics of poverty in India.

POLICY SUGGESTIONS AND CONCLUSION

First and foremost, it is pertinent to develop a fool proof mechanism and a sound methodology for estimation of poverty in India. In doing so, it is to be remembered that the consumption baskets change over a period of time, due to varied reasons like change in consumer preferences, ups and downs in the prices of the consumable goods, changes in the availability of public goods, etc. Taking these factors into account would result in estimates that could capture the change in the consumption behaviour of the people and this would go long way in bringing in larger degree of accuracy in the poverty estimates. This in turn could guide policy making and implementation, aimed at reducing poverty in the country. Secondly, it is important to stop the creation of new poor and avoid the existing poor to become poorer. The State should take a larger responsibility in providing basic amenities and services - housing, sanitation, drinking water, health and education- whose absence would only accelerates the movement of population into poverty trap. It is in this context, schemes like MNREGA act as a scaffolding that would prevent the creation of new poor to some extent. Third, it is pertinent to create a complete eco system that enables the individuals to earn necessary capabilities to earn higher incomes, through improvement in skills and productivity. While these are the structural issues, attempts need to be made parallelly, to address the institutional challenges. Ensuring the rule of law, improvement in the efficiency of the government structures, fighting corruption and ensuring a stable policy environment would provide a fertile ground for the economy to achieve a sustainable level of economic growth and also attracts investments, which in turn would generate higher incomes, employment and wealth creation. This is what a tiny nation Singapore did to come out of acute poverty and large scale unemployment and evolve as a poster child of economic prosperity and stability. Singapore model may not be an exactly template for India, given the variance in their size, population, diversity and political setup. However it still serves as an example that it is possible for a poor or developing country to get rid of poverty with a strong political will, committed bureaucracy and disciplined citizens. If India could draw a leaf from its growth story, it would be a major step towards larger strides in addressing poverty. Last but not the least, there is an urgent need to understand the reasons behind the paradox of high economic growth coupled with high levels of poverty. This in fact is due to the ambiguity about the term 'poverty' itself by the policy elite since independence. Every definition of poverty confines





Monika Kashyap

itself to some boundaries and comes to address a specific target assuming as if poverty is a variable that is static. This pushes the policy makers to draw a line either in terms of annual income or consumption levels or nutrition intake and see how many people are below it or above it. It is in this context the initiatives of the Government of India to link Aadhar to Public welfare schemes and other Direct Transfer schemes and linking of PAN card to Aadhar would help in tracing the people and exactly identifying their current economic status. Thus identifying the deserving poor people and weeding out the undeserved to get benefits of Public Welfare Schemes becomes easy which is a big step towards poverty reduction in India. Parallely this drive must be supported by the re-designing of social safety nets according to the changing needs of the needy poor. Besides this, efforts must be put into increasing productivity of the individuals through skill development that makes them self-sufficient. Skill India initiative goes a long way in supplementing the efforts towards higher employment generation. With these initiatives, dealing with poverty and reducing it to a significant level by 2024 is still a thinkable proposition.

REFERENCES

1. Ahluwalia, M. 1978. Rural Poverty and Agricultural Performance in India. *Journal of Development Studies*, 14(3), 298-323.
2. Bardhan, P. 1973. On the minimum level of living and the rural poor. *Indian Economic Review*, 5
3. Bhagwati J, A Panagariya (Eds.). 2012. *India's Reforms: How They Produced Inclusive Growth*. New York: Oxford University Press.
4. Bhagwati J, A Panagariya. (Eds.). 2013. *Reforms and economic transformation in India*. New York: Oxford University Press.
5. Bhalla, Surjit S. 2002. *Imagine there's no country: Poverty*, Washington, DC: Institute for
6. International Economics.
7. Deaton A, J Dreze. 2002. Poverty and inequality in India: a re-examination. *Economic and political weekly*, 3729-3748.
8. Dandekar V, N Rath, 1971. Poverty in India-I: Dimensions and trends. *Economic and Political Weekly*, 25-48.
9. Srinivasan T, P Radhakrishnan Srinivasan, and AVaidyanathan, 1974. *Data on Distribution of Consumption Expenditure in India: An Evaluation'* in TN Srinivasan and PK Bardhan (eds), *Poverty and Income Distribution in India*.
10. DeatonA , V Kozel, 2005. Data and dogma: the great Indian poverty debate. *The World Bank Research Observer*, 20(2), 177-199.
11. Chadha N, B Nandwani, 2019. Growth, Development Spending, and Inequality in Indian States. *Economic & Political Weekly*, 54(11), 45.
12. Panagariya A, M Mukim, 2013. A comprehensive analysis of poverty in India. *Asian Development Review*, 31(1), 1-52.
13. Mehta J, S Venkatraman, 2000. Poverty statistics: Bermicide's feast. *Economic and Political Weekly*, 2377-2382.
14. Nayyar G, R Nayyar, 2016. India's 'Poverty of Numbers'. *Economic and Political Weekly*, 51(25), 61-67.
15. Rudra et al. 1998, *Criteria for Identification of Rural Poor-Preliminary Results based on a Survey in West Bengal'* in S Balakrishna and K Rao (eds.) *Database on Rural Poverty Indicators*, National Institute of Rural Development, Hyderabad: 87-109.
16. Ravallion M, G Datt. 1996. How important to India's poor is the sectoral composition of economic growth? *The World Bank Economic Review*, 10(1), 1-25.
17. Gaur A. 2005, *An Inter-State Analysis of Human Poverty*, in K Rao (ed.), *Poverty in India, Global and Regional Dimensions*, Deep and Deep Publications, New Delhi: 135.
18. Gupta I. 2005, *Poverty in the Pre-Post Reform Period in India*, in K Rao (ed.), *Poverty in India, Global and Regional Dimensions*, Deep and Deep Publications, New Delhi: 167-83.
19. R Ray, G Lancaster. 2005. Methodological Errors in Poverty Estimation on setting the poverty line based on estimated nutrient prices: condition of socially disadvantaged groups during the reform period. *Economic and Political Weekly*, 46-56.





Monika Kashyap

20. Sen and Chakraborty. 2005, Poverty and Social Spending: An Inter State Analysis, in K. N. Rao (ed.), Poverty in India, Global and Regional Dimensions, Deep and Deep Publications, New Delhi: 184-96.
21. <https://www.thehindubusinessline.com/economy/india-lifted-271-million-people-out-of-poverty-in-10-years-un/article28403303.ece>





Role of Business Communication in Effective and Efficient Functioning of an Organisation with Special Reference to Region of Udupi District

Vinay Patil* and Tejaswi Devadiga

Final Year B.Com Trisha Vidya Evening College, Udupi, Karnataka, India.

Received: 01 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Vinay Patil

Final Year B.Com Trisha Vidya Evening College,
Udupi, Karnataka, India.

Email: vinaypatil.agalur123@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

“COMMUNICATION IS YOUR TICKET TO SUCCESS, IF YOU PAY ATTENTION AND LEARN TO DO IT EFFECTIVELY”

- THEO GOLD

Business communication plays a vital role in every organization as it is very important to avoid confusion and bringing clarity into the work. Sharing information between peoples within and outside the company plays a major role in effective and efficient functioning of an organization. Even though business communication has a lot of importance, the implementation of proper business communication methods is a difficult task and many organizations are not able to achieve it. The main purpose of this study is to analyze the significance of Business Communication involving both internal and external factors. The methodology used in this paper is both primary and secondary data. This study provides clear picture on how business communication helps in effective and efficient functioning of an organization and how it is significant to the employees and outsiders to remain updated towards information of organization thus helps in improving both employee satisfaction and customer retention.

Keywords: Business Communication, Methods, Implementation , efficient functions

INTRODUCTION

The art of communication is finding the most effective and efficient means of sharing one's ideas and information. Employees and customers are the engine that drives the entity, and business communication is like fuel that runs the engine. Many organizations fail to function in an effective and efficient manner because there is a gap that exists



**Vinay Patil and Tejaswi Devadiga**

between the communication methods used by the organization and preferable methods expected by the employees. In the same way various business communication methods are used by an organization to connect with their customer but the same may not be convenient to them to express their views.

LITERATURE REVIEW

Sashko Gramatnikovski, Aleksandra Stoilkovska, Gordana Serafimovic in their work they conducted the study on “business communication in function of improving the organization culture of the company.”(2015)And they have stated that the business communication is inevitable in every working organization for every individual employee and for every individual communicating with the company. They have also find that the existing state of written communication it means the client and the employees have been recovered. The use of the logo, the necessary information of the organization, the use of positive tone in the content of letters have been identified as element which are present in the written communication. Diaz Soloaga– in their work they studied on “ according to him the implementation of specific communication strategies to transfer corporate identity successfully to team employees helps in effective and efficient work. Stavros Kalogiannidis – in their work they studied on “Impact of effective business communication on employee performance” (2020) stated that organizations that are so deficient in their way of business communication rarely achieve greater performance as compared to those that follow high level of business communication methods. Trend Korea (2022) – according to their analysis , distinctive social trends are expected to arise in 2022 for the efficient communication in workplace. In the workplace digital transformation is seen in social organization.

OBJECTIVES OF THE STUDY

- 1) To analyze the importance of business communication with respect to internal and external people of an organization.
- 2) To know how the business communication methods helps in effective and efficient functioning of business operations
- 3) To study the perception of customer and employees towards business communication and it's importance.
- 4) To analyze the gap between the communication method used by the organization and preferable methods expected by the employees.
- 5) To identify the gap between how the organizations are currently communicating with the customers and what the consumers prefer as per their convenience

RESEARCH METHODOLOGY**Research design**

A researcher usually goes for research design as it serves answer to the question and the purpose of study. The ‘survey research design’ is one in which a group of people are studied by analyzing data from only few people or item to be considered to be representative of the entire group. In our research we prepared 3 set of questionnaires. Wherein one is for organization, one is for employees and another one is for customers, we obtained answers through 3 set of questionnaires in order to analyze their perceptions towards business communication.

Population of the study

The study is targeted on different types business organizations (including partnership firm, company, retail business etc), the employees of organization and customers of organization within the region of Udupi district.

Sample of the population

The sample of population is 122.Out of which 20 samples are collected from different organizations. 54 samples are collected from customers and 48 samples are collected from employees who are working in different kinds of business organizations.



**Vinay Patil and Tejaswi Devadiga****Sampling techniques**

Selective random sampling is used for our survey to collect the data. It is used to arrive at unbiased conclusion

Method of data collection

To collect data from various organizations, we used physical survey method wherein the managers were asked to fill the hard copy of questionnaire to get an appropriate result. To collect the data from employees and customers we did survey through digital questionnaire.

Data source**Primary data**

Primary data is data observed or collected directly from first hand experience. In our survey, we have collected the primary data through Questionnaires .

Secondary data

The benefit of using this data is, that much of the background work needed has already been carried out. It will be obtained from books, internet, websites, literature journals, personal communication with experts etc.

Limitations

1. The sample size is restricted to 122.
2. The area of study is concentrated only on regions of Udupi.
3. The collection of data done with random sampling.
4. Time constraint is one of the limitations of the survey

Research Goal

The main aim of this research is to help the organizations to understand the employees preference and customers convenience to implement proper business communication methods. This research is also done to identify the significance of business communication in effective and efficient functioning of an organization.

DATA ANALYSIS AND INTERPRETATION**INTERPRETATION**

Table 2. 55% of the business organization from our survey, depicts that they follow business communication policy regularly. 10% of organization depicts that they have business communication policy but they don't follow it regularly. And 20% of organization from the survey depicts that they don't follow any business communication policy and 15% of organizations currently do not have any business communication policy but they are planning to implement it shortly.

INTERPRETATION

Table 3. 95% of the organizations in the survey , agrees that business communication is important for efficient functioning of business because of the following reasons

1. It enhances moral and efficiency
2. It helps in clear conveying of messages and strategies
3. Retention of old customers and attracting new customers.

INTERPRETATION

Table 4. The survey shows that 45% of the organizations opt for face to face communication, 30% of the organizations opt for written communication, 20% of the organizations opt for virtual conference and remaining 5% of the organizations opt for telecommunication while communicating and connecting with the internal employees regularly.



**Vinay Patil and Tejaswi Devadiga****INTERPRETATION**

Table 5. The survey depicts that, 40% of business organizations opt for phone calls, 25% of the business organizations opt for virtual conference, 15% of the business organizations opt for SMs and remaining 20% organizations opt for other ways as per the situations while connecting with their employees during any uncertainties and emergencies.

INTERPRETATION

Table 6. In the survey, all the organizations agree that business communication is important in improving the customer relationship.

INTERPRETATION

Table 7. Out of 100%, 40% of organizations use feedbacks and reviews with the customers as a communication method. 40% of the organizations prefer hand notes as a communication method and the remaining 20% organizations use ratings a communication method with the customers.

INTERPRETATION

Table 8. At the time of launching a new product or service 40% of organization choose advertisements, 20% of organization choose attractive brochures, 15% of organization choose social media, 10% of organization choose personal communication and other 15% of organization choose SMS to communicate with the customers.

INTERPRETATION

Table 9. This table shows that 65% of organization says that they follow same method of business communication with their existing and new customers. 15% of organization says that they do not follow same business communication methods. And rest 20% of organization follow same methods of business communication only if it's relevant for both existing and new customers.

INTERPRETATION

Table 8. In our survey, 49% of the employees opted for virtual conferences, 22% opted face to face communication, 17% of the employees opted for telecommunication and 12% of them opted for written communication to communicate with their superior management in their organization.

MAJOR FINDINGS

1. In line with the objective of the study, it is been observed that 100% of the organizations have agreed that 'business communication is important in improving customer relationship'.
2. In respect to the second objective, (i.e. business communication methods helps in effective and efficient functioning of an organization) our study depicts that 95% of organizations agreed to the point, business communication methods are important to enhance efficiency, to convey messages and strategies clearly and to retain old customers as well as to attract new customers.
3. Our study also figures out the perception of employees towards business communication. Wherein 62% of employees are satisfied with their business communication policy and other percentage constitutes dissatisfaction as well as not complete satisfaction. This is the point where business organizations need to think and work on.
4. Our study also illustrates that 44.4% of employees are expecting flexible business communication in their organization.
5. With respect to the 4th objective; We figured out that 45% of organizations choose face to face meeting as business communication tool to connect with their employees whereas 50% of employees preference is virtual conference to communicate with their top level management. This is one of the major gap that organization need to consider as we know employees are the engines that drives the organization.





Vinay Patil and Tejaswi Devadiga

6. With respect to 5th objective our study found out that 40% of organization choose feedbacks , 40% of organization choose written hand notes and only 20% of organization are using ratings as a communication method to connect with customers. Wherein the customers preference and convenience is completely different, because, in our survey 52 % of customers opted for 'rating' as the convenient method and 36% of customers prefer giving feedbacks in online websites for an effective communication with the business organization. These are the major areas in which our research study is concerned about. Because, these are the major areas where there is a gap between the business communication methods an organization practices and preferable methods the employees and customers opt for. Since employee retention and customer satisfaction are the two major pillars of an effective business organization, the organization has to look into the matter regarding the same.

CONCLUSION

“A WRONG WAY OF COMMUNICATION IS THE ROOT OF BUSINESS PROBLEM, THINK ABOUT IT”

To conclude, the objectives of this study are achieved with the help of descriptive and reasonable analysis. Our study showcases that business communication is an essence for effective and efficient functioning of an organization. So it is imperative for every organization to follow precise business communication methods, taking into consideration the preferences of its employees and customers. In order to follow precise business communication methods, organizations need to understand the gap between the business communication methods they are following and what exactly the employees and customers are expecting from the organization. Our study clearly depicts the dissimilarities between the communication methods that the business organizations are following, and preferable methods that the employees and customers are expecting. This study is going to help the organizations to find out where they are going wrong thus helps them to bridge the gap that would result in effective and efficient functioning of an organization.

REFERENCES

1. Sashko Gramatnikovski, Aleksandra Stoilkovska, Gordana Serafimovic ,in their work “business communication in function of improving the organization culture of the company.”(2015)
2. Diaz Soloaga – in their work on “ Business Communication”.
3. Stavros kalogiannidis – in their work they studied on “ Impact of effective business communication on employee performance”(2020)
4. Trend korea (2022) – analysis on Business communication

Table1: Responses from several business organizations in Udupi District.

| Type of business organisation | No.of Respondents | Percentage |
|-------------------------------|-------------------|-------------|
| Partnership | 2 | 10% |
| Limited Liability Partnership | 1 | 5% |
| Company | 5 | 25% |
| Others(retail, hotel, etc) | 12 | 60% |
| Total | 20 | 100% |

Table 2. Do you follow any business communication Policy in your Organisation?

| Options | Respondents | Percentage |
|---|-------------|------------|
| Yes we do follow regularly | 11 | 55% |
| Yes but we don't follow it regularly | 02 | 10% |
| No. We don't follow any business communication policy | 04 | 20% |





Vinay Patil and Tejaswi Devadiga

| | | |
|--|-----------|-------------|
| No but we are planning to implement it shortly | 03 | 15% |
| Total | 20 | 100% |

Table 3 : Why do you think business communication is important for efficient functioning of an organization?

| Options | Respondents | Percentage |
|--|-------------|-------------|
| Enhance moral and efficiency | 0 | 0 |
| Helps in clear convey of message and strategy | 1 | 5% |
| Helps in retention of old customers and attracting new customers | 0 | 0 |
| all of the above | 19 | 95% |
| Total | 20 | 100% |

Table 4: What business communication method you follow regularly to connect with the internal people?

| Options | Respondents | Percentage |
|----------------------------|-------------|-------------|
| Face to Face communication | 09 | 45% |
| Virtual Conference | 04 | 20% |
| Telecommunication | 01 | 05% |
| Written Communication | 06 | 30% |
| All of the above | - | - |
| Total | 20 | 100% |

Table 5: How do you connect with your employees during uncertainties and emergencies?

| Options | Respondents | Percentage |
|--------------------|-------------|-------------|
| Phone calls | 8 | 40% |
| Virtual conference | 5 | 25% |
| SMS | 3 | 15% |
| Others | 4 | 20% |
| Total | 20 | 100% |

Table 6: What are the different communication methods you often use with your customers?

| Options | Respondents | Percentage |
|-----------------------|-------------|-------------|
| Feedbacks and reviews | 8 | 40% |
| Emails | 3 | 15% |
| Ratings | 1 | 5% |
| Hand written notes | 8 | 40% |
| Total | 20 | 100% |

Table 7: At the time of launching of a new product or service how do you communicate with your customers?

| Options | Respondents | Percentage |
|------------------------|-------------|-------------|
| Advertisements only | 8 | 40% |
| Personal Communication | 2 | 10% |
| SMS | 3 | 15% |
| Attractive brochures | 4 | 20% |
| Social media | 3 | 15% |
| Total | 20 | 100% |





Vinay Patil and Tejaswi Devadiga

Table 8: Data Regarding the Responses from Customers

| Gender | Respondents | Percentage |
|--------------|-------------|-------------|
| Male | 32 | 59% |
| Female | 22 | 41% |
| Total | 54 | 100% |

| Gender | Respondents | Percentage |
|--------------|-------------|-------------|
| Male | 32 | 59% |
| Female | 22 | 41% |
| Total | 54 | 100% |

| Age group | Respondents | Percentage |
|--------------|-------------|-------------|
| Below 20 | 10 | 18.5% |
| 20-30 | 44 | 81.5% |
| 30 and above | - | - |
| Total | 54 | 100% |

| Qualification | Respondents | Percentage |
|-----------------|-------------|-------------|
| Post Graduation | 2 | 3.7% |
| Graduation | 41 | 76% |
| PUC | 10 | 18.5% |
| SSLC | 1 | 1.8% |
| Total | 54 | 100% |

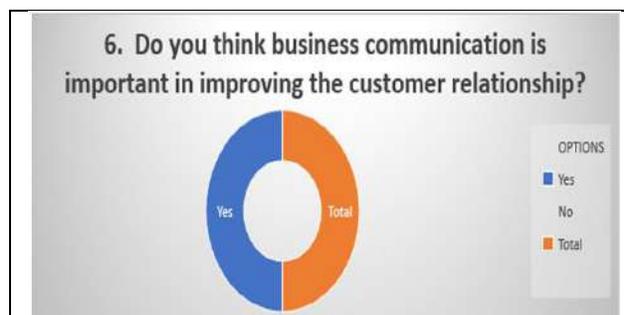


Fig. 1: Do you think Business communication is important in improving the customer relationship

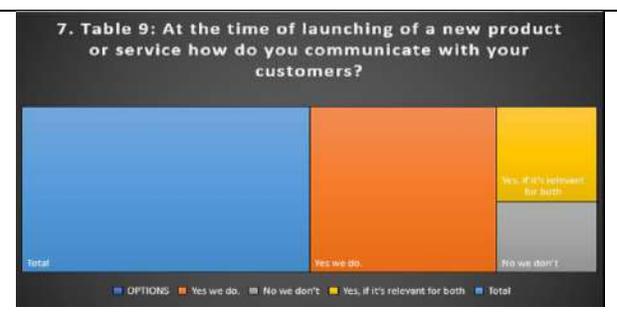


Fig. 2: Table 9: At the time of launching of a new product or service how to you communicate with your customer?

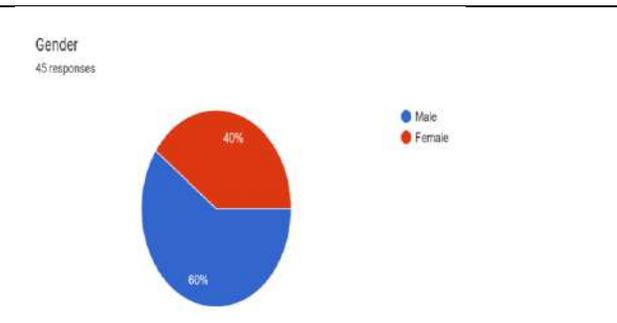
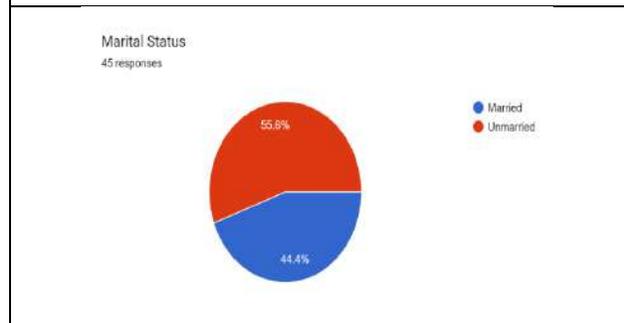


Fig. 3: Data Regarding The Responses From Employees





Vinay Patil and Tejaswi Devadiga

| | |
|--|---|
| <p>Educational Qualification 45 responses</p> | <p>1. Are you satisfied with your organization's business communication policy? 45 responses</p> |
| <p>Fig. 4: Educational Qualification</p> | <p>Fig. 5: Are you satisfied with your organization's business communication policy?</p> |
| <p>Type of Organization you work in 45 responses</p> | <p>3. Through which communication channel, you are most often addressed by your organization? 45 responses</p> |
| <p>Fig. 6: Type of Organization work</p> | <p>Fig. 7: Through which communication channel, you are most often addressed by your organization?</p> |
| <p>4. Do you think your opinions are being valued and considered? 45 responses</p> | <p>Type of business communication employees prefer.</p> |
| <p>Fig. 8: Do you think your opinion are being valued and considered</p> | <p>Fig. 9: Type of business communication employees prefer</p> |
| <p>Face to face communication Virtual Conferences Telecommunication Written Communication All of the above Total</p> | <p>2. "Feedback is an integral part of communication to an organization." As a customer, which method of feedback do you prefer? 50 responses</p> |
| <p>Fig. 10: As an employee, which type of business communication method you prefer to communicate with your superior management in an organisation?</p> | <p>Fig. 11: Feedback is an integral part of communication to an organization. As a customer, which method of feedback do you prefer</p> |





Vinay Patil and Tejaswi Devadiga

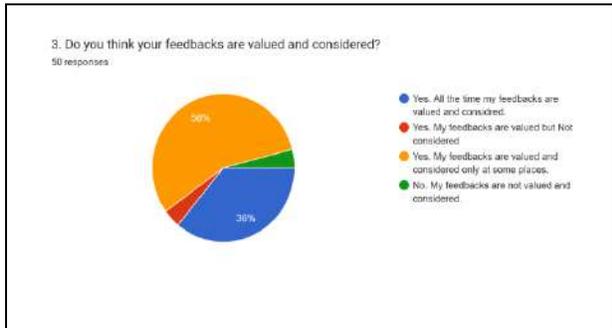


Fig 12: Do you think your feedback are valued and considered



Fig. 13: You, being a regular customer of any particular business organization, what kind of business communication do you expect to keep you update?





A Study on the Process Involved in Mergers and Acquisitions of the Indian Banking Sector

Nagesh B^{1*} and Sunil M Rashinkar²

¹Research Scholar, Presidency University, Bengaluru, Assistant Professor and HoD, Department of Commerce, Nagarjuna Degree College, Affiliated to Bengaluru City University, Bengaluru, Karnataka, India.

²Assistant Professor, School of Management, Presidency University, Bengaluru, Karnataka, India.

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Nagesh B

Research Scholar, Presidency University,
Bengaluru, Assistant Professor and HoD,
Department of Commerce, Nagarjuna
Degree College, Affiliated to Bengaluru City University,
Bengaluru, Karnataka, India.

Email: Nageshrao569@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

When banks merge or acquire other financial institutions, they access the developed institutions' additional resources, a more significant geographic reach, and more workforce. To enhance commercial ties, it is advised that two different affiliations be recalled. Acquisitions are the norm, not the exception. In the current state of affairs, one company is buying another. M&A deals allow banks to grow their brand names, geographic reach, and responsibilities and give them the power to pitch to newly acquired records. An acquisition or merger in the Indian banking sector is nothing new. In this article, we intend to study the influence of M&A on the Indian banking industry and establish the motives behind the deals conducted in this market. The overview is supported by information gleaned from publications like books and magazines and online resources.

Keywords: Development, Indian Banking Sector, Mergers Strategy, Synergy,

INTRODUCTION

The post-financial change period has tremendously impacted India's banking sector. There are numerous growth opportunities, and it is dynamic with a clear offer in gross money assets. The banking sector has maintained its position as the primary source of hard currency, and other financial institutions have yet to test the region's



**Nagesh and Sunil M Rashinkar**

unstoppable intermediation. Because of its new pals, it has gotten more in-tuned and broad-based. In addition, banks have grown clever and vicious. They are advantageous and reliable, and their execution documentation is astounding.

Types of Mergers and Acquisitions

Consolidations come in a variety of forms. Based on the current product or administration lines, they can be divided. All of them fit under one of the following four categories:

- a. Horizontal Merger
- b. Vertical Merger
- c. Conglomerate Merger
- d. Concentric Merger

Flat consolidation

You can merge two or more companies from the same industry into one. This co-driven consolidation includes at least two inventions, creative process, encouraging examination, improvement, and administrative units. These coalitions need to reduce or eliminate competition by ceasing cost-cutting and economies of scale as well as new work, showcasing, and executives.

For Example

- (a) Times Bank Limited with HDFC Bank Limited
- (b) Nedungadi Bank Limited with Punjab National Bank Limited.
- (c) Associated Cement Companies Limited. With Damodar Cement.

Vertical Merger

Companies at different points in their development or dispersion link forces to form one larger entity known as a vertical conglomeration. The drop in the cost of raw materials has been the key engine of its growth. The fundamentals of these mergers are reducing transportation costs, ensuring supply, and expanding the market or putting anticipated competitors in a wrong position. In this case, a group could consider a reverse-joining or acquisition of a supplier (forward combination).

For Example:

- (a) AT&T Limited with Time Warner Limited
- (b) Reliance Limited with FLAG Telecom bunch

Aggregate Merger

An aggregate consolidation must include at least two unconnected specialist units. Ultimately, companies participating in meaningless or unique exercises are grouped. Consolidation movements are motivated by the desire to increase the odds of success. One of the most common reasons for these acquisitions is to expand an organization's market reach while reducing its overall risk.

For Example:

- (a) L&T Limited with Voltas Limited.
- (b) Reliance Industries Limited converged with Reliance Petroleum Limited.

Concentric Merger

Consolidation can be divided into two categories: concentrated or blended. Instead of relying on limited administrative capabilities, the concentric coalition depends on broad administrative ones. The activities of the parts have been related to clear administrative capacities, such as promoting research and marketing as well as putting together and staffing.

For Example:

- a) Citigroup (mainly a bank) converged with Salomon Smith Barney, a venture investor/stock financier activity.



**Nagesh and Sunil M Rashinkar**

REVIEW OF LITERATURE

Sonia Singh and Subhankar Das are the authors of this article (2018). The study piece aimed to examine the influence of mergers and acquisitions on the performance of the Indian financial sector. Three of India's leading banks focused on in-depth analyses of M&A deals and their subsequent consequences. Ongoing consolidation and procurement development in the Indian monetary region has led to a rise in mergers and acquisitions (M & As). For example, net benefit edge, working benefit edge, return on capital used, return on value, etc., are all money-related constraints used to keep cash in the post-union financial execution of an unionized member's post-union financial execution. The crucial revelations revealed the importance of procedural, physical, and socio-group ways and systems in the post-union and obtaining processes. They were critical. Accounting reports, market appraisals, and important source depictions of the post-M&A activities are enormous and pivotal in dealing with the introduction of the bank and its capacities.

That the board's plans and techniques, such as the credit procedure and construction backing for internal and external operations, should be revisited to improve internal and external errands; a more extensive method for managing written displaying correspondences mix should be established in the progression of bank's current and additional things to get a slice of it. Dhruva S. (2018) As a result of their work, expert consolidation and acquisitions are a major cycle in India's monetary business that generates substantial benefits from the monetary sector. Making inroads into large-scale economies of scale in the financial industry is an indicator of the monetary region's solidification and growth While one association is squeezed by while the other loses its corporate presence, the consolidating framework merges the two. Getting, on the other hand, implies control. Businesses in India's financial sector are increasingly opting for consolidations and acquisitions to maintain and improve their performance. A key component of the strategy is the integration of many initiatives to ensure that each one is ready for the changing conditions they face. Coordination can be gained by practicing fundamental exercises in structural cycles and plans and constructing theoretical conditions that aid human execution.

The workplace can influence social relationships when an individual is willing to accept a fundamental role in diversity and compromise in light of one's typical assertion of oneself and the other in any accommodating concerted effort. Combinations and acquisitions in the banking sector resulted in new brand names, plans, and commitments to assets. They also provide major possibilities to sell the new records acquired decisively. The process of solidification and acquisition is nothing new in the Indian monetary business. All the mergers and acquisitions (M&A), the types of unions, actual construction, financing of Save Bank of India, and unquestionable perspectives of M&A in the banking business were examined. Rishi and Janaki Rathore, Verma, and Rathore (2018) Ongoing research aim to organize and investigate the various gadgets used by academics worldwide to investigate banking enterprises with similar challenges. The number of sources hoped to examine the makeup of Banks' M&As was hoped to review, and the model for the ongoing audit was structured out of 82 evaluation papers. The Indian monetary region is the focus of 22 publications, while the banking industries of other nations focus 60 of the 82 studies. Over the years 2001-2017, this survey was conducted as a pilot study. Indian and global evaluations are linked using the concepts of "Primary Focal Point of the Audit" and "Variable utilized for observational examination.". The examination identifies significant discrepancies between the inquiry work done in India and other nations throughout the selected period.

There are separate assessments for India and the rest of the world. Research into Banks' M&A deals is concentrated primarily in the United States and Europe. Several countries have recently expressed an interest in the topic. Kumara Naveen R and others (2019) The Consolidation statement is a part of the Indian organizations' business practices. An upcoming survey will examine combination statements' influence on banks before and after stock cost reductions. Bank unions that were active for a long period between 2010 and 2018 are included in the current survey. The data from private and public region banks were combined for seven days before and seven days after the union announcement. Event studies conducted as a result of this investigation found that the announcement of merger dates had no impact on stock price increases. It is Kausingh Yadav. Singh Bharat Singh and Sridharan N.,co-authors



**Nagesh and Sunil M Rashinkar**

of this paper (2019), M&As in the Indian monetary region to sort out the subsequent cooperative efforts and long-term consequences of monetary solidification in India's financial sector. The report also looks at new examples and suggests steps that institutions should take in the future to prevent this from happening again. According to the various viewpoints, M&A instances in Indian banking are cited as those whose effects on the industry have been studied. The continuous audit includes all aspects of the execution examination of M&As in the Indian monetary region throughout the timeframe. This research examines the pre- and post-combination monetary executions of mixed sets aside cash with money-related limitations. Many believe that M&As have improved the Indian financial landscape to some extent. When marketing the premium of the supporters of distressed banks, the public authority and strategy makers should never again promote the idea of a "solidification" between strong and distressed banks.

The State Bank of India and its Partners have formed a close relationship with the bank's experts and employees. It is no need to collect vital records as part of the audit. She is J Ishwarya (2019). Consolidation and acquisition (M&a) deals that have taken place in the Indian monetary region are examined to determine the long-term effects of the union and the subsequent coordinated efforts. Additionally, developing examples are assessed, with future recommendations for banks to consider. Shortly after the paper's instances of M&As in the Indian financial industry were discussed, the impact of M&As was felt. In the period under review, the audited M&A transactions in the Indian monetary region were appraised based on publicly available information. The investigators examine pre- and post-solidification financial execution of joint cash reserves using money-related limits. The analysis findings suggest that M&As have been viable in the Indian monetary region. To boost the premium of the financial backers of upset banks, the public authority and its strategy makers should not encourage mergers between assertive and beleaguered banks. We can see that the State Bank of India and its Partners have both advantages and disadvantages regarding their integration with other institutions and personnel.

Objectives of the study

- To know the consolidated balance sheet and profit and loss account of SBI and BOB
- To study the impact of banks in the Indian scenario.
- To study the process involved in M and A.

BANKS MERGED FROM THE YEAR 1961 TO 2021

Between 1961 and April 2021, there have been 98 mergers and acquisitions. From 1993 through 2021, only mergers and acquisitions (M&A) were reported. Following the country's economic reforms, the Indian banking sector saw a sea change. Since then, it is grown to be a significant player in the global gross domestic product (GDP). Other financial institutions have not challenged the banking sector's all-pervasive intermediation as the primary provider of financial services. With forays into insurance and investment banking, it has solidified its position and broadened its scope. Banks have also gotten more technologically advanced and competitive. The performance indicators show that they are both profitable and reliable. Balance sheet, profit and loss account of SBI and BOB,

Limitations of the study

- The study is the process involved in M and A
- The study is limited to only knowing the Indian mergers and acquisitions.
- The study is focused on the conceptual process.

CONCLUSION

Consolidations and acquisitions are considered to have a fundamental impact on the development of a company. Overall, the advantages of M&A help speed up the lengthy development process. Even if the viability of M&A depends on the Load up's tactics, organizing time, or hunger, they can get there if it is prepared and needs to implement acquisitions and conglomerations genuinely. In India, M and An have had a massive impact on the





country's economy, with public banks recording the best productivity and total assets expanding, share the capital profit of the banks increasing, and Bounce reporting a net gain of Rs 50,305.69 in 2018 and Rs 81,364.73 in 2022, respectively. Compared to 2018, Bounce's total shop count was 2,706,343.29 rupees, but that figure is expected to double by 2022, reaching 4,051,534.12.

REFERENCES

1. Singh Sonia & Das Subhankar (2018) "Impact of post-merger and acquisition activities on the financial performance of banks: a study of Indian private sector and public sector banks," Revista Espacios. Vol. 39 (Number 26) Year 2018, Page 25.
2. S. Indrapriya (2018) A Study on Merger and Acquisition in Banking Industries", IJLMH, Volume 1, Issue 5, ISSN: 2581-5369.
3. Ruchita Verma and Janaki Singh Rathore (2018) "Mergers and Acquisitions (M&As) In the Banking Sector: A Comparative Review of The Indian and International Literature," Journal of Banking, Information Technology and Management Volume 15 No. 1 • January-June 2018.
4. Ishwarya J (2019) "A Study on Mergers and Acquisition of Banks and a Case Study on SB," International Journal of Trend in Research and Development (IJTRD), ISSN: 2394-9333. Page Number 22- 26.
5. Naveen Kumara R, Vidhya VJ & Meghana B Reddy (2019) "A Study on the Impact of Pre and Post Bank Merger Announcement on Stock Price Movements," IJRAR January 2019, Volume 6, Issue 1.
6. Ruchita Verma and Janaki Singh Rathore (2018) "Mergers and Acquisitions (M&As) In the Banking Sector: A Comparative Review of The Indian and International Literature," Journal of Banking, Information Technology and Management Volume 15 No. 1.
7. Yadav Bharatsingh Kausingh and Dr. N. Sridharan (2019) "A Study on Mergers and Acquisition of Banks in India," Journal of Information and Computational Science, Volume 9 Issue 8.

Table 1: Motives for Bank Mergers and Acquisitions in the Indian Banking Sector in the Post-Liberalization era

| Year of Merger | Acquiring Bank | Acquirer Bank | Motives for Mergers and acquisition |
|----------------|----------------------------------|-----------------------------|-------------------------------------|
| 2010 | Bank of Rajasthan Limited | ICICI Bank Limited | Voluntary Merger |
| 2014 | ING VysyaBank Limited | Kotak Mahindra Bank Limited | Voluntary Merger |
| 2017 | State Bank of Patiala | State Bank of India | Voluntary Merger |
| 2017 | State Bank of Mysore | State Bank of India | Voluntary Merger |
| 2017 | State Bank of Hyderabad | State Bank of India | Voluntary Merger |
| 2017 | State Bank of Bikaner Ans Jaipur | State Bank of India | Voluntary Merger |
| 2017 | State Bank of Travancore | State Bank of India | Voluntary merger |
| 2017 | Bharatiya Mahila Bank | State Bank of India | Voluntary Merger |

Source: Collected from various reports from RBI





Emergence of Educational data mining and its Implications in India: A Reviews

Rongali Yer Naidu^{1*} and K. Rajakumari²

¹Research Scholar, Department of Computer Science, BIHER, Chennai, Tamil Nadu, India

²Associate Professor, Department of Computer Science, BIHER, Chennai, India.

Received: 01 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

RongaliYer Naidu

Research Scholar,

Department of Computer Science,

BIHER, Chennai, Tamil Nadu, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Educational data mining can classify and predict student and instructor performance. It can help educators track academic achievement, students select courses, and educational management become more efficient and productive. In recent years, growing interest in AI has fueled pedagogical data mining and analytics. Large data sets are analyzed using machine learning, statistics, and database systems. Database knowledge discovery (KDD) is finding usable information in massive data sets. Data mining with an educational aim (EDM). EDM collects and analyses data from educational records, usually online logs, and exam results. EDM is based on educational theory. Currently, there is little actual evidence to support a scientifically accepted theoretical framework. Because learning settings vary greatly in the actual world, they determine EDM's analytical approaches. Thus, the research shows that EDM can be effective in real-world educational procedures. So, this paper examines the studies on this topic and draws conclusions.

Keywords: Artificial intelligence (AI), Covid-19, Knowledge discovery in databases (KDD), Online Teaching & Learning Process

INTRODUCTION

Educational data mining tools have been successful in improving student learning outcomes on the online platform. The outstanding advancement for educational data is the recognition that not all vital data is saved in one data stream. Education research has led to several new instructional advancements. Computer-based advances have revolutionized our lives. Today, the information gathered from these achievements is supporting a second cycle of transformation in all sectors and learning. Data mining is a powerful approach that can assist schools and colleges emphasis on the most critical data points concerning students and future students. Finding new patterns and links in



**Rongali Yer Naidu and Rajakumari**

massive datasets is called data mining. Statistical models, mathematical algorithms, and machine learning techniques can be used. These strategies can uncover data that queries, and reports can't.

Data mining in education

This computer science field seeks to find features and patterns that can aid decision making. The model shown here is for Educational Data Mining. Data mining can help institutional memory. KDD is the process of mining knowledge from massive data collections. A school usually has a big database. Students and alumni data may be included. Educational data mining is the study of educational data. These figures originate from regular classrooms, online courses, and educational software. According to the International Educational Data Mining Society (2011), information in any learning situation often contains many hierarchical levels that cannot be expected but must be proven. Educational data analysis considers time, sequence, and context. Students' participation, login frequency, chat messages, and inquiry categories can be analyzed. The online learning platform decides what data can be recorded. Without time variables in the online learning platform database, researchers cannot measure students' exam completion timing. The online learning platform dictates EDM's data handling capabilities. In truth, machine learning is still designing learning designs for online learning systems. India's education business mainly relies on technology studies. Big data is a growing industry in the country. Big data is now everywhere. So the education sector can no longer ignore technology. Many Indian schools use technology to improve pedagogy. Students now have global access to data and resources thanks to big data. These are essential in big data education. Analytical issues include database, data warehouse, and data mining. The Ministry of Human Resources pushed many national tech universities to construct AI research and development centres. The Indian Institute of Information Technology Design and Manufacturing is also at Kancheepuram. The interim budget for 2019-2020 allotted INR93,848 crore (US\$13.15 billion) to education. The National Strategy for AI issued by India's Policy Commission (NITI Aayog) claims that AI can help improve educational quality and access. From 2011 to 2015, private educational technology investment grew by 32% annually, to \$4.5 billion. India is a global leader in big data analytics. This market will grow from US\$5.5 billion in 2020 to \$18.9 billion in 2025, predicts Analytics Insight. In the same year, it will account for 32% of the global analytics market, extending educational and employment options. India's big data analytics industry is booming due to its large English-speaking population. India's education system is still a priority. Since 2002, the government has automatically approved 100% FDI in education. Between April 2000 and March 2020, the DPIIT recorded a total FDI inflow of \$3.24 billion. In 2020, the Indian government would invest INR3,063 crore (US\$477 million) in AI, IoT, big data, cybersecurity, machine learning, and robot research. E-government, banking, education, and health will be promoted in over 2 lakh villages by 2019. In her 2019 Budget, Finance Minister Nirmala Sitharaman pledged to train 10 million people in industry-relevant skills.

CONCEPTUAL FRAMEWORK AND STRUCTURE OF EDUCATIONAL DATA MINING (EDM)

Large data sets are mined for patterns and linkages. Database knowledge discovery uses clustering, classification, regression, neural networks, AI, association rules, genetic algorithms, decision trees, etc. Clustering is the process of grouping things and dividing a data collection into subsets (clusters) that share common properties. Data classification expresses data links and values for future observation. Classification is an objective function that maps each attribute set A to a class level B. Classes can be defined as a set of rules or a set of decision trees. This is done using test data. The rules can then be applied to new data tuples. These pre-classified samples are used to determine parameter placement. Regression can predict. It can be used to show the relationship between variables. The response factors are unknown in data mining. Regrettably, many daily challenges are unpre Complex methods like logistic regression, neural networks, and decision trees may be required. Future education data mining: Educational Data Mining is a new popular domain that focuses on finding relevant data from educational environments. Data mining is a huge field that uses numerous algorithms and strategies to uncover patterns.

Objectives of Educational Data Mining

- Improve student models to predict learner behaviour. Modeling is describing and categorising a student's knowledge, motivation, metacognition, and attitudes.



**Rongali Yer Naidu and Rajakumari**

- Revising knowledge domain structure models. For example, there are models that explain the interrelationships of knowledge in a domain.
- Exploring how learning systems can best promote student learning.

Benefits

- Optimizing or suggesting individual learning styles, materials, and experiences.
- Analyzing students' learning behaviors, acquiring the most supporting education, and anticipating student learning.
- Assessing the usefulness of data mining techniques and evaluating instructional materials.
- Increasing the efficiency and cost-effectiveness of higher education decision-making procedures such as admissions and financial resource allocation.

Various data mining approaches have been used to various educational contexts as educational data mining research has grown. In each scenario, the goal is to turn raw data into relevant information about the learning process to improve learning environment design and trajectory. Thus, EDM comprises four phases: Finding relationships in data is the first stage in EDM. This involves searching a database of educational data for correlations. To find these associations, researchers have employed classifiers and regressions, as well as factor and social network analysis. To avoid over fitting, confirm found correlations. Validated associations are utilized to forecast classroom happenings. Predictions aid decision- and policy-making. Data visualization or distillation is common in phases 3 and 4. The best ways to visualize data have been thoroughly studied. Cristobal Romero and Sebastian Ventura present a list of the most common EDM uses. The following are the areas of EDM application, according to their taxonomy:

- Data analysis and visualization
- Providing comments to instructors who are assisting you
- Suggestions for students
- Predicting student achievement
- Modeling by students
- Identifying and preventing unfavorable student behaviours
- Students are divided into groups.
- Analyzing social networks
- Constructing concept maps

Courseware development - EDM works with course management systems like Moodle. Moodle records user activity data including exam scores, readings finished, and participation in discussion boards. Data mining may be used to customise learning exercises and pace students. This is great for online classes of varying levels.

Setting up a plan

New research suggests data mining may be beneficial in mobile learning. The differences in content management between mobile devices and standard PCs and web browsers can be used to tailor information to mobile users. Users of new EDM apps will be able to use and engage in data mining tools and activities, making data collection and processing more accessible. Techniques for studying social networks and their impact on learning and productivity

Educational Data Mining Initiatives in India

The Indian education industry has prepared numerous IT hopefuls. Its innovative educational and industrial infrastructure has benefited worldwide education. With government funding and mergers, India now possesses one of the world's largest network of higher education institutions. With a large population aged 5 to 24, the Indian education market is expected to reach US\$225 billion by 2022. In India, technology-related training, courses, and education have long been important. Big data is one of India's burgeoning educational disciplines. This ecosystem will include large IT businesses, governments, and academia. Indian big data students now have access to the best resources and data. With limited funds, India supports national conferences, webinars, brainstorming sessions, in-



**Rongali Yer Naidu and Rajakumari**

house instructors, and graduate and doctoral students. At addition to the Indian Institutes of Technology in Kharagpur and Madras, there is the Indian Institute of Information Technology Design and Manufacturing in Kancheepuram. This year's interim budget allocated 88,002 crore INR to education, including tech-related programmers. The National Strategy for AI issued by India's Policy Commission (NITI Aayog) claims that AI can help improve educational quality and access. From 2011 to 2015, private educational technology investment grew by 32% annually, to US\$4.5 billion. India has emerged as a global leader in big data analytics. The Indian Big Data Analytics market is expected to increase from US\$204.23 million in 2022 to US\$928.55 million in 2026. In the same year, it will account for 32% of the global analytics market, extending educational and employment options. India's big data analytics industry is booming due to its large English-speaking population. In education, human capital and economic growth are intertwined. As India's IT industry grows, the government has focused on bridging the IT talent gap. This is a major Endeavour by the Indian government. Government developed National Initiative for Technology Transfer to aid research parks. The government is committed to fostering a vibrant startup culture. IITs in Delhi, Guwahati, Kanpur, Hyderabad, and Bangalore have opened new research parks. The Startup India Higher Education Scheme granted INR 75 crore.

Eminent Platform of Educational Data Mining

1. DataShop
2. Peerwise
3. Ripple(Recommendation in Personalized Peer Learning Environment)

The first chapter of the study deals with the introduction to educational data mining and the second chapter is dedicated to conceptual framework and third chapter provides review of literature and fourth chapter offers concluding remarks.

SURVEY OF LITERATURE

According to Siti Khadijah Mohamad and ZaidatunTasir, data mining is very useful in online learning contexts (2013). A manual search for hidden information in data is challenging and time intensive. It focuses on e-learning platforms like Moodle and WebCT. Some researchers create their own learning tool. We might move our research focus from e-learning to popular social networking tools like Blog and Facebook that can engage students in collaborative learning. However, by integrating Google Analytics into the blog environment, the log data may be exported for data mining study. This review aims to educate scholars and educators about educational data mining. According to Alisa Bilal Zoric (2020), educational data mining can predict student accomplishment, dropouts, and teacher performance. It can help teachers track student progress, students choose courses, and educational management become more efficient. Attract and retain students for university profitability. Understanding effective instructional practises requires analysing student data. This study examined the benefits and uses of data mining in education. T.Thilagaraj and N. Sengottaiyan (2017) studied educational data mining in higher education The study concluded that educational data mining techniques are rapidly evolving. This study discusses the future of educational data mining technologies and methodologies. Academic achievement is becoming a primary concern for management in all professional institutes. As a result, early prediction of student performance improvement through counseling and extra coaching will assist management in reducing student performance issues. Classification and clustering techniques are employed to increase student success rates in higher education. They were utilized to construct a decision support system and help authorities take quick action on weak kids. Using Educational Data Mining, Nilesh v. Ingale et al(2020)the EDM approaches are excellent in predicting student academic achievement, which helps management and teachers make required judgments and actions. Teaching-Learning-based This optimization strategy is popular due to its low computing cost and great consistency. Thus, it has been widely used by researchers in numerous engineering fields. It uses teaching and learning philosophy to handle multi-dimensional, linear and nonlinear problems efficiently. The core TLBO algorithm has recently been upgraded in terms of exploration and exploitation performance. Recent TLBO algorithm developments and applications are little studied. The successful TLBO algorithm research over the last decade are reviewed. A study by K.G. Nandha Kumar and A. Jayanthila Devi indicated that categorization techniques are used more in education than other data mining approaches. Most models are predictive, but few are assessment. They are commonly utilized in classification and



**Rongali Yer Naidu and Rajakumari**

prediction tasks. In some circumstances, ordinary perceptron networks with back propagation learning are used. Most mining tasks indicate poor learners, failures, and dropouts. Rarely used cluster analysis and association rule mining methods. The research directions are unclear and underdeveloped. There are very few methods and algorithms utilized for data mining. So many researchers rely on old algorithms. Along with typical data mining methods, evolutionary optimization, machine learning, and genetic algorithms may be used. Other supervised and unsupervised algorithms and techniques should be improved. Different data mining paradigms could be applied to e-learning and e-assessment. Increasing the use of artificial intelligence and expert systems for automatic assessment and prediction in educational data mining. According to Christian Fischer et al (2020), big data has spawned new data-driven decision-making methodologies and initiatives to increase educational efficacy. Traditional data sources and methodologies cannot provide scalable and fine-grained comprehension and support of learning processes. This document outlines big data's micro, meso, and macro benefits. To operationalize and comprehend knowledge, cognitive techniques, and behavioural processes. NLP is commonly used to connect linguistic features to cognitive, social, behavioural, and emotional processes. Systems for course advising and early warning use institutional data to benefit students and administrators. Big data access, analysis, and use issues are also discussed here. Researchers must learn to reconcile data privacy and protection with data sharing and research. Consider the possible benefits of big data in education. Ed Tech trends examined by Rajni Jindal and Malaya Dutta Borah the study concluded that mining heterogeneous data is critical in an IT-driven society. This article presents a study and practice path from 1998 to 2012. Research trends in Offline, Online, and Uncertain Data in an Educational Context. To better utilize current resources, colleges/institutions linked with the same university should use a common academic planning model. Finally, this work can be refined to create Knowledge Discovery based Decision Support System (KDDS) that can make appropriate decisions for scientific and technological research.

According to AbhilashaSankari et al (2019) Educational data mining is an emerging field. Difficulty Factor Assessments, Knowledge Inferences, Recommender Systems, and Social Network Analysis have all been explored. Learning analytics and educational data mining capture student learning proof. These include Bayesian Knowledge Tracing, Q-Metrics, PFA, and LKE. Students' performance can also be assessed using matrix factorization and knowledge components. Learners' performance can be predicted using learning analytics and educational data mining. Compare student learning outcomes from various teaching methods. Jaya Srivastava and Abhay Kumar Srivastava (2012) examined data mining in education and concluded that researchers and stakeholders can increase student satisfaction through EDM. Educational data mining is used in descriptive, predictive, and prescriptive analytics, where appropriate actions can be prescribed. Understanding pupils, suitable profiling, and correct predictions can not only improve education but also improve students' learning experience. Data mining can assist educators develop effective educational practices for our children.

ChitraJalota and Rashmi Agrawal (2019) analysed educational data mining. Higher education institutions are usually quite interested in student success rates. As a result, they must use numerous methods such as physical examination, statistical methods, and currently popular data mining technologies to forecast student success. Educational Data Mining is a new study topic that uses data mining techniques. It uses machine learning algorithms and statistical methods to interpret student learning patterns, academic performance, and future development. The study indicated that using data mining approaches can help make better educational decisions for students. The data set has 163 instances and 16 attributes. Weka uses five classifiers and compares their accuracy using different error metrics to get the best classifier. Among various classifiers, Multilayer Perceptron has the best performance in tests. More datasets will be collected and compared to other data mining techniques like association and clustering.

Mr. Algarni (2016) researched the use of data mining in education. Educational data mining is a rapidly growing discipline that benefits from new algorithms and approaches established in other data mining and machine learning fields. Educational data mining (EDM) helps develop strategies for extracting interesting, interpretable, relevant, and new information that can assist better understand students and their learning environments. EDM can be used to identify at-risk students, priorities student learning needs, increase graduation rates, measure institutional performance, maximize campus resources, and optimize topic curriculum renewal. Yu-Sheng Su and Chin-Feng Lai



**Rongali Yer Naidu and Rajakumari**

(2021) used educational data mining to investigate flipped classroom watching habits and performance on Face book. Teachers exchange resources, and students can see them before class. Teacher and students can discuss questions from previewing learning materials during class. Face book provides access to learning materials and diverse interactions such as knowledge sharing and annotating learning materials. The results reveal that the experimental group outperforms the control group in terms of learning performance. Using Face book to actively engage in flipped classrooms may increase student learning outcomes, according to the above studies and debate. Facebook can be used in flipped classes to increase student involvement. Thus, the study provides insights into how students use Facebook in flipped classes. G. ShiyamalaGowri et al. A case study on students in four government schools in Vellore district, Tamil Nadu, shows the use of educational data mining to predict student performance. The consequence was two clusters of pupils, good and bad. After examining 100 students, the overall performance is anticipated to be satisfactory. Overall, the case study shows that educational data mining using Weka outperforms previous utility mining methods that rely on classification rather than comparison. The analysis can classify students based on academic data, family history, learning style, and personal qualities. Also, a student-to-staff ratio of 20: Parents Every month, teachers can gather. Daily notifications to parents through mobile/internet regarding student behaviour, attendance, exam schedule, and grades. Both pupils and teachers should see a psychiatrist regularly. Teachers and students can be required to meditate or do yoga. So, by adopting the aforementioned principles, an Educational Institution's performance will improve.

Ed Data Mining: Determining Factors Affecting Student Academic Performance by Leena Khanna et al. The study indicated that "quality" is now the top priority in Higher Education. Institutes, Colleges, and Universities in numerous countries are struggling to improve higher education quality. The present market position, acknowledgment of institutionalization, legalization, and regularization of quality assurance are some measures that add to excellent education in any country. Finding significant characteristics that Educational data mining is primarily focused on student performance and the teaching-learning process. Educational data mining offers several tools and methods. Commercial tools include ANOVA, Clementine, and Neuro Shell Classifier. Classification is a common EDM method. Currently, EDM lacks universal instructional tools. Kumar and Pal (2011) studied Educational Data Mining to Analyze Students' Performance. The study used student database classification to forecast student division. The decision tree method is one of many data classification methods. Attendance, class tests, seminars, and assignments were utilized to predict student achievement. This study will aid students and teachers alike. In addition to lowering failure rates, this project will prepare students for the next semester's tests. Toivonen et al. The study revealed that a computer and a user collaborate to grasp the instructional context. The computer creates a model that the end-user learns from and adapts based on subjective interpretation. The computer updates the model based on the results. user's The AUI technique outperforms the other two algorithms in terms of accuracy over time. Also, evaluating clusters using only one dataset and measure does not imply one technique is superior. Our results show that the AUI approach takes longer and requires more iterations. The AUI technique helps EDM users acquire new knowledge from context.

CONCLUSION

Penetration of digital services and vast usage of 4G enabled Smart Phones to become handy for the young generation to adapt the new ways and means of learning. With the estimation of Indian education market worth of US\$225 billion and more in 2022 there is a huge market for Edu tech firms to explore opportunities in India using educational data mining. The benefits of EDM are found to be prediction Analysis Create a model that predicts some variables according to the values of other variables. The influential variables might be fixed or derived from the data. Determine which students are at risk. Recognize the educational outcomes of students. Clustering assigns a certain quantity of data to different clusters based on the data's qualities. The number of clusters might vary depending on the model and the clustering process's goals. Find out what students or schools have in common and what they have in common. New student behavior has been classified. Exploration of Relationships The association between two or more variables in the data collection should be extracted. Determine the link between parent education and students





Rongali Yer Naidu and Rajakumari

who have dropped out of school. Finding curricular connections in course sequences; determining whether instructional practices promote more effective/durable learning Models for Discovery Its goal is to create a prediction or connection mining model that includes grouping, prediction, or knowledge engineering. The research subject is explored in a variety of situations to uncover relationships between student behaviour and student attributes. Data Distillation for Human Judgment The major goal of this model is to find a new technique for researchers to quickly identify and classify patterns in data. Patterns in student learning, behavior, or teamwork identified by humans, data labelling for later creation of a prediction model. Educational data mining (EDM) Usage in the Higher educational institutions will help to meet the targets and improve efficiency of students and staff it's a revolution in the educational system in the country if it is adopted by all for the overall development of the country and better utilization of human resources with skilling using EDM.

REFERENCES

1. Abdulmohsen Algarni. (2016). Data Mining in Education. International Journal of Advanced Computer Science and Applications, 456-461.
2. AbhilashaSankari et.al. (2019). A Review On Research Areas In Educational Data Mining And Learning Analytics. INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, 319-323.
3. Alisa Bilal Zorić. (2020). Benefits of Educational Data Mining. Journal of International Business Research and marketing, 12-16.
4. Analytics insights. (2022, march 26). indian govt initiatives to boost big data education. Retrieved from analytics insights: www.analyticsinsight.net/report-indian-governments-initiatives-to-boost-big-data-education/
5. Abdulmohsen Algarni. (2016). Data Mining in Education. International Journal of Advanced Computer Science and Applications, 456-461.
6. AbhilashaSankari et.al. (2019). A Review On Research Areas In Educational Data Mining And Learning Analytics. INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, 319-323.
7. Alisa Bilal Zorić. (2020). Benefits of Educational Data Mining. Journal of International Business Research and marketing, 12-16.
8. Analytics insights. (2022, march 26). indian govt initiatives to boost big data education. Retrieved from analytics insights: www.analyticsinsight.net/report-indian-governments-initiatives-to-boost-big-data-education/
9. analytics insights. (2022, march 25). indian government investments in big data education. Retrieved from analyticsinsights.net: <https://www.analyticsinsight.net/indias-government-investments-in-big-data-education/>
10. Chitra Jalota and Rashmi Agrawal . (2019). Analysis of Educational Data Mining using Classification. International Conference on Machine Learning, Big Data, Cloud and Parallel Computing , 243-247.
11. Christian Fischer et.al . (2020). Mining Big Data in Education: Affordances and challenges. Review of Research in Education, 130-160.
12. G.Shiyamala Gowri et al . (2017). Educational Data Mining Application for Estimating Students Performance in Weka Environment. IOP Conference Series: Materials Science and Engineering, 1-8.
13. Jaya Srivastava and Abhay Kumar Srivastava. (2019). Data Mining in Education Sector: A review. Special Conference Issue: National Conference on Cloud Computing & Big Data , 184-190.
14. K.G. Nandha Kumar and A. Jayanthila Devi. (2019). Perspectives on Educational Data Mining:A Study. Man In India, serials publication, 55-60.
15. Leena Khanna et al. (2017). Educational Data Mining and its Role in Determining Factors Affecting Students Academic Performance: A systematic review. IEEE, 1-7.
16. Mining Educational Data to Analyze Students" performance. (2011). Brijesh Kumar Baradwaj and Saurabh Pal. International Journal of Advanced Computer Science and Applications, , 63-69.
17. Nilesh V. Ingale et al. (2020). Study on Prediction System for Student Academic Performance utilizing Educational Data Mining. Turkish Journal of Computer and Mathematics Education, 1273- 1281 .
18. Rajni Jindal and Malaya Dutta Borah. (2013). A SURVEY ON EDUCATIONAL DATA MINING AND Research Trends. International Journal of Database Management Systems, 53-73.





Rongali Yer Naidu and Rajakumari

18. Siti Khadijah Mohamad. (2013). Educational data mining: A review. *Procedia - social and behavioural sciences*, 320-324.
19. T.Thilagaraj and .N Sengottaiyan . (2017). A Review of Educational Data Mining in higher education system. *Proceedings of the Second International Conference on Research in Intelligent and Computing in Engineering*, 349-358.
20. Tapani Toivonen et.al. (2019). Augmented intelligence in educational data mining. *Smart Learning Environments*, 6-10.
21. towards data science. (2020, march 26). why educational data mining is imporatant. Retrieved from towardsdata science.com: <https://towardsdatascience.com/why-is-educational-data-mining-important-in-the-research-e78ed1a17908>
22. Yu-Sheng Su and Chin-Feng Lai . (2021). Applying educational data mining through social media. *frontiers in psychology*, 1-8.

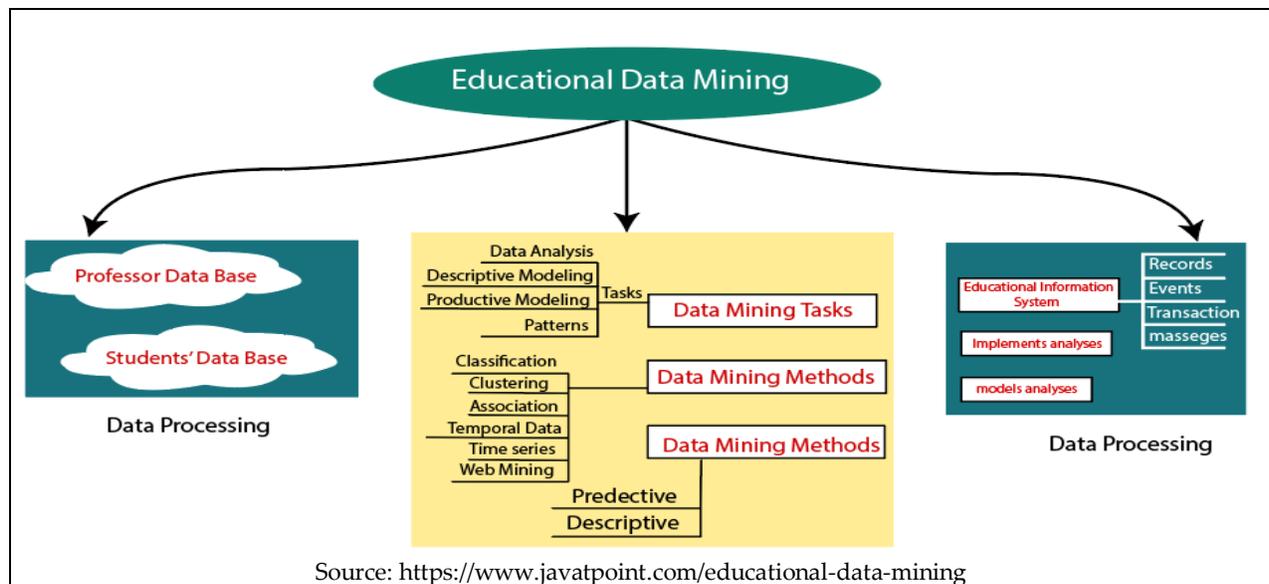


Fig1: Educational Data Mining

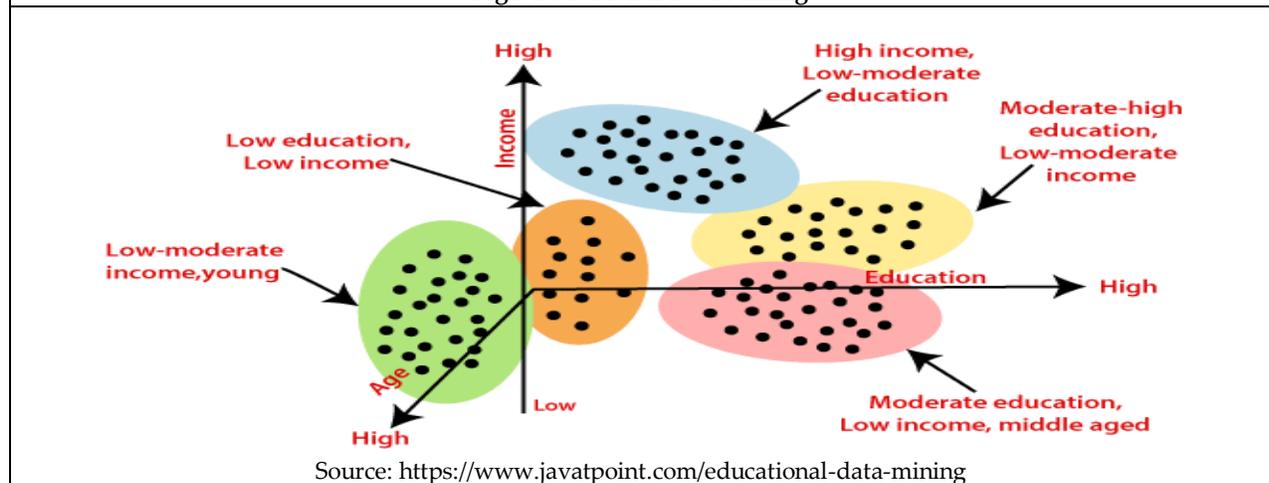


Fig2: Database knowledge discovery





Rongali Yer Naidu and Rajakumari

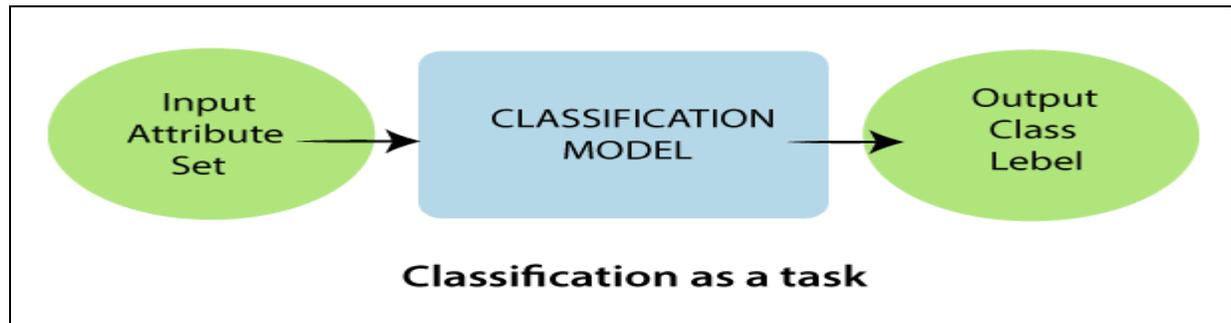


Fig 3: Classification as a task

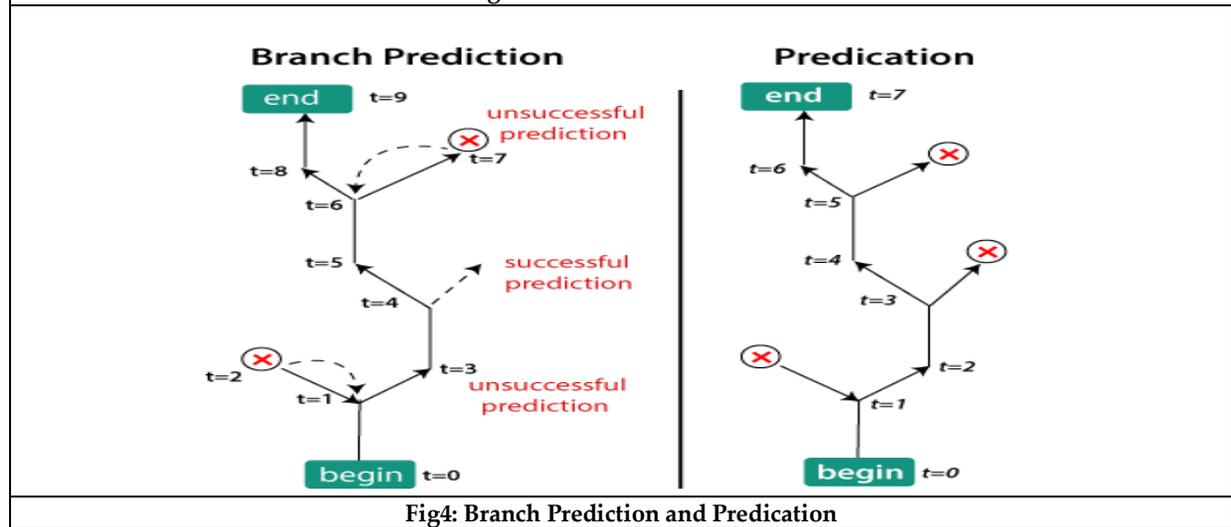


Fig4: Branch Prediction and Predication





Analyzing the Work Stress of NRI Employees in relation to Incentive System of Private Sector Undertakings in UAE

Archana K M^{1*} and P Deivanai²

¹Research Scholar and Assistant Professor in Commerce, Sree Narayana College, Palakkad, Kerala, India.

²Assistant Professor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India.

Received: 05 June 2022

Revised: 26 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Archana K M

Research Scholar and Assistant Professor in Commerce

Sree Narayana College,

Palakkad, Kerala, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Work stress and work performance has long been a topic of argument among the corporates. As Human Resource Management gains much importance in this global corporate world these elements need continuous discussion and arguments to find a better solution to eliminate the stressors and improve the efficiency of employees all over the world. The pay/incentive systems in any organization are counted as an important additive motivator for better performance and reduced stress of work among the employees. Hence this study has been conducted to see the relation between the incentive system, work stress and in turn the work performance. The study has been conducted among the NRIs working in the private sector companies of United Arab Emirates which is a prominent source of foreign exchange for India. The selected sample of employees are analyzed using the statistical tools of ANOVA and Post hoc Analysis. The study would enhance further studies in Human Resource Management.

Keywords: Work stress, employees, NRIs working, ANOVA, Human Resource Management

INTRODUCTION

Work stress is a global problem faced by people all over the world on which discussions and arguments are enduring. It has a direct bearing on work performance and individual efficiency and hence it assumes much importance in the corporate world as well as individual output. Work stress may be defined as the corporeal and cognitive response to acute circumstances (Usman Ali et al., 2014). The subject of work stress is a significant area of discussion of business organizations as it has a lot to deal with the overall performance. Stress could make an individual go to depression and could severely affect his health and attitude towards work. Many factors contribute to work stress including work place atmosphere, employer employee relationships, reduced role of employees in



**Archana and Deivanai**

participative management and excessive workloads. Work stress has a strong bearing on managerial interference in work and hence the type of management is an important factor influencing the degree of work stress and work performance. In contrast to public sector which is guided mainly by maintaining a socio-economic balance of society, Private sector organizations are motivated by profit maximization and growth of market share and hence put high demands on employee performance and resourcefulness (Macklin et al., 2006). Hence the study would like to look into the work stress related issues of employees in the private sector employees. According to the Migrant Stock 2020, as released by the Population Division of the UN Department of Economic and Social Affairs (DESA), UAE has an ethnic community of 3.5 million Indians constituting 30% of the country's population. The UAE private sector is capable of creating tens of thousands of jobs every year. The UAE uses its rich oil resources to accelerate its economic development by importing specialized financial and social services as well as setting up well defined trading networks. Country uses imported services to the extent of 80% of its total population (Satisf, n.d.). Hence the study focuses on the private sector NRI employees in UAE who are a major contributor of wealth of our nation.

Literature Review and Research Gap

There are endless studies and ongoing discussions in the area of work stress and a few of them are reviewed and the major findings are discussed here. According to a study by K Bhui and S Dinos there are a number of factors contributing to work stress including high demand on productivity and low control situations, imbalance in effort and rewards, management style and the type of job. One of the most significant and persisting stressor is management practices followed in the business organization. It is also highly prominent in private as well as public sectors (Bhui et al., 2016). In a study on teachers in European countries it was held that the educators experience emotional exhaustion rather highly. It is held that the educators are satisfied with their job but were not satisfied with their salary they receive. In the public sector it could be seen that the employees were satisfied with their job but were not comfortable with the management, whereas in the private sector the reverse happens. It was revealed that the nature of work and management style contributed significantly to the emotional exhaustion of employees in the public sector (Tsigilis et al., 2006). In a review paper on the causes and effect of employee turnover in the private sector organizations in Malaysia some crucial factors in job turnover have been identified which could seriously affect the work stress of employees. They include influence of management, poor managerial understanding of employees, pay related issues, disparity in job and qualification, poor opportunities in career growth, lack of fringe benefits and influence of co-workers (Arokiasamy, 2013).

In a comparative study on employees' stress management in private and public sector banks in Nagapattinam District, Tamilnadu, the author analyzes the impact of various socio-demographic factors on stress levels of bank employees and is revealed to have a direct impact on employees' stress levels. The author put forth a number of factors related to work, organization, personal, health environment, psychological, and emotional as impacting stress levels (Xavior Selvakumar & Advisor, 2015)

Work stress in the Private sector of the UAE

As UAE private sector is a major contributor of our national income and tens of thousands of Indians are working in the private sector organizations of the United Arab Emirates, we could see lots of unending discussions and written articles and studies in the said area. A few of them are reviewed here. According to a study held in UAE it is put forth that job stress contributes to lower levels of job satisfaction. In the study five different factors are being identified as stressors; they are, work related stressors, work-role stressors, pay and growth stressors, status of job and work-family conflict. Out of these pay and growth related factors as well as work related factors are considered to be highly significant and the pressure on these factors alone amounted to decreased job satisfaction of academic staff of UAE (Jawabri et al., 2019).

In a study to identify the elements of job stress and productivity in UAE based organizations it is found that the most prominent variables are work load, role ambiguity, gender discrimination and low interpersonal relationships. The factors responsible for productivity are identified as job schedules, efficiency of the supervisor, remuneration, systems and procedures, group dynamics, absenteeism and presentism (T & Gupta, 2018). Though there are a vast



**Archana and Deivanai**

number of studies held in the area of work stress and productivity or work performance across the world, only few literatures are found in the work stress related performance of NRIs in UAE.

Statement of the Problem

There are concrete evidences on the negative impact of work stress on the performance of employees. Varied factors account for the work stress including workload, working hours, management styles, inter personal relationships, pay related and career related issues. The United Arab Emirates (UAE) is a foreign country where around more than 3 million Indians are employed especially in the private sector. India is a country depending much on the remittances of the NRIs. Hence the study here is aiming at the Human Relations aspect of the UAE private sector organizations. It analyzes the work stress implications on the performance of NRIs in the private sector business organizations in UAE. Absence of monetary or non-monetary schemes of incentives are also one of the factors leading to work stress and hence the impact of the incentive system should be evaluated to check whether these have an impact on reducing or increasing the work stress of employees. According management theories good incentive system could reduce the workload stress to some extent and therefore employees' perception of the effect of incentive system should be analyzed

Objectives of the Study

1. To analyze the work stress of private sector employees of UAE
2. To evaluate the relationship between work stress and work performance
3. To evaluate the effectiveness of incentive system on work stress of employees

Significance of the Study

India has long been one of the top most country in receiving remittances from foreign countries especially middle east. Around 3.5 billion expatriate Indians are employed in the oil rich Gulf countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates (UAE). The remittances from these NRIs have always been a permanent and consistent source of strength and support to India's balance of payments in more than 5 decades (Pattanaik, 2007). Out of the total population of NRIs in middle east countries, more than 2.5 million are from Kerala. In UAE alone 7,73,624 Keralites are permanently resident. Out of these except a minority are employed in the private sector organizations in construction, financial services, trading etc. Reviewed literature shows that employees in Gulf countries face considerable work stress from varied factors which are irresistible. In a study held among the employees in the Al-Ain Municipality public sector work force, work stress was evident and was caused by a number of heterogeneous reasons including even the economic rather financial tensions in the country's economy (Jenaibi, 2010). As the work stress has a considerable effect on work performance and productivity the work stress studies are taken up seriously by many organizations in a move to improve their overall performance. There are a number of studies in the area of work performance, but only limited sources to view in the area of work stress and work performance relativity. Hence it assumes much importance in the context.

Research Design

The study titled 'Analyzing the work stress and work performance of NRI employees in the private sector undertakings in UAE' aims at the relationship between work stress and work performance. The population of the study is the Non-resident Indians working in the private sector business organizations in the United Arab Emirates. A sample size of 98 respondents were selected using convenience (non-random) sampling method. Data has been collected using structured questionnaire in electronic form. Statistical analysis tools of ANOVA and Post hoc tests have been used to analyze the data.

Analysis and Findings**Demographic factors- Age**

Majority of the respondents (48%) belong to the age group of 30 – 40 years. 35% respondents were more than 40 years of age. This demographic factor is analyzed with the help of a non-parametric test ANOVA to study the relationship of demographic factors on work stress as well as its impact on incentive system in the organization.



**Archana and Deivanai**

H_0 : There is no significant relationship between age and work stress of employees

H_0 : There is no significant relationship between age and incentive system in the organization. Since the p values are greater than 0.05, it can be inferred that the age of the respondents has no significant influence on stress and incentive system for 5% level of significance.

Monthly Income

42% of the respondents fall within an income group of Rs. 50,000 to Rs. 1,00,000. 29% respondents earn income between Rs. 1,00,000 to 3,00,000. In order to see whether the income level has any bearing on the work stress of the employees as well as their income levels and the incentive system in the organization. Since the p values are greater than 0.05, it can be inferred that the monthly income of the respondents has no significant influence on stress and incentive system for 5% level of significance.

Years of work experience

Since the p value corresponding to stress value is greater than 0.05, we can conclude that the work experience of the respondents has no significant influence on stress for 5% level of significance. But, since the p value corresponding to incentive score value is less than 0.05, we can conclude that the work experience of the respondents has significant influence on the incentive system for 5% level of significance. In order to find the significantly different category post hoc test is performed and the results are given below.

Post hoc test

From the table it is clear that the incentive systems of the respondents who have 1- 5 years and 5 – 10 years of experience in gulf countries are significantly different from that of the respondents who have more than 10 years of experience. Also, the respondents belonging to other groups are not significantly different each other with respect to incentive system.

Family staying with the employee abroad

Since the p values are greater than 0.05, it can be inferred that the presence of the family members with the respondents has no significant influence on stress and incentive system for 5% level of significance.

Frequency of your visit to home land

Since the p value corresponding to incentive score is greater than 0.05, we can conclude that the frequency of visiting home lands of the respondents has no significant influence on the incentive system for 5% level of significance. But, since the p value corresponding to stress score is less than 0.05, we can conclude that the frequency of visiting home lands of the respondents has significant influence on stress for 5% level of significance. In order to find the significantly different category post hoc test is performed and the results are given below

Post hoc test

From the table it is clear that the stress of the respondents who visits their homeland 2-3 times in a year is significantly different from that of the respondents who visits their homeland less than 2 times in a year. Also, the respondents belonging to other groups are not significantly different each other with respect to stress score.

DISCUSSION AND CONCLUSION

A number of variables including demographic factors, years of work experience in UAE, the family visa status of NRI employees in UAE, work performance, incentive system etc. have been analyzed for studying the relationship between work performance and work stress of employees in private sector organizations in UAE. From the results it could be referred that the variables age gender, or family status bear no significant relation on the stress levels of employees as well as the incentives provided by these organizations. Whereas work experience and frequency of visit to home land has a significant influence on work stress as well the work performance of employees. It is





Archana and Deivanai

scientifically proved that employees visiting their home places lesser than twice in a year has a considerably higher levels of stress compared to those visiting their home lands at least twice in a year. Likewise, years of work experience in gulf countries has a considerable effect on reduced work stress as well as the benefits associated with their works. This shows that the performance of employees has an indirect bearing on their reduced stress levels due to frequency of visits to their home places and as their work experience rises their work stress are also reduced as well as incentive systems could boost their work performance. Further studies should be conducted to compare private sector as well public sector employees to see whether these management factor has an influence on work stress and work performance.

REFERENCES

1. Arokiasamy, A. R. A. (2013). A qualitative study on causes and effects of employee turnover in the private sector in Malaysia. *Middle East Journal of Scientific Research*, 16(11), 1532–1541. <https://doi.org/10.5829/idosi.mejsr.2013.16.11.12044>
2. Bhui, K., Dinos, S., Galant-Miecznikowska, M., de Jongh, B., & Stansfeld, S. (2016). Perceptions of work stress causes and effective interventions in employees working in public, private and non-governmental organisations: a qualitative study. *BJPsych Bulletin*, 40(6), 318–325. <https://doi.org/10.1192/pb.bp.115.050823>
3. Jawabri, A., Alarmoti, A., & Mohammed, M. A. (2019). Job stress and satisfaction among academic staffs in public universities: An empirical study in the United Arab Emirates (UAE). *Management Science Letters*, 9(7), 973–986. <https://doi.org/10.5267/j.msl.2019.4.007>
4. Jenaibi, B. Al. (2010). Job Satisfaction: Comparisons among diverse public organizations in the UAE. *Management Science and Engineering*, 4(3), 60–79.
5. Pattanaik, S. (2007). Gulf NRIs and Their Remittances to India: The Saga of Overlooked Great Expectations. *Journal of International and Area Studies*, 14(1), 31–53. http://iia.snu.ac.kr/iia_publication/iia_publication_jias.htm%5Cnhttp://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=0929930&site=bsi-live
6. Satisf, J. (n.d.). Exploring Under-representation of Young Emirati Adults in the UAE Private Sector by Examining Emirati.
7. T, B., & Gupta, K. (2018). Job Stress and Productivity: A Conceptual Framework. *International Journal of Emerging Research in Management and Technology*, 6(8), 393. <https://doi.org/10.23956/ijermt.v6i8.171>
8. Tsigilis, N., Zachopoulou, E., & Grammatikopoulos, V. (2006). Job satisfaction and burnout among Greek early educators: A comparison between public and private sector employees. In *Educational Research and Review* (Vol. 1, Issue 8). <http://www.academicjournals.org/ERR>
9. Xavior Selvakumar, A., & Advisor, R. (2015). EMPLOYEES STRESS MANAGEMENT IN PUBLIC AND PRIVATE SECTOR BANKS IN NAGAPATTINAM DISTRICT-AN ANALYSIS. *Asia Pacific Journal of Research*. www.apjor.com
10. Zachariah, K. C. & Rajan, S. Irudaya (2011), Kerala Migration Survey 2011 (PDF), Department of Non-resident Keralite Affairs, Govt. of Kerala, p. 29.
11. Macklin, D. S., Smith, L. A., & Dollard, M. F. (2006). Public and private sector work stress: Workers compensation, levels of distress and job satisfaction, and the demand-control-support model. *Australian Journal of Psychology*, 58(3), 130–143. <https://doi.org/10.1080/00049530600940190>
12. Usman Ali, W., Rizwan Raheem, A., Nawaz, A., & Imamuddin, K. (2014). Impact of Stress on Job Performance: An Empirical study of the Employees of Private Sector Universities of Karachi, Pakistan. In *Research Journal of Management Sciences* ISSN (Vol. 3, Issue 7). www.isca.me





Archana and Deivanai

Table1: Demographic factors- Age

| ANOVA | | | | | | |
|-----------------|----------------|----------------|------|-------------|-------|------|
| | | Sum of Squares | d. f | Mean Square | F | Sig. |
| Stress Score | Between Groups | .180 | 2 | .090 | .088 | .915 |
| | Within Groups | 96.820 | 95 | 1.019 | | |
| | Total | 97.000 | 97 | | | |
| Incentive Score | Between Groups | 4.799 | 2 | 2.399 | 2.472 | .090 |
| | Within Groups | 92.201 | 95 | .971 | | |
| | Total | 97.000 | 97 | | | |

Table2: Monthly Income

| ANOVA | | | | | | |
|-----------------|----------------|----------------|----|-------------|-------|------|
| | | Sum of Squares | df | Mean Square | F | Sig. |
| Stress Score | Between Groups | 7.350 | 3 | 2.450 | 2.569 | .059 |
| | Within Groups | 89.650 | 94 | .954 | | |
| | Total | 97.000 | 97 | | | |
| Incentive Score | Between Groups | 6.133 | 3 | 2.044 | 2.115 | .104 |
| | Within Groups | 90.867 | 94 | .967 | | |
| | Total | 97.000 | 97 | | | |

Table3: Years of work experience

| ANOVA | | | | | | |
|-----------------|----------------|----------------|------|-------------|-------|------|
| | | Sum of Squares | d. f | Mean Square | F | Sig. |
| Stress Score | Between Groups | 2.808 | 3 | .936 | .934 | .428 |
| | Within Groups | 94.192 | 94 | 1.002 | | |
| | Total | 97.000 | 97 | | | |
| Incentive Score | Between Groups | 9.795 | 3 | 3.265 | 3.519 | .018 |
| | Within Groups | 87.205 | 94 | .928 | | |
| | Total | 97.000 | 97 | | | |

Table4: Post hoc test

| Multiple Comparisons | | | | | | | |
|----------------------|--|--|-----------------------|------------|-------|-------------------------|-------------|
| Dependent Variable | (I) Your work experience in Gulf countries | (J) Your work experience in Gulf countries | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | | Lower Bound | Upper Bound |
| Incentive Score | > 10 Years | < 1 Year | -0.05737 | 0.36728 | 0.876 | -0.7866 | 0.6719 |
| | | 1 - 5 Years | -.63617* | 0.30049 | 0.037 | -1.2328 | -0.0395 |
| | | 5-10 Years | -.65365* | 0.22818 | 0.005 | -1.1067 | -0.2006 |

*. The mean difference is significant at the 0.05 level.





Archana and Deivanai

Table 5: Family staying with the employee abroad

| ANOVA | | | | | | |
|-----------------|----------------|----------------|----|-------------|------|------|
| | | Sum of Squares | df | Mean Square | F | Sig. |
| Stress Score | Between Groups | .985 | 2 | .493 | .487 | .616 |
| | Within Groups | 96.015 | 95 | 1.011 | | |
| | Total | 97.000 | 97 | | | |
| Incentive Score | Between Groups | .350 | 2 | .175 | .172 | .842 |
| | Within Groups | 96.650 | 95 | 1.017 | | |
| | Total | 97.000 | 97 | | | |

Table6: Frequency of your visit to home land

| ANOVA | | | | | | |
|-----------------|----------------|----------------|----|-------------|-------|------|
| | | Sum of Squares | df | Mean Square | F | Sig. |
| Stress Score | Between Groups | 10.043 | 3 | 3.348 | 3.619 | .016 |
| | Within Groups | 86.957 | 94 | .925 | | |
| | Total | 97.000 | 97 | | | |
| Incentive Score | Between Groups | 6.225 | 3 | 2.075 | 2.149 | .099 |
| | Within Groups | 90.775 | 94 | .966 | | |
| | Total | 97.000 | 97 | | | |

Table7: Post hoc test

| Multiple Comparisons | | | | | | | |
|----------------------|---------------------|-------------------|-----------------------|------------|------|-------------------------|-------------|
| Dependent Variable | | | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | | Lower Bound | Upper Bound |
| Stress Score | 2-3 times in a year | Once in a year | .74212* | .26725 | .007 | .2115 | 1.2727 |
| | | Once in two years | .25902 | .43586 | .554 | -.6064 | 1.1244 |
| | | Rarely | -.00136 | .43586 | .998 | -.8668 | .8640 |

*. The mean difference is significant at the 0.05 level.





Effect of Green Marketing-Mix on Consumers' Intention to Purchase Green Fast-Moving Consumer Goods (FMCG): An Empirical Evidence

Umang Agrawal^{1*} and Mohammad Salman Ansari²

¹Research Scholar, Department of Commerce, Shibli National P.G. College, Azamgarh, Uttar Pradesh, India.

²Associate Professor, Department of Commerce, Shibli National P.G. College, Azamgarh, Uttar Pradesh, India.

Received: 04 June 2022

Revised: 25 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Umang Agrawal

Research Scholar,

Department of Commerce,

Shibli National P.G. College, Azamgarh,

Uttar Pradesh, India

Email: umang71994@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of this study is to analyze the relationship between the green marketing-mix and the green FMCG purchase intention and to measure the extent to which marketing-mix affect the green purchasing. Data was gathered using a structured questionnaire from the living residents of Azamgarh District. A total of 217 collected responses were analyzed by employing correlation, regression, and independent sample t-test. Findings of the study indicated that only green price and promotion have a significant relation with the green purchase intention. However, these relations were negatively very low. Any increase in green price and promotional green claims will slightly decrease the green purchase intention. Moreover, no difference was found among the responses of males and females. Both the genders reflect almost same set of minds for the green marketing and green purchasing.

Keywords: Green Marketing, Green Marketing-Mix, Green Product Purchase Intention, Green FMCG Purchase, Green Behaviour.

INTRODUCTION

Today, economies are growing. But companies' unsustainable way of profit generation has impacted the planet, negatively and their negligence brought forward various ecological issues. Environment condition has been degrading, day-by-day. Pollution has been also increasing. Natural resources are depleting at a faster rate. Marine



**Umang Agrawal and Mohammad Salman Ansari**

life has become toxic. Fresh drinking water is running out. Ozone layer has been depleting. These are just some examples which our planet is now facing. The compounding effect of these environmental problems is proving harmful for the human health and makes a way for the humanity to have a look toward these issues. Therefore, today societies are demanding from firms to have sustainable behaviour in their business practices. Since no firm can survive in isolation, they necessarily are required to coordinate with their target market. Firms should offer such products that have ability to meet their consumers' expectation and satisfy their need. With the increase in environmental discussion and concern in the societies, firms cannot evade their environmental responsibility, and this need of the hour instigates marketers to incorporate green concept in the business activities/marketing. Thus, marketers are now trying to match their activities with the environmental demands of their target segments(Solaiman et al., 2015). Under the green marketing concept, marketers try to persuade consumers by their green marketing strategies. An effective green marketing strategy requires an effective blend of the marketing elements. Therefore, by assimilating the green idea, marketers follow green marketing-mix concept. Basically, Green marketing-mix include Green Product, Green Price, Green Place/Distribution, and Green Promotion. These can also be called as '4 Green Ps' of the marketing'. All the marketing elements are equally important and interrelated with each other(Sinnappan et al., 2015),and reflect their compound effect on the consumer's choice & behaviour.

Green marketing-mix are the tools with the help of which a firm can either stand-out, or lose itself in the highly competitive market. Fast-Moving Consumer Goods(FMCG) sector is one of sectors in Indian market, that is highly competitive. It has a very large market share, i.e., consumer. Fast-Moving Consumer Goods (FMCG) sector provides everyday essentials, and therefore every consumer is highly connected with this industry, regardless of their age, gender, religion, income, class, etc. Since with the increase in the environmental awareness, Indian consumers are now recognizing the environmental issues in their purchasing. Even, Fast-Moving Consumer Goods (FMCG) sector is now also subsuming the green concept in their marketing-mix strategies(Kumar et al., 2011). But for the success of their green strategies, it is important for them to take their target consumers' behaviour in consideration. Every consumer has different personality, need, taste & preference. They differ in ability to receive the marketing messages. They translate and respond to the messages according to their behavioral characteristic, like perception, learning, attitude, personality, etc. Indian consumers are diverse in nature. At about every 50 km taste & preferences of the consumer gets changed. Therefore, to retain a large section of the consumers, evaluation of the effect of the green marketing-mix strategy on the consumers is a necessary requirement. Understanding of the effect of marketing-mix on the consumers' behaviour, and/or purchasing will help a lot in redesigning of the marketing strategy. Though, various studies were already conducted in the past to examine the relation between green marketing-mix & the consumer purchasing, or its effect on consumer behaviour. But in this regard, little or no such study is so far carried out in the Azamgarh District. Hence, this study is undertaken to understand the effect of green marketing-mix on the green purchasing intention of FMCG by the Azamgarh's consumers.

LITERATURE REVIEW**Green Marketing-Mix**

Green is now a contemporary topic. With increase in the environmental concern, companies are now investigating & evaluating the successfulness of their green marketing-mix strategies (Leonidou et al., 2013). Green marketing-mix can help marketers in improving the brand image (Papadas et al., 2017), and market share (Abzari et al., 2013) of their firms. In line with the traditional marketing-mix, there are 4 types of the green marketing-mix: Green Product, Green Price, Green Place/Distribution, and Green Promotion. These are interrelated (Sinnappan et al., 2015)and help marketers in persuading the target audience. Since every company has different need and requirements, they adopt a unique blend of these green marketing-mix elements as their green marketing strategy(Abzari et al., 2013). However, based on these elements (Ginsberg & Bloom, 2004) indicated 4 types of the green marketing-mix strategy, that a marketer can follow and implement in his marketing: Lean, Defensive, Shaded, and Extreme.



**Umang Agrawal and Mohammad Salman Ansari****Green Product**

Encouragement of the green products are the inevitable result of the scarce resources demand, wastes, and environmental problems. These are the set of ecological attributes embedded with the core product and designed after considering its whole life-cycle from manufacturing to disposal. However, eco attributes are generally intangible in nature (Fuller, 1999). Green product is the epicenter of every green marketing. There are various terms synonymously attached with it, such as ecological product, sustainable product, environmental product, eco-friendly product (Goyal, 2018)(Mahmoud, 2018). Simply, green product refers to those products which have least negative impact on the environment and its consumers. Though, it is a set of various environmental features with which marketers try to gain & retain their consumers (Dangelico & Pontrandolfo, 2010). Padmavati (2012) has defined it as “goods which causes minimal/ no harm to the environment, helps conserve resources like water and energy or less detrimental to human health”. For Goyal & Bansal (2018), green product is an alternative to enjoy a healthier life. (Eneizan et al., 2019) describe “green product as a strategy for sustainable consumption of scarce resources with the help of recycling, energy saving, and natural production”. Different authors have given different explanations for the green product (Fuller, 1999)(Chen & Chai, 2010) (Sivasamy & Yoganandan, 2017). Like every product, the success of green product also requires consumer satisfaction. Any over-emphasis on environmental benefits or consumer satisfaction may distort the image of the green product. Therefore, a green product should have a balance between environmental feature and consumer satisfaction (Ottman et al., 2006). In a nutshell, green product along-with fulfilling the need of the consumer should include environmental & health benefits like repairable, non-toxic, natural, biodegradable, recyclable, up-cycled, ozone friendly, innovative, energy efficient, no animal tested, biodiversity conservative, green certified, healthy, multiple functioning, etc. (Schmidheiny, 1992); (Coddington, 1993); (Belz, 1999); (Chen & Chai, 2010); (Sachdev, 2013); (Goyal & Bansal, 2018); (Eneizan et al., 2019).

Green Price

Green pricing is one of the major & crucial elements of the green marketing-mix. This concept is basically linked with the production of green renewable energy. (Holt & Holt, 1997) defined it as “a generic term for the offer of electricity generated from clean, environmentally-preferred sources such as solar, wind, geothermal and some types of biomass and hydro energy resources. Consumers who choose to purchase this product pay a small premium for the green electricity.” Therefore, green pricing is the amount charged from the buyer in exchange of the green products. It can be perceived as a payment for the enjoying the environmental benefits. Green pricing can help economy in shifting toward the use of renewable and eco alternatives (Ahammad, 2012). However, a green price should also have ability to cover the cost of investment incurred by the companies in green alternatives. According to (Al -Bakri, 2007) as cited by (Hashem & Al-Rifai, 2011), “The green pricing refers to the price specified in the light of company's policies with regard to environmental consideration imposed by rules and company instructions or its initiatives in this regard”.

Green Place / Distribution

Place or distribution act a means through which a consumer can access the marketer's product. It deals with all the process related with the delivery of green products from the company's warehouse to its consumers, ensuing its compatibility the environmental norms and quality (Al -Bakri, 2007). Though, relying on the renewable resources may be an extra cost to the producer in short business period. But, in real sense, green place/distribution is not a cost-generator, and rather help marketer in more revenue generation and a better company & brand image. (Hossain & Khan, 2018). As per (Solaiman et al., 2015), “Green distribution is about managing logistics to cut down on transportation emissions, thereby in effect aiming at reducing the carbon footprint”. However, green place/distribution is not only concerned with the distribution, logistic, and supply chain management. But it is also related with the internal environment of the company, business units, or distribution channels (middleman). Green place concept encourage these institutions to have a sense of environmental responsibility at their working place too (Abzari et al., 2013).





Umang Agrawal and Mohammad Salman Ansari

Green Promotion

Green promotion refers to those marketing communication which is used to inform its potential consumers about the environmental benefits of the product & services in such a way that it does not harm the environment (Mahmoud, 2019). According to (Shil, 2012), "Green promotion involves configuring the tools of promotion, such as advertising, marketing materials, signage, white papers, web sites, videos and presentations by keeping people, planet and profits in mind." By offering customers alternatives of the non-green products that do not hurt the environment and highlighting the advantages of their decisions, green advertising primarily aims to show customers that the company cares about the environment (Cherian & Jacob, 2012). However, excessively relying on green promotion may develop a perception of green washing among the consumers which lead toward downfall of the green initiative (Furlow, 2010).

Green Marketing-Mix and Green Purchase Intention

Evaluation of the consumers' behaviour is very necessary for achievement of the company's objectives. According to the (Ginsberg & Bloom, 2004), company's greenness and green market size depends upon effective understanding of the green values among the desired consumers. The level of consumers' green perception & behaviour affect the company's green policy & success. This means to say that green aspect in the marketing strategy of the firm must coincide with the consumers' green demand, and which can be done successfully by evaluating the marketing effect on the consumers or their responsiveness to the marketing changes. (Mahmoud et al., 2017) found in their study that all the 4 green Ps (green product, green price, green place, & green promotion) have a significant positive impact on the consumer green purchase intention. In addition, (Bahl & Chandra, 2018) also indicated a combined effect of the green marketing-mix on the purchasing. A critically evaluated marketing-mix will create positive eco-attitude and purchase intentions. However, (Hossain & Khan, 2018) found only green product and promotion as the influential elements. Price sensitiveness is one of the major factors influencing the green purchase intention. A reasonable & competitive price can increase consumer's green purchase intention (Karunathna et al., 2020) (Solaiman et al., 2015). Also, credible green advertising can have a significant positive impact on influencing green purchase intention (Patel & Chugan, 2015). (Hindol, 2012) by carrying out a study to examine the effect on eco-advertising on the consumer purchasing pattern found that a more relevant environmental information may bring change in purchasing pattern.

OBJECTIVES OF THE STUDY

Objectives are required to give the direction to the study. Therefore, following objectives were undertaken for this study:

- To understand the relationship between the green marketing-mix of the marketers and green FMCG purchasing intention of the Azamgarh consumers.
- To estimate the degree to which green marketing-mix influences the Azamgarh consumers' green FMCG purchasing intention.
- To analyze any difference among the gender in response to the green marketing-mix and their behaviour.

HYPOTHESES

In line with the literature referred and the objectives of the study, following hypotheses were framed and same were tested & presented in further sections:

- ❖ **H1:** There is relation between green product (GP) and green product purchase intention (GPI).
- ❖ **H2:** There is relation between green price (GPR) and green product purchase intention (GPI).
- ❖ **H3:** There is relation between green place (GPL) and green product purchase intention (GPI).
- ❖ **H4:** There is relation between green promotion (GPRO) and green product purchase intention (GPI).
- ❖ **H5:** There is a difference in the opinion of males and females regarding the said variables.





Umang Agrawal and Mohammad Salman Ansari

RESEARCH METHODOLOGY

This research study was exploratory in nature and conducted to measure the effect of green marketing-mix on the Azamgarh's consumers green purchase intention of fast-moving consumer goods (FMCG). Consumers aged between 18-65 living in the Azamgarh District were only considered for the purpose of this study. The primary data were gathered using structured questionnaire. However, questionnaire was divided into 2 sections. First section deals with the demographic information (i.e., gender, age, & monthly family income). Second section were intended to gather information related with the 5 study variables green product (GP), green price (GPR), green place (GPL), green promotion (GPRO), & green product purchase intention (GPI). A total of 19 questions were asked in section-2 on 5-point Likert scale ranging from strongly agree, agree, neutral, disagree and strongly disagree (numerically assigned from 1 to 5). A preliminary survey of 40 respondents was conducted to examine the reliability of the research instrument, i.e., questionnaire. After analyzing, Cronbach's Alpha of GP, GPR, GPL, GPRO & GPI were found to be 0.675, 0.731, 0.849, 0.661, & 0.607, respectively. Whereas, the overall Cronbach's Alpha was 0.641. According to (Malhotra & Dash, 2019), generally Cronbach's Alpha of more than 0.6 is satisfactory. Hence, the internal consistency reliability of the instrument seems satisfactory for the final data collection. A total 225 questionnaire were distributed among the target population (Azamgarh). After the removal of outliers, a final data set of 217 respondents (Table 1) were considered for the further analysis. Hypotheses of the study were tested through correlation, regression, and independent sample t-test and were summarized under their respective analysis.

FINDINGS AND INTERPRETATIONS

Pearson Correlation Analysis

Correlation was performed in order to understand the strength of relationship between the variables. The result of the analysis was summarized and put-forward as a correlation-matrix under the following table no. 2: Findings of the Pearson Correlation results into that acceptance of hypotheses H2 and H4, whereas hypotheses H1 and H3 were got rejected.

H1: Pearson correlation between green product & green purchase intention reveals a statistically insignificant relationship ($r = -.123$, $p = .070$).

H2 and H4: Pearson correlations between green price & green purchase intention, and green promotion & green purchase intention were found negatively very low, but statistically significant ($r = -.242$, $p < .001$), and ($r = -.151$, $p = .026$) respectively. It reveals that increase in green product price and green promotion will result into slightly decrease in intention to purchase the green products.

H3: Pearson correlation between green place & green purchase intention reveals a statistically insignificant and negligible relation ($r = .095$, $p = .161$). This indicates that availability of the green product and the business environmental responsibility does not have any impact on the consumers green purchase intentions.

Regression Analysis

Multiple regression was performed to analyse the effect of independent variables (GP, GPR, GPL & GPRO) on the dependent variable (GPI). Overall, all the independent variables have worked well in explaining the variation in intention to purchase green product, $F(4, 212) = 4.938$, $p < .001$. Moreover, the $R^2 = .085$ depicts that 8.6% change in dependent variable (GPI) is accounted by independent variables. However, independent variables GP & GPL failed to have a significant impact on the dependent variable GPI, individually. Table 3 summarises the findings.

Independent Sample T-Test

Independent- sample t-tests were performed to compare means for male & female of all the five study variables. Table 4 present the summary findings.



**Umang Agrawal and Mohammad Salman Ansari**

GP: There were no significant differences found ($t(215) = -.691, p = .491$) in the score with mean score for Males ($M = 2.3714, SD = .64356$) & Females ($M = 2.4304, SD = .61349$).

GPR: There were no significant differences found ($t(215) = .251, p = .802$) in the score with mean score for Males ($M = 2.6222, SD = .61349$) & Females ($M = 2.5982, SD = .71609$).

GPL: There were no significant differences found ($t(215) = -.034, p = .973$) in the score with mean score for Males ($M = 2.3048, SD = .72555$) & Females ($M = 2.3080, SD = .68196$).

GPRO: There were no significant differences found ($t(215) = .667, p = .505$) in the score with mean score for Males ($M = 2.1981, SD = .72563$) & Females ($M = 2.1321, SD = .72909$).

GPI: There were no significant differences found ($t(215) = .261, p = .794$) in the score with mean score for Males ($M = 1.7381, SD = .41076$) & Females ($M = 1.7232, SD = .42759$).

The magnitude of the differences in means (M.D. = $-.05893, 95\% \text{ CI: } -.22713 \text{ to } .10928$), (M.D. = $.02401, 95\% \text{ CI: } -.16423 \text{ to } .21225$), (M.D. = $-.00327, 95\% \text{ CI: } -.19160 \text{ to } .18506$), (M.D. = $.06595, 95\% \text{ CI: } -.12881 \text{ to } .26072$), and (M.D. = $.01488, 95\% \text{ CI: } -.09745 \text{ to } .12721$) of GP, GPR, GPL, GPRO, & GPI, respectively were very small and thus, insignificant. Hence, H5 were not supported.

CONCLUSION

Green marketing-mix is a very sensitive marketing activity. All the marketing success is based on these marketing-mix elements. Fast-Moving Consumer Goods (FMCG) Industry is an intensively competitive industry. Therefore, an effective and targeted strategy will help marketers in successful brand positioning, building loyal customers, and clean sweep all the brand competitors. This study tried to analyze the relationship between green marketing-mix and consumers green FMCG purchase intention. Findings of this study showed that only the green price and green promotion may have an impact on the green FMCG purchasing of the consumers. An increase in price will result into a slightly decrease in purchasing intention, which indicates that consumers consider green product costly and do not want to pay an increased premium amount. Similarly, a low negative relation between green promotion and purchase intention signals that some consumers perceive green FMCG promotional activity just a business gimmick to persuade them to buy their products. However, inconsistent with the previous studies (Mahmoud, 2018; Mahmoud et al., 2017) (Karunarathna et al., 2020), green product and green place showed an insignificant relation with and impact on green purchase intention. Presence of eco & health feature in the product does not significantly change the purchase intention. Moreover, ease of green accessibility is not concern for the consumer. Additionally, result witnessed no difference in the male & female consumers. Both the groups have almost same mindset regarding the marketing elements and green purchasing. Overall, result of this study signify that somehow Azamgarh's consumer do not have a clear understanding of the green marketing-mix & its benefits. They have a lack of green enthusiasm. However, spreading & educating green awareness can develop positive green perception in them toward green FMCG.

LIMITATIONS AND FUTURE DIRECTION

This study was area restricted and surveyed only those Azamgarh's consumer who are aged between 18-65 years. Because of time & cost issues, convenience sampling was resorted. Even, sampling size was very small as compared to the Azamgarh' population. There may be the possibility of response-bias. Thus, by considering these points, result may vary if this study repeated on a much larger sample size, or if consumers below 18 years were also surveyed. Future study may be conducted to understand the reason which restrict consumers form green purchasing. Further study can also be undertaken to understand the effect of green marketing-mix on the Azamgarh's consumers green purchasing mediated by environmental awareness & concern. Even, this study can be replicated at a different region, or at country level.





REFERENCES

1. Abzari, M., Shad, F. S., Sharbiyani, A. A., & Morad, A. P. (2013). Studying the effect of green marketing mix on market share increase. *European Online Journal of Natural and Social Sciences*, 2(3), 641.
2. Ahammad, R. (2012). *Green Pricing*. Energy, 2.
3. Al –Bakri, T. (2007). *Marketing and Social Responsibility (in Arabic) (1st ed.)*. Dar Wael.
4. Bahl, S., & Chandra, T. (2018). Impact of Marketing Mix on Consumer Attitude and Purchase intention towards “Green” Products. *A Journal of Research Articles in Management Science and Allied Areas*, 11(1), 1–11.
5. Belz, F. M. (1999). Eco Marketing 2005: Performance Sales instead of Product Sales. In M. Charter & M. J. Polonsky (Eds.), *Greener Marketing* (pp. 84–94). Greenleaf Publishing.
6. Chen, T. B., & Chai, L. T. (2010). Attitude towards the Environment and Green Products: Consumers’ Perspective. *Management Science and Engineering*, 4(2), 27–39. <https://doi.org/10.3968/j.mse.1913035X20100402.002>
7. Cherian, J., & Jacob, J. (2012). Green Marketing: A Study of Consumers’ Attitude towards Environment Friendly Products. *Asian Social Science*, 8(12). <https://doi.org/10.5539/ass.v8n12p117>
8. Coddington, W. (1993). *Environmental marketing: positive strategies for reaching the green consumer*. McGraw-Hill.
9. Dangelico, R. M., & Pontrandolfo, P. (2010). From green product definitions and classifications to the Green Option Matrix. *Journal of Cleaner Production*, 18, 1608–1628. <https://doi.org/10.1016/j.jclepro.2010.07.007>
10. Eneizan, B., Mohamad Alhamad, A., Bin.Mat Junoh, M. Z., & Binti Tunku Ahmad, T. S. (2019). Green Marketing Strategies: Theoretical Approach. *American Journal of Economics and Business Management*, 2(2), 77–94. <https://doi.org/10.31150/ajeblm.vol2.iss2.69>
11. Fuller, D. A. (1999). *Sustainable Marketing: Managerial - Ecological Issues*. SAGE Publications.
12. Furlow, N. E. (2010). Greenwashing in the New Millennium. *The Journal of Applied Business and Economics*, 10(6), 22.
13. Ginsberg, J. M., & Bloom, P. N. (2004). Choosing the Right Green Marketing Strategy. *MIT Sloan Management Review*, 46(1), 79–84.
14. Goyal, A., & Bansal, S. (2018). Customer Perception for Eco-Friendly FMCG Product & Factors Influencing Its Purchase. *IOSR Journal of Business and Management*, 20(2), 28–39. <https://doi.org/10.9790/487X-2002042839>
15. Goyal, A. P. (2018). “Environment- Friendly Products- Adapt Green Now.” Partridge India.
16. Hashem, T. N., & Al-Rifai, N. A. (2011). The Influence Of Applying Green Marketing Mix By Chemical Industries Companies In Three Arab States In West Asia On Consumer’s Mental Image. *International Journal of Business and Social Science*, 2(3).
17. Hindol, R. (2012). Environmental advertising and its effects on consumer purchasing patterns in West Bengal, India. *Research Journal of Management Sciences*, 1(4), 16–20.
18. Holt, E. A., & Holt, M. (1997). “GREEN PRICING RESOURCE GUIDE. The Regulatory Assistance Project.”
19. Hossain, A., & Khan, M. Y. H. (2018). Green Marketing Mix Effect on Consumers Buying Decisions in Bangladesh. *Marketing and Management of Innovations*, 4, 298–306. <https://doi.org/10.21272/MMI.2018.4-25>
20. Karunarathna, A. K. P., Bandara, V. K., Silva, A. S. T., & De Mel, W. D. H. (2020). Impact of Green Marketing Mix on Customers’ Green Purchasing Intention with Special Reference to Sri Lankan Supermarkets. *South Asian Journal of Marketing*, 1(1), 127–153.
21. Kumar, D., Kumar, I., Rahman, Z., Yadav, S., & Goyal, P. (2011). Green Marketing Mix: Rethinking Competitive Advantage during Climate Change. *The First International Conference on Interdisciplinary Research and Development*.
22. Leonidou, C. N., Katsikeas, C. S., & Morgan, N. A. (2013). “Greening” the marketing mix: do firms do it and does it pay off? *Journal of the Academy Marketing Science*, 41(2), 151–170. <https://doi.org/10.1007/s11747-012-0317-2>
23. Mahmoud, T. O. (2018). Impact of Green Marketing Mix on Purchase Intention. *International Journal of Advanced and Applied Sciences*, 5(2), 127–135. <https://doi.org/10.21833/ijaas.2018.02.020>
24. Mahmoud, T. O. (2019). “Green Marketing: A Marketing Mix concept.” *International Journal of Electrical*,





Umang Agrawal and Mohammad Salman Ansari

- Electronics and Computers, 4(1), 20–26. <https://doi.org/10.22161/EEC.4.1.3>
25. Mahmoud, T. O., Ibrahim, S. B., Ali, A. H., & Bleadly, A. (2017). "The Influence of Green Marketing Mix on Purchase Intention: The Mediation Role of Environmental Knowledge Does Environmental knowledge moderate the relationship between the green marketing mix and purchase intention View project Decision of Listing in St. International Journal of Scientific and Engineering Research, 8(9). <https://doi.org/10.14299/ijser.2017.09.006>
 26. Malhotra, N. K., & Dash, S. (2019). Marketing Research: An Applied Orientation. Pearson Education.
 27. Ottman, J. A., Stafford, E. R., & Hartman, C. L. (2006). Avoiding green marketing myopia: Ways to improve consumer appeal for environmentally preferable products. Environment Science and Policy for Sustainable Development, 48(5), 22–36. <https://doi.org/10.3200/ENVT.48.5.22-36>
 28. Padmavati, D. (2012). "Green Consumer Behaviour- An Empirical Study With Respect to Select Eco-Friendly Products." Bharathiar University, Coimbatore.
 29. Papadas, K.-K., Avlonitis, G. J., & Carrigan, M. (2017). Green Marketing Orientation: Conceptualization, Scale Development and Validation. Journal of Business Research, 80, 236–246. <https://doi.org/10.1016/j.jbusres.2017.05.024>
 30. Patel, C., & Chugan, P. K. (2015). The Influence of Consumer Perception Towards Green Advertising on Green Purchase Intention. International Journal of Entrepreneurship & Business Environment Perspectives, 4(3), 1865–1873.
 31. Sachdev, S. (2013). "GREEN MARKETING CONSUMER ATTITUDE TOWARDS ECO FRIENDLY FAST MOVING HOUSEHOLD CARE AND PERSONAL CARE PRODUCTS."
 32. Schmidheiny, S. (1992). Changing Course: A Global Business Perspective on Development and the Environment. In Foreign Affairs (Issue 4). MIT Press.
 33. Shil, P. (2012). EVOLUTION AND FUTURE OF ENVIRONMENTAL MARKETING. IRJC Asia Pacific Journal of Marketing & Management Review, 1(3).
 34. Sinnappan, P., Aziz, Y. A., & Rahman, A. A. (2015). Conceptualisation of Green Marketing Mix in the Hotel Industry. INNOVATION AND BEST PRACTICES IN HOSPITALITY AND TOURISM RESEARCH, 227–231. <https://doi.org/10.1201/B19162-50>
 35. Sivasamy, G., & Yoganandan, G. (2017). A study on green products buying behaviour in Indian market . International Journal of Multidisciplinary Research and Development, 4(8).
 36. Solaiman, M., Osman, A., & Halim, M. S. B. A. (2015). Green Marketing: A Marketing Mix Point of View. International Journal of Business and Technopreneurship, 5(1), 87–98.

Table 1: Demographic Profile

| Profiles | Frequency | Percentage |
|------------------------------|-----------|------------|
| Gender | | |
| Male | 105 | 48.40% |
| Female | 112 | 51.60% |
| Total | 217 | 100.00% |
| Age | | |
| 18-30 | 67 | 30.90% |
| 31-40 | 75 | 34.50% |
| 41-50 | 49 | 22.60% |
| 51-65 | 26 | 12.00% |
| Total | 217 | 100.00% |
| Family Monthly Income | | |
| Below 10000 | 65 | 30.00% |
| 10001-20000 | 62 | 28.60% |
| 20001-30000 | 39 | 18.00% |
| 30001-40000 | 17 | 7.70% |
| 40001-50000 | 18 | 8.30% |
| 50001 & Above | 16 | 7.40% |
| Total | 217 | 100.00% |





Umang Agrawal and Mohammad Salman Ansari

Table 2: Correlation-Matrix

| | GP | GPR | GPL | GPRO | GPI |
|------|--------|--------|-------|--------|-----|
| GP | 1 | | | | |
| GPR | .112 | 1 | | | |
| GPL | -.283* | .020 | 1 | | |
| GPRO | .070 | .158* | -.016 | 1 | |
| GPI | -.123 | -.242* | .095 | -.151* | 1 |

*Correlation is significant at the 0.05 level (2-tailed).

Table 3: Multiple Regression Analysis

| Hypotheses | Regression Weights | Beta Coefficient | t | p-value | Hypotheses Supported |
|----------------|--------------------|------------------|--------|---------|----------------------|
| H1 | GP→GPI | -.046 | -.996 | .320 | NO |
| H2 | GPR→ GPI | -.130 | -3.254 | .001 | YES |
| H3 | GPL→ GPI | .047 | 1.143 | .254 | NO |
| H4 | GPRO→ GPI | -.063 | -1.653 | .001 | YES |
| R ² | .085 | | | | |
| F (4, 212) | 4.938 | | | | |

Note: *p < 0.05

Table 4: Independent Sample T-Test

| Variables | Gender | Means | SD | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|-----------|--------|--------|--------|---|------|------------------------------|-----|-----------------|-----------------|-----------------------|---|--------|
| | | | | F | Sig. | t | df | Sig. (2-Tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | | | Lower | Upper |
| GP | M | 2.3714 | .64356 | .147 | .702 | -.691 | 215 | .491 | -.05893 | .08534 | -.22713 | .10928 |
| | F | 2.4304 | .61349 | | | | | | | | | |
| GPR | M | 2.6222 | .68884 | .137 | .712 | .251 | 215 | .802 | .02401 | .09550 | -.16423 | .21225 |
| | F | 2.5982 | .71609 | | | | | | | | | |
| GPL | M | 2.3048 | .72555 | .364 | .547 | -.034 | 215 | .973 | -.00327 | .09555 | -.19160 | .18506 |
| | F | 2.3080 | .68196 | | | | | | | | | |
| GPRO | M | 2.1981 | .72563 | .095 | .758 | .667 | 215 | .505 | .06595 | .09881 | -.12881 | .26072 |
| | F | 2.1321 | .72909 | | | | | | | | | |
| GPI | M | 1.7381 | .41076 | .116 | .733 | .261 | 215 | .794 | .01488 | .05699 | -.09745 | .12721 |
| | F | 1.7232 | .42759 | | | | | | | | | |

Note: M= Male and F= Female





Umang Agrawal and Mohammad Salman Ansari

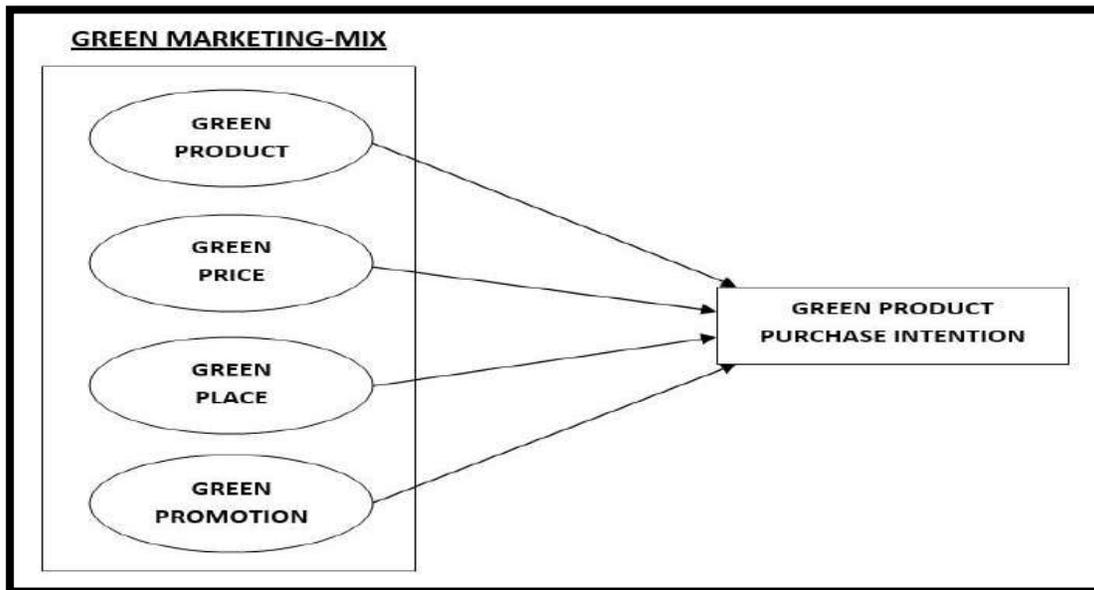


Figure 1: Theoretical Framework





Drivers of Green Supply Chain Management with Special Reference To MSME

Angel Chakraborty

Assistant Professor, Department of MBA, Brindavan College, Dwarakanagar, Yelahanka, Bengaluru, India.

Received: 05 June 2022

Revised: 24 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Angel Chakraborty

Assistant Professor, Department of MBA,
Brindavan College, Dwarakanagar,
Yelahanka, Bengaluru, India.
Email: angel.chakraborty@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

There are different drivers of GSCM with respect to agro-sector. This study includes the Eight elements of sustainable green supply chain network, associated risk variables and their impact. Effective GSCM execution relies up on strengthening on farmers 'reception of eco-friendly practices under ecological vulnerabilities. The examination is an end eavorto uncover interior and outer tension for reception of GSCM with unique reference to a gro based MSME in India. It aims to give a coordinated supply chain network frame work and recognize key variables for Information Communication Technology (ICT) applications for a practical development of agro based MSME in India in terms of financial, natural, and social execution. The agro-industry has considerable negative effects on the environment, society, and the economy, according to the findings. The study's findings showed that, when compared to the other 11 PIs, three PIs—environmental management (PI 1), competitive pressure (PI 2), and regulatory pressure (PI 3)—are significantly more important.

Keywords: Green Supply Chain Management, MSME, Sustainability, agro-industry, Review of Literature, GSCM Drivers.

INTRODUCTION

Consumer awareness about green practices is very critical for sustainable development in general. Supply Chain management refers to coordinated inflow and outflow of goods and information from the origin to the destination or from the place of origin till consumption. It includes transformation of raw material into finished goods and distribution of goods and services to end users. The supply chain management process involves the following steps: plan, source, make, deliver, and return. It is a process of integrating supply and demand not only within the organization but also outside. Green supply chain management" (GSCM) alludes to the idea of incorporating economical natural cycles into the conventional supply chain. This can incorporate cycles, for example, green



**Angel Chakraborty**

sourcing, green product design, green manufacturing, green packaging, green material handling and choice, green assembling and creation, green distribution etc. Indian government is the largest customer of MSME based products and services. MSME contribute approximately 8% of the nation's GDP, 45% of manufacturing output, 40% total export of the country. Therefore, It will not be inappropriate to allude them as the 'Backbone of the country'. In order to comprehend and improve the role of GSCM, the current research attempts to address a wide variety of subjects w.r.t agro based MSME in India. MSMEs are a significant area for the Indian economy and have contributed colossally to the country's financial turn of events. It creates business openings as well as works connected at the hip towards the advancement of the country's retrogressive and provincial regions. According to the authority information as of 31st Aug 2021, there are as of now roughly 6.3 crore MSMEs in India. The research primarily focuses on identifying the key drivers or execution pointers of GSCM IN Agro based MSME in India. It is necessary to underline their relationship with each other as well as overall GSCM implementation along with various challenges and risk variables. It is vital to find answers for the questions like:

- Q1. Which are the essential EPs of GSCM in terms of the agro-based supply chain?
- Q2. What is the relationship between the chosen EPs?
- Q3. Which EPs have the greatest impact?

GSCM adoption works on the general productivity of the supply chain and further develops intensity. Henceforth, there is an impressive need to investigate and display the highly influential EPs of GSCM. Building environmentally friendly supply chain administration methods is the main source of the multidisciplinary issue known as "green supply chain." (Eltayeb et al., 2011). Srivastava (2007) detailed that The introduction of the GSCM idea aimed to foster ecological thinking in SCM. It includes phases such as product design, material sourcing and selection, manufacturing processes, product delivery, and product end-of-life management. As may very well be inferred from the term, GSCM offers a remarkably broad range of potential applications. Each firm must achieve a balance in the economic, social, and ecological cycles and be successful in its efforts with regard to each of these three factors if it is to be sustainable. In any case, because of the intricacy of these characteristics and their association between them, it isn't not difficult to accomplish this equilibrium and arrive at progress. Diabat and Govindan (2011) brought up that GSCM might turn out a decent method for adjusting ecological, financial, and social benefits.

It is essential to educate agro-based farmers about the benefits of adoption of ecofriendly practices with proper knowledge transfer and training programs with the help of technology. Information and communication technology plays a very important role in reducing wates and improving efficiency in the supply chain. Considering the previously cited inadequacies, in this paper, we distinguished few GSCM facets like (green procurement, green production, green logistics, green packaging, green marketing, ecological training, inward natural administration and venture recuperation) and meant to explore the impacts of these aspects on monetary, natural, and social execution.

Critical Review of Literatures and Identification of research gaps

Bhaskar Gardas et.al (2018) worked on the key performance indicators for the agro-green industry's supply chain management. One of the fundamental problems facing the globe today is the question of food security. The importance of implementing green supply chain management (GSCM) in their supply chains has begun to dawn on the government and enterprises. In the agro-area, there are many GSCM drivers. This paper plans to investigate 14 such drivers utilizing an interpretive primary demonstrating (ISM) approach. The after effect of the examination underlined those three drivers, specifically, ecological administration, administrative pressure and competitive pressure strain are the critical ones having high driving power. Taking everything into account Only 14 critical drivers were considered for the investigation. Additionally, well qualified judgments utilized in the review could be biased which impact the dependability of the model. It tends to be improved with ISM technique other MCDM tools, for example, analytic hierarchy process, analytic network process, interpretive ranking process. Sheila Namagembe (2020) studied boosting environmentally acceptable adequate procedures in SME agri-food upstream chains. The review inspected the impact of natural guidelines set by the SME agro-based handling firms and farmers' ecological



**Angel Chakraborty**

empowerment on farmers' reception of harmless to the ecosystem agrarian practices. Environmental standards and SME agricultural processing firms were found to be positively correlated. But the study largely addresses the upstream supply chains efficiency. Vanessa Yanes- Este'vez et. al (2010) observed Perceived environmental vulnerabilities in agri-food distribution network. He expected to foster a conclusion of the atmosphere of the agri-food distribution channels dependent on individuals' impression of natural vulnerability. As per the view of the people belong from agri-food sector (agriculture, agri-food business, and dispersion), the fundamental wellsprings related to ecological vulnerability are requirement and rivals. The agriculture area sees to some degree more vulnerability than agri-food industry area, while the dispersion area sees a steady environment. For future study Investigation of the likelihood of each firm seeing each ecological variable as pretty much mind boggling, or dynamic can be redrawn based on present requirements.

Jitesh Thakkar et. al (2009) discussed the Supply chain management for SMEs. He proposed key regions that impact dealing with the distribution networks in the small and medium-sized enterprises. It diagrams the research ecosystem of SCM in SMEs. Insightful inquiries were determined and further assembled to distinguish explicit issues and additionally spaces of concern. A critical path method (CPM) plan is proposed for using time productively. Future examinations are relied upon to recognize causal relationships among SCM and SMEs, which will additionally assist with focusing on decision making in SMEs. Nearsighted perspectives and limitation bring about frail quality cycles and products, late conveyances, issues with stock administration and a helpless confound among demand and predictions can be observed under states of vulnerability. Ravindra Baliga et.al (2019) confirms the result of SSCM depends on the three main concern methodology, thus being characterized not just in friendly and green terms, rather likewise economical term as well. His work is to foster an incorporated review which utilizes forerunner practices execution standards to decide the drivers of SSCM practices. As per his observation he found that motivators, lean management and supply management have lot of positive influence on natural and social practices in the SCM. This model was developed for the manufacturing setup. Subsequently, future scientists can maybe zero in on one specific area/industry for expanded believability and legitimacy of results.

Arun Jose et.al (2019) elaborated the Supply chain concerns in the Indian SME food region. He highlighted the various modeling techniques used in SME FSC and explored important supply chain issues in Indian small and medium-sized businesses, particularly in the food industry. In the FSC, he recognized five key study themes. The dairy industry (36%) receives the most attention, followed by fruits and vegetables (27%), meat and poultry (18%), fish (10%), and grains and oilseeds (9%). (8 percent). The dairy industry has received significant attention in the topic "GHG Emission Effect of Homestead Food Framework" as well as "Traceability and Product Quality" for meat and poultry. Rebeca B. Sánchez-Flores et. al (2020) global evaluation of supply chain management for sustainable development in developing nations. To investigate the three aspects of sustainability and how they affect supply chain performance, he carried out a methodical literature review. Additionally, he mentioned how important topics like partnerships, originality, obtaining, supplier development, environmental and social implications, new technology, etc. were in SSCM. They have great influence on emerging market operations and execution. Although, social issues research in SSCM is very limited and primarily focused on developed countries. It will be interesting to see the relationship between economic performance & Social Performance in future.

Tadesse Kenea Amentae et. al (2021) analyzed the likely contribution of digitalization of the food supply chain system by assessing 76 research papers. He adopted descriptive content analysis with MAXQDA 2020 software. Artificial intelligence, big-data analytics, Block chain, the Internet of Things, and similar information and communications technologies were recognized as initiators for viable conversion of the food supply chain system. Although, the complexity of implementation of IoT implementation, risk propensity, risk awareness and implementation of advanced technologies without covering agro-food small and medium enterprises (SMEs). R.P. Mohanty (2014) affirms and approves that Indian MSMEs face huge compels from outside partners to take on GSCM practices. As indicated by him major elements of GSCM in India includes inbound greening, ecological greening, reverse logistics greening, outbound greening, technology greening and compliance greening. The examination on GSCM rehearses have been seen as generally restricted to large organizations. He suggests that future exploration



**Angel Chakraborty**

can use structural equation modeling methodology for GSCM. Purba Halady Rao (2019) observed that eco-friendly Inbound Logistics is substantially attained but eco-friendly Inbound Logistics with respect to process is not substantially attained. Eco-friendly production is being attained but outbound logistics is not attained. The study elaborated the economic performance and environmental performance association. The review centers around GSCM which can impact environmental performance yet needs incorporation of feasible advancement boundaries for by and large improvement of supply chain. Harish Babu et.al (2020), identified the major risk variables and their association towards manufacturing SMEs. Author also suggested that in future structural equation modeling (SEM), etc can be used to identify different risk variables for different industries. He concluded that most influencing risk variables are information technology risk, financial risk and external risk.

Literature Review Gaps

As can be seen from the literature review section above, particularly when employing multi-criteria decision-making approaches, very little study has been done on the needed EPs for the implementation of GSCM in the agro-industry. Additionally, it's important to lessen the experts' biases when making decisions so that the generated model is more reliable.

OBJECTIVES

- To find the execution pointers or drivers of GSCM w.r.t Agro-based MSME in India.
- To analyze the components of GSCM w.r.t Agro-based MSME in India.
- To enhance GSCM efficacy in agro based MSME in India.

METHODOLOGY

I will direct my exploration embracing an experimental and iterative methodology, primarily empirical. Firstly, I will conduct a thorough literature review on new trends in GSCM with special reference to Agro-Based MSME in India. This underlying stage will fabricate a fundamental beginning for the remainder of my work.

OUTCOME OF THE REVIEW

This review outlined the strategic green supply chain framework, execution pointers, new theories and concepts along with supporting facts to enhance supply chain efficacy and improve overall holistic performance and sustainability of agro-based MSME in India.

CONCLUSION

The agricultural industry has substantial environmental, social, and economic consequences. Crop yield and productivity must be raised to meet rising food demand. Using innovative techniques like precision farming, agricultural output may be increased. Additionally, the effectiveness of the current supply chains must be increased. Increasing the efficiency of the food supply chain will help to meet the growing demand for food while creating less environmental harm. In this study, a literature review was used to determine the EPs of GSCM in the agro-industry. The levels of each EP were determined via level portioning after the creation of a reach ability matrix. The study's findings showed that, in comparison to the other 11 PIs, three PIs—environmental management (PI 1), regulatory pressure (PI 3), and competitive pressure (PI 2)—are significantly more important. The effectiveness of agricultural supply chains as a whole can be significantly impacted by green agriculture approaches. The results of this study can be used by managers, supply chain designers, and policymakers to better understand how the key PIs interact with one another. Additionally, the research supports the development of policies and strategies for ensuring food security, protecting the environment, and improving industry financial performance. To better address shifting customer expectations, managers in the food industry and agriculture can enhance the sustainability of processes



**Angel Chakraborty**

and products. Additionally, the amount of time needed for the ideas to be implemented effectively might be looked at.

LIMITATIONS AND FUTURE STUDIES

This rapid literature review mainly focused on green supply chain practices and its implementation in MSME. The results are outcome of preliminary information gathered and the research is in its initial stages. Future research may examine moderator effects to better understand how GSCM affects performance utilizing ISM and MCDM Methodologies.

REFERENCES

1. Abdel-Basset, M., Gunasekaran, M., Mohamed, M. and Chilamkurti, N. (2019), "A framework for risk assessment, management and evaluation: economic tool for quantifying risks in supply chain", *Future Generation Computer Systems*, Vol. 90, pp. 489-502.
2. Alkhalidi, A., Tahat, S., Smadi, M., Migdady, B. and Kaylani, H. (2019), "Risk assessment using the analytic hierarchy process while planning and prior to constructing wind projects in Jordan", *Wind Engineering*.
3. Arun Jose et.al (2019), Supply chain issues in SME food sector: a system aticreview, *Journal of Advances in Management Research*, Vol. 17, No. 1, 2020, pp. 19-65, Emerald Publishing Limited, 0972-7981.
4. Bag, S. and Anand, N. (2015), "Modelling barriers of sustainable supply chain network design using interpretive structural modeling: an insight from food processing sector in India", *International Journal of Automation and Logistics*, Vol. 1 No. 3, pp. 234-255.
5. Banu, N. and Yashoda, K. (2018), "Empowering young farmers for sustainable agriculture", *Journal of Pharmacognosy and Phytochemistry*, Vol. 7 No. 3, pp.3291-3300.
6. Bhaskar Gardas et.al (2018), Exploring the key performance indicators of green supply chain management in agro-industry, *Journal of Modelling in management*, Emerald Publishing Limited, 1746-5664.
7. Choi, D. and Hwang, T. (2015), "The impact of green supply chain management practices on firm performance: the role of collaborative capability", *Operations Management Research*, Vol. 8 Nos 3/4, pp. 69-83.
8. Ghosh, M. (2019), "Determinants of green procurement implementation and its impact on firm performance", *Journal of Manufacturing Technology Management*, Vol. 30 No. 2, pp. 462-482.
9. Harish Babu et.al (2020), Modelling the supply chain risk variables using ISM: a case study on Indian manufacturing SMEs, *Journal of Modelling in Management*, Emerald Publishing Limited, 1746-5664.
10. Jitesh Thakkar et. al (2009), Supply chain management for SMEs: a research introduction, *Management Research News*, Vol. 3, No. 10, Emerald Group Publishing Limited, pp. 970-993.
11. PurbaHalady Rao (2019), Green Supply Chain Management: A Study Based on SMEs in India, *Journal of Supply Chain Management Systems*, Volume 8 Issue1 2019, 15-24.
12. R.P. Mohanty (2014), Green supply chain management practices in India: an empirical study, *Taylor & Francis, Production Planning & Control*, 2014, Vol.25, No. 16, 1322-1337.
13. Ravindra Baliga et.al (2019), Sustainable supply chain management practices and performance, *Management of Environmental Quality: An International Journal*, Emerald Publishing Limited, 1477-7835.
14. Rebeca B. Sánchez-Flores et. al (2020), Sustainable Supply Chain Management—A Literature Review on Emerging Economies, *Sustainability* 2020, 12, 6972.





Angel Chakraborty

Table 1: Reach ability matrix of Performance Indicators

| S. No. | Performance indicators | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--------|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
| 1 | Organisational environmental management (PI 1) | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | Competitive pressure (PI 2) | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | Regulatory pressure (PI 3) | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 4 | Green design (PI 4) | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | Green purchasing (PI 5) | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | Green manufacturing (PI 6) | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 7 | Knowledge and training (PI 7) | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 8 | Collaborative cold storages and green transportation (PI 8) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | Brand image and market share (PI 9) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 10 | Operational performance (PI 10) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 11 | Economic performance (PI 11) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 12 | Environmental performance (PI 12) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 13 | Cooperation with customers and suppliers for joint action (PI 13) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 14 | Reverse logistics (PI 14) | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |

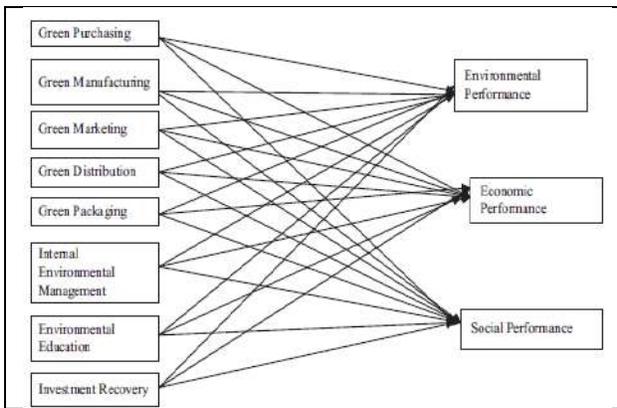


Figure 1: Theoretical Model of EPs Relationship

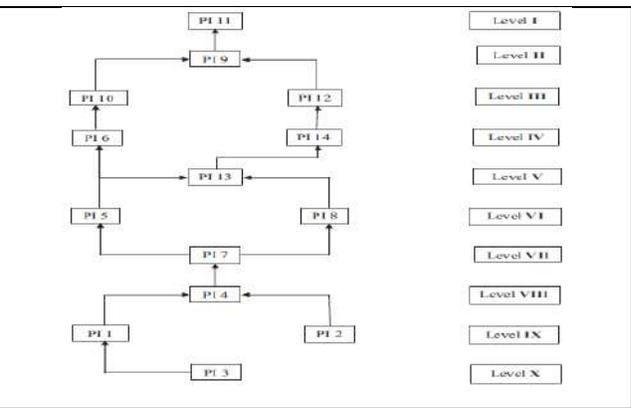


Figure 2: Performance Indicator Levels





Effect of Covid-19 Pandemic on Foreign Direct Investment: Indian Perspective

Subba Rayudu Thunga^{1*} and Lavanya P B²

¹Associate Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India,

²Assistant Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India

Received: 01 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Subba Rayudu Thunga

Associate Professor,

Andhra Loyola Institute of Engineering and Technology,

Vijayawada, Andhra Pradesh, India,

Email: rayudu.thunga@gmail.com,



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Capital inflows are the most important source of investment for developing economies like India and acts as an engine for fostering economic growth. But the world economy has been witnessing a great difficulty for the last two years due to Covid pandemic. This has impacted the investment pattern across the business environment. The pandemic has created great uncertainty on investments. World foreign direct investment inflows fell by half up to second quarter of 2020 and the measures taken by governments could not encourage investments at global level. Investors' preference also changed because of pandemic from investments in primary and manufacturing sectors to other desirable sectors. Keeping in view the above objective the key aim of this research is to get out the outcome of Covid epidemic on foreign direct investment flows from different countries to India using yearly data for the time period 2018 to 2022. The study is based on secondary sources. Data were analyzed using parametric test. The results shows foreign direct investments differ significantly between the countries and sectors. However it does not differ significantly between the years. The study limits to foreign direct investment flows from few countries to select sectors. The findings will be valuable to the policy makers for attracting more funds into the desirable sectors for fostering economic development.

Keywords: Covid-19 pandemic, Crisis, Foreign Direct Investment (FDI), Lockdown, Priority sectors.





INTRODUCTION

Investments are the key for economic development (Liesbeth et al., 2008) and human progress (Torabi, 2015), due to that it is an important to increase the wealth of nation as well as individuals. Among the many investments, FDI has a crucial Impact on the fiscal development of a country, as a form to attract funds to develop and progress the nation and the quality of human capital (Simionescu & Naros, 2019). FDI is an investment made by investor or company of one country in another in various forms. It facilitates in advancement of a nation in terms of technology, human potential and enhances economic growth (Alfarro, 2017). FDI can also signify an input for inclusive growth in specific sectors (Cicea et al., 2019). Increase of GDP and Quality of human life is a yardstick for the development of a country (Botha et al., 2020). During 1990s Foreign Direct Investments was proved to be the most significant source of investment for developing countries. (Mahmoodi & Mahmoodi, 2016). The positive consequence of investment in FDI is that it has less volatile to economic cycle. It is a boost for the emerging economies like India for its economic growth. This paper is going to examine the effect of covid-19 pandemic on foreign direct investment with Indian perspective.

Literature review

Internationalization is a driving force integrating economies across the globe (Velde, 2005) and develops economies (Iqbal et al., 2012). It has significant impact of capital movement among various nations (Hill & McKaig, 2015). Host countries derive many benefits with the inflows from foreign nations (Büthe & Milner, 2008). Technical, Skill, managerial gaps of nations, people and business can be bridged with FDIs (Masron et al., 2012). FDI creates job opportunities, helps in fostering GDP, infrastructure, competition and enhance productivity of the host nations (Edrak et al., 2014). Similar outcomes were found in the study of Yucel (2014) and Yildirim and Tosuner (2014). Foreign Direct investment in any country is influenced by multiple factors. Political Environment is one of the important factors of FDI flows Büthe and Milner (2008). Governments of emerging economies are making efforts to encourage overseas inflows by liberalized policies (Masron et al., 2012). Study of Wang and Wong (2011), proved that various incentives such as tax and financial assistance to MNCs attracts more potential foreign inflows. Many studies pointed out the negative consequences of FDIs on host countries. Investors and business entities are pulling out the profits from host to home countries (Hill & McKaig, 2015). Emerging economies are facing the trouble of over dependence on foreign inflows and irregular inflows and investment low priority and less- tech industries creating pressure on domestic firms Chen et al. (2010). The negative consequences lead to restricted entry of FDIs by those nations.

Objectives of the study

The purpose of present research is to know the conceptual framework of foreign direct investment and examine the effect of covid-19 epidemic on foreign direct investment flows from different countries to India for the time period 2018 to 2022.

Research hypothesis

H₀₁ = Foreign Direct Investment do not differ significantly between the years

H₀₂ = Foreign Direct Investment do not differ significantly between the countries

H₀₃ = Foreign Direct Investment do not differ significantly between the sectors

Methodology of the study

Sources for data collection

The data has been gathered from secondary sources which include annual reports of Reserve Bank of India, journals, magazines.





Techniques for data analysis

Information collected from different sources was examined with statistical technique of analysis of variance without replication

Analysis and Discussion

Figure 1 depicts that growth rate of inflows to Indian economy from other countries during the study period recorded positive growth except Mauritius and Germany. Switzerland recorded highest growth rate followed by US, Cayman Island, UK, Canada, Netherlands and Singapore. Figure 2 exhibits growth rate of inflows in various sectors to India. Analysis revealed that all the selected sectors showed a positive growth rate between 2018 to 2022 except for communication services and Electricity & other energy generation sectors. Education and R & D has highest inflow potential followed by mining, computer services, manufacturing, hospitality, transport, retail & wholesale, construction and financial services.

Inference

Since the value of F is 1.11 which is less than 2.92 therefore, we accept the null hypothesis concluding that overseas investments not differ between the years. The value of F 23.28 is more than 2.16 therefore; we reject the null hypothesis concluding that overseas investments differ between the countries

Inference

Since the value of F = 0.52 is less than 2.92 hence, we accept null hypothesis concluding that overseas investment not differ between the years. The value of F 4.72 is more than 2.16 therefore; we reject null hypothesis concluding that overseas investments differ between the sectors.

CONCLUSION

The study has found that there are significant differences between countries and sectors regarding foreign direct investment flows to India. Additionally, foreign direct investment flows do not differ significantly between the years. The present study is not free from limitations. Firstly, the study has been conducted based on secondary data. Secondly, the study covers a period of five years i.e. 2018 to 2022. Thirdly, the study has considered foreign direct investment flows of 11 countries. The limitations of this study can provide a scope for further qualitative study in the field of foreign direct investment from many countries; further studies can also continue the effect of government policy initiatives in specific sectors and its impact on foreign direct investment. The study concluded that foreign inflows are not sufficient for fostering economies like India. Especially more investment support is required in priority sectors such as manufacturing, energy, hospitality and other priority and growing sectors for fostering economic growth. Therefore, this study has a significant contribution to the government and policy makers to attract more funds in to the desirable sectors.

REFERENCES

1. Abdouli, M., & Hammami, S. (2017). Investigating the causality links between environmental quality, foreign direct investment and economic growth in MENA countries. *International Business Review*, 26(2), 264–278.
2. Azman Saini, W. N. W., Baharumshah, A. Z., & Law, S. H. (2010). Foreign direct investment, economic freedom and economic growth: International evidence. *Economic Modelling*, 27(5), 1079–1089.
3. Amar Iqbal Anwar & Mazhar Mughal, 2012. "Economic Freedom and Indian Outward Foreign Direct Investment: An Empirical Analysis," *Economics Bulletin*, AccessEcon, vol. 32(4), pages 2991-3007.
4. Botha, I., Botezatu, M. A., & Coanca, M. (2020). Innovative calculation model for evaluating regional sustainable development. *Economic Computation and Economic Cybernetics Studies and Research*, 54(3), 5–24.



**Subba Rayudu Thunga and Lavanya**

5. Büthe, T., & Milner, H. V. (2008). The Politics of Foreign Direct Investment into Developing Countries: Increasing FDI through International Trade Agreements? *American Journal of Political Science*, 52, 741-762.
6. Bakhsh, K., Rose, S., Ali, M. F., Ahmad, N., & Shahbaz, M. (2017). Economic growth, CO2 emissions, renewable waste and FDI relation in Pakistan: New evidences from 3SLS. *Journal of Environmental Management*, 196, 627–632. <https://doi.org/10.1016/j.jenvman.2017.03.029>
7. Billas, V. (2020). FDI and economic growth in EU13 countries: Co integration and causality tests. *Journal of Competitiveness*, 12(3), 47–63.
8. Chen, C.-M., Melachroinos, K., & Chang, K.-T. (2010). FDI and Local Economic Development: The Case of Taiwanese Investment in Kunshan. *European Planning Studies*, 18, 213-238.
9. Carbonell, J. B., & Werner, R. A. (2018). Does foreign direct investment generate economic growth? A new empirical approach applied to Spain. *Economic Geography*, 94(4), 425–456. <https://doi.org/10.1080/00130095.2017.1393312>
10. Chaudhary, N. (2018). Foreign direct investment and economic growth in India. *Pacific Business Review International*, 10(12), 113–118.
11. Cicea, C., & Marinescu, C. (2021). Bibliometric analysis of foreign direct investment and economic growth relationship. A research agenda. *Journal of Business Economics and Management*, 22(2), 445-446.
12. De Andrade, A. G., & Quing, Y. (2015). The role of foreign direct investment on economic growth. In *Proceedings of the 12th International Conference on Innovation and Management* (pp. 1110–1114).
13. Dinh TT-H, Vo DH, The Vo A, Nguyen TC (2019). Foreign Direct Investment and Economic Growth in the Short Run and Long Run: Empirical Evidence from Developing Countries. *Journal of Risk and Financial Management*. 2019; 12(4):176. <https://doi.org/10.3390/jrfm12040176>
14. Edrak, B. B., Gharleghi, B., Fah, B. C. Y., & Tan, M. (2014). Critical Success Factors Affecting Malaysia' SMEs through Inward FDI: Case of Service Sector. *Asian Social Science*, 10, 131-138
15. Furková, A. (2012). Does foreign direct investment affect economic growth? Evidence from OECD countries. In *Proceedings of the International Conference Quantitative Methods in Economics. Multiple criteria decision making XVI* (pp. 56–61).
16. Ghasem Torabi (2015, May 1). Foreign Direct Investment and Human Development: The Law and Economics of International Investment Agreements. *Journal of Human development and capabilities*, 15(2), 316-317.
17. Hill, C., & McKaig, T. (2015). *Global Business Today* (4th Canadian ed.). Toronto: McGraw-Hill Ryerson.
18. Hagan, E., & Amoah, A. (2020). Foreign direct investment and economic growth nexus in Africa New evidence from the new financial fragility measure. *African Journal of Economic and Management Studies*, 11(1), 1–17.
19. Hakimi, A., & Hamdi, H. (2016). Trade liberalization, FDI inflows, environmental quality and economic growth: A comparative analysis between Tunisia and Morocco. *Renewable and Sustainable Energy Reviews*, 58, 1445–1456.
20. Hlavacek, P., & Bal Domanska, B. (2016). Impact of foreign direct investment on economic growth in Central and Eastern European countries. *Inzinerine Ekonomika-Engineering Economics*, 27(3), 294–303.
21. Hussain, M. E., & Haque, M. (2016). Foreign direct investment, trade, and economic growth: An empirical analysis of Bangladesh. *Economies*, 4(2).
22. Iamsiraroj, S. (2016). The foreign direct investment-economic growth nexus. *International Review of Economics & Finance*, 42, 116–133.
23. Khamphengvong, V., Xia, E., & Srithilat, K. (2017, July). The relationship among FDI, trade openness and economic growth: Empirical evidence from Lao PDR. In *4th International Conference on Industrial Economics System and Industrial Security Engineering (IEIS)* (pp. 1–6). Kyoto, Japan.
24. Kondyan, S., & Yenokyan, K. (2019). The effect of foreign direct investment on economic growth. *Eastern Economic Journal*, 45(4), 532–564.
25. Laura Alfaro (2017, March). Gains from Foreign Direct Investment: Macro and Micro Approaches. *The World Bank economic review*, 30(1), S2-S15.
26. Liesbeth Colen, Miet Maertens and Jo Swinnen LICOS (2008, September). Foreign direct investment as an engine for economic growth and human development: a review of the arguments and empirical evidence. LICOS Centre for Institutions and Economic Performance, Working Paper No. 16 - September 2008 Prepared for the IAP P6/06 Project, Working Package FDI-1.





Subba Rayudu Thunga and Lavanya

27. Maria-Simona Naroş (2019, June). Foreign Direct Investment and Human Capital Formation. Journal of Intercultural Management, 11(2), 163-178.
28. Majid Mahmoodi & Elahe Mahmoodi (2016, February). Foreign direct investment, exports and economic growth: evidence from two panels of developing countries. Economic Research-Ekonomska Istraživanja 29(1), 938-949.
29. Tajul Ariffin Masron, Zulkornain Yusop (2012, November). The ASEAN investment area, other FDI initiatives, and intra-ASEAN foreign direct investment. Asian Pacific Economic Literature, 26(2), 88-103.
30. Velde, D. W. (2005). Globalisation and Education: What Do the Trade, Investment and Migration Literatures Tell Us? London: Overseas Development Institute.
31. Vijayalakshmi, R., Palanisingham, V., Lingavel, G., & Gurumoorthy, T. R. (2019). Factors determining in foreign direct investment (FDI) in India. International Journal of Recent Technology and Engineering, 8(2), 722–729.
32. Yildirim, D. C., & Tosuner, O. (2014). The Effects of FDI on Human Capital Stock in Central Asian Turkic Republics. Eurasian Journal of Business and Economics, 7, 51-60.
33. Yucel, G. E. (2014). FDI and Economic Growth: The Case of Baltic Countries. Research in World Economy, 5, 115-134.
34. Yulek, M., & Gur, N. (2017). Foreign direct investment, smart policies and economic growth. Progress in Development Studies, 17(3), 245–256.
35. <https://www.rbi.org.in/Scripts/AnnualReportPublications.aspx?year=2022>
36. <https://www.cescube.com/vp-fdi-in-india-during-covid-19-pandemic>
37. <https://www.scirp.org/journal/paperinformation.aspx?paperid=108158>
38. <https://essaypro.com/blog/research-paper-format>

Table 1- Country-wise Foreign Direct Investment flows to India (pre and post Covid) (US\$ billions)

| Year | Singapore | US | Mauritius | Netherlands | Switzerland | Cayman Islands | UK | Japan | UAE | Germany | Canada |
|-------------|-----------|------|-----------|-------------|-------------|----------------|-----|-------|-----|---------|--------|
| 2017-18 | 12.2 | 2.1 | 15.9 | 2.8 | 0.5 | 1.2 | 0.8 | 1.6 | 1 | 1.1 | 0.3 |
| 2018-19 | 16.2 | 3.1 | 8.1 | 3.9 | 0.3 | 1 | 1.4 | 3 | 0.9 | 0.9 | 0.6 |
| 2019-20 | 14.7 | 4.1 | 8.2 | 6.5 | 0.2 | 3.7 | 1.3 | 3.2 | 0.3 | 0.5 | 0.2 |
| 2020-21 | 17.4 | 13.8 | 5.6 | 2.8 | 0.2 | 2.8 | 2 | 1.9 | 4.2 | 0.7 | 0 |
| 2021-22 | 15.9 | 10.5 | 9.4 | 4.6 | 4.3 | 3.8 | 1.6 | 1.5 | 1 | 0.7 | 0.5 |
| Average | 15.28 | 6.72 | 9.44 | 4.12 | 1.1 | 2.5 | 1.4 | 2.24 | 1.5 | 0.78 | 0.32 |
| Growth rate | 30.33 | 400 | -40.88 | 64.29 | 760 | 216.67 | 100 | 6.25 | 0 | -36.36 | 66.67 |

Source: RBI

Table 2- Sector-wise Foreign Direct Investment flows to India (US\$ billions)

| Year | Manufacturing | Computer services | Communication Services | Retail & Wholesale trade | Financial services | Education, R&D | Transport | Construction | Hospitality | Mining | Electricity & other energy generation |
|-------------|---------------|-------------------|------------------------|--------------------------|--------------------|----------------|-----------|--------------|-------------|--------|---------------------------------------|
| 2017-18 | 9 | 3.4 | 9.1 | 4.6 | 4.6 | 0.4 | 2.5 | 2.8 | 0.5 | 0.1 | 2.8 |
| 2018-19 | 9.6 | 3.7 | 6.5 | 4.9 | 7.2 | 0.9 | 1.2 | 2.3 | 0.8 | 0.3 | 2.6 |
| 2019-20 | 9.6 | 5.1 | 7.8 | 5.1 | 5.7 | 0.8 | 2.4 | 2 | 2.7 | 0.3 | 2.8 |
| 2020-21 | 9.3 | 23.8 | 2.9 | 3.9 | 3.5 | 1.3 | 7.9 | 1.8 | 0.3 | 0.2 | 1.3 |
| 2021-22 | 16.3 | 9 | 6.4 | 5.1 | 4.7 | 3.6 | 3.3 | 3.2 | 0.7 | 0.4 | 2.2 |
| Average | 10.76 | 9 | 6.54 | 4.72 | 5.14 | 1.4 | 3.46 | 2.42 | 1 | 0.26 | 2.34 |
| Growth rate | 81.11 | 164.71 | -29.67 | 21.63 | 2.17 | 800 | 32 | 14.29 | 40 | 300 | -21.43 |

Source: RBI





Subba Rayudu Thunga and Lavanya

Table: 3- Country-wise Foreign Direct Investment flows to India

| | Sum of squares | Df | Mean square | F | Critical value |
|-------------------|----------------|----|-------------|-------------|----------------|
| Between years | 12.737 | 3 | 4.24568 | 1.114250267 | 2.92 |
| Between countries | 887.357 | 10 | 88.7357 | 23.28807514 | 2.16 |
| Error | 114.31 | 30 | 3.81035 | | |
| Total | 1014.4 | 43 | | | |

Table: 3- Sector-wise Foreign Direct Investment flows to India

| | Sum of squares | Df | Mean square | F | Critical value |
|-----------------|----------------|----|-------------|----------|----------------|
| Between years | 17.24091 | 3 | 5.74697 | 0.52171 | 2.92 |
| Between sectors | 519.9364 | 10 | 51.99364 | 4.719985 | 2.16 |
| Error | 330.4691 | 30 | 11.01564 | | |
| Total | 867.6464 | 43 | | | |

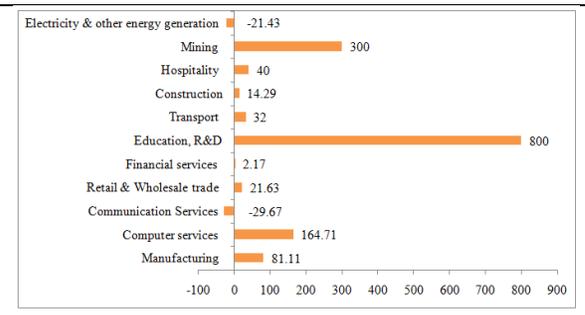
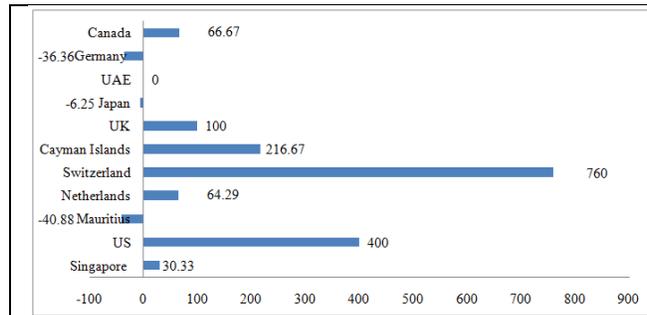


Figure: 1-Country-wise Growth rate of FDIs from 2017-18 to 2021-22

Figure: 2-Industry-wise Growth rate of FDIs from 2017-18 to 2021-22





A Study of GST and its Beneficiaries in India

Shaista Parween*

Ph.D Scholar, Department of Commerce St. Xavier's University, Kolkata West Bengal, India.

Received: 01 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Shaista Parween

Ph.D Scholar,

Department of Commerce,

St. Xavier's University ,

Kolkata, West Bengal, India.

Email: Shaistap076@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Tax is the most significant source of revenue for the government, Direct tax and indirect tax are two types of it and is levied by the government on the people of the nation, due to need of money to maintain law and order in the country; defense the security of the nation and promote the welfare of the people. The study is based on government as well as consumer perspective. So the data required is secondary as well as the primary. The paper tries to know about the actual beneficiary of GST whether the Government or/and consumer, and the Government should adopt the measure which will benefit the both at large in the long run.

Keywords: government, tax, consumer, beneficiary.

INTRODUCTION

Tax is the most significant source of revenue for the government, Direct tax and indirect tax are two types of it and is levied by the government on the people of the nation, due to need of money to maintain law and order in the country; defense the security of the nation and promote the welfare of the people. In direct tax, the tax incidence fall on the same person who is liable to pay tax, it can't be shifted. example income tax, wealth tax and gift tax etc, whereas, in indirect tax the incidence of tax fall on the other than the person who is liable to pay tax. E.g goods and service tax. Goods and service tax (GST) which comes under the ambit of indirect tax its main objective is to curve out the cascading effect of tax and provide relief from paying multiple taxes and expected to increase the GDP of India that is directly related to the economic development of India. The four types of GST currently applicable in India; Central GST, State GST, IGST, and UTGST. The introduction date of Goods and service tax in India is 1st July 2017 after its long struggle. The idea of GST was first talked by Atal Bihari Vajpayee in 2000. Unfortunately, due to have political issues and opposition it has taken a long time to come in effect. The slab rate of





Shaista Parveen

GST in India is 0%; 5%; 12%; 18%, and 28%. France is the first nation that implemented GST, since then most of the countries have adopted this tax system. India followed a dual tax system and believed to be the biggest tax reform since independence.

Literature review

1. Dani, S. (2016) has interested to know about how the company growth and development can be hampered by the GST. And he came up with, Modi's government model for GST doesn't propose the growth in fact increase price inflation and tax revenue collection may not increase. It can only be achieved if there is a clear consensus over the issue of threshold limit, the revenue rate, the introduction of petroleum, electricity, liquor and real estate under the ambit of GST.
2. Swadia, B.U & Patel, S.M (2016) have studied indirect tax and GST and comparison between them and he found that the taxes on manufactured goods will come down to 24.25% to 20.21%, taxes on retail may rise from 12.5% to 20%. On imported items, the local taxes would go up from 16% to 20%. Manufacturer and service providers will have to register separately in each state.
3. Swarupa, P.U (2016) has discussed the concept of GST and the mode of its operation through explanatory research. And he came up with both positive as well negative impact of GST and he also concluded about the winning and losing sector of this. FMCG, cement, logistic and consumer durables would be the gainer of GST implementation while mobile phones, branded jewellery, luxurious car, and pharmaceutical, etc would be the loser of this.
4. Maji, S. K, Giri & et. al (2016) attempted to explore the extent of GST literacy and preparedness among the tax professionals and also tried to understand the reason of the non-implementation of GST. And revealed that many of the business houses waiting for the implementation of GST so that, the multiple tax system will exit and he found appropriate literacy among the tax professional. and the reason of the non implementation of GST is political unwillingness, bureaucratic delays and opposition parties.
5. Holla, R. (2016) in his paper tried to do SWOC analysis of goods and service tax. The Author highlighted the strength, weakness, opportunity and challenges of GST. And concluded that GST will be the biggest tax reform in India and will have positive impact on product and service industry.
6. Pathan (2017) has done study on GST in India and the other countries. In the short run may it have negative or neutral impact but in the long run it will benefit to all. The author studied the current state of GST in many nations and he found netherlands applied the highest GST rate while Canada and Jersey found with the lowest rate of GST and India, the rate of GST is at 18%. At the end he left a question that Does the rate of GST should increase?
7. Nisa (2017) has studied the impact of GST on India's foreign trade. The study is based on secondary data and concluded GST would be positive for certain sector while negative for others. At last left a question whether the forecast made for GST will be actually happened or not.
8. Azhar, S. & Ramesh, B. (2017) have discussed about the impact of GST on Power Sector of India. And he came to know about the different segments of power sector, where GST benefited the some and some not and the author suggested that the government should boost the use of renewable resources of energy by reducing the tax on the turbine, solar panels, etc. which is used in solar plant and hydro power.
9. Sharma, B. & Kharub, M. (2018) have talked about the technical issues faced by the businessman during GST registration in the first quarter of implementation and propose the solution related to this problem. He concluded that at the time of registration six potential issues were traced. Provisional ID invalid, registration certificate cancelled, OTP not received, range code error, the GST helpline number not working and the internet speed is low. The study propose to have the workshop on GST that will be helpful for traders, stakeholders, small businessman and small manufacturer, etc.
10. Amutha, (2018) has examined the consequence of goods and service tax in the context of Indian tax structure, he also discussed about the anticipated barriers and future prediction of GST, and concluded GST have expected in the form of higher GDP, transparency in the tax system and it also control the tax evasion.





Shaista Parveen

11. Ranawat , M.& Puri ,G.(2019) have scrutinized the present GST model ,its merit & demerit ; thrown the light on the impact of GST on the division of power between state and centre . And concluded. Industries mainly benefited and consumer imposed over the burden of double taxation . Again the federal structure being violated as the right of states are curtailed .
12. Gulati ,N .& Adhana ,D.(2019) tried to understand the tax structure of petrol and diesel , also did price comparison of petroleum product with other countries and he concluded that petrol and other petroleum products should be included in GST ambit which will bring the uniform taxation and abolish the multiple tax .
13. Madathil ,J.&T,A.(2019) analysed about the impact of GST on CPI (consumer price index) where he collected the data from thye Ministry of Statistics and Programme implementation .And he concluded that the implementation of GST has had no significant impact on CPI .Hence, the step taken by the government to curb inflation has had the positive impact on CPI.
14. Chauhan , A .S, Gupta &et.al(2019) have examined about the impact of GST on stock indices . applied different statical tools and techniques , with one sample KS-test he found that the data of pre and post selected sectoral indicies are normally distributed except few .Again through the paired sample test found the mean number of sectoral indices of NSE and BSE pre GST was less than the mean number of sectoral indices of NSE & BSE after GST and concluded that the post GST the stock indices have affected significantly .
15. Rathi ,R.A &Kumar S.S (2019) have done conceptual study on impact of GST on Textile Industry of India and he concluded that the implementation of GST may have positive impact on textile business of India along with some drawbacks of GST, that is the higher tax rate and removal of benefit which is provided earlier to cotton value chain .
16. Geeta , Mathiraj, Devi &et.al (2019) have discussed about the impact of GST on MSME'S, and concluded the positive as well as negative consequence of GST on MSME'S. It is a growing sector where enterprise does not survive in long run , so the implementation of GST has had great on it. It has been found that unorganized MSME'S were growing fast than organized ones because of tax avoidance .
17. Karla ,A. & Mewarguru , M.(2019) studied the concept of GST in India and its positive and negative impact on common people and concluded .The low cost additionally prompts an expansion in the utilization of product , while on the other hand ,author also highlights the negative impact of GST. All merchants and specialized organisation have to pay GST with different tax slab, with the revised slab ,the common man have to suffer a lot as they are paying tax not with revised table and the company and mediators earn profit.
18. Mukherjee ,S (2020) tried to explore the possible cause of the revenue shortfall and guage the feasible impact of revenue shortfall on union and state finances. And he concluded the reason for the shortfall of revenues are the design and structure issues related to GST , policy and practices of GST , administration and tax compliance and he state that the revenue shortfall on union and state are protected under GST upto June 2022 .So yet there was the impact had realized.
19. Chitra ,V.(2020) presented about the impact of GST on the spending behaviour of consumer And concluded his result that there is strong relationship income and electronics and sports equipment while there is no relation between income and wheat , clothing ,soap, toothpaste , fast food ,internet connection ,the newspaper ,fruits ,vegetables, entertainment and vehicles and he also found that GST is impacted more on essential items than the comfort and unneeded items.
20. Benjamin , R& Singh .A (2020) through this paper he presented the impact of GST on Mutual Fund . And the author observed there is a marginal decrease in the absolute return due to increase in tax rate as earlier it was 15% and post GST is 18% applied .

Research Gap

The researcher has gone through the literature reviews from different source like journal ,magazine and internet etc , and found that work has mainly done on impact of GST on the different sector , such as impact on MSME , the banking sector , cement industry , stock indices and etc . Analyses the GST model of India , its merit, demerit , proposed the economic consequence of GST , the study on the losing and gaining sector after the implementation of GST all these works have already been done .The researcher has discovered the gap that yet there is no study have been done on the beneficiary of GST ,Government and /or consumer ? After the implementation of GST who



**Shaista Parveen**

benefited more do the Government revenue increased or whether the tax burdened the consumer. The paper would try to perceive the actual beneficiary of this .

OBJECTIVE

- To study about the beneficiary of GST Government or the consumer.
- To study about the consumer satisfaction due to GST implementation.
- To analyze the GST revenue collection of the government.

RESEARCH METHODOLOGY

The study is based on government as well as consumer perspective . So the data required is secondary as well as the primary . Secondary data for the revenue collection by GST before and after its implementation it can be from journal , internet and GST council ,etc .While for collection of the consumer side information, it required primary data which can be collected through questionnaire and field survey .

CONCLUSION

Goods and service tax is the historical reformation in the Indian tax system .It's roll out from 17th July 2017 with the view of increase in GDP by 2% and harmonize indirect tax system.GST end towards the economic development of the country .After the implementation of GST few sector has gained while few other has loosed .GST also put an end to tax evasion as different slab rate has been declared under GST regime . It is also suggested to introduce the clear consensus over the threshold limit , and bring petroleum ,electricity and real estate under the GST regime .The paper tries to know about the actual beneficiary of GST whether the Government or/and consumer ,and the Government should adopt the measure which will benefit the both at large in the long run.

REFERENCES

- 1 Dani ,S.(2016)
- 2 Swadia ,B.U& Patel, S.M(2016)
- 3 Swarupa ,P.U(2016)
- 4 Maji , S. K, Giri & et. al (2016)
- 5 Holla,R.(2016)
- 6 Pathan (2017)
- 7 Nisa (2017)
- 8 Azhar ,S.& Ramesh ,B. (2017)
- 9 Sharma, B. & kharub ,M.(2018)
- 10 Amutha ,(2018)
- 11 Ranawat , M.& Puri ,G.(2019)
- 12 Gulati ,N .& Adhana ,D.(2019)
- 13 Madathil ,J.&T,A.(2019)
- 14 Chauhan , A .S, Gupta &et.al(2019)
- 15 Rathi ,R.A &Kumar S.S (2019)
- 16 Geeta , Mathiraj, Devi &et.al (2019)
- 17 Karla ,A. & Mewarguru , M.(2019)
- 18 Mukherjee ,S (2020)
- 19 Chitra ,V.(2020)
- 20 Benjamin , R& Singh .A (2020)





An Ensemble Classification Model for Early Diagnosis of Alzheimer's Disease

Rajasree RS¹ and Brintha Rajakumari^{2*}

¹Research Scholar, Dept.of CSE Bharat Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

²Associate Professor, Dept.of CSE Bharat Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

Received: 04 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Brintha Rajakumari

Associate Professor, Dept.of CSE,
Bharat Institute of Higher Education
and Research, Chennai, Tamil Nadu, India.

Email: .ramesh@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Alzheimer's disease (AD) is a form of neurological brain ailment that causes a gradual memory loss in people. It is a chronic brain disorder which when affected leads to dependency on caretakers for daily activities and eventually leads to death. There are various factors that leads to the disease which may be damages caused to the brain, hereditary and lifestyle diseases. Early diagnosis of the disease is significant as it reduces hospitalization and delays the severity of the disease. There are predictions for the disease carried out using various ML approaches. In this research work, we have a proposed ensemble technique with voting and Gradient Boost classifier methods which classify the disease and helps to identify the early onset of the disease. In the proposed work we created different machine learning models such as KNN model, naïve Bayes model, Decision tree model and SVM model. The proposed method uses a SMOTE technique to deal with class imbalance problem followed with ensemble method using voting technique and Gradient Boost classifiers are also created and their performances are evaluated. Results of this research work shows that Gradient Boost methods outperforms all the other models. It also gives more accuracy, specificity, sensitivity and F1-score as compared to ensemble(voting) technique.

Keywords: Alzheimer's Disease (AD),Mild Cognitive Impairment (MCI), Mini Mental State Examination (MMSE),Ensemble Methods, Bagging, Boosting, Synthetic Minority Oversampling Technique (SMOTE).



**Rajasree and Brintha Rajakumari**

INTRODUCTION

Alzheimer's disease (AD) is a neuronal infection that affects cognitive impairment and some other mental disabilities, as well as behavioural problems, ultimately leading to total reliance. [1]. It causes the brain to shrink, as well as the death of memory cells which are associated with language-related brain operations[12]. Neurofibrillary plaques and tangles are developed in the brain which affects the connection between the neurons. Certain symptoms of the Alzheimer's disease shows loss of memory, issues with attention, neurological deficiencies, problems with spatial awareness, problems with speaking, reading or writing, personality or behavior changes. According to studies, the condition or a related form of dementia affects around 44 million individuals globally. According to the reports of National Institute of Aging, the percentage of people that is affected by the disease doubles every year after the age of 65.

Literature Survey

In recent years, many research studies has been carried out in the field of neuro disorders. In [8] Cyrus Raji et. al organized the worktop identify the relationship of person age ,volume of brain and AD. The work showed the analysis using the sample of 92 subjects which were cognitively normal persons and 26 probable AD cases. The results showed that brain atrophy in probable AD subjects was seen in the hippocampal regions and precuneus. Another study that was performed by A I Scher et.al [2]found that hippocampal volume were 11.5% smaller in subjects with AD as compared to normal controls. Amira Ben Rabeh et. al [15] applied SVM algorithm in image data set to detect the disease in early stage. The work was carried out with 75 subjects in which 50 Normal, 17 MCI (Mild Cognitive Impairment and its suffering from AD. The classification of hippocampus ,measure of corpus callosum and the cortex are carried out in the image. SVM (Support vector machine) algorithm was used to classify the different components followed by a decision tree classifier to classify the AD patients and normal controls. The system yield an accuracy of 90.66%. The disadvantage with this system are the data set size is small which may lead to class imbalance.

With a single T1-weighted MRI scan, Zing Wan and Zhilin Zang [7], inorder to to predict AD in participants with mild cognitive impairment (MCI),achieved a technique for rating the components of the temporal lobe using reliable cerebral layer thickness A sparse multiple regression analysis model as well as an experimental dense Bayesian learning technique are used to accomplish this. The suggested method adds block architectures to the predictive matrix and outputs a non - linear model of the determinants. In [9] Panagiota Papapostolou, F Goutsaridou, MArvaniti has done a research study with Alzheimer Disease subjects to find the relationship between total Brain Volume and Cognitive Function and Education. The quantitative assessment of the entire brain volume is calculated individually for the grey matter, CSF (cerebrospinal fluid) and white matter. Descriptive classification was achieved by comparing persons with less than 6 years in school to someone with Twelve or even more years of higher education. According to the research, connecting entire brain size assessments of Alzheimer's patients with the same MMSE but distinct stages of schooling indicated that there is really no significant variation with whole brain size between both the 2 categories of survey respondents [9]. Personalized relevance parameterization approaches (PReP-AD) depends on the AI Learning techniques have been developed to calculate the impact of cell growth on persons with AD [10]. The mutations that influence AD-related enzyme biomarkers, as well as MMSE ratings and hippocampus volume measures, are often used in that method. The observation made was for a period of 72-month with average error rate 4.8% employing PReP-AD-MMSE and above 12 months 1.63% with PReP-AD-HVL is considered. According to the research, artificial intelligence-based computational approaches is being used to develop decision-support systems for detecting AD growth.

In [11] Viraj Adduru et al., Explore the usage of CT images for the prediction of brain atrophy in AD. Massive brain size and entire intracranial capacity are estimated using a computerized technique called CT seg. A cross-sectional Alzheimer's disease data collection of 58 Alzheimer's patients and 58 normal healthy was used to apply computerized CT segmentation. The CT scanning approach revealed a decrease in percent complete brain size (as a proportion of



**Rajasree and Brintha Rajakumari**

total cerebral volume) with age (P.001), and a distinction between Alzheimer's patients and controls (P, .01). In [16] Ramesh Kumar Lama et al. has used SVM(support vector machine), IVM(import vector machine)and RELM refers to regularized extreme learning machine are the AD predictive approaches for structural magnetic resonance (sMR) images to distinct the AD, mild cognitive impairment (MCI) and the healthy control (HC) items. The RELM technique is more effective when comparing with the existing classification techniques.

MATERIALS AND METHODS

The dataset used is ADNI (Alzheimer's Disease Neurogenerative Imaging) repository. Under the direction of Dr. Michael W. Weiner, ADNI was founded in 2004.It is a private-public partnership. The main objectives of ADNI are to detect the Alzheimer's Disease at the very early stage, to support the prevention and treatment through new diagnostic methods. The dataset used is a subset of ADNI called as ADNIMERGE which includes information on clinical test, psychometric assessment tests and CSF biomarkers. For this study, we have taken 343 AD patients, 524 healthy people, and 872 MCI patients. For this work, base line data is considered, which is the first visit of the patient. The age range of the participants in this data ranges from 54 to 91 years old. In the dataset that is considered for the work, there are 772 women data and 964 men data.The high number of patients have inbetween 14 and 20 education. All the features are accessible for the persons who have the disease.So we have considered variables without missing values or variables which has less than 20 percent missing values.

In the proposed method we applied different supervised ML methods to classify the subjects in to normal, MCI and AD. ML approaches which including Kmeans, Nave Bayes, as well as the Decision Tree algorithm were examined for accuracy, specificity, and sensitivity. The important features were identified with the help of feature selection methods and those extracted features are given as input to the supervised ML algorithms. The outcomes of the many methods are integrated together to form an ensemble model. The work of this model is to combine the outcomes of the various independent models.By mixing the inputs from many models, ensemble models will increase the performance of our model. It gives the majority voting approach. In majority voting, the results of various models are summed up.The results of Kmeans, Naïve Baye's and Decision tree classifier models are summed up and and it predicts the class with maximum number of labels.

The proposed methodology consists of the following steps

i)Data pre-processing and Feature Selection (ii) Train the model (iii) perform testing using test dataset.(iv) Create an ensemble model. The proposed methodology is explained as follows.

Data Pre-processing and Feature Selection

The analysis of the research work is to identify the HC, MCI, and AD.The data was cleaned by removing the redundant rows and missing values are treated by imputing mean. The data is standardized using different standardization techniques. The table1 shows the mean value of the dataset Alzheimer's disease is predicted using a numerous approaches. One of the widely used modality for the detection of the disease is sMRI (Structural Magnetic Resonance Imaging)[13][14]. sMRI is used widely because of its high resolution and non-invasive characteristics. Cerebral atrophy which is caused due to this disease can be detected through sMRI. Currently there are no methods to detect the early diagnose of the conversion of MCI to AD. There are several biomarkers that changes during the conversion of MCI to AD. However, no one biomarker can accurately predict whether MCI will progress to AD in its early stages. The use of merely the features of a brain MRI will not help in the early detection of the disease. In the proposed work, we have combined various MRI features like Whole Brain Volume, Hippocampus, biomarker like FDG (fluorodeoxyglucose) and psychometric examination scores like MMSE (Mini Mental State Examination), ADAS11(Alzheimers Disease Assessment Scale), ADAS13, RAVLT-immediate (Rey Auditory Verbal Learning Test), FAQ(Functional Activities Questionnaire), CDRSB (Clinical Dementia Rating Sum of Boxes) . Cognitive function decline impacts the physical functioning which occurs due to death of brain cells. MMSE (Mini Mental State Examination) is the frequently used approach to monitor the brain function to check the orientation, attention,



**Rajasree and Brintha Rajakumari**

memory, language used and visual spatial skills. The CDR which represents the Clinical Dementia Rating is used tool for measuring the severity of AD. memory, orientation, judgement, and problem solving are the brain regions considered for this approach. Along with that the community issue, affairs of home, personnel care are also considered. In 1980, ADAS11 named as Alzheimer's Disease Assessment Scale[18] is invented to incorporate the 11 tasks of the exams completed and the observation based on assessments. A memory section, a rating section and a general section are among the 13 subgroups of the ADAS13 (Alzheimer's Disease Assessment Scale)[19]. The FAQ means the Functional Activities Questionnaire which is a collection of queries that are used to assess the routine tasks. By that it is easy to classify between the AD and medium disorder patients. RAVLT-immediate refers the Rey's Auditory Verbal Learning Test which is used as the bio marker for identifying the AD regions. A set of 15 items are given in a sequential way to read and later they are asked to recall the words. Intracranial Volume (eTIV) and Whole Brain Volume (nWBV): The eTIV gives the size of cranial cavity. nWBV means the Normalized Whole Brain Volume which measures the size of the brain. The study underwent by Sluimer et al suggests that whole brain atrophy is at the rate of -1.9% and patients are at the risk of reducing their brain volume. The graphical plot in Fig 1 shows the variation of HC, MCI and AD. Missing parameter values are calculated by the continuous feature selection. Normalization of the dataset is also performed in order to normalize the entire dataset. Additional tree classification is carried out to predict the main features whereas the Extreme Random Classifier is considered to combine the outcomes of multiple classifiers. Selection of feature is carried out using total reduction technique. For feature selection, normalized total reduction is used. Here the gini features are represented as descending order. To solve the class imbalance problem a SMOTE (Synthetic Minority Oversampling Technique) technique is used. This technique reduces the effect of data imbalance in the dataset

Training

The dataset is split into two parts: training and testing dataset. The features like CDRSB, ADAS11, ADAS13, RAVLT-immediate, Whole Brain volume, FDG, FAQ, hippocampus and MMSE scores are considered as features to train and test the model. The dataset used in this research work is splitted into 80 percentage of training data and 20 percentage of testing data for further processing. The classifier algorithms takes as input training dataset. Here we have used different models like KNN, Naïve Bayes, SVM and Decision trees to classify the subjects. Also Ensemble method that employs voting techniques is used. A boosting approach called as gradient Boosting approach is also used. Afterwards when, the model has been trained on the many features that have been chosen. A grid approach is taken to predict the best hyper parameters. The model is constructed using the perfectly alright hyper - parameters only after parameters have been fine-tuned.

Testing

The proposed method is evaluated using the testing dataset with the parameters like accuracy, precision and the recall characteristics. Along with that the 10-fold cross – validation approach is used to enhance the accuracy rate. Performance indicators such as efficiency, precision, and sensitivity are covered in the following sections. The Models that are created like Naïve Bayes, Decision trees and KNN are then combined together to create an ensemble model with voting technique. A majority voting techniques is employed in where the output of KNN, naïve Bayes and Decision trees are combined together. The label with the majority vote will be predicted as the output. This technique takes the advantage of getting better performance by combining multiple models. The below table shows the performance results. When compared to individual models, the findings in the table clearly reveal that the ensemble model outperforms them in terms of accuracy, precision, and recall.

RESULTS AND DISCUSSION**Performance Evaluation**

The performance of a classification algorithm is measured using a confusion matrix. In the above confusion matrix, the columns indicate the actual class and the rows indicate the predicted class. True Positive (TP) is the number of positive samples correctly classified as positive. True negative (TN) is the number of negative samples correctly classified as negative. False Positive (FP) is the number of negative samples incorrectly classified as positive. False Negative (FN) is





Rajasree and Brintha Rajakumari

the number of positive samples incorrectly classified as positive. False Negative(FN) is the number of positive samples incorrectly classified as negative.

Accuracy

Accuracy is the total number of correct predictions towards total number of instances in the dataset.

$$\text{Accuracy} = TP / (TP + FP + TN + FN)$$

Precision

Precision is the ratio of true positive towards sum of true positive (TP) and false positive (TP+FP)

$$\text{Precision} = TP / (TP + FP)$$

Recall

Recall is the ratio of true positive towards sum of true positive and false negative

$$\text{Recall} = TP / (TP + FN)$$

F1-Score

F1-score is the harmonic mean between precision and recall values

$$\text{F1 Score} = 2 * ((\text{precision} * \text{recall})) / ((\text{precision} + \text{recall}))$$

The results of the different classification model is shown in the above table. The performance results clearly indicate that KNN and SVM are weak learners as they have the least values in terms of accuracy. From the results it is also shown that decision tree model has also better performance than ensemble model in terms of accuracy, precision, recall and F1-score. The highest performance for accuracy is given by Gradient Boost algorithm in terms of all performance indicator such as accuracy, precision, recall and variance.

CONCLUSION

In this research, we investigated the effects of multiple machine learning techniques for Alzheimer's disease, moderate cognitive impairment, and normal control. Through the use of an evolutionary algorithm for classification, our model's accuracy, specificity, and sensitivity have mostly improved. It has been demonstrated that using ensemble methods and Boosting techniques increases the model's performance by pooling the results of multiple models.

REFERENCES

1. G. McKhann et al., "Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group under the auspices of Department of Health and Human Services task force on Alzheimer's disease," American Academy of Neurology, vol. 34, no. 7, pp.939–939, DOI: <https://doi.org/10.1212/WNL.34.7.939>.
2. G. McKhann et al., "Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group under the auspices of Department of Health and Human Services task force on Alzheimer's disease," American Academy of Neurology, vol. 34, no. 7, pp.939–939, DOI: <https://doi.org/10.1212/WNL.34.7.939>
3. Yuan Xu, Daniel J Valentino, Ann I Scher, Ivo Dinov, Lon R White, Paul M Thompson, Lenore J Launer, and Arthur W Toga "Age Effects On Hippocampal Structural Changes In Old Men: The Haas" 2007 Dec, doi: 10.1016/j.neuroimage.2007.12.034.
4. Valizadeh S, Hånggi J, Mérillat S, Janke L. "Age prediction on the basis of brain anatomical measures". Hum Brain Mapp. (2017) 38:997–1008, DOI:10.1002/hbm.23434.
5. Fjell AM, Westlye LT, Amlien I, Espeseth T, Reinvang I, Raz N, Agartz I, Salat DH, Greve DN, Fischl B, Dale AM, Walhovd KB. "High consistency of regional cortical thinning in aging across multiple samples. Cereb Cortex". 2009 Sep;19(9):2001-12. doi: 10.1093/cercor/bhn232. Epub 2009 Jan 15. PMID: 19150922; PMCID: PMC2733683.




Rajasree and Brintha Rajakumari

6. Lan Lin, Cong Jin, Zhenrong Fu, Baiwen Zhang, Guangyu Bin, Shuicai Wu, Predicting healthy older adult's brain age based on structural connectivity networks using artificial neural networks, *Computer Methods and Programs in Biomedicine*, Volume 125, 2016, Pages 8-17, ISSN 0169-2607, <https://doi.org/10.1016/j.cmpb.2015.11.012>.
7. Adluru N, Korponay CH, Norton DL, Goldman RI, Davidson RJ. "BrainAGE and regional volumetric analysis of a Buddhist monk: a longitudinal MRI case study. *Neurocase*." 2020 Apr;26(2):79-90. doi: 10.1080/13554794.2020.1731553. Epub 2020 Feb 26. PMID: 32100616; PMCID: PMC7150651.
8. Wan, Jing & Zhang, Zhilin & Rao, Bhaskar & Fang, Shiaofoen & Yan, Jingwen & Saykin, Andrew & Shen, Li. (2014). "Identifying the Neuroanatomical Basis of Cognitive Impairment in Alzheimer's Disease by Correlation- and Nonlinearity-Aware Sparse Bayesian Learning." *IEEE transactions on medical imaging*. 33. 1475-1487. 10.1109/TMI.2014.2314712.
9. Cyrus Raji, James Becker, Owen Thomas Carmichael, "Age, Alzheimers Disease and Brain Structure", Article in *Neurology* · October 2009, DOI: 10.1212/WNL.0b013e3181c3f293, Source: PubMed
10. Panagiota Papapostolou, F Goutsaridou, M Arvaniti, "Is Total Brain Volume Correlated to Cognitive Function and Education in Patients with Alzheimer Disease?" Volume: 21 issue: 4, page(s): 500-504 DOI: 10.1177/197140090802100405.
11. Aydin Saribudak, Adarsha A Subick, Na Hyun Kim, Joshua A Rutta, M Umit Uyar, "Gene Expressions, Hippocampal Volume Loss, and MMSE Scores in Computation of Progression and Pharmacologic Therapy Effects for Alzheimer's Disease" *IEEE/ACM Trans Comput Biol Bioinform* doi: 10.1109/TCBB.2018.2870363. Epub 2018 Sep 14.
12. Adduru V, Baum SA, Zhang C, Helguera M, Zand R, Lichtenstein M, Griessenauer CJ, Michael AM. A Method to Estimate Brain Volume from Head CT Images and Application to Detect Brain Atrophy in Alzheimer Disease. *AJNR Am J Neuroradiol*. 2020 Feb;41(2):224-230. doi: 10.3174/ajnr.A6402. Epub 2020 Jan 30. PMID: 32001444; PMCID: PMC7015210.
13. Plant C, Teipel SJ, Oswald A, Böhm C, Meindl T, Mourao-Miranda J, Bokde AW, Hampel H, Ewers M. Automated detection of brain atrophy patterns based on MRI for the prediction of Alzheimer's disease. *Neuroimage*. 2010 Mar;50(1):162-74. doi: 10.1016/j.neuroimage.2009.11.046. Epub 2009 Dec 2. PMID: 19961938; PMCID: PMC2838472.
14. Radanovic M, Pereira FR, Stella F, Aprahamian I, Ferreira LK, Forlenza OV, Busatto GF. White matter abnormalities associated with Alzheimer's disease and mild cognitive impairment: a critical review of MRI studies. *Expert Rev Neurother*. 2013 May;13(5):483-93. doi: 10.1586/ern.13.45. PMID: 23621306.
15. A. Chincarini et al., "Alzheimers disease markers from structural MRI and FDG-PET brain images," *Eur. Phys. J. Plus*, vol. 127, no. 11, pp.1–16, 2012.
16. Amira Ben Rabeh, Benzarti Faouzi, Hamid Amiri "Diagnosis of Alzheimer Diseases in Early Step Using SVM (Support Vector Machine)" 13th International Conference on Computer Graphics, Imaging and Visualization (CGiV), DOI 10.1109/CGiV.2016.76
17. Ramesh Kumar Lama,1,2 Jeonghwan Gwak,1,3 Jeong-Seon Park,4 and Sang-Woong Lee , " Diagnosis of Alzheimer's Disease Based on Structural MRI Images Using a Regularized Extreme Learning Machine and PCA Features" *Hindawi Journal of Healthcare Engineering* Volume 2017, Article ID 5485080, 11 pages <https://doi.org/10.1155/2017/5485080>.
18. Schapire R.E. (2003) The Boosting Approach to Machine Learning: An Overview. In: Denison D.D., Hansen M.H., Holmes C.C., Mallick B., Yu B. (eds) *Nonlinear Estimation and Classification*. Lecture Notes in Statistics, vol 171. Springer, New York, NY. https://doi.org/10.1007/978-0-387-21579-2_9.
19. Kueper, J. K., Speechley, M., & Montero-Odasso, M. (2018). The Alzheimer's Disease Assessment Scale-Cognitive Subscale (ADAS-Cog): Modifications and Responsiveness in Pre-Dementia Populations. A Narrative Review. *Journal of Alzheimer's disease : JAD*, 63(2), 423–444. <https://doi.org/10.3233/JAD-170991>.
20. Grochowalski, Joseph & Liu, Ying & Siedlecki, Karen. (2015). Examining the reliability of ADAS-Cog change scores. *Neuropsychology, development, and cognition. Section B, Aging, neuropsychology and cognition*. 28. 1-17. 10.1080/13825585.2015.1127320.





Rajasree and Brintha Rajakumari

21. Elaheh Moradi, Ilona Hallikainen, Tuomo Hänninen, Jussi Tohka, Rey's Auditory Verbal Learning Test scores can be predicted from whole brain MRI in Alzheimer's disease, NeuroImage: Clinical, Volume 13, 2017, Pages 415-427, ISSN 2213-1582, <https://doi.org/10.1016/j.nicl.2016.12.011>.
22. Sluimer JD, Vrenken H, Blankenstein MA, Fox NC, Scheltens P, Barkhof F, van der Flier WM. Whole-brain atrophy rate in Alzheimer disease: identifying fast progressors. Neurology. 2008 May 6;70(19 Pt 2):1836-41. doi: 10.1212/01.wnl.0000311446.61861.e3. PMID: 18458218.

Table1: Statistical Data of CN, MCI and AD Subjects

| Features | 0(CN) | 1(MCI) | 2(AD) |
|-----------------|----------|----------|----------|
| AGE | 74.23 | 73.31 | 75.02 |
| PTEDUCAT | 16.37 | 15.89 | 15.17 |
| APOE4 | 0.30 | 0.59 | 0.85 |
| FDG | 1.31 | 1.22 | 1.07 |
| CDRSB | 0.04 | 2.25 | 4.39 |
| ADAS11 | 5.93 | 11.91 | 19.58 |
| ADAS13 | 9.23 | 18.53 | 29.94 |
| MMSE | 29.06 | 26.52 | 23.21 |
| RAVLT_immediate | 44.68 | 32.55 | 22.80 |
| FAQ | 0.24 | 5.47 | 13.13 |
| MOCA | 25.76 | 22.80 | 17.14 |
| Ventricles | 33833.42 | 43950.05 | 49699.23 |
| Hippocampus | 7378.41 | 6557.92 | 5738.71 |
| WholeBrain | 1.03 | 1.016 | 9.76 |
| Entorhinal | 3835.66 | 3358.13 | 2817.01 |
| Fusiform | 17915.18 | 17092.73 | 15495.30 |
| MidTemp | 20372.68 | 19031.17 | 17253.90 |
| ICV | 1.51 | 1.54 | 1.53 |

Table 2: Confusion Matrix

| | Actual Positive | Actual Negative |
|--------------------|-----------------|-----------------|
| Predicted Positive | TP | FP |
| Predicted Negative | FN | TN |

Table 3: Performance Comparison

| Model | Accuracy | Precision | Recall | F1-score |
|------------------------|----------|-----------|--------|----------|
| Decision trees | 94.1 | 94.3 | 94.1 | 94.0 |
| Naïve Bayes | 83.2 | 83.4 | 83.2 | 83.1 |
| KNN | 83.2 | 83.1 | 83.2 | 82.7 |
| SVM | 91.6 | 91.9 | 91.6 | 91.7 |
| Ensemble Model(voting) | 92.2 | 92.3 | 92.2 | 92.1 |
| Gradient Boost | 96.0 | 96.0 | 96.0 | 95.9 |





Rajasree and Brintha Rajakumari

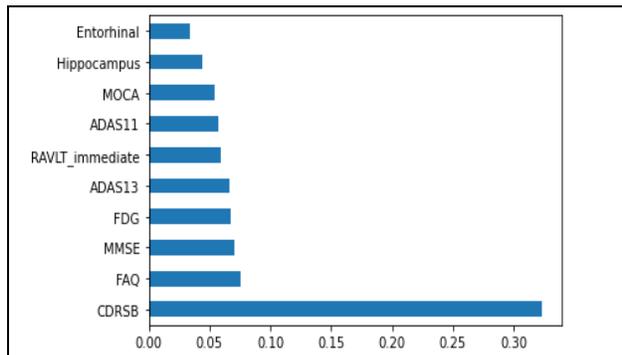


Fig1: Feature Importance

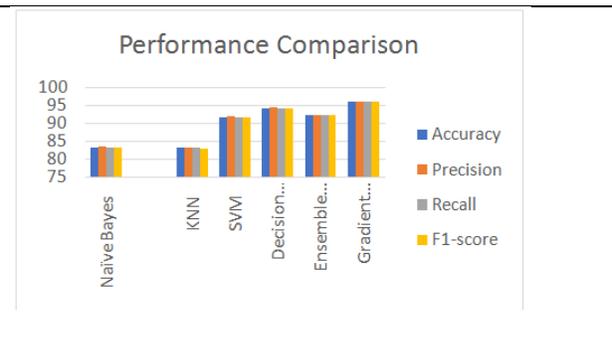


Fig2: Performances Analysis





A Review of the Literature on the Impact of Sales promotion Techniques on Consumer Purchase Decisions

SushmaYadav^{1*} and Kapil Malhotra²

¹Research Scholar, Department of Commerce, Maharshi Dayanand University, Rohtak, Haryana, India

²Assistant Professor, Department of Commerce, Maharshi Dayanand University, Rohtak, Haryana, India

Received: 01 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

SushmaYadav

Research Scholar,

Department of Commerce,

Maharshi Dayanand University,

Rohtak, Haryana, India.

Email: sushma.rs.comm@mdurohtak.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In today's corporate environment, as the global market gets more competitive, marketers must adopt a variety of sales promotion methods to set themselves apart from their competitors. Manufacturers must match client needs in order to remain competitive. Sales promotion is the marketing tactic used to gain customers' attention. As consumers become more sensitive to sales promotion tactics, marketers must determine the most suitable sales marketing strategy for their items. The goal of this research was to look at the impact of various sales promotional strategies, such as coupons, samples, buy one get one, and price discounts, on customer purchase decisions. International journals are retrieved from a number of well-known databases, including Emerald, JSTOR, and Proquest, and are reviewed in this paper. The research's findings will show that numerous promotion tools such as; price discounts, samples, and buy one get one free prove that there is a strong positive link between sales promotion and customer purchasing behavior. The findings will aid marketers and merchants in better understanding consumer behaviour and implementing the most successful sales promotion strategies. So that marketers and dealers will be able to strengthen their competitive positions and obtain a competitive advantage as a result.

Keywords: Sales promotion, Consumer Purchase Decision, Price Discount, Coupons, Samples





INTRODUCTION

In the current period, the world of marketing is evolving at a rapid pace, and manufacturers must be more adaptable in their research and development by enhancing their products and marketing strategies so that they can be applied accurately and in accordance with the current market. As technology advances and to improve society's quality of life, many different new products are developed and launched onto the market. At the same time, retail competition is on the rise. Marketers are currently using a variety of promotional activities to differentiate themselves in the market. More ideas for tactics to entice consumers to buy a product can be generated by catching their attention (Aditya and Wardana, 2017). Applying sales promotion is one of the most effective and simple strategies to stand out in a competitive market. According to Haugh, 1983, "a direct inducement that adds value to a product for the sales force, distributors, or final consumer with the primary goal of obtaining an immediate sale." According to Gilbert and Jackaria (2002), "The giving of an incentive in order to induce the desired sales outcome is characterised as sales promotion." These concepts have a number of crucial applications. First, a sales promotion is an additional incentive to buy, in addition to the product or brand's core benefits, as quoted in Laroche et al., 2003; Schultz and Robinson, 1982; and Strang, 1983. They are sales speeding up solutions that help to accelerate the procedure for selling and boost sales volume (Neslin, Quelch, and Handerson, 1984). According to Kazmi and Batra, "Sales promotion encompasses incentive offers and interest-creating activities that are often short-term marketing events other than advertising, personal selling, publicity, and direct marketing." The goal of sales promotion is to "stimulate, encourage, and influence the firm's consumers' purchases and other desirable behavioral responses." (Batra & Kazmi, 2008). Sales promotions elicit rapid reactions and provide better value for money.

Different techniques are used for sales promotion as depicted in Fig. 1. Consumer promotions are marketing strategies used by businesses to draw in new clients or strengthen relationships with current ones. It is a marketing strategy for raising product demand in retail establishments. Wholesalers and/or retailers are offered significant price cuts during a trade promotion. Sales force promotion tactics are employed to motivate salespeople to put in more effort in order to increase sales, widen distribution, promote new or seasonal items, and raise Sales force enthusiasm and morale. Coupons, free samples, price discounts, and Buy One Get One Free are all examples of sales marketing strategies used for consumer sales promotion shown in Fig. 2. As a result, the goal of sales promotion is to entice current and new customers to participate in promotional activities in order to boost profit margins through instant sales. By influencing consumers' purchase behavior, sale promotions lead to faster and larger purchases. Coupons, price discount, free samples, and buy one, get one deals are some of the promotional techniques which influence the Consumer Purchase Decisions as shown in Fig.3. Coupons are one of the most prevalent marketing methods used by businesses to tempt customers by giving them a voucher or certificate that allows them to receive a discount on next purchase in the future, such as a 25% discount off the regular price (Harmon and Hill, 2003). Customers are readily persuaded by coupons since they are a handy tool for trial purchases and are thought to be an effective approach to encourage customers to switch brands (Cook, 2003). While some studies have indicated that using coupons to promote sales is ineffective. These studies looked at how buyers responded to the significant price cuts offered by coupons, which could have an adverse effect on a product's value and hence change product trials. (Silva-Risso and Bucklin, 2004; Gilbert and Jackaria, 2002). Sampling is the technique of proposing a lesser quantity of products to customers at no cost so that they can inspect them and decide whether or not to buy them later (Pramataris et al., 2001). The free sample method is a way for getting buyers to try new products that have just been released. Price reduction is a well-known approach for lowering the purchase price by a large amount, which is conspicuously displayed at the point of sale (Fill, 2002). Reduced product prices are important factors in enticing customers to try new products, and new customers might be drawn as a result (Blackwell, Miniard and Engel, 2001). Sporadic consumers would probably return to their preferred products in their portfolio rather than buying the promoted brand at full price after taking advantage of the price decrease, as this would prevent short-term sales spikes from occurring. (Ehrenberg et al., 1994). "Buy one get one free" is a sales promotion method in which a second product is provided to buyers at the same price as the first but with a better package. Customers might easily be persuaded to buy the product because no more cost is required, therefore the customer should regard it as more



**SushmaYadav and Kapil Malhotra**

valuable (Sinha & Smith, 2000). According to the studies research gap, there are numerous studies focused on sales promotion and consumer behavior. Few researcher talked about the fundamentals of sales promotion, while others talked about consumer behavior. However, no research has been done to evaluate how different sales promotion tactics affect consumer purchase choices.

The major goal of this research is to look at how different sales and marketing methods affect consumer purchasing decisions or to look into how customers react to various promotional tools. As a result, promotional tool research is necessary and must be understood as the most powerful instrument in order to compete with rivals. Marketers and merchants should better manage their resources based on this information to maximize profit. This study will look into consumer preferences for various promotional tactics so that marketers and merchants may make better decisions and use the most successful promotion strategies to attract customers.

DISCUSSIONS

The study's main purpose is to establish the influence of different promotional methods on consumers purchasing decisions, as well as how business owners might employ these techniques to enhance sales. The four promotion tools that can influence a customer's purchasing decision were used for the promotion strategies. The study use four promotional strategies the Price Reduction, Buy One Get One, Discount Level, Free Sample. (Ndubisi and Oly .,2006) found that sales promotion aids in recruiting new customers, retaining loyal customers, and convincing them to form better relationships with the firm. During a sale, people are more likely to follow the lead of existing customers and buy more items. Interestingly, previous research has found that purchasing activity during sales promotions tends to boost consumers' mental contentment (Chandon et al., 2000). When customers bought products or services during a sales drive, they felt more accomplished and had a better feeling of self-worth (Darke& Freedman, 1995; Schindler, 1992). Furthermore, when there is a favorable crowd of customers, additional new potential customers prefer should go with the flow and be interested in the product that previous customers have purchased. When customers bought products or services during a sales drive, they felt more accomplished and had a better feeling of self-worth. (Darke& Freedman, 1995; Schindler, 1992).

The biggest achievement of the marketing strategy is to get long term profit as per the view point of the marketer. Apart from the impact on customers' purchase decisions, this research looked at the numerous forms of sales promotions available, such as coupons, free samples, price discounts, and buy one get one deals, and how they affect consumers' purchasing decisions. Product trials are tied to price concessions (Cook, 2003) and revealed in his study that Coupons are a wonderful tool for trial purchases and are regarded to be an effective approach to convince customers to transfer brands, therefore it's simple to encourage consumers to switch brands using this strategy. (Gilbert and Jackaria's, 2002) discovered that coupon promotions don't have a big effect on a consumer's purchase volume. Coupons have been demonstrated in several studies to be an ineffective tool for use as a sales promotion; these research looked at customers' reactions to the substantial price reductions provided by coupons; since coupons can reduce the value of anything. In the study of (Lammers ,1991) revealed that customer purchasing behavior is strongly influenced by the sample method and is linked to a speedy selling procedure. Shimp (2003) found that free product samples influence consumers' purchasing power and their purchasing decision as well. "Buy one get one free" promotions are a very helpful strategy for marketers and manufacturers looking to move their inventory more rapidly. (Li, Sun, and Wang, 2007). Free sampling has a positive effect on consumer purchasing behaviour, according to researchers (Parmataris, 2001; Fill, 2002; Shimp, 2003). However, Free samples and customer purchase behaviour have a positive correlation, although Jackaria and Gilbert (2002) argued that these relationships can vary from product to product and from time period to time period. BOGO is a significant element for affecting consumer behavior, according to Smith and Sinha (2000) and Shi et al. (2005), however Gilbert and Jackaria (2002), Shamsi and Khan (2018) found it to have a substantial impact only for a few consumer behavior factors. Bonus packages and free supplementary products encourage people to purchase the goods because they believe it is a good deal, especially if



**SushmaYadav and Kapil Malhotra**

it comes in large bundles and is well publicized. Gardener and Trivedi, 1998; Percy, Rossiter, and Elliott, 2001) say that such promotions encourage customers to explore new items and switch companies. Price discount is “reduce the price for a given quantity or increase the quantity available at the same price, thereby enhancing value and create an economic incentive to purchase” (Raghubir and Corfman, 1999). Chen et al., 2012 found in his study the consumers are impacted by the price cut, which enhances the worth of the high-priced goods and has a significant impact on the market. Consumers are more likely to be lured by price discount promotions, according to Percy (2001). Price discounts are deliberately utilized in numerous industries to boost customer buying behaviour to buy a product (Blackwell and colleagues, 2001). The findings of this study corroborated previous findings by who found that Price discounts influence consumers' purchase trial behaviour, according to Smith and Sinha (2000), who discovered that price promotions can inspire Sales Promotion and result in short-term sales increases.

(Kaveh,2020) in his study revealed that attracting customers to a store's offering by giving them the option to select the type of special discount that most closely matches their preferences is linked to increased purchase intent. Different promotional offers are intended for different types of items, thus the marketer must choose which form of order to achieve the finest possible result, sales promotion is the best option for the concerned products. Furthermore, marketers must guarantee that the quality of their items remains consistent should avoid before and after the sales promotion client displeasure. The structure offers new insights into how different customers adapt to various promotional tools supplied by marketers, as well as their impact on consumer purchase decisions and sales promotion, which could be critical for marketers looking to improve their product promotion approaches and promotional tools. In other words, when a company provides benefits to its customers such as cash rebates or gift. It has a higher chance of attracting new clients and retaining existing ones. Sales promotion has not only helped to progress in the atmosphere of retail stores by drawing a more promising to a large number of customers, but it has also helped to successfully boost the company's sales profit.

CONCLUSION

The study concludes that Sales promotion techniques proved to be useful to influence the consumer purchasing decision. Different promotional tactics have different effects on customer decisions. Coupons and customer purchasing patterns are closely related (Bhatti.A, et.al. 2020).Coupons are a means to entice customers to take advantage of more attractive deals. Discounts have a beneficial impact on consumer purchasing intent (Santini et al., 2015). The findings of this study support Salvi(2013) and Shamsi and Khan (2018), who claim that discounts are the strategies which influence the consumer purchasing behavior and even more effective than Buy-one-Get-one deals. Customers' purchasing behavior is positively influenced by bonus packages and free supplementary products. Buy one get one deals also helpful for the marketers to clear their stock (Shamout. M, 2016) and Li, Sun & Wang (2007). The practise of free sampling influences customer purchasing decisions favourably as well. But, the sampling method is not suitable to each kind of product. Overall, sales promotion techniques are crucial in encouraging consumers to purchase any promoted item, which will undoubtedly improve marketers' and retailers' profits and market share. In this study it demonstrated how the use of various promotional techniques, such as price reductions, free samples, and buy one get one deals, can positively influence consumers' behavior which proves thatthere is a strong link between sales promotion and customer purchasing habits. Though this research has aided marketers in comprehending the possible consequences of various promotional offers in creating profit and their impact on consumers' purchasing behavior. To put it another way, marketers must pay special attention to selecting the most appropriate sales promotional offers for specific products. The limitation of this study was that it focused only on a few promotional offerings, such as coupons, free samples, buy one get one free, and discounted prices, with no attention paid to other promotional offers, such as rebates, cash back, and premiums. The study's findings revealed that in order to target potential customers, marketers must weaken this habit by offering offers for prospective buyers that they can't refuse, causing them to try a product or brand that they have never tried before and also suggest that businesses can improve sales by providing the appropriate promotional tools to attract trial customers.





REFERENCES

1. Aditya, Kadek Yoga and I Made Wardana. (2017). The Role of Brand Equity in Mediating the Effect of Word of Mouth on Purchase intention. *E-Journal of Unud Management*, 6 (2), pp. 830-856.
2. Bhatti, Anam&Talat, &Javaid, Anam& Mahwish, Syeda& Naqvi, Raza. (2020). "Impact of Sales Promotion on Consumer Buying Behavior: A Case of Garments Industry of Pakistan". *International Journal of Advanced Research In Engineering & Technology*. Vol. 11, No. 10, {ISSN 0976-6499} 10.34218/IJARET.11.10.2020.010
3. Blackwell, R.D., Miniard, P.W. and Engel, J.F. (2001), "Consumer Behavior", 9th ed. Fort Worth, TX: Harcourt College Publishers.
4. Chandon, P., Wansink, B., & Laurent, G. (2000). A benefit congruency framework of sales promotion effectiveness. *Journal of Marketing*, 64(4), 65-81. doi:10.1509/jmkg.64.4.65.18071
5. Chen, H., Marmorstein, H., Tsiros, M., & Rao, A. R. (2012). When more is less: The impact of base value neglect on consumer preferences for bonus packs over price discounts. *Journal of Marketing*, 76(4), 64- 77
6. Cook, A. (2003) "How to cash in on the coupon craze" *Incentive Business*. 3 Jun
7. Darke, P.R. & Freedman, J.L. (1995). Nonfinancial motives and bargain hunting. *Journal of Applied Social Psychology*, 25, 1597–1610
8. Ehrenberg, A.S.C., Hammond, K. and Goodhardt, G.J. (1994) "The after effects of price related consumer promotions" *Journal of Advertising Research*. Vol. 34, No. 4, pp. 11-21.
9. Fill, C. (2002) *Marketing communications: Contexts, strategies and applications*, 3rd ed. Italy: Pearson Education Limited
10. Gardener E, Trivedi M. (1998), A communication framework to evaluate sale promotion strategies. *J. Advert. Res.*, 38 (3): 67-71.
11. Gardener, E. and Trivedi, M. (1998) "A communication framework to evaluate sale promotion strategies" *Journal of Advertising Research*. Vol. 38, No. 3, pp. 67-71.
12. Haugh L.J., 'Defining and redefining', *advertising Age*, Feb14, 1983, p. M44.
13. Jorge M. Silva-Risso, Randolph E. Bucklin. (2004), Capturing the Effect of Coupon Promotions in Scanner Panel Choice Models", *Journal of Product and Brand Management*, Vol.13 (6), pp.442-452
14. Kaveh, Azam&Nazari, Mohsen & van der Rest, Jean-Pierre & Mira, Seyed. (2020). Customer Engagement in Sales Promotion. *Marketing Intelligence & Planning*. ahead – of - print. 10.1108/MIP-11-2019-0582.
15. Laroche, M., (2003) 'A model of consumer response to two retail sales promotion techniques', *Journal of Business research*, Vol.56, No.7, pp. 513-522.
15. Li, S. Sun, Y. and Wang, Y. (2007) "50% Off or Buy One Get One Free? Frame Preference as a Function of Consumable Nature in Dairy Products" *The Journal of Social Psychology*, Vol. 147, No. 4, pp. 413-421.
16. Ndubisi O.N. (2005), Customers Behavioral Responses to sales promotion: The Role of Fear of Losing Face, Vol. 17, No.1, pp.32-49
17. Neslin S. A., Henderson C., Quelch J., (1984), 'Consumer promotions and the acceleration of product purchases', *Marketing Science*, Vol. 4, Issue 2, p. 147- 165.
18. Pramatataris, K.C., Vrechopoulos, A.P., and Doukidis, G.I. (2001), "The transformation of the promotion mix in the virtual retail environment: An initial framework and comparative study".
19. Raghubir, P. and Corfman, K.P. (1995), "When do price promotions signal quality? The effect of dealing on perceived service quality", *Advances in Consumer Research*, Vol.22 No.1, pp.58-61
20. Santini, Fernando &Ladeira, Wagner &Sampaio, Claudio & Araujo, Clecio. (2015). "Perception of value, attractiveness and purchase intention: revisiting promotion techniques sale". *Review of Business Management*. Vol.17 No.57. pg. 1173-1192. 10.7819/rbgn.v17i57.2040.
21. Schindler, R. M. (1992). A Coupon Is More Than a Low Price: Evidence from a Shopping-Simulation Study. *Psychology & Marketing*, 9 (6), 431-51.
22. Schultz, D., Robinson W., (1982), *Sales promotion Management*, Chicago, Crain Books.
23. Shamout, Mohamed. (2016). "The Impact of Promotional Tools on Consumer Buying Behavior in Retail Market". *International Journal of Business and Social Science*. Vol. 7/No.1 {ISSN 2219-6021}





SushmaYadav and Kapil Malhotra

24. Shamsi, Mohd. Salman & Khan, Mohd. (2018). "Impact of Sales Promotion on Consumer Behavior: An Analytical Study of Readymade Garments and Footwear Segments. Al-Barkaat Journal of Finance & Management. Vol.10 No.1. 94. 10.5958/2229-4503.2018.00008.5
25. Sinha, I. and Smith, M. F. (2000) "Consumers perceptions of promotional framing of price" Psychology & Marketing, Vol. 17, No. 3, pp. 257-75.
26. Smith, M. F., & Sinha, I. (2000). The impact of price and extra product promotions on store preference. International Journal of Retail & Distribution Management, 28(2), 83–92. <http://doi.org/10.1108/09590550010315269>
27. Strang, R.A., (1983), Sales promotion research: contribution and issues, Unpublished paper, Presented at AMA/MSI/PMAA Sales promotion Workshop, Babson College, May
28. Susan K. Harmon, C. Jeanne Hill. (2003), "Gender and coupon use ", Journal of Product & Brand Management, Vol. 12 Iss: 3, pp.166 – 179



Figure 1. Techniques for Sales Promotion



Figure 2. Popular Tools for Consumer Sales Promotion





SushmaYadav and Kapil Malhotra

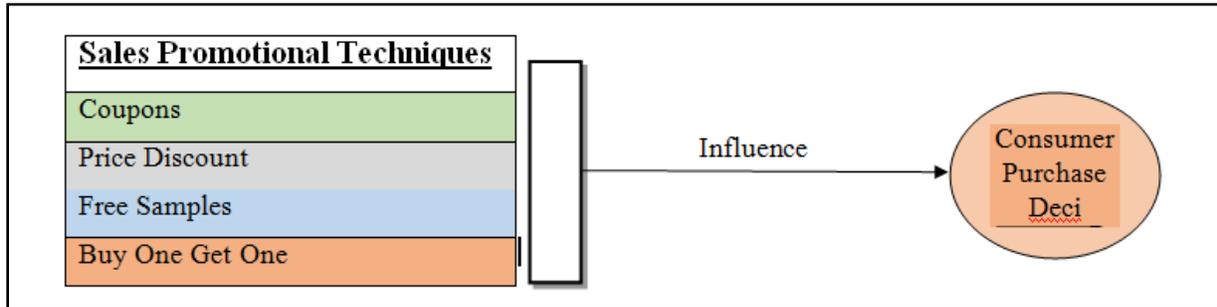


Figure: 3 Influence of Sales Promotional Offers

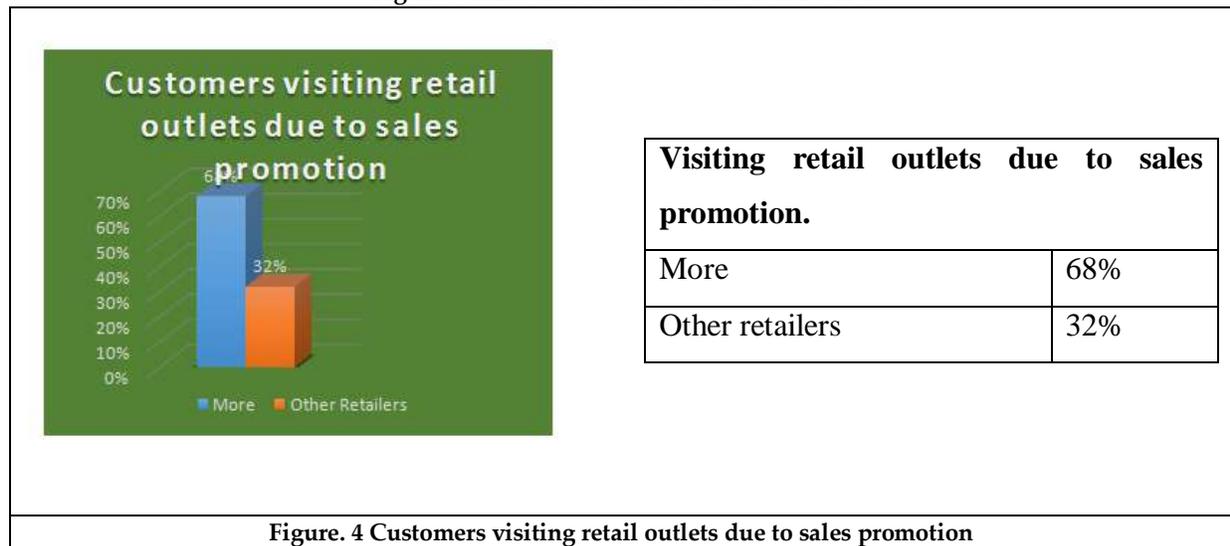


Figure. 4 Customers visiting retail outlets due to sales promotion





A Study on Modern banking services rendered by State Bank of India with Reference to Tiruchirappalli City

S.Prasath

Assistant Professor, Department of Management Studies, Brindavan College, Bengaluru -560063, India

Received: 02 June 2022

Revised: 25 June 2022

Accepted: 23 July 2022

*Address for Correspondence

S.Prasath

Assistant Professor,

Department of Management Studies,

Brindavan College, Bengaluru -560063, India

Email: royalsivaprasath@Gmail.Com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The most innovative services supplied by banks are Modern Banking. The shift from old-school to new-school banking has been significant. Direct Bill Payment, EFT, and revolutionary online banking are all examples of how contemporary banking has progressed since the introduction of ATMs, telephone banking, and immediate bill payment. Joshi and Sankaranarayanan, both from the University of California, Berkeley (2015). Customers will be more likely to purchase products and services from companies that vide high-quality service in a highly competitive market like banking. In the future, bank customers will likely promote e-banking / online banking to their friends and family. Customers may also continue to use e-banking/internet banking in the future," according to the findings.

Keywords: Customer Satisfaction, Modern Banking, e-service

INTRODUCTION

ATMs, online banking, telephone, and mobile bank services are helping to drive the banking industry's rapid expansion. This expansion has been bolstered by technological advancements that would not have been conceivable without them. There is a vast range of services provided by banks these days, ranging from small savings accounts for individuals to major corporations and even non-profit organizations, to meet clients' financial and non-financial demands. Depending on the nature and size of the bank, a bank's range of services might vary considerably. The primary topic of this research is A Study of State Bank of India's Modern Banking Services in Tiruchirappalli City.



**Prasath****REVIEW OF LITERATURE**

Amruth Raj Nippatlapalli (2013) When a company's products and services meet or exceed customer expectations, the term "customer satisfaction" is widely used in marketing. Satisfaction is "the number of consumers or a proportion of the overall customer base reporting that they are satisfied with the quality of the company's product, service, or experience." India's first bank was established in the late 1700s. General Bank of India, NOW, and Bank of Hindustan, established in 1790, were the country's first banks. Both have now gone out of business and are no longer in operation. When the State Bank of India was founded in June 1806, the Bank of Calcutta has renamed the Bank of Bengal, and the Bank of Bengal was renamed the Bank of Bengal. A presidential bank was one of three formed under British East India Company licenses, along with the other two: the Bank of Bombay and the Bank of Madras. The Presidency banks and their successors served as quasi-central banks for a long time. To become the Imperial Bank of India, the three banks amalgamated together in 1921. The socio-economic development of the country is heavily dependent on the banking industry.

For this study, we looked at the relationship between service quality and customer satisfaction in two private sector banks in India. The concept of service quality has been defined as a type of attitude that arises from comparing the prospect to the recital (Cronin and Taylor, 1992, Parasuraman et al., 1985). When evaluating the quality of service, Gronroos (1982) stated that clients compare expectations and perceptions when evaluating service quality. For academics and the banking industry, it's a puzzle as to why certain banks' products are favoured over others while they're all fundamentally similar. Customer preference for two banks in the same industry may differ from those in the public and private sectors. To find out the answers to these questions, we conducted this investigation. The eminent Dr. Bhupendra Singh Hada (2016) states that Digital age infrastructure may be used to create both local and worldwide opportunities through e-banking, which is what the term refers to. IT allows for a considerable reduction in transaction costs and the emergence of new banking opportunities that overcome the obstacles of time and location. The advantages of e-banking extend beyond the local to the global. Internet banking has several advantages over traditional banking systems. Internet banking provides banks with an expanded customer base, cost savings, mass customization, product innovations, improved marketing and communication, the capacity to establish non-core businesses, and the ability to supply services regardless of geography and time constraints. Internet banking will soon overtake traditional brick-and-mortar banking as the preferred method of doing financial transactions. Because it allows users to access their accounts remotely rather than in person, internet banking lowers the bank's operating expenses for both the bank and the consumer. This study examines the various online services offered by central public and private banks in Jaipur and determines how these services affect customer satisfaction. There are two Narang sisters (2017). Like many other financial service companies, banking is dealing with fast-changing markets, new technology, economic uncertainties, severe rivalry, and significantly more demanding consumers; and the shifting atmosphere has brought an unparalleled set of Challenges. When it comes to customer service is one of the most important aspects of any financial business. Throughout the banking sector, everything revolves around the customer and income generation. The Indian banking sector has evolved from a tranquil haven to a battlefield where banks compete for the loyalty of their customers and the maximization of their profits, rather than the other way around (Private bank vs. Nationalized Bank). According to this research, public and private sector banks are equally satisfied with their customers. Using a simple random sampling method, the sample size is 50 from the Malout and Bathinda districts of Punjab.

Doctor John Ditto (2017) states that E-banking is one of the newest banking innovations in India. E-Banking, Net banking, Online banking, and Internet banking are all forms of e-banking that have replaced the old banking system due to ICT advancements. Net banking client satisfaction and perception are the primary goals of the study. "With a sample of 100 participants, this research was conducted by scheduled interviewing. Customers' opinions on net banking were gleaned using basic percentage calculations and a chi-squared test of significance. Krishna V. NarasimhaRao (2018) In the late 1700s and early 1800s, India's current banking system was born. There are a large number of Indian banks that the government owns. Over the years, government efforts to promote banking





Prasath

technology and support expansion in unbanked and non-metropolitan regions have helped to expand access to the banking system. Basel II and most of Basel III have already been adopted by Indian banks, with a March 31st, 2019, deadline for implementation. To combat black money and cashless transactions in India, Prime Minister Narendra Modi launched an unprecedented step on November 8th, 2016. Because of this, consumers all around the country have experienced significant difficulties using banking services. After demonetization, customers' attitudes toward banking and financial services have shifted dramatically. In India, Non-Performing Assets (NPAs) are the major problem (NPAs). To restore public confidence in the banks, there must be an end to the problem of NPAs. The country's financial institutions are intertwined; if one fails, so does the entire economic system.

NEED FOR THE STUDY

Regarding today's banking industry, supplementary services like remittances and web-enabled services ranging from train ticket booking to e-shopping and SMS goods play a crucial role. Banks must retain profitability by satisfying customers' demands for speed, efficiency, and cheap cost to preserve excellent relations for growth and long-term survival. It is necessary to thoroughly research and analyze the demands of the consumer in order to achieve this goal. As a result, research on these topics must be ongoing.

OBJECTIVES OF THE STUDY

To know various modern banking services rendered by State Bank of India

RESEARCH METHODOLOGY

Researchers in Tiruchirappalli, a State Bank of India branch, examined how clients felt about the bank's current banking services. Primary and secondary data are used in the investigation. Personal observations and interviews with the respondents have been used to gather the primary data. The Reserve Bank of India's reports, circulars, encyclopedias, and websites were used to gather secondary data. These sources included bank records, published and unpublished publications, journals, reports, and circulars.

PILOT STUDY

Unlike a full-fledged study, the interview schedule, postal questionnaire, or measurement scale for a pilot study has been determined. The researcher made several trips to the chosen area as part of the pilot study to gain a complete picture of the study's potential understanding. In addition, the researcher went into detail about the study's goals and methodology.

PRE-TEST

The researcher's Pre-testing has served a variety of purposes. In order to see if the instrument would elicit the responses needed to meet the study's goals, a pre-test was administered to 30 participants. The final program was tweaked several times based on the participants' responses. Modifications such as common terminology, precision, clarity, and objectivity have all been made. Other question-wording issues include unjustified assumptions, personalization, presumptions, and hypotheses; inquiries in humiliating situations are adapted. Finally, the obtained pre-samples were not included in the final analysis. The data in the preceding table illustrates how satisfied customers are with various service providers. First, 31% of respondents were delighted with the supply of financial advice, followed by 24% satisfied, 18.3% unsatisfied, 15.5% unconvinced, and the remaining 11% dissatisfied, as shown in the first statement. Some 35.5 percent of respondents were highly satisfied with NEFT/RTGS transfers; 20.7 percent were satisfied; 19 percent had no opinion; 12.7 percent were dissatisfied, and 12.2 percent were highly dissatisfied. To sum up, 29.3% of respondents were delighted with electronic services (ECS system), 24.8% were satisfied, 17.7% were unsatisfied, 14.3% were dissatisfied, and the remaining 13.8% were highly dissatisfied, as shown in the third statement. Over a third (36.2%) of those polled said they had a very high level of satisfaction with front office services, while 22.2% said they were somewhat content, 14.5% said highly dissatisfied, and the remaining 13.5% said they had no opinion. One-third (36.7 percent) of respondents were extremely satisfied with bank





Prasath

employees' ability to answer customer questions; another 23.2% were satisfied; 16.8 percent had no opinion; 14.2 percent were highly dissatisfied, and the final 9.2 percent of respondents were dissatisfied with the bank's employees' knowledge of how to answer customer questions. According to the sixth statement, only 6.8% of respondents were unsatisfied: 31.5 percent said they were satisfied, 25.5 percent were satisfied, 23 percent were severely dissatisfied, and 13.2 percent had no opinion. Some 33.5 percent of respondents were highly satisfied with ATM service system availability, 23.7 percent were satisfied, 13.7 percent were highly dissatisfied, and the rest had no opinion, according to the eighth statement. 34.7 percent were highly satisfied with the experienced management team, while 22.8 percent said they were satisfied; 16.2 percent were dissatisfied; 15.2 percent said they had no opinion, and 11.2 percent said they were highly dissatisfied. More than a third of the respondents (32.7%), 23.7%, were satisfied, 19.7% had no opinion, and 13.7% had a dissatisfaction rating of more than 90%. The remaining 11.1% were severely dissatisfied with the privacy and secrecy of the bank. Thirty-eight percent of respondents were satisfied with the language and information content, thirty-one percent were satisfied, eleven percent were severely dissatisfied, eleven percent were dissatisfied, and the remaining ten percent had no opinion. Thirty-seven percent of respondents were highly satisfied with convenient hours of operation (24X7), 25 percent were satisfied, 21 percent were undecided, 12 percent were dissatisfied, and the remaining 10.8 percent were severely dissatisfied. There were 28.7% of respondents who were highly satisfied with brochures for new customers, 25.8% were satisfied, 19.5 % had no opinion, 17 % were dissatisfied, and the remaining 9 % were severely dissatisfied, according to the twelfth statement. 31.3 percent of respondents were highly pleased with customer feedback services, 24.5 percent satisfied, 22 percent indifferent, 12.5 percent dissatisfied, and 9.7 percent displeased. Three-quarters (73.2%), 24.7 (24.7%), 17.7 (17.7%), 16 (16.7%), and 8.5% of respondents were highly unsatisfied with the support desk or call centers of their bank, respectively, in the fourteenth report. The sixteenth statement discloses that 29.7 percent of respondents were highly satisfied with electronic bill payments, 25.3 percent were satisfied, 23.2 percent were undecided, 11 percent were dissatisfied, and the remaining 10.8 percent were highly dissatisfied with electronic bill payments. A total of 36% of those polled said they were delighted with ATM security, 23% said they were content, 16% said they did not have an opinion, 13% said dissatisfied, and the remaining 10% said they were highly dissatisfied. According to the sixteenth statement, 37.8% of respondents were delighted with how problems with ATM services were handled, while 20% were satisfied, 18% were satisfied, 14.5% were dissatisfied, and the other 9.3% were highly dissatisfied. Some 33.5 percent of the respondents were highly satisfied with responsibility for essential banking services; 28.3 percent were content; 14.3% were unsatisfied; 13 percent were dissatisfied; and the remaining 10.8 percent were highly dissatisfied, according to the ninth teen survey.

Research Hypothesis

Modern financial services and customer satisfaction with banking operations are virtually identical. The first dimension of mean and S.D. values from ATM/Debit card (n=224) 35.654.338, Internet banking (n=89) 34.125.325, mobile banking (n=85) 36.844.474, Credit Card (n=19) 34.795.968, Electronic fund transfer (n=62) 36.234.496, E-payment (n=40) 34.234.753, RTGS (n=39) 35.494.762, and NEFT (n=42) 35.214.877 customers in their satisfaction with banking operations. As a result, the calculated value is less than the table value (.006 0.05). As a result, customers have varying levels of satisfaction with traditional and modern banking services. There were 224 customers with ATM/Debit card (n=224), Internet banking (n=89), mobile banking (n=85), 50.095.331, Credit Card (n=19) 51.533.549, Electronic fund transfer (n=62) 50.586.507, E-payment (n=40) 48.854.980, RTGS (n=39) 49.155.451 and NEFT (n=42) 49.296.978 customers in their satisfaction with technology use. As a result, the calculated value (.590>0.05) is higher than the table value. Consequently, there is no major difference between modern banking services and their views on technology satisfaction. Customers' experiences with ATM/Debit card (n=224) 54.145.649, Internet Banking (n=89) 53.976.315, Mobile Banking (n=85) 53.927.434, Credit Card (n=19) 55.896.732, Electronic Fund Transfer (n=62) 53.655.625, E-payment (n=40) 57.336.911, RTGS (n=39) 54.875.232, and Table value (.0120.05) is less than the calculated value (.0120.05). This means that modern financial services and their views on the challenges posed by technology are vastly different. Customers' satisfaction with various service offerings is measured by the fourth dimension of mean and standard deviation (n=224) 63.80–6.535, Internet banking (n=89) 63.99–6.121, mobile banking (n=85) 61.31–6.590, Credit Card (n=19) 63.32–5.879, Electronic fund transfer (n=62) 64.24–6.303, E-payment (n=40) 64.45–6.064, RTGS (n=39) 61.95–6.786 and NEFT (n=42) 64.12–5.209 customers. Thus, the estimated value (.0300.05) is





Prasath

smaller than the table value. As a result, there is a huge disparity between the modern banking industry and its customers' perceptions of how satisfied they are with the services they receive. Modern banking services rely on the fifth dimension of mean and standard deviation values from ATM/Debit card (n=224) 24.623.906, Internet banking (n=89) 24.333.599, mobile banking (n=85) 25.543.759, Credit Card (n=19) 24.054.156, Electronic fund transfer (n=62) 23.973.917, E-pay (n=40) 24.133.917, RTGS (n=39) Because of this, the calculated value is lower than the table value (.0430.05). Consequently, modern financial services and their views on adapting current banking services differ significantly. Lastly, the mean and standard deviation of the factors influencing the use of modern banking services for the n=224 ATM/Debit card (n=89 Internet banking (n=89) 59.244.931, mobile banking (n=85) 59.255.814, credit card (19) 60.796.015, electronic fund transfer (n=62) 61.355.766, E-payment (n=40) 61.135.788, RTGS (n= In this case, the calculated value (.036) is smaller than the table value (.051). As a result, modern banking services and people's perspectives on what motivates them to use them diverge significantly. We can rule out that theory.

Findings

31% of those polled said they were delighted with their financial advice. A third of those polled (35,5%) said they were delighted with how money was sent (through NEFT/RTGS). Over a third of the respondents (29.3%) reported that they were satisfied with electronic services (ECS system)A third of those polled (33,5%) said they were delighted with ATM service system availability. More than a third of respondents (32.7%) were happy with the bank's privacy and confidentiality.

SUGGESTIONS

Banks must do everything they can to raise awareness among rural residents about the benefits of the bank's e-banking/internet banking services. E-banking/internet banking should be improved so that users can conduct online inquiries and payments more efficiently.

CONCLUSION

The study's findings show that ATM, Telebanking, and Internet banking use are important and connected with respondents' socio-economic and demographic factors. Even though most customers prefer manual banking over electronic banking, customers are increasingly turning to e-banking and internet banking, and their use of these services is heavily influenced by how frequently they visit their banks and how many transactions they conduct each month.

REFERENCES

1. Amruth Raj Nippatlapalli (2013), "A Study On Customer Satisfaction Of Commercial Banks: Case Study On State Bank Of India," 'IOSR Journal of Business and Management (IOSR-JBM)', ISSN: 2319-7668, Vol.15, Issue.1, Pp.60-86.
2. Dr.A.JohnDitto(2017), "A Study On Customer Perception And Satisfaction Towards Net Banking," 'International Journal of Interdisciplinary Research in Arts and Humanities(IJIRAH)', ISSN:2456-3145, Vol.2, Issue.1, Pp.29-32
3. Dr.Bhupendra Singh Hada (2016), "Online Banking and Customer Satisfaction in Public and Private Sector Banks: Evidence from India," 'IOSR Journal of Business and Management, ISSN:2319-7668, Vol.18, Issue.4, Pp.10-20.
4. Narasimha Rao V(2018) "Customer Perception towards Banking Services- Post Demonetization," 'IOSR Journal of Business and Management (IOSR-JBM)', ISSN:2319-7668. Vol.20, Issue.4, Pp.79-86.





Prasath

TableNo.-1: Level of satisfaction towards various services provision

| Sl. No | Statements | Highly Dissatisfied | Dissatisfied | No opinion | Satisfied | Highly Satisfied | Mean |
|--------|---|---------------------|---------------|----------------|----------------|------------------|------|
| 1 | Provisions of financial advices | 110 (18.3%) | 66 (11%) | 93 (15.5%) | 145 (24.2%) | 186 (31%) | 3.38 |
| 2 | Transfer of Funds (NEFT/RTGS) | 73 (12.2%) | 76 (12.7%) | 114 (19%) | 124 (20.7%) | 213 (35.5%) | 3.55 |
| 3 | Electronic Clearing Services (ECS System) | 83 (13.8%) | 86 (14.3%) | 106 (17.7%) | 149 (24.8%) | 176 (29.3%) | 3.41 |
| 4 | Front Office Services | 87 (14.5%) | 78 (13%) | 85 (14.2%) | 133 (22.2%) | 217 (36.2%) | 3.53 |
| 5 | Employees of bank have the knowledge to answer the Customer Questions | 85 (14.2%) | 55 (9.2%) | 101 (16.8%) | 139 (23.2%) | 220 (36.7%) | 3.59 |
| 6 | Employees are always willing to help you | 138 (23%) | 41 (6.8%) | 79 (13.2%) | 153 (25.5%) | 189 (31.5%) | 3.36 |
| 7 | System Availability In ATM services | 82 (13.7%) | 96 (16%) | 79 (13.2%) | 142 (23.7%) | 201 (33.5%) | 3.47 |
| 8 | Experienced management team | 67 (11.2%) | 97 (16.2%) | 91 (15.2%) | 137 (22.8%) | 208 (34.7%) | 3.54 |
| 9 | Privacy and Confidentiality of the Bank | 66 (11%) | 82 (13.7%) | 118 (19.7%) | 138 (23%) | 196 (32.7%) | 3.53 |
| 10 | Language and information content | 68 (11.3%) | 67 (11.2%) | 63 (10.5%) | 187 (31.2%) | 215 (35.8%) | 3.69 |
| 11 | Convenient hours of operation (24X7) | 65 (10.8%) | 75 (12.5%) | 126 (21%) | 150 (25%) | 184 (30.7%) | 3.52 |
| 12 | Brochures to educate new users | 54 (9%) | 102 (17%) | 117 (19.5%) | 155 (25.8%) | 172 (28.7%) | 3.48 |
| 13 | Customer feedback services | 75 (12.5%) | 58 (9.7%) | 132 (22%) | 147 (24.5%) | 188 (31.3%) | 3.53 |
| 14 | Help desk and call centres of bank | 96 (16%) | 51 (8.5%) | 106 (17.7%) | 148 (24.7%) | 199 (33.2%) | 3.51 |





Prasath

| | | | | | | | |
|----|--|---------------|---------------|----------------|----------------|----------------|------|
| 15 | Electronic Bill Payments | 65 (10.8%) | 66 (11%) | 139 (23.2%) | 152 (25.3%) | 178 (29.7%) | 3.52 |
| 16 | Security in ATM services | 63 (10.5%) | 79 (13.2%) | 99 (16.5%) | 143 (23.8%) | 216 (36%) | 3.62 |
| 17 | Problem handling relating to ATM services | 56 (9.3%) | 87 (14.5%) | 108 (18%) | 122 (20.3%) | 227 (37.8%) | 3.63 |
| 18 | Responsibility about core banking services | 65 (10.8%) | 78 (13%) | 86 (14.3%) | 170 (28.3%) | 201 (33.5%) | 3.61 |

Source: Primary Data

TableNo.-2:Oneway ANOVA difference between modern banking services and their satisfaction level towards banking operation

| Modern banking services | N | Mean | SD | SS | DF | MS | Statistical inference |
|---|-----|-------|-------|-----------|-----|--------|---------------------------------------|
| Level of satisfaction toward banking operation | | | | | | | |
| Between Groups | | | | 435.634 | 7 | 62.233 | F=2.841 .006<0.05 Significant |
| ATM/Debit Card | 224 | 35.65 | 4.338 | | | | |
| Internet Banking | 89 | 34.12 | 5.325 | | | | |
| Mobile Banking | 85 | 36.84 | 4.474 | | | | |
| Credit Card | 19 | 34.79 | 5.968 | | | | |
| Electronic Fund Transfer | 62 | 36.23 | 4.496 | | | | |
| E-payment | 40 | 34.23 | 4.753 | | | | |
| RTGS | 39 | 35.49 | 4.762 | | | | |
| NEFT | 42 | 35.21 | 4.877 | | | | |
| Within Groups | | | | 12966.260 | 592 | 21.902 | |
| Level of Satisfaction towards Technology Usage | | | | | | | |
| Between Groups | | | | 188.861 | 7 | 26.980 | F=.797 .590>0.05 NotSignificant |
| ATM/Debit Card | 224 | 49.87 | 6.067 | | | | |
| Internet Banking | 89 | 50.45 | 5.385 | | | | |
| Mobile Banking | 85 | 50.09 | 5.331 | | | | |
| Credit Card | 19 | 51.53 | 3.549 | | | | |
| Electronic Fund Transfer | 62 | 50.58 | 6.507 | | | | |
| E-payment | 40 | 48.85 | 4.980 | | | | |

| | | | | | | | |
|---|-----|-------|-------|-----------|-----|--------|--|
| RTGS | 39 | 49.15 | 5.451 | | | | |
| NEFT | 42 | 49.29 | 6.978 | | | | |
| Within Groups | | | | 20049.097 | 592 | 33.867 | |
| Problems faced by the Technology Usage | | | | | | | |
| Between Groups | | | | 682.163 | 7 | 97.452 | |
| ATM/Debit Card | 224 | 54.14 | 5.649 | | | | |
| Internet Banking | 89 | 53.97 | 6.315 | | | | |
| Mobile Banking | 85 | 53.92 | 7.434 | | | | |





Prasath

| | | | | | | | |
|---|-----|-------|-------|-----------|-----|--------|-------------------------------------|
| Credit Card | 19 | 55.89 | 6.732 | | | | F=2.597 .012<0.05 Significant |
| Electronic Fund Transfer | 62 | 53.65 | 5.625 | | | | |
| E-payment | 40 | 57.33 | 6.911 | | | | |
| RTGS | 39 | 54.87 | 5.232 | | | | |
| NEFT | 42 | 56.64 | 5.634 | | | | |
| Within Groups | | | | 22217.511 | 592 | 37.530 | |
| Level of satisfaction towards various services provision | | | | | | | |
| Between Groups | | | | 629.826 | 7 | 89.975 | F=2.237 .030<0.05 Significant |
| ATM/Debit Card | 224 | 63.80 | 6.535 | | | | |
| Internet Banking | 89 | 63.99 | 6.121 | | | | |
| Mobile Banking | 85 | 61.31 | 6.590 | | | | |
| Credit Card | 19 | 63.32 | 5.879 | | | | |
| Electronic Fund Transfer | 62 | 64.24 | 6.303 | | | | |
| E-payment | 40 | 64.45 | 6.064 | | | | |
| RTGS | 39 | 61.95 | 6.786 | | | | |
| NEFT | 42 | 64.12 | 5.209 | | | | |
| Within Groups | | | | 23810.674 | 592 | 40.221 | |

| | | | | | | | |
|---|-----|-------|-------|-----------|-----|--------|-------------------------------------|
| Important to adapt modern banking services | | | | | | | |
| Between Groups | | | | 213.934 | 7 | 30.562 | F=2.091 .043<0.05 Significant |
| ATM/Debit Card | 224 | 24.62 | 3.906 | | | | |
| Internet Banking | 89 | 24.33 | 3.599 | | | | |
| Mobile Banking | 85 | 25.54 | 3.759 | | | | |
| Credit Card | 19 | 24.05 | 4.156 | | | | |
| Electronic Fund Transfer | 62 | 23.97 | 3.917 | | | | |
| E-payment | 40 | 24.13 | 3.917 | | | | |
| RTGS | 39 | 24.97 | 3.065 | | | | |
| NEFT | 42 | 23.12 | 4.192 | | | | |
| Within Groups | | | | 8652.039 | 592 | 14.615 | |
| Factors influencing to use modern banking services | | | | | | | |
| Between Groups | | | | 493.299 | 7 | 70.471 | F=2.163 .036<0.05 Significant |
| ATM/Debit Card | 224 | 60.36 | 6.085 | | | | |
| Internet Banking | 89 | 59.24 | 4.931 | | | | |
| Mobile Banking | 85 | 59.25 | 5.814 | | | | |
| Credit Card | 19 | 60.79 | 6.015 | | | | |
| Electronic Fund Transfer | 62 | 61.35 | 5.766 | | | | |
| E-payment | 40 | 61.13 | 5.788 | | | | |
| RTGS | 39 | 61.51 | 4.850 | | | | |
| NEFT | 42 | 58.38 | 5.346 | | | | |
| Within Groups | | | | 19288.941 | 592 | 32.583 | |





Efficacy of PMMY A Study with reference to State Bank of India

Jagadish. Hudagi*

Assistant Professor, Department of Commerce, K.L.E. Society's S.Nijalingappa College Bengaluru, Karnataka, India

Received: 01 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Jagadish. Hudagi

Assistant Professor,

Department of Commerce,

K.L.E. Society's S. Nijalingappa

College Bengaluru, Karnataka, India

Email: Jmhudagi@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

SBI is one of the largest leading bank in India it is continuously putting best efforts in promoting financial inclusion simultaneously enhancing the scope of micro enterprises. In this regard government of India launched the PM MUDRA Scheme on 8/4/2015. The basic intention of the government is to up lift financial strength as majority of the people depending upon small scale businesses as their source of revenue. Most of the individuals from unorganized sectors depend for loans and other credit facilities which have high rate of interest along with intolerable terms and conditions at the end they led to poverty becoming much poorer lastly falling in debts. A big portion of unorganized petty and small trade sectors operate as unregistered enterprises. They do not maintain proper books of accounts and are not formally covered under ambit of tax. This is the reason why banks find difficult to lend money such a section of micro and small businesses majority of small sectors not at all having an access to outside sources of finance. After identifying the importance of self employment and establishing small business units. Government of India launched MUDRA Scheme under PMMY to provide financial assistance to those who provide employment to a large number of people like young, educated, skilled, semi-skilled, unskilled workers and especially women entrepreneurs to uplift them towards mainstream economy. In this regard it is an attempt to analyze length and breadth of PMMY.

Keywords: PMMY, MSME, SBI, Self employment, Skill.



**Jagadish. Hudagi**

INTRODUCTION

State Bank of India is having more than 22000 branches not only in India even across the world including rural areas. Reserve Bank of India the pioneer and parent bank in India. Since SBI is having 1/4 market share in Indian banking system it is having higher responsibility regarding financial inclusion of these deprived sectors. Indian MSME's contributes nearly about 15 to 17 percent of the country's GDP. Small businesses are not in a position to play their role effectively due to various constraints. The problems tackling by the MSMEs, Insufficiency of finance skill development gap, basic infrastructure, proper policy and encouragement, regular information. Majority of these unorganized MSME's operating without having any registration they do not maintain proper accounts and are not formally covered under any constitutional Act of corporate sector. Hence banks finding difficulty to lend money to this unorganized sector. Mainly these small and micro enterprises not having access any outside sources of finance in this regard PM MUDRA YOJANA attempts to bank the unbanked. Basic intention of this scheme is to support these unorganized entrepreneurs who are deprived from main stream in this regard it is an attempt to bring them back through micro unit's development and refinance agency i.e. MUDRA Bank.

For availing loan facility eligibility of borrowers mentioned as under. Individuals Proprietary concern, partnership firm, private ltd. company, public company, and any other legal forms. The applicant should not be defaulter to any bank or financial institution and should have a satisfactory credit track record. Security purpose first charge on all assets created out of the loan extended to the borrower and the assets which are directly associated with the enterprises for which credit has been extended. Credit guarantee funds trust for micro and small enterprises, MUDRA Guarantee cover In terms of RBI guidelines issued circular on lending to MSME Sector.

STATEMENT OF PROBLEM

Since SBI is second biggest bank in India after RBI it is having major stake in Indian banking system also having higher responsibility regarding financial inclusion of deprived sectors. Indian MSME's contribution expected in between 15% to 17% growth rate country's GDP for the year ending 2022 according to study by ASSOCHAM, crisis it is not at all enough. MSME sector is back bone of Indian economy in this context PMMY seems to be one step towards up lift MSME's. But still there are lots of loop holes, lacunas and problem exists. Some of the basic things to be assessed like to what extent bank officials guided regarding MUDRA Scheme, deserved group of people are getting benefits or not, do they have awareness or knowledge in this regard. In this view the present study has been undertaken.

OBJECTIVES

- To analyze effectiveness of PMMY with respect to State Bank of India
- To study variation in funds utilized under the scheme from the point of view of SBI
- To evaluate the different schemes of MUDRA i.e. SHISHU, KISHORE, and TARUN
- To study the strength and weakness MUDRA in full filling the needs of MSME's
- To offer necessary suggestions to be considered from the findings of our study

HYPOTHESIS OF THE STUDY

- **H0:** There is no significant association in undistributed funds under MUDRA Scheme between SHISHU, KISHORE, and TARUN.
- **H1:** There is a significant association in undistributed funds under MUDRA Scheme between SHISHU, KISHORE, and TARUN.

METHODOLOGY

The present study is descriptive and analytical in nature by considering a period five years. It intends to collect data from both primary as well as secondary source in order to evaluate efficacy of PMMY from the point of SBI going



**Jagadish. Hudagi**

through path of objectives. Primary data collected from bank officials and beneficiaries of the scheme and secondary data collected through journals, magazines, annual audited reports of SBI and RBI website. And data so collected is tabulated and analyzed by using appropriate statistical tools. Also the study intends to analyze the measures taken by government through banking sector in implementation of MUDRA YOJANA.

ANALYSIS AND INTERPRETATION

- It can be noticed from the above table 3 that a significant variation in undistributed loan amount between SHISHU, KISHORE and TARUN during the study period from 2017-18 to 2021-22 i.e. on average an amount of Rs. 15.37, Rs. 108.23 to Rs. 43.52.
- Statistical ANOVA factor analysis test shows that calculated value $P = 0.00034698$ at 5 percent level of significance and the table 4 F- value is 16.63424854 which is higher, thus the null hypothesis is rejected and alternative hypothesis is accepted.

NATURE AND TYPE OF BUSINESS, ENTERPRISE

From the table 5 we can interpret that the majority of respondents who have applied for MUDRA loan have used their loan for sole trade respondents 42 are doing, 26 respondents are doing their family owned business, 18 respondents having partnership firm, 9 have private ltd and 6 of them follow other entrepreneurship. From this we can get know that maximum number of beneficiaries used the MUDRA loan to start sole proprietorship. Further we can analyze that out of 101 respondents around 17.82% of the respondents have partnership firm, 41.58 respondents are sole proprietors, 25.74% are doing their family owned business, 8.92% are Private Ltd and 5.94% have other nature of enterprises since these percentage of respondents who have availed the loan from MUDRA scheme for different nature of enterprise as shown in above table 5.

UTILIZATION OF LOAN AMOUNT

From the above table 7 we can clearly identify the purpose of utilization of the loan from MUDRA- scheme. 19 of the respondents have utilized the loan for the running business, 46 of the respondents have used their loan for new business, 28 of them have used their loan for the existing business and another 8 of the respondents have used the loan for other purpose this shows that MUDRA is helping in entrepreneurship development. From graph we can analyze that out of 101 respondents. 18.81% of the respondents have utilized the loan amount for the running business and 45.54% of the respondents have utilized the loan for new business and 27.72% of the respondents have used the loan for existing business and another 7.92% of the respondents have used their loan for other purpose.

PMMUDRAY CAPABILITY IN PROVIDING EMPLOYMENT

From the above table 8 it is observed that 26 respondents strongly agree and 46 respondents agree that PPMY is capable in providing employment, 27 respondents have neutral opinion and 2 respondents disagree. So we can conclude majority of respondents agree that PPMY is capable in providing employment opportunities to the individuals.

FETURES OF SBI FOR MUDRA YOJANA

The above table 9 shows that 14 respondents have chosen SBI because it has faster service. 20 respondents have chosen SBI because of its Brand Name, 31 respondents have selected SIB because of it excellent services offered to its customers and majority of the respondents have chosen SBI because of all the features mentioned above. SBI e-MUDRA scheme has low interest rate and provide faster and excellent services to the customers SBI has sanctioned loans to about 2 lakh MSMES and nearly 60% of them has been disbursed, the bank has adopted digital process for lending loans under MUDRA scheme and the entire process is now end-to-end digitalized this help the beneficiaries to avail there loan easily.



**Jagadish. Hudagi****FINDINGS OF THE STUDY**

- It was found that 45.54% of the respondents utilized the loan for starting new business. Highest number of loan was applied under KISHORE category followed by SHISHU and TARUN. Majority of the respondent felt MUDRA scheme was easily accessible.
- Centralization and digitalization of MUDRA loan is acceptable by many respondents as it will be easily accessible to everyone.
- Majority of respondents say that PMMY has reduced the dependency on informal institution. 72 respondents agree that PM MUDRA YOJANA is capable in providing employment opportunity.
- As loan under MUDRA scheme are available from 50,000 to 10 lakh it helps in solving the financial problem of MSMEs.
- Majority of the respondents have chosen SBI because they provide faster service, excellent offers and also because of brand name of the bank.
- Majority of the respondents that is 49.5% of the respondents are satisfied by the benefits and interest rates offered by the SBI bank under MUDRA scheme.
- Due to COVID-19 majority of the entrepreneurs were affected and caused major disruption.

SUGGESTIONS

- In order to make use of MUDRA loan effectively one should have proper business plan. The bank should intimate the people to avail the benefits of the MUDRA scheme. Awareness is very essential for the scheme
- Proper documents should be provided to avail the benefits of the scheme. The people who know about the MUDRA scheme should intimate to their neighbor's and other people to take part in the scheme.
- Uneducated people are not aware of the scheme. But they are able to run small scale industries so it is suggested that the scheme should also extend the benefit to them also.
- The discrimination should be eradicated between the rich and poor, educated and uneducated.
- Each and every bank should provide the loans under MUDRA scheme for the benefits of the small scale entrepreneur's.
- The possible survey should be conducted by the banks for proper utilization of loan amount. It is suggested that beneficiaries to utilize the amount of MUDRA loan for the purpose which you have been mentioned in the applications.

CONCLUSION

MUDRA bank is not a separate bank. It is a government financing scheme to provide business loan to new business in India. To get business loan under the PMMY scheme the candidates have to contact the nearest public, private sector bank. MUDRA will be operating as a refinancing institution through state and regional level intermediaries. MUDRA delivery channel is conceived to be through the route of refinance primarily to NBFCs, MFIs, besides other intermediaries including banks, primary lending institutions etc. The rate of interest will be fixed by the institution time to time based on guidelines from the RBI. Majority of the respondents through this study I came to know that MUDRA scheme is providing the loans to the purpose of engaging the small scale business, which may lead to development of the rural business and that leads to increment in the per capita income and increase the national income finally it leads to the development of the country.

REFERENCES

1. Dixit, S. M. (2017). Closing the Credit Gap in Women Owned SMEs for Societal Transformation: A Theoretical Assessment of Indian Scenario.
2. Ferdousi, F (2015). Impact of microfinance on sustainable entrepreneurship development Studies Research, 51-63.
3. Girish S, N. K. (2016). MUDRA Performance in Karnataka. International Journal of Research and Analytical Reviews, 10.





Jagadish. Hudagi

4. India, G. O. <https://www.mudra.org.in>
5. Jain, Vineeth (2016). "Mudra Bank: A Step towards Financial Inclusion", Review of Research International Multidisciplinary Journal, Vol.5, Issue 4.
6. Purnima Rao. S. K. (2017). What constitutes financing gap in Indian SMEs – owners' perspective? Qualitative Research in Financial Markets.
7. Seema (2015). MUDRA: Micro Units Development & Refinance Agency, International Journal in Commerce, IT and Social Sciences, Vol.2, Issue 10, pp. 23-27.
8. T, Avani (2016). "How the MUDRA Bank Helps SME's to Grow", International Journal of Research in Applied, Natural and Social Sciences, Vol.4.

Table 1: PMMY Category

| SL. NO | CATEGORY | LOAN AMOUNT |
|--------|----------|------------------------------|
| 1 | SHISHU | Loans up to 50000 |
| 2 | KISHORE | Loans from 50001 to 5 lakh |
| 3 | TARUN | Loans from 500001 to 10 lakh |

Table 2: SBI Pmmudra Yojana Sactioned & Disbursement (AMT IN CRORE)

| YEAR | SHISHU Up to-50000 | | KISHORE 50001-500000 | | TARUN 500001-1000000 | |
|---------|-----------------------|---------------------|-------------------------|---------------------|-------------------------|---------------------|
| | Sanctioned Amt | Disbursement Amt | Sanctioned Amt | Disbursement Amt | Sanctioned Amt | Disbursement Amt |
| 2017-18 | 1893.80 | 1873.21 | 11258.15 | 11093.39 | 15638.95 | 15596.52 |
| 2018-19 | 6150.08 | 6113.25 | 10807.62 | 10676.13 | 16868.23 | 16823.12 |
| 2019-20 | 9325.36 | 9322.83 | 9771.52 | 9671.07 | 16027.99 | 15983.86 |
| 2020-21 | 1130.92 | 1125.50 | 12898.35 | 12842.4 | 23944.03 | 23915.76 |
| 2021-22 | 1183.49 | 1171.91 | 8147.67 | 8058.21 | 19180.45 | 19122.76 |
| Average | 3936.73 | 3921.34 | 10576.66 | 10468.24 | 18331.93 | 18288.40 |

SOURCES: PMMY STATE BANK OF INDIA.

Table 3: SBI Mudra Yojana UN- Disbursement Amount(Amt in Crore)

| YEAR | SHISHU | KISHORE | TARUN |
|---------|---------------------|---------------------|---------------------|
| | Un-Disbursement Amt | Un-Disbursement Amt | Un-Disbursement Amt |
| 2017-18 | 20.59 | 164.73 | 42.43 |
| 2018-19 | 36.83 | 131.49 | 45.11 |
| 2019-20 | 02.53 | 100.45 | 44.13 |
| 2020-21 | 05.42 | 55.05 | 28.27 |
| 2021-22 | 11.48 | 89.46 | 57.69 |
| Average | 15.37 | 108.23 | 43.52 |

SOURCES: PMMY STATE BANK OF INDIA.

Table 4. ANOVA: Summary

| Groups | Count | Sum | Average | Variance |
|----------|-------|--------|---------|------------|
| Column 1 | 5 | 76.85 | 15.37 | 191.69505 |
| Column 2 | 5 | 541.18 | 108.236 | 1743.55778 |
| Column 3 | 5 | 217.63 | 43.526 | 109.35988 |





Jagadish. Hudagi

Table 5: ANOVA

| Sources of Variation | SS | D f | MS | F | P-Value |
|----------------------|----------|-----|-------------|-------------|------------|
| Between Groups | 22673.73 | 2 | 11336.86533 | 16.63424854 | 0.00034698 |
| Within Groups | 8178.451 | 12 | 681.53757 | | |
| Total | 30852.18 | 14 | | | |

Table 6: Nature and Type of Business, Enterprise

| ENTERPRISE | RESPONDENTS | PERCENTAGE |
|-------------------|-------------|------------|
| Partnership firms | 18 | 17.82 |
| Sole trading | 42 | 41.58 |
| Family business | 26 | 25.74 |
| Private ltd. | 9 | 8.92 |
| Some others | 6 | 5.94 |

SOURCES: Primary data.

Table 7: Utilization of Loan Amount

| LOAN AMOUNT UTILIZED | NO. OF RESPONDENTS | PERCENTAGE |
|-----------------------|--------------------|------------|
| For Running Business | 19 | 18.81 |
| For New Business | 46 | 45.54 |
| For Existing Business | 28 | 27.72 |
| Any other specify | 08 | 07.92 |

SOURCES: Primary data.

Table 8: PMMU Dray Capability in Providing Employment

| RESPONSE | NO. OF RESPONDENTS | PERCENTAGE |
|-------------------|--------------------|------------|
| Strongly Agree | 26 | 25.74 |
| Agree | 46 | 45.54 |
| Neutral | 27 | 26.73 |
| Disagree | 2 | 1.98 |
| Strongly Disagree | 0 | 0 |

SOURCES: Primary data.

Table 9: Futures of SBI for Mudra Yojana

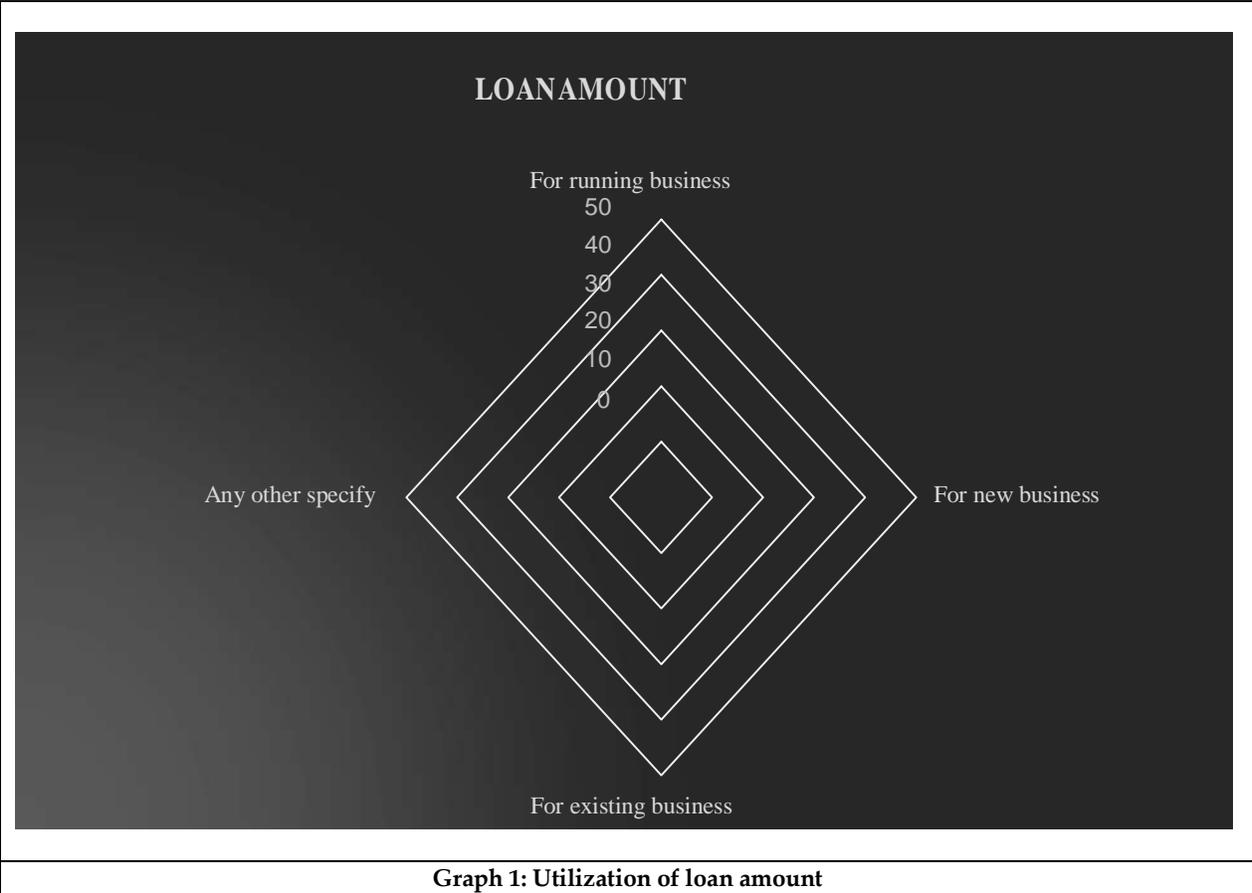
| RESPONSE | NO. OF RESPONDENTS | PERCENTAGE |
|-----------------------------------|--------------------|------------|
| Faster Service | 14 | 13.86 |
| Brand Name of the Bank | 20 | 19.80 |
| Excellent Service Offered by Bank | 31 | 30.69 |
| All the Above | 36 | 35.64 |

Sources: Primary data.





Jagadish. Hudagi





Financial Literacy: A Study on Money Management Skills of Working Women with Special Reference to Chennai City

K. Rajeswari^{1*}, K. Halimunnisa² and K.Ramu³

¹Associate Professor, Dept. of Commerce and Management, Nagarjuna Degree College, Bangalore, India

²Assistant Professor, Dept. of Commerce, Jamal Mohamed College, Tiruchirappalli, Tamil Nadu, India

³Dept. of Commerce, Dhanraj Baid Jain College, Chennai, Tamil Nadu, India

Received: 03 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

K. Rajeswari

Associate Professor, Dept. of
Commerce and Management, Nagarjuna
Degree College, Bangalore, India
Email: rajeswarianand18@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The quality of education has changed the perspective of women while competing with men in each filed from workplace to financial knowledge, they are equally competing with men. Technology have also played dominant role in enhancing women participation in financial etiquettes. Education have also boosted the financial literacy of women. Literacy is higher among working women in the state. Hence, the present study tries to identify the financial decision-making skills of working in Chennai city. A well-structured questionnaire has been used to collect data from 200 working women delegating from various occupational groups using convenient sampling methods. Both bivariate and multivariate statistical tools have been used to examine the relationship and difference among the variables. The results show 12 aspects were observed under determinants of financial decision-making skills which has brought into four latent factors namely Economic Influence Factor followed by Ability Factor, Earnings and Debt Factor and Predictive Activity Factor. Working women with financial knowledge significantly related to higher financial decision-making skills compare to those don't have financial knowledge. Higher the earning of working women higher would be their decision-making skills in finance. Age has positive and significant influence on determinants of financial decision-making skills. Higher the age of working women higher would be their financial decision-making skills similarly lower age of working women would be lower financial decision-making skills.

Keywords: Finance, Skills, Earning, Knowledge, Decision and Technology.



**Rajeswari et al.,**

“Feminism isn’t about making women stronger. Women are already strong. It’s about changing the way the world perceives that strength”

By G.D. Anderson

INTRODUCTION

The term finance is a wide phrase that contain money, banking, debt, credit, capital markets, investment and leverages. Finance in basic terms denotes managing of money and process of precuring needful finance. It can also define as management, development and analysis of money, banking, credit, investment, assets and liabilities which comprise of the total financial systems. Women participation in every nook and corner of the economy has raised the present scenario of Indian GDP. Working women work wisely and smartly and they effortlessly takeover the working atmosphere. The money management skills and financial management skills of women are well judged by several factors. Financial wellbeing of women is well proposed by better education and salary advancement in the life of women. Women save habitually from their proposed earning and tap some of their savings into profitable ventures or avenues. The social development is achieved through fulfillment of needful funds managed through SHG’s and microfinance institutions. The importance financial literacy has risen in the present competitive market and increasing value of investments. Women can now tap large and advance from of investments portfolios apart for traditional investment in gold.

Both men and women should have adequate financial knowledge to enhance their financial condition and financial needs and to be financially protected in the uncertain future. When it comes to women from our country, it is well known that, despite an increase in the number of working women, the majority are housewives, and financial choices are made by their husbands. Women must possibly understand the significance of their wages, savings, and investment components in order to avoid unfavorable scenarios at any stage of their lives. To meet their financial demands, women must develop a talent that will assist them improve their socioeconomic situation. Women in India have a propensity of hoarding cash rather than investing it. They believe that this "idle cash" may be readily utilized to cover needs such as jewellery, other amusement wants, and so on. Few women, however, invest in less risky areas such as bank accounts and post office programmers. They often avoid hazardous decisions involving equities and derivatives since it is difficult to grasp equity market trends and patterns because they are unexpected and turbulent.

LITERATURE REVIEW

Agarwalla K et al.(2013) have examined the effect of different personal profile or personal characteristic variables on magnitudes of financial literacy among working class of metropolitan Indian youths. Besides from basic profile of participants such as age, gender, education, income. It also considered additional demographic elements like joint family and their joint decision have a considerable impact on their financial literacy. The study focused on the dependent relationship between demographic characteristic and financial literacy of participants. This also enlighten the comprehensive empirical knowledge of country’s towards financial literacy deficits and make needful preliminary policies to address it.

Tapashi Desgupta (2015) have studied the cultural structure that one must grasp future financial demands. This research focuses on our country’s budding nation builders, who rise from the kitchen nook to every main stream. They have superior financial understanding than men since they save a little portion of their salary. The similar association between their income and investment was investigated. The survey included 50 respondents from the teaching sector. It is identified that women are lacking in financial literacy, and there is a significant needs to impart fundamental financial skills to catch up with needful living style.

Kumari Asmita et al. (2018)have studied the saving and investment behavior are strongly influenced by many factors which includes employment status, income, education, life cycle stages, wealth, banking, pension, infrastructure and insurance. The most influencing factors of investment for school teachers are safety of their investment followed by





Rajeswari *et al.*,

returns, liquidity and saving tax. Similar influence has been identified in the case of college teachers towards investment decisions. Blessy Roy and Ruchi Jain (2019) made an investigation to study the financial literacy levels of working women in Udaipur City because women are taking numerous household decisions but they are not keen on deeply thinking about their investment decision because of limited choice of investment avenues. It was found in their study that generally working women knew about the investment avenues but put their savings in bank deposits and post office saving schemes.

RESEARCH METHODOLOGY

The present research used to select items from the sample using multistage random sampling technique which is collected from working women in Chennai city. A well designed structure through which questionnaire has designed and developed for data collection. 250 questionnaires have been distributed among women working in various institutions out of which 38 questionnaires were excluded due to their extreme values and remaining 12 are not properly filled. Hence the final sample is 200 working women.

- Determinants of Financial Decision-Making skills: It has been evaluated with 5 Point Likert scale of Strongly Agree to Strongly Disagree with a weight age of 5,4,3,2 and 1 respectively.
- The reliability and consistency of the scale developed for determining the financial decision-making skills of working women are calculated with Cronbach's Alpha coefficient value. The value of 0.863 shows a excellent consistency in the questionnaire and reliability of data.

STATISTICAL TECHNIQUES USED

The collected data are subjected to statistical test to validate the hypothesis framed using number of statistical techniques namely Percentage analysis, Factor analysis, Correspondence analysis, ANOVA, and Multiple Linear Regression.

DATA ANALYSIS AND INTERPRETATION

Maximum 43% of the working women are under graduates with 29% of PG/Professional qualification. 76% of the working women are working in private organization followed by 40% of the working women are earning a monthly salary of less than Rs.10,000. Majority 92% of them have bank accounts and reveals basic financial literacy level.

Table 1 explicates the descriptive statistical values of Financial Decision-Making Skills which is developed with total score of 60 (12X5). There is robustness of the present distribution as mean value is far higher than standard deviation values. The mean score of 43.800 indicates that there is higher level of financial skills among working women. The median and modal values are 42.000 each. The skewness and kurtosis values are under the threshold limit, indicating normality in distribution. The minimum and maximum score is 35 and 55 for the respective Determinants of Financial Decision-Making skills among working women.

Table 2 reveals the 12 Determents of Financial Decision-Making Skills (DFDMS) variables. The mean and standard deviation score shows there is robustness of the distribution as standard deviation values are lower to their mean values. The KMO value of 0.886 which Chi-square value of 878.950, Df:66 and Probability value 0.000 indicates that factor analysis can be used for factorization of 12 DFDMS variables. The communalities values ranging from 0.600 to 0.863 indicating that the variables are explaining good of variance to their respective factors, consequently factor analysis can be implemented to those 12 DFDMS variables. The extracted four factor together explain 67.371% of total variance in DFDMS. The first factor 1 which holding four items of DFDMS namely Change in Price, Cost of sustaining, Influence rate effect and Banking Extensive technology in the order of their relative position it has been termed as Social Needs Factor. The second factor 2 which having three items of DFDMS namely Comparing Investing and Financial Wealth, Controlling personal finance and dependents needs in the order of their relative position it has been labelled as Wealthiness and Monitoring Factor. The third factor 3 which holding of three items





Rajeswari et al.,

of DFDMS namely Probable return on investment, Asset Liquidity and Exposing outstanding debts, in the order of their relative correlation among the variables it has been termed as Revenue and Liquidity Factor and the last dominant factor 4 which hold of two items of DFDMS namely Future financial requirements and Takeover future inflation, in the order of their relative correlation among the variables it has been termed as Needs and Inflation Factor. Together they are termed as Determents of Financial Decision-Making Skills.

Statistical test like t-test and ANOVA have been adopted to identify the significance of difference among or between personal profile of working women in overall Determinants of Financial Decision Making Skills and the outcomes are shown in below table: Table 3 displays there is no significant of difference among monthly income group in DFDMS [F=21.049, P<0.000]. Hence, there is rejection of null hypothesis at 1% level as probability value is lower than 1% level. Women earning more than Rs.50,000 per month express higher financial decision-making skills followed by those are earning less than Rs.10,000 and lest financial decision making skills are shown by women earning between Rs.10,000 to Rs.50,000. The Duncan Multiple test shows women earning less than Rs.10,000 and between Rs.10,000 to Rs.50,000 form a sub group which significantly differs from women earning more than Rs.50,000 per month.

Table 4 shows there is significant of difference between opinion on financial knowledge group in overall Determinants of Financial Decision Making Skills [t=5.7009, P<0.000]. Therefore, there is rejection of null hypothesis 1% level of significance has been identified. The mean and standard deviation values reveal those women's have financial knowledge (M=45.307, S. D=5.286) are higher financial decision-making skills compare to those don't have financial knowledge (M=42.166, S. D=4.378). Correspondence analysis has been used to identify the relationship between personal profile of working women and determinants of financial decision-making skills groups. Based on the quartile value respondent has been grouped into three dominant groups namely High DFDMS Group, Higher DFDMS Group and Highest DFDMS Group. Both Occupation of working women and Monthly Earnings of working women have been used to examine the association between both the groups.

Table 5 and Fig. 1 shows significant of association between occupation of the working women and Determinants of Financial Decision Making (DFDM) Groups ($\chi^2=23.052$, P<0.000). Working women from Self-Employed/Business groups shows a closely associated with Highest DFDMS Group, while women working in Government organization have close association with High DFDMS group, Women working in private setups are closely connected with Higher DFDMS groups. Women as housewife's shows close association with High DFDMS group.

Table 6 and Fig. 2 shows significant of association between monthly earnings of working women and DFDMS groups ($\chi^2=55.073$, P<0.000). Women receiving a monthly salary of less than Rs.10,000 shows significant of association with Highest DFDM group followed by those are earning monthly salary of between Rs.10,000 to Rs.50,000 shows significant of association with High DFDM group and Working women earning more than Rs.50,000 shows significant of association with Highest DFDM groups. Higher the earning of working women higher would be their decision-making skills in finance. Similarly lower earning among working women are significantly associated with low decision making skills. Multiple Linear Regression has been used to examine influence of personal characteristic of working women on overall Determinants of Financial Decision-Making Skills (DFDMS) and the outcomes are shown in below tables.

Table 7 shows an excellent fit of present OLS model for measuring the influence of demographic profile of working women on Determinants of Financial Decision-Making Skills (DFDMS). The significant influence of demographic profile of working women on overall Determinants of Financial Decision-Making Skills (DFDMS) [F=121.146, P<0.001]. The correlation coefficient value of 0.614 shows that 38.4% of variance is explained by demographic profile of working women in determining the influence of same on DFDM. The co effect value of Age 1.545 signifies the fractional effect of Age of working women on DFDM holding other variables as constant. The predicted positive symbol explains that such impact is positive and DFDM would enhance by 1.545 units for every one unit increase in age of working women and this coefficient value is significant at 1% level (t=11.008, P<0.000).



**Rajeswari et al.,****MAJOR FINDINGS**

Sizable number of women are under graduates with professional qualification and working in private organization. Common number of working women are earning monthly earning of less than Rs.10,000 and maintain a perpetual bank account. Sizable number of women are shows they have basic financial knowledge. Four independent factors has been identified out of 12 Determents of Financial Decision Making Variables (DFDM) namely Economic Influence Factor followed by Ability Factor, Earnings and Debt Factor and Predictive Activity Factor which together explaining 67.371% of variance in overall Determents of Financial Decision Making.

Women earning more than Rs.50,000 per month express higher financial decision-making skills followed by those are earning less than Rs.10,000 and lest financial decision making skills are shown by women earning between Rs.10,000 to Rs.50,000. The Duncan Multiple test shows women earning less than Rs.10,000 and between Rs.10,000 to Rs.50,000 form a sub group which significantly differs from women earning more than Rs.50,000 per month. Working women with financial knowledge significantly related to higher financial decision-making skills compare to those don't have financial knowledge. Working women from Self-Employed/Business groups shows a closely associated with Highest DFDMS Group, while women working in Government organization have close association with High DFDMS groups, Women working in private institution and setups are closely linked with Higher DFDMS groups. Women as housewife's shows close association with High DFDMS group. Working women earning a monthly salary of less than Rs.10,000 shows significant of association with Highest DFDM group followed by those are earning monthly salary of between Rs.10,000 to Rs.50,000 shows significant of association with High DFDM group and Working women earning more than Rs.50,000 shows significant of association with Highest DFDM groups. Higher the earning of working women higher would be their decision-making skills in finance. Similarly lower earning among working women are significantly associated with low decision making skills. Among the personal profile of the working women age have positive and significant influence on determinants of financial decision-making skills. Higher the age of working women higher would be their financial decision-making skills similarly lower age of working women would be lower financial decision-making skills.

CONCLUSION

Because of the fast growth of new products and financial services, financial markets have become more accessible to small investors. On the one hand, people with credit cards were in an exceptional position to choose the amount of borrowing, while on the other hand, new sorts of financial services such as loans, pawn shops, vehicle title loans, rent-to-own shops, and so on had become quite common. At the same time, pension income has shifted the burden of saving, investing, and disposing of capital to employees and pensioners, whereas in the previous, older workers who were pensioners relied on social security pension programmers. The study is aiming to determine the financial decision-making skills of working women in Chennai city. 12 aspects were observed under determinants of financial decision-making skills which has brought into four latent factors namely Economic Influence Factor followed by Ability Factor, Earnings and Debt Factor and Predictive Activity Factor. Working women with financial knowledge significantly related to higher financial decision-making skills compare to those don't have financial knowledge. Higher the earning of working women higher would be their decision-making skills in finance. Similarly lower earning among working women is significantly associated with low decision-making skills. age have positive and significant influence on determinants of financial decision-making skills. Higher the age of working women higher would be their financial decision-making skills similarly lower age of working women would be lower financial decision-making skills. It is suggested that working women should learn advance financial literacy like investing in share market and Bonds, investing in forex market. Government needs to come forward in promoting the need for basic financial literacy among unaccusable and poor women. Apart from investing in gold in the form of ornament they can invest in SIPs through mutual funds. Hence, there is significant of lower margin of financial skills among working women in Chennai city.





Rajeswari et al.,

REFERENCES

1. Sobhesh Kumar Agarwalla, Samir K. Barua, Joshy Jacob and Jayanth R. Varma (2013). Financial Literacy Among Working Young in Urban India. IIM Ahmedabad, Research and publication , W.P. No. 2013-10-02,2-27.
2. Tapashi Desgupta (2015). Sneak Peek in to Financial Literacy and Investment: A Case Study of Working-Women in Nagaland. Online International Interdisciplinary Research Journal, 5,149-157.
3. Kumari Asmita, Satya Prakash and Kritika (2018). Factors Affecting Saving and Investment Behavior of the Teachers. International Journal of current Microbiology and Applied Sciences, 7(6), 278-281.
4. Blessy Roy and Ruchi Jain (2019). Assessment of Financial Literacy among Working Women of Udaipur City. International Journal of 360 Management Review, 7 (1), 62 -71.
5. Bahl Sarita (2012). Investment Behaviour of Working Women of Punjab. Arth Prabhand: A Journal of Economics and Management, 1 (6),176 -190.
6. Hemalatha,T.M and Pavithra.S. (2018). A Study on Savings and Investment Pattern of Salaried Women in Coimbatore District. IJRAR- International Journal of Research and Analytical Reviews, 5(3,), 143-148.
7. Rekha G& Vishnupriya, R. (2019). A Study on Investment Pattern Among Working Women. IJRAR- International Journal of Research and Analytical Reviews,6(1), 760-764.
8. Annamaria Lusardi, Olivia S. Mitchell. "The Economic Importance of Financial Literacy: Theory and Evidence", Journal of Economic, Literature, 2014

Table 1: Descriptive statistics of Financial Decision-Making Skills

| Statistics | Values | Statistics | Values |
|----------------|--------|------------|--------|
| Mean | 43.800 | Range | 19.000 |
| Std. Deviation | 5.407 | Minimum | 35.000 |
| Median | 42.000 | Maximum | 55.000 |
| Mode | 42.000 | Q1 | 42.000 |
| Skewness | 0.056 | Q2 | 45.000 |
| Kurtosis | 0.988 | Q3 | 50.000 |

Table 2: Factorisation of Determents of Financial Decision-Making Skills (DFDMS) Variables

| S.no | Variables | Factor Loading | MSA | Communalities | Mean | S.D | Factor Name |
|------|--|----------------|--------------|---------------|------|-------|-----------------------------------|
| 1 | Change in Price | 0.849 | 0.624 | 0.729 | 3.68 | 0.735 | Social Needs Factor |
| 2 | Cost of sustaining | 0.791 | 0.565 | 0.727 | 3.60 | 0.695 | |
| 3 | Influence rate effect | 0.675 | 0.693 | 0.617 | 3.44 | 0.754 | |
| 4 | Banking Extensive technology | 0.486 | 0.708 | 0.600 | 3.5 | 0.857 | |
| 1 | Comparing Investing and Financial Wealth | 0.918 | 0.791 | 0.863 | 3.66 | 0.888 | Wealthiness and Monitoring Factor |
| 2 | Controlling personal finance | 0.764 | 0.581 | 0.724 | 3.73 | 0.974 | |
| 3 | Dependent needs | 0.638 | 0.642 | 0.597 | 3.97 | 0.906 | |
| 1 | Probable return on investment | 0.707 | 0.633 | 0.731 | 4.14 | 0.851 | Revenue and Liquidity Factor |
| 2 | Asset Liquidity | 0.664 | 0.488 | 0.725 | 3.44 | 0.754 | |
| 3 | Exposing outstanding debts | 0.646 | 0.588 | 0.655 | 3.34 | 0.683 | |
| 1 | Future financial requirements | 0.846 | 0.672 | 0.725 | 3.52 | 0.757 | Needs and |





Rajeswari et al.,

| | | | | | | | |
|---|---------------------------|-------|-------|-------|------|-------|-------------------------|
| 2 | Takeover future inflation | 0.747 | 0.549 | 0.689 | 3.74 | 0.797 | Inflation Factor |
| KMO value: 0.886, Total Variance Explained = 67.372% | | | | | | | |
| Chi Square value of 878.950 with df 66 at P Value of 0.000 | | | | | | | |

Table 3: Significance difference among Monthly Earnings group in DFDMS

| Income Groups | | | F-Value | Inference |
|--------------------------------|--------------------------------|--------------------------------|----------|-----------|
| Below Rs.10,000 | Rs.10,000 to Rs.50,000 | Above Rs.50,000 | 21.049** | S |
| 43.000 ^a (4.150) | 41.875 ^a (5.050) | 47.142 ^b (4.881) | | |

*S: Significant, NS: Not Significant

Table 4. Significant Difference between opinion on Financial Knowledge group in Total DFDMS

| Test | Value | Inference |
|------------|----------|-------------|
| Chi-Square | 23.052** | Significant |

| Factor | Group | Mean | S.D | T value | Inference |
|-------------|-------|---------|---------|---------|-------------|
| Total DFDMS | Yes | 45.3077 | 5.28614 | 5.709** | Significant |
| | No | 42.1667 | 4.37858 | | |

**Significant at 1% level

Table 5 Association between Occupation Groups and Determinants of Financial Decision-Making Skills Groups

| Test | Value | Inference |
|------|----------|-------------|
| X | 23.062** | Significant |

Table 6 Association between Monthly Earnings group and Determinant of Financial Decision Making Skills groups

| Test | Value | Inference |
|------|----------|-------------|
| X | 55.073** | Significant |

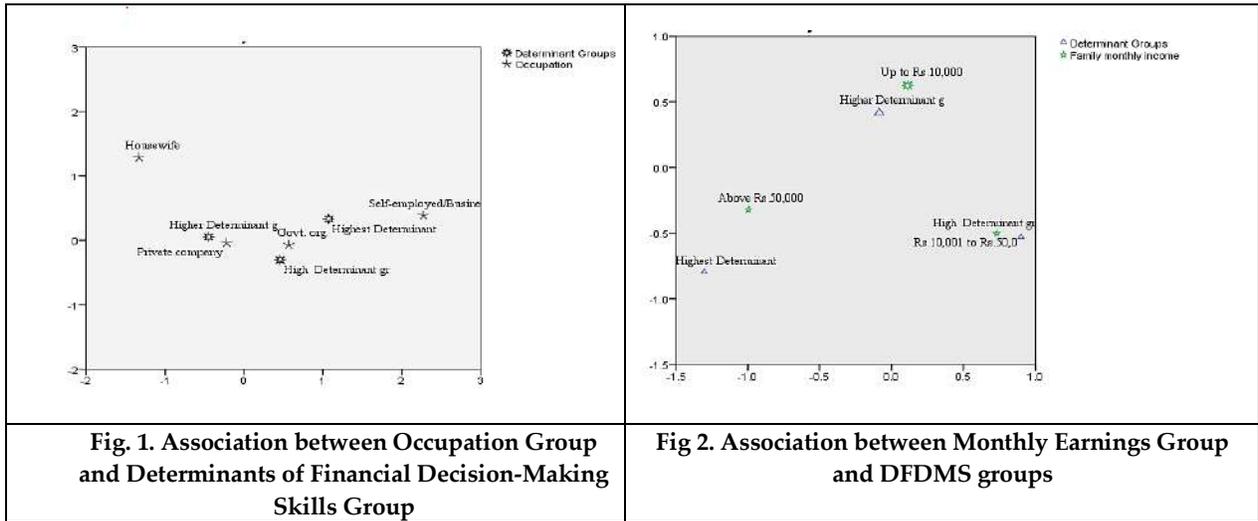
Table 7. Significant Influence of Personal Characteristic on overall Determinants of Financial Decision-Making Skills (DFDMS)

| | Unstandardized Coefficient | | t | P value |
|------------|----------------------------|--------------------------------|------------------|---------|
| | B | Std. Error | | |
| (Constant) | 13.674 | 2.756 | 4.978 | 0.000 |
| Age | 1.544 | 0.142 | 11.004 | 0.000 |
| R=0.614 | R ² = 0.384 | Adjusted R ² =0.374 | F-value= 121.146 | |





Rajeswari et al.,





Approach in Modern Green Marketing

R B Nagarathinam*

Department of Commerce and Management Nagarjuna Degree College, Yelahanka, Bangalore, Karnataka, India.

Received: 03 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

R B Nagarathinam

Department of Commerce and
Management Nagarjuna Degree College,
Yelahanka Bangalore, Karnataka, India.

Email: jai.rathina007@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

When it comes to marketing, green strategies use can include marketing items or methods that help promote sustainability, such as environmental factors, nature- and environment-friendly initiatives, and eco-friendly or green selling methods, respectively. Companies in green marketing are concerned with processes and how their entire products are produced, distributed, and handled. "Green tech" refers to technologies that might include alternative energy production methods or a method of producing energy that is less damaging to the environment than conventional techniques. As the impacts of global warming and the increased scarcity of natural resources have grown, green technology has gained recognition in the investment market. The phrase "green marketing" refers to various strategies of approaches, including product or service promotion that focuses on sustainability. Likewise, the method may be sustainable in itself or environmentally responsible, such as: Devised in a sustainable method including fabrication in the home or at home. This book focuses on a wide variety of activities related to green marketing, including modifying the product, manufacturing, and advertising for environmentalism. It must also improve the environment, as well as the customer's level of satisfaction. If you miss the former by believing in the latter, it is "greenery myopia." Products with less to the environment might also tend toward ex-ante and ex-post myopia, mainly if they are weak. Green marketing campaigns highlight the features of a business's offerings.

Keywords: Environment, Business, Green Market





Nagarathinam

INTRODUCTION

A different way of looking at the marketing mix includes using aspects of the environment to advertise or promote your products and services is called Green marketing. Organizations that are marketing their products in green tend to address the entire process of their activities, including the raw materials, distribution, manufacturing, and disposal. Green technology is defined as technology that results in minor damage to the environment than fossil fuels. To the Green Marketing, the AMA (Association of Marketing Consultants) has said, "This means marketing activity, institutions, and processes which all value customers, partners, and the public at large." previously, this is defined as a "function and a process for providing value to customers and for managing relationships with them while helping the organization." The strategy underlies sales methods, business communications, growth strategies, and business innovation is generated here. It is a process that both encourages firms to establish strong customer relations and provides customers with more excellent value.

1. Coming from a long-as opposed to non-toxic materials such as synthetic
2. A non-toxic substance-free of O-deo hazards or depleting ozone
3. Bamboo and Ceder being built with renewable components

Green marketing helps customers to be identified, met, and retained. It is one of the most significant aspects of business management and is based on its needs. Marketing has been somewhat slower in meeting new and saturated markets' immobility over the previous two or three centuries due to overproduction in developed markets. To stay competitive, they must focus on their customers' perceptions of value and desires. The concept of marketing states that effective marketing relies on knowing the requirements and preferences of targeted markets and delivering the offerings. Organizational objectives should be defined as satisfying consumer needs and wants above others.

CONTEMPORARY GREEN MARKETING APPROACHES

Green marketing is the marketing of environmental and socially conscious products to customers who, in turn, influence their decisions about the environment. Consumer taste has a significant influence on the ways that companies market their products. The earlier approaches were production-oriented, but marketing is the only one still employed today. Today's marketing efforts include customer relationship marketing, industrial marketing, and social/societal benefit marketing.

Relationship marketing

The approach depends on good communication and maintaining and strong customer relations. To provide excellent customer service and to their customers, they need to maintain loyalty.

Business marketing

The approach is more about building and maintaining relationships for the long term. The product will be made for the industrial or business sector rather than the end-user sector.

Social marketing

This approach takes advantage of society's benefit and includes the following safeguards: It will curtail activities that do not serve the community's greater good while supplying new products to people that help it.

Green Marketing

Environmental responsibility refers to selling products and services based on products' Some products or services may be inherently green or produced in a way that promotes environmental sustainability.





Nagarathinam

GREEN MARKETING OVERVIEW

Over the last few years, the organic industry has dramatically accelerated India's economy, resulting in the country being the primary consumer. Green building and green infrastructure investments are highly dependent on economic growth as a country's primary driver, home and commercial construction. An approximate 2.97 million green product tones were consumed in India in March 2016, with the industry's total domestic market valuation amounting to Rs.78 billion. With the country's growing appetite for green energy, they are producing and expanding to meet that demand. Additionally, as with an industry with seasonal demand, there are periods of greater and lesser demand. When the stock market's value is low, customers are least likely to care. However, when the circus is in town, you will find them speculating on equities.

Regional Dynamics of Green Marketing

Companies are going green because of the rising environmental awareness and market pressure. In India, a quarter of the population prefers buying and using environmentally-friendly products and ecologically-minded products. When consumers have more options for greener products, better quality, the environment, and more time and money to spend, they tend to buy. However, "greenwashing" goes hand in hand with the green revolution.

SELECTION OF GREEN MARKETING STRATEGY

In order to gain the trust of stakeholders, five principles are critical:

1. Walk your talk: People believe that if a company has these policies in place, it will become positively acclaimed for its environmental and socially responsible attitudes. Instill an awareness of climate change, clean technology, and improve the populace's behavior to reduce environmental impact.
2. Be Transparent: Let people see precisely what you are selling and how you operate your business. You can choose whether to accept these voluntary global measures for overall economic, environmental, and social performance in your assessment. In the public's eyes, people become angered when they suspect the corporation is keeping information secret information.
3. Enlist the support of third parties: You can also use credible and reputable third-party assistance such as eco certifications, cause-marketing, and environmental impact ratings. When companies use ribbons or similar symbols, they should also indicate if this will donate or if they are merely representing a cause-oriented
4. Promote responsible consumption throughout the life cycle: Although creating greener products reduces the life cycle impact, using and disposing of them responsibly is also essential. The stage is full of users who use the most eco-friendly products
5. Focus on primary benefits :It is preferable to take a primary-first and an environmental approach when making a story that offers additional benefits. For environmentally-conscious consumers, the decision about product adoption or avoidance is as much about them as it is about the products themselves. There is nothing better than the same practical and caring products; they are just sold differently.

CHARACTERISTICS OF GREEN MARKETING

1. Complex nature of products: Complexity is the usual connotation of industrial goods, with a bias in favor of labor-intensive industries. A layperson cannot be trusted to assess their value, and it is not feasible for anyone who does not know the law, especially regarding litigation, to do so. Not being knowledgeable about technical issues, aspects is the opposite of being creative.
2. Derived demand: The demand for manufactured goods is a derivative demand, which means the number of produced products determines it. If there is sufficient demand for this equipment, then it will be supplied.
3. A limited number of Buyers: Compared to customers and capital goods, there are only a finite number of agricultural products buyers. Seekers for such goods are also to be found in some places.
4. Inelastic demand: Industrial goods demand is inelastic, which means they do not respond strongly to price changes.
5. Buying is always a group process: Customers may purchase commodities. Individuals may buy items that may include goods for both consumer and farm use. However, purchasing industrial goods often necessitates a team or organization. Engineers, financiers, experts, and others all have various roles in the team.





Nagarathinam

6. Higher purchase value: For high-priced industrial goods, each transaction incurs a substantial fee. It is the opposite of consumer and agricultural goods in which there is a much smaller amount to be spent each time.
7. After-sale service: This is an industrial good that needs to be promoted throughout the product's lifetime. To keep a buyer from losing his or her interest, the seller must maintain his or her strategy's focus.
8. Seller's reputation: In the agricultural goods market, the seller's reputation is critical. To some extent, it is essential in the market for consumer goods since they must last for a long time. A good reputation for the seller is essential in business operations involving industrial products. Buyers always prefer to purchase items known to be of good quality rather than purchasing those from unproven sources.
9. Leasing: Since many green marketing strategies rely on getting people to buy your product rather than giving it away, a standard method is for the seller to enter into a lease agreement with the user on the same day as they buy your green technology. Consumer goods are not included.
10. Rational and not emotional buying: About goods for the buyer, status and prestige play a critical role, but emotional considerations also often enter into the choice of whether or not to purchase. The person purchasing industrial goods makes an objective analysis, whereas the buyer of agricultural keeps an objective eye on the value.
11. Greater awareness of the buyers: The buyer's knowledge is not absolute: the consumers do not always know precisely what they have purchased. They prefer a simple buying process. There are, however, buyers of industrial goods who know the availability of the source of the product, the alternative products, the prices of the various models, and the viability of each, so-called compared to one another
12. A shorter channel of distribution: When a product manufacturer wants to supply a large quantity of merchandise to a region, they first give it to a marketer who establishes a distribution outlet in that region, and the marketer, in turn, supplies it to the customer. Whalers, retailers, and those who deal with agricultural and industrial products are typically absent from the market. Due to only a limited number of potential customers in regions like this, industrial buyers use direct supply.

Specifically, the marketing strategies we want to sell and the target customer matches on every level. Additionally, the process should include the customer, and the relationship the supplier has with the customer should play a prominent role in the decision-making process. Accordingly, selling products in the market will necessitate relating to other clients and customers is the best strategy.

RELATIONSHIP MARKETING

Relationship marketing can be defined as a mix of direct and transaction marketing campaigns developed for customer satisfaction. The essence of relationships is not perfection or betrayal but rather satisfaction and retention.

Satisfaction

The relationship marketing technique usually relies on communicating and soliciting customer requirements in a voluntary exchange between two mutually beneficial parties because "opt-in" is used as a system of permission. Relative prices and the price and quality of goods and services produced or sold are critical determinants of their competitiveness.

Retention

Since customers are more profitable to both you and your competitors when they stick with you, use several channels to keep them coming back and out and meet their unique needs. We emphasize making longer-term commitments when we urge or require customers to take action.

- Expected marketing claims like ads boasting of youth-protecting are considered to be less effective
- When looking at eco-friendly products, the customer's attitude towards environmentally friendly practices is essential, not the actual practices.
- There is no one way to do the job. It is an arduous undertaking that calls for determination and our support.





Nagarathinam

CONCLUSION

The green industry goes through cycles because of business and uses raw materials in a seasonal pattern. Most large industries follow a gradual implementation approach to innovation; typically, progress is implemented in small steps. Their business depends on a lot of different cycles, forcing them to buy longer-term products rather than go for short-term ones. The ultimate users of the products do not own or reside in the locale. Money is a critical element of green marketing; green marketing must not solely focus on emotional issues and environmental. Green marketing is still an emerging discipline, and there is still much research to be done in this area to be done.

REFERENCES

1. www.marketingpower.com
2. Kotler, Philip; Gary Armstrong, Veronica Wong, John Saunders (2010). "Marketing defined." Principles of Marketing (5th ed.). p. 7
3. Adcock, Dennis; Al Halborg, Caroline Ross (2001). "Introduction." Marketing: principles and practice. p. 16.
4. Gale, B.T. Chapman., R.W. (1994) Managing Customer Value: Creating Quality and Service That Customers Can See, New York: Free Press
5. Reichheld, F. and Sasser, W. (1990) "Zero defects: quality comes to services," Harvard Business Review, Sept-Oct, 1990, pp 105-111





An Exploratory Study on Creating Credit through Mobility using Fintech and IoT

Sandhya. R*

Assistant Professor, Department of Commerce, Brindavan College Bagalur Main Rd, Yelahanka, Bengaluru, Karnataka, India.

Received: 03 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Sandhya. R

Assistant Professor,
Department of Commerce,
Brindavan College Bagalur Main Rd,
Yelahanka, Bengaluru, Karnataka, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Cutting-edge technology is symbolized by FinTech and the Internet of Things (IoT). FinTech has resulted in the development of a wide range of new products and services, including accounting systems. Even with all of these initiatives to create new value, a large number of them still fail. The financial technology industry is referred to as the "FinTech" industry. For the sake of this term, I'll use my anxiety and trepidation around so-called FinTech as a backdrop. A new type of finance and new financial products may be created with the assistance of technology that has the potential to revolutionize the way finance is conducted. The fourth industrial revolution is being celebrated for FinTech as well as IoT. Individuals and small enterprises will be able to engage in the financial industry thanks to new technology. New technology, for example, will make financial services more readily available to those who are disadvantaged. An excellent illustration of this "seed-oriented" way of thinking is the financial technology industry. Financing and account settlement services may be delivered more efficiently if they looked for ways to do so. Their main worry with the Internet of Things is what new products and services it will allow them to create. We shouldn't be thinking about FinTech and IoT since the way things have always been done precludes us from doing so. Consider not "What other countries would accept as products or services," but rather "What current society's requirements are."

Keywords: IoT (Internet of Things), FinTech (Financial Technology), Block chain, DLT (Distributed Ledger Technology).



**Sandhya****INTRODUCTION**

FinTech and the Internet of Things (IoT) have both become so well-known as symbols of cutting-edge technology. Many new goods and services are being developed as a result of FinTech, such as accounting systems and other tools for managing financial assets. Even those who aren't directly involved in the sector are keeping tabs on the latest developments in IoT because of the wide range of businesses and industries that this technology touches or has had an influence on. It's safe to say that the Internet of Things (IoT) is now permeating every sector. Since everything is now connected to the internet, businesses are creating new products and services based on the premise that "wouldn't it be amazing to do this!" is a brilliant idea. Even as more large firms, the so-called "enterprises," turn to the Internet of Things (IoT) to generate new value, a significant proportion of these attempts still fail. Whenever you have a concept for a new product or service that you believe would add value, ask yourself, "Who am I designing this for and what type of value am I providing?" Consider: "what are the foundations or theories that allow me to state conclusively this must be created?" in addition. Only a very tiny fraction of contemporary goods and services based on new technology are able to gain long-term use in the market, despite their evident novelty and relevance to current events. What may be the reason behind this? Is it possible that the technology was not advanced enough? What if the technology was misapplied? Or was it possible that the system's quality was too low?.

For each of these questions, there appears to be a valid answer at first glance, however confirming that answer is accurate is difficult. Is this product or service essential to society, or is it just a waste of time and money? In order to make my point crystal clear, let me use an example. Self-driving cars, for example, use IoT to connect to the internet and manage their movement using sensor data from the world around them, which is seen as a sophisticated technology. Despite the fact that self-driving cars and the technology that go with them are cutting-edge, fashionable, and difficult to duplicate, self-driving cars as a product are revolutionary and almost nonexistent. Can we honestly assume that a company that builds the most advanced self-driving vehicle in the world and then sells it at a fair price would be successful if this is the case?"No!" is the correct response to this question. Essentially, this is a misinterpretation of the developer's intent. If the response is "No!" then this paper will explain why and then go into how to go about resolving the problem.

FinTech is a term that refers to the financial technology industry. In the FinTech sector, the same misinterpretation of IoT-related product creation and technology use may be seen. The word "FinTech" has to be defined first before we can move further with this discussion. It's possible to define FinTech as the application of information technology (IT) to the financial sector, which is what the term "FinTech" means. My definition of FinTech is something that has the potential to revolutionise how finance functions, a technology that can help to create a new kind of finance and that can give rise to new financial products. My fear and apprehension about so-called FinTech is the backdrop to my explanation of this definition. New account settlement systems offered by financial institutions using block chains, information systems that facilitate trading and so on are examples of FinTech products, but these are only methods of using technology to achieve further growth of existing financial institutions or to cultivate affluent new investors, and in the sense of FinTech, as I defined it above, these are nothing more than examples of one way of using FinTech, while actual FinTech is much more expansive. There are new technologies that can expand the scope of finance and revolutionise how finance operates in today's world, so FinTech may be defined as new technologies. As an example, new technologies that are not financial institutions but are intended to give individuals and small businesses the ability to participate in the financial sector are being developed. These include new technologies that will allow underprivileged classes, who have been unable to access finance in the past because of their lack of wealth, to gain access to the financial sector.

FinTech, like the Internet of Things (IoT), is being hailed as the fourth industrial revolution because of its potential influence on a wide range of businesses. Many types of FinTech have made headlines, but it is indisputable that these are the technologies that have drawn the most attention because of their ability to simultaneously improve, enhance, or sustain financial institutions' present operations. Technology that threatens to fundamentally alter the





Sandhya

way the financial system works is either ignored or hindered from reaching consumers. This is similar to manufacturers' refusal to invest in electric cars ten years ago because they feared it would spark a reorganization that would wipe out the industry as we know it. It's unlikely that this "business as usual" usage of technology will survive for very long, given how quickly it has hit its limits out of a purposeful effort to safeguard the present business. Third, "business as usual" has its limits.

When it comes to FinTech and IoT, organizations generally begin development by looking at what they can do with existing technology, products, and services in order to grow their present business. FinTech is a good example of this type of "seed-oriented" thinking; they should look out methods to deliver the financing and account settlement services they presently provide in even more efficient ways so that they may generate more profits. As far as the Internet of Things (IoT) is concerned, they want to know what new goods and services they may develop by connecting existing products to the web. "We want to use IoT to enhance the value added through our current business to boost our competitiveness," is a common refrain. A "now fashionable" notion is one that responds to the demands of the time, and the term "currently trendy" doesn't seem particularly strange when used in this context. However, it's difficult to conclude that this approach always works. The market has matured enough to begin identifying potential clients for IoT-based products and services. However, it cannot be said that this method will boost the likelihood of a new initiative's success unless there is a way to identify clients who actually need this product, service, or technology. There is an alternative strategy, though, which is to think about new ideas and ignore the current goods and services of one's organisation. In fact, the less likely a corporation is to use this strategy if it has a strong focus on expanding its current business. A corporation must embrace a new set of viewpoints if it wants to succeed in the FinTech and IoT industries, yet existing business units inside the company only produce thoughts from the perspective of their current industry. This seems odd to me.

FinTech and the Internet of Things (IoT) as a whole aren't new ideas worth considering because of the way things have traditionally been done. Products and services will undergo radical change as a result of this new wave of technological innovation, but it will also affect business as a whole and companies in particular. Because of this, the crucial issues to address while thinking about this process are not "What sorts of products or services will be acceptable to the rest of the world?" or "How do you think the people would want to live in a society?" Those are some of the questions you should be asking yourself. In other words, "What are the necessities of modern society?" Moreover, this is unlikely to serve as a springboard for organizational initiatives or strategic planning. The moment for evaluating this problem in light of our own business's existing products and services has already passed, and this mode of thinking relies on carefully contemplating how to relate these to the products and services that one's firm delivers in order to generate value.

To put it another way, FinTech and IoT aren't only means to make the world easier and more efficient. It is their job to bring about a paradigm shift in the way people live and the way they think by providing better pleasure or contentment in their life. It's critical to understand and empathies with those who live in today's society, including their hopes, fears, aspirations, and aspirations for the future. As a result, goods and services developed with the help of the general public will be in high demand and spread widely. Through "positively connecting with (local) people who live in the present" and "creating and improving together," as well as "exchanging and smoothing out viewpoints," the process of thinking from this social perspective will produce goods and services that will be vital to society. The end result of such an approach is the development of new business models, products, and services that aren't simply expansions of old ones. A new civilization can be created by imagining an ideal society and integrating it into the present one.

LITERATURE REVIEW

Growth for small and medium-sized enterprises (SMEs) is hindered by a lack of finance. SMEs can benefit from a supply network that is more efficient in terms of money flow. The Internet of Things (IoT), cloud computing, big





Sandhya

data, and analytics are just a few of the key components of Industry 4.0. (Soni, 2022). We must forget that the insurance business must undergo a fundamental change. Despite its size, the insurance industry is underrepresented in academic writing. Analysis of journals, publications, and white papers on Block chain and IoT deployment in the insurance business is provided in this research. (Chauhan, 2022). Agriculture's digitization process is hindered by low levels of e-literacy and digital skills in rural and emerging nations. The use of data analytics, the Internet of Things, and financial technology (Fintech) has a positive impact on agricultural production and efficiency. (More, 2022).

The Internet of Things (IoT) and current digital applications such as digital financial services and delivery make it easier to replicate and re-distribute digital materials. Text document picture watermarking researchers present a novel technique that prioritizes visual quality and resilience, the two most essential metrics. (Hasan, 2021) Technology that uses Internet of Things (IoTs) for energy trading is a popular area of study. The user's personal information might easily be leaked during the process of energy trading. Block chain technologies and homomorphic encryption are used to develop a safe energy trading solution. (Yi, 2021). Massive environmental sensing will be supported by Narrowband Internet-of-Things (NB-IoT). Data trading is made possible by a decentralized approach based on distributed ledger technology (DLT). Data trade mechanisms in IoT contexts are still lacking in benchmarks. (Nguyen, 2021). A sensor wallet application is discussed in this study. TTN takes sensor data from the cloud system and displays processed data on a dashboard for the end user. The machine learning service is a unique element of the system that may be put to use in a variety of ways. (Šolić, 2020).

Peer-to-peer energy trading enables families to trade energy with each other, therefore reducing their dependence on energy providers. Local energy markets might benefit from V2G-enabled vehicles. Smart contracts running on a local Ethereum block chain on Raspberry Pis make up the Demonstrator. (Brousmiche, 2020). In Supply chain finance (SCF), a risk evaluation of the liquidity capacity and turnover ability is required for inventory financing. Traditional SCF is difficult to use in a commercial context because it lacks the ability to monitor tangible goods. According to the examination of the performance index, the technique offered is a successful solution for SCF. (Chen, 2019). Technology developments and sharing economy principles are used in FinTech to improve finance services. A proactive FinTech strategy that utilizes the Internet of Things to offer positive feedback from InsurTech is presented in this article. MapBar Auto Guard devices in China captured real-world user data, which we utilized in our research. (Marafie, 2018).

Objectives

1. Advances in technology that will benefit both industry and society.
2. Platforms that will help usher in a new era of civilization
3. FinTech and the Internet of Things (IoT) will be used to improve society in the next section
4. Demand for services is a necessity

RESEARCH METHODOLOGY

The researcher analysed information that had been acquired from a range of secondary sources, including the internet, journals, magazines, and prior study reports, using an exploratory research technique. Studies of feasibility aid in our comprehension of the market, the potential for marketing, and the significance of IoT in Fintech.

Findings

To establish new financial services, FinTech and the Internet of Things (IoT) have the ability to connect the present financial world and industrial businesses. A robust competition environment allows financial service providers to grow and develop, allowing them to remain relevant in the market. For many Filipinos, riding a tricycle, a three-wheeled taxi, is an essential part of getting around town for both business and pleasure. If they possessed a tricycle, many individuals would be able to make a living as a tricycle driver every day. There are social creative initiatives





Sandhya

that GMS uses this IoT platform for. Paying your utility bills is only one of the many services GMS provides to its customers. GMS may use data from these centres to generate extra credit by leveraging enormous amounts of data acquired from automobiles. It is possible for Filipinos to develop credit on their own with the use of GMS, a financial technology platform. People who couldn't get loans in the past now have the opportunity to establish their credit. People were given fresh credit as a result of the information gleaned from the usage of automobiles. Certain social issues would be impossible to address without FinTech and IoT services. Thus, the market accepts these services and they may continue to develop. Loans previously inaccessible to customers can now be accepted by the company. If GMS used a FinTech IoT service to collect all of the fee settlement histories and car usage data from low-income earners, it might provide more distinctive, new, and interesting services. A really social service, rather than a restriction on who may use this data, might benefit both the data's source and people who receive it.

CONCLUSIONS

Innovating using FinTech or IoT only to improve the functionality or efficiency of existing products and services is not sufficient. To satisfy latent social demand, I've shown how providing services that were accepted as essential and creating value beyond simply visualizing collected information can satisfy latent social demand; however, in this era when new technologies come into use, it will be possible to achieve the provision of needed products and services that will be acceptable to society only by going beyond simply providing services to transform the way services are provided in res. It's not that these will be improved versions of existing technology, but rather new technologies that solve society's problems. It is preferable to use these technologies to create businesses that cross business and industry boundaries rather than "business as usual" to create a more desirable society or to further advance society. While our company's success is important, we must also keep in mind how our efforts might benefit the greater good. That's why I believe that technology-based businesses and services will not only clarify and solve society's issues, but also lead to the creation of a new society in which diverse firms and industries can work together without putting up walls that have long prevented collaboration. A new era of financial services previously unimaginable will open up as FinTech and the Internet of Things usher in a platform-as-a-service model that will be required to give society full access to these advancements, a view that takes into account society's needs and wants as well as society's ability to pay for these new financial services. Understanding this secret is vital for today's businesses of all sizes, and it means more than just adopting technology; it means creating social value via the application of technology. To accomplish this social creation, a new method to conducting business is needed: one that places social value as the primary aim and devises strategies to achieve this goal via open innovation. Such a business plan and business strategy may be realized using Fintech and IoT, which is a technology that will be in high demand in the future. So to sum it up: those who have the goal and social vision to develop the next generation society will transcend the barriers that separate their various organizations, businesses, and sectors.

REFERENCES

1. Brousmiche, K. M. (2020). Peer-to-Peer Energy Market Place Powered by Blockchain and Vehicle-to-Grid Technology. *2nd Conference on Blockchain Research and Applications for Innovative Networks and Services, BRAINS 2020*.
2. Chauhan, R. C. (2022). Blockchain and IoT in developing Fintech Ecosystem- An assistance to Insurance Industry. *International Conference on Decision Aid Sciences and Applications*.
3. Chen, R.-Y. (2019). IoT-enabled supply chain finance risk management performance big data analysis using fuzzy QFD. *ACM International Conference Proceeding Series*.
4. Hasan, M. K. (2021). An improved watermarking algorithm for robustness and imperceptibility of data protection in the perception layer of internet of things. *Pattern Recognition Letters*.
5. Marafie, Z. L.-J. (2018). Proactive fintech: Using intelligent IoT to deliver positive insurtech feedback. *roceeding - 2018 20th IEEE International Conference on Business Informatics*.





Sandhya

6. More, A. A. (2022). Role of ICT & Fintech in Indian Agriculture. *International Conference on Decision Aid Sciences and Applications*.
7. Nguyen, L. L.-M. (2021). Modeling and Analysis of Data Trading on Blockchain-Based Market in IoT Networks. *IEEE Internet of Things Journal*.
8. Šolić, P. K. (2020). IoT Wallet: Machine Learning-based Sensor Portfolio Application. *5th International Conference on Smart and Sustainable Technologies, SpliTech 2020*.
9. Soni, G. K. (2022). A decision-making framework for Industry 4.0 technology implementation: The case of FinTech and sustainable supply chain finance for SMEs. *Technological Forecasting and Social Change*.
10. Yi, H. L. (2021). Energy trading IoT system based on blockchain. *Swarm and Evolutionary Computation*.





Importance of Sustainable Financial Practices in Indian Banking Sectors towards Sustainable Development Goals

Nirmala S¹ and G. Indhumathi²

¹Research Scholar, Department of commerce, Mother Teresa Women's University, Kodaikanal, Tamil Nadu, India

²Assistant Professor, Department of Commerce, Mother Teresa Women's University, Kodaikanal, Tamil Nadu, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Nirmala .S

Research scholar, Department of commerce,
Mother Teresa Women's University,
Kodaikanal, Tamil Nadu, India
Email: nirmala0803@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of the study is to analyze the extent literature on the various sustainable financial practices in banking sectors and its role and importance towards sustainable development goals in 2015 with the India and other countries have collaborated to implement of sustainable development goals, with the objective of improvement of people's living standards, removal of poverty, environment protection, Government and Social welfare activities etc. Many industries have been implemented these SDGs, banking sectors also is not excluded it has major roles and importance towards SDGs by adopting various sustainable financial practices. Initially only public sector banks were implemented these practices later it also applicable to all kinds of banking industries. So the research is concentrated on various sustainable financial practices were implemented both in private and public sector banks and its role and importance to achieve various sustainable development goals in India.

Keywords: sustainable financial practices, public and private sector banks, sustainable development goals, roles and importance.

INTRODUCTION

In 2015 the international community adopted the 2030 agenda for 17 Sustainable goals that underpin it. Set the goals all over the world with ambitious and universal of 15 year agenda. In India also sustainable development goals have been implemented in 2015 which are applicable to all kinds of industries in leading banking sectors. To achieve



**Nirmala and Indhumathi**

SDFs required sufficient funds, capital and financial industries are very essential. This was made government of India to implement on 2015 in different sustainable financial practices in public sector banks to strengthening social, environment and economical factors. Currently few public sectors banks have been implement these practices. Recently some of the private banks and joint stock companies also initiated to bring out these practice in their investment towards to achievement of SDGs by 2030.

REVIEW OF LITRATURE

1. Kablana, J (2015) in her study on “Green Banking in India: A study on various strategies adopt by banks for sustainable development” . The study is mainly concentrated on how the green banking strategies are developed by Indian banks; various challenges are faced implementation of green banking and also explained about various steps involved. The study found out that many Indian banks and other institutions have been implemented green banking system but few were not and also explain that sustainable banking is compulsory to adopt in all the Indian banks as their business without any further delay.
2. Kumar and prakash (2019) in their study on “Examination of sustainability reporting practices in Indian banking sector”. The study is concentrated on sustainability report by Public sectors banks as well as private sector banks and it analyzed in which social-economical and environmental plans the banks have been invested as contribution to achieve SDGs in our country and also indentified according to the GBI guidelines UNGC principles sustainability report have been prepared and found that many Public sector banks like SBI and other banks have prepared reports as per the above rules, other banks like private banks required to implement sustainable financial practices and report for that.
3. Ziolo, M., Bak, I., & Cheba, K. (2021) in their study on “The role of sustainable finance in achieving sustainable development goals” Does it work?” the main aim of research is to analyze on all 17 SDGs except 6 and 14. All SDGs have implemented with proper sustainable financial inclusions in European countries and also link between sustainable finance and SDGs, how sustainable finance model play a fundamental role in implementing SDG and its role in the European countries. Finally the research found traditional financial model and sustainable financial model roles and its importance to achieve that SDG in European countries and also found out there are 23 countries have accepted the Sustainable financial model is essential to achieve SDGs.

STATEMENT OF PROBLEM

Government of India has implemented SDGs by 2030, banking sectors forced to implement various sustainable financial practices and products to achieve social, environmental and economic factors of our country. Worldwide people have understood our ecological system is spoiling day by day in the name of development. But nobody have solution for ecosystem problems. The international community by collaboration with all other countries initiated with SDGs in the year 2015 to achieve these goals various sustainable financial practices required this has been implemented in many private and public sector banks. Unfortunately there is lack of awareness of these practices and products information, especially business and institutions that are ready to invest towards SDGs. Therefore, it is necessary to study the various sustainable financial practices of banks, role and importance of these practices towards achievement of SDGs.

OBJECTIVES

1. To identify various sustainable financial practices implemented in banking sectors.
2. To understand the roles of sustainable financial practices.
3. To evaluate the importance of sustainable financial practices in banking sectors.





Nirmala and Indhumathi

RESEARCH METHODOLOGY

Research design

The research design used in this study is a descriptive type of research

Methods of data collection

The study is utilized only Review of Literature and secondary data available in the annual reports of banks, RBI bulletins and few banks and other websites.

Analysis of data

The study is analyzed by using graphs and charts, conceptual analyses have been done.

Limitations of the study

- a. The study is limited only to India and information available.
- b. The study is restricted only on various sustainable financial practices and its role and importance in India.
- c. Time constrain for study is very limited, that is a period of less than one month. So the result may vary.
- d. The result of the study cannot be generalized for entire sustainability concept.

DATA ANALYSIS AND INTERPRETATION

Analysis of various sustainable financial practices and products implemented by Indian banking sectors:

Sustainable financial products and practices are subset of traditional financial practices which is mainly investment seeks to place capital into projects that reinforce sustainable development goals.

Privately placed green bonds

Green bond is types of investment that allows an entrepreneur or business owner to borrow money from private investors using a bond secured against their house. These bonds were issued by banks and private financial institutions to the customers who are undertaken business of eco friendly.

Renewable and sustainable equity

This type of financing is for householders and business. The most common example is solar power by setting up solar panels on your home. The public can receive tax credit or cash payments in return for the power generated by your solar panels. The benefits of this option are that it is stable and guaranteed over a 20 years' timescale.

Green mutual funds

These types of green finance are similar to regular mutual funds but it invests in companies that provide goods and services that are environmentally friendly.

Solar bonds

These types of sustainable finance cannot be bought with cash instead must be purchased with green energy credits. A business owner can receive 2 to 4 % on their investment depending on the company offering the bond and its history.

Green mortgages

These types of sustainable financial available only homeowners with existing traditional loans can take advantages of these types of green finance. They may save money by utilizing forms of renewable energy like solar panels which are offered through various kinds of green financing and its is 0% interest.

Green credit cards

A green credit card is provided for waste management powers, which earn additional rewards for green financing for every rupee spent with waste management.



**Nirmala and Indhumathi****Green stocks**

Many companies have initiated with green investment schemes to the public. They receive diverse sort of green financing at the same kinds of investments as your other forms of finance which includes additional advantages than traditional investments.

Renewable energy credits

Renewable energy credits are provided by Indian banking sectors towards the following green practices as sustainable financial practices.

- I. Electric vehicles loan
- II. Water conservation and infrastructure assets
- III. Waste management and recycling initiatives projects loan
- IV. Biodiversity conservation and ecosystem services schemes
- V. Social impact investing and micro finance
- VI. Finance on carbon markets, green practices schemes and sustainable development bonds etc.

Green car loans

The SBI has introduced car loan is being offered for the purpose of purchasing electric vehicles with zero processing fee and subsidized rate of interest. An applicant can receive up to 90% of the vehicles on road price in the form of finance from SBI with the rate of interest 7.55% to 8.25% per annum.

Green home equity loans

It's an unsecured green loan designed for home improvement such as solar panels, energy efficient windows and rain water storage system or energy efficient appliance purchases. These loans are provided under home equity line of credit.

Green certificates of deposits (CDs)

IndusInd bank has announced the launch of "green fixed deposits" where by the deposits proceeds will be used to finance projects and firms which are establish to supporting the SDGs. These deposits will be offered to both retail and corporate customers in the private sectors banks.

Role and importance of sustainable financial practices in Indian banking sectors towards achieve of sustainable development goals**Stable economic growth**

The sustainable financial practices are from both Public sector and Private sector banks with helps to provide various investments opportunity to the public with maximum benefits and to maintain stable economic growth which are required to achieve SDGs.

Conservation of natural resources

Achieve universal access of basic services such as water, sanitation, food and sustainable energy is main goals of SDGs, to achieve these basic services finance is very important. So all the financial institution and banks are adopted sustainable financial practices and products which are undertaken only investments in SDGs but not on traditional investment for the purpose of conservation of natural resources.

Social progress and equality

This is another importance aspect of sustainable financial practices in India. This goal will reduces inequality in the world, especially gender on equalities for supporting the generation by the development of opportunities through inclusive education and decent work. This is possible only through sustainable finance form the Indian banks.



**Nirmala and Indhumathi****Environmental protection**

The main role of sustainable finance towards of the SDGs is environmental protection. It includes protecting oceans and terrestrial ecosystem and eco friendly sustainable economic growth. The goal of which brings the harmony between environmental, social and economical sustainability. Sustainable financial practices is always encourages public to invest in conserve and enhance our resources.

Key to a better future

Humans rely on natural resources for business activities and survival ignoring sustainability can lead to the exhaustion of natural resources. SFPs are important to investing projects which preserve our resources for future generation.

Sustainable financial strategies

Indian banks by adopting green banking as business model for sustainable finance strategies some of the strategies little reflected in their banking sector or must be adopted by the banks are under as follows.

- I) Carbon credit
- II) Carbon emission
- III) Green banking financial products
- IV) Paperless banking
- V) Energy consciousness
- VI) Using mass transportation system for their employees
- VII) Green building
- VIII) Plantation activities as CRS
- IX) Online banking services

List of Indian banks are implemented sustainable financial practices and products initiated as their business model

- I) State Bank of Mysore
- II) Punjab National Bank
- III) Bank of Baroda
- IV) Canara bank
- V) ICICI Bank Ltd
- VI) HDFC bank Ltd
- VII) Axis Bank Ltd
- VIII) Kotak Mahindra Bank
- IX) IndusInd Bank
- X) Yes Bank
- XI) HSBC group
- XII) IDBI Bank
- XIII) IDFC Bank

FINDINGS AND SUGGESTIONS

- ❖ The study found that SBI is the first bank which is initiated to implement sustainable financial practice and sustainability report.
- ❖ The study revealed that many public sector and private banks have been implemented these sustainable financial practices.
- ❖ Study found that many eco friendly products and practices are introduced by both the sector banks and it is utilized by consumers.
- ❖ The research revealed that many public sector companies and joint stock companies are started investment towards to achieve SDGs.



**Nirmala and Indhumathi**

- ❖ Study also found few public sectors banks are prepare and disclose the sustainability report along with annual reports as per international report institutions principals
- ❖ Study revealed that many private sector banks have been implemented sustainable financial practices but report is not prepared separately for sustainability.

SUGESSTION

- ❖ The private sectors and public sectors banks must be compulsorily need to be implementing sustainable financial practices and report for the same.
- ❖ The public sector companies and joint stock companies must be introduced sustainability investment schemes to the public with maximum benefits.
- ❖ State and central government and RBI have to mandatorily regulate to all the banks to implement sustainability finance practices and products and report for the same.
- ❖ Create awareness by the banks about sustainable financial products to their consumers by providing more benefits to those customers who are willing to invest towards sustainability.
- ❖ The study suggest that sustainable finance is not only restricted to the banks and public companies. But also private sectors companies required implementing and contributing towards sustainability finance for the purpose of save our natural resources and good ecological system for future generations.

CONCLUSION

In conclusion, the sustainable finances are recently introduced by international and community and central government to the public and private sector banks and also few public sector companies. It has great impact on achievement of SDGs for protection against the exploitation of resources and polluted environment by investing on different eco friendly products and projects regarding above which helpful for our future generation. But there are some challenges to be manage huge finance and capital for introduction of new technology and machinery for social, economical and environment projects. Since research has been found out that sustainable financial practices are very essential to implement SDGs for the purpose of our social, economical and environment welfare especially human being alive. It is require setting standards and regulations and guidelines by the central government to successful achievements of SDGs are possible worldwide. Sustainable financial practices and products are will bring revolutionary changes in future though achieve of 17 SDGs.

REFERENCES

1. Kablana, J. (2015). Green banking in India: A study of various strategies adopt by banks for sustainable development.
2. Kumar, K., & Prakash, A. (2019). Examination of sustainability reporting practices in Indian banking sector. *Asian Journal of Sustainability and Social Responsibility*, 4(1), 1-16.
3. Ziolo, M., Bak, I., & Cheba, K. (2021). The role of sustainable finance in achieving Sustainable Development Goals: Does it work?. *Technological and Economic Development of Economy*, 27(1), 45-70.
4. Websites and other sources of Data
5. www.google.com
6. www.googlesholar.com
7. www.researchgate.com
8. www.clearbook.co.in
9. www.wikipedia.com
10. www.sbi.com
11. www.rbi.com





The Future of Financial Technology Development

Bharath.S^{1*} and Pradeep Kumar S V²

¹Research Scholar, School of Commerce, Presidency University, Bengaluru, Karnataka, India

²Asst. professor, School of Commerce, Presidency University, Bengaluru, Karnataka, India

Received: 04 June 2022

Revised: 24 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Bharath.S

Research Scholar, School of Commerce,
Presidency University, Bengaluru,
Karnataka, India

Email: bharath15889@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Banks as we know them now will look nothing like the digital institutions we'll see in the future. Digitization of financial services, liquidity transformation, and data collecting and usage are all challenges that banks will face in the future. Due to digital technology breakthroughs, banking has completely changed. Because of the way transactions are recorded, digital currencies, whether public or private, are now simpler to use. In the past, banks and their clients had an information imbalance that no longer exists. Researchers will have to weigh in on whether or not this poses a risk to financial stability. With a challenger bank, you don't have to worry about the costs of maintaining a branch network. Due to the fact that they don't have any money, a peer-to-peer lender is more like a broker. This begs the question of how future financial institutions will manage intermediation.

Keywords: Banking, Fintech, Crypto currencies, P2P Lending, Intermediation, Digital Payments

INTRODUCTION

It is likely that the bank of the future will take on a variety of forms. Extending theory, this study examines how financial technology and the Internet have changed the essence of banking. Academic study on these dynamics is guided by an analytic framework built around these current tendencies. Financial intermediation and transactions are examined in this way. When it comes to structure and outward appearance, digital banking will be very different from the institutions that have been detailed thus far. This is accomplished by building on Klein's (1971) banking firm theory work. An overview of banking as a service and social media payment, and how they will change the competitive environment for incumbent and challenger banks, is provided. Since Banca Monte dei Paschi di Siena first opened its doors in 1472, the banking business has seen several changes. Although it has shown to be very scalable over the years, it is now experiencing new issues due to its leveraged business strategy. According to



**Bharath and Pradeep Kumar**

Bergere et al (1995), its book-to-capital ratio has steadily decreased since 1840. As the level of competition rises, this pattern is likely to continue. The industry's return on tangible equity (ROTE) has decreased during the past decade. Net interest margin (associated with conventional lending activities) is one factor, although reducing leverage and fee revenue are also factors. After the financial crisis of 2008, these patterns increased. At the same time, technological advancements have raised the bar for banks in their respective markets. The entire essence of banking is changing as a result of advancements in digital technologies. Mobile banking services are now being offered by banks. Low interest rates are also having an effect on the economy. Brei et al. (2020) observe that many banks have expanded their emphasis on fee-generating services in order to sustain their profitability. A bank, according to Fama (1980), is a middleman. Financial service providers' roles are being transformed, however, as a result of the Internet. It's reshaping the banking industry from the ground up. As a result, financial services and the manner in which they are provided are evolving. As a result, banks must change in order to compete in the rapidly changing digital market. Banks in the future will have to deal with issues such as digitization of financial services and the transformation of liquidity as well as the collection and use of data. In the face of this background, established banks are rethinking their business models. The challenger banks, on the other hand, are beginning from scratch. These dynamics provide research concerns that must be addressed within the framework of banking theory, necessitating a revision of the present paradigm.

Banks play a critical role in an economy's payment and transfer systems. As a result of advances in internet technology, certain tasks are now possible to do. Digital currencies, both public and private, are now easier to use because of the way transactions are recorded in ledgers. While banks formerly worked in an environment of knowledge asymmetry with their customers, that is no longer the case. One bank had an advantage over the other because it had a better understanding of its customers. Because this information can be evaluated digitally, the digital revolution of financial technology diminishes this advantage. Deposits themselves are being re-engineered. Central Bank Digital Currencies (CBDCs) or crypto currencies will be accepted and processed by banks in the future. To begin, this alters the way financial services are provided; to continue, discussions about resiliency, security, and competitiveness in payments must be had; and to establish a foundation for improved cross-border money transfers, this raises several challenges. (4) it brings up the issue of private vs public money issuance. It's up to the researchers to decide if this is a threat to financial stability. Edge worth was the first scholar to study banking (1888). According to his theory, it is a matter of chance. A bank's business model is determined by the likelihood that it will not be required to satisfy all of its liabilities at once. As a result, banks are able to lend out more money than they receive in deposits. The capital structure of a bank is extremely vulnerable to changes in liquidity because of the resulting mismatch between long-term assets and short-term obligations. In their book, Diamond and Rajan discuss this in detail (2000).

Taker conducts a literature study on financial technologies and banking (2020). He emphasizes the fact that non-deposit taking competitors are now providing financial service firms. An important point presented in his review is how theories of financial intermediation might be changed to include banks, shadow banks, and non-intermediated solutions. This work examines one of these problems. In order to qualify as a bank, a business must be able to take deposits from the public. Therefore, a challenger bank can be considered a bank in the conventional sense. However, it is free of the expenses associated with a branch network. Since they don't have any money to work with, a peer-to-peer lender is more like a broker. This raises the question of how the banks of the future will handle intermediation, which is the focus of this study. Understanding the nature of the aforementioned intermediation and how it is evolving is critical to predicting the future of banking. Here, intermediation is divided into two main categories. First, there is quantitative asset transformation, and second, there is brokerage. Disintermediation of the banking industry is possible with the use of financial technology. The banks of the future will be shaped by the competition they face as a result of this. The Internet and/or mobile devices are presented as the avenues that will assist this. Challengers can take part in this by marketing white label items or by connecting borrowers and savers directly over the Internet. There is no need to worry about the liquidity mismatch because banking as a service is possible. Service delivery is undergoing physical modifications as a result of these technological advancements. The number of brick-and-mortar businesses is declining. M-banking, as described by Liu et al (2020), is becoming an increasingly essential



**Bharath and Pradeep Kumar**

distribution route. To better serve customers, robots are increasingly being deployed. Improved efficiency and quality of execution are described by Vishnu and colleagues (2017). They provide for greater control and may be created from scratch or on top of existing systems. M-banking will soon have the same level of capability thanks to APIs. They can be used to grant access to banking information to third parties. The OECD estimates that the financial industry accounts for 20-30% of GDP in industrialized nations, therefore how banks change through time is critical. Finally, financial technology has progressed to the point where internet banks and banking services as a service are undermining traditional banking institutions and the nature of banking mediation. As a result of technological advancements, banking is rapidly evolving. As a result of digital money's ability to be cryptographically safeguarded and so eliminate the problem of duplicate spending, paper money may become obsolete in the future. To make sense of this ever-shifting environment, one needs a theoretical framework.

Literature Review

Affecting every area of the financial system, fintech and decentralized finance are now mainstream. Regulating the crypto-currency sector might encourage innovation by boosting public confidence in the market. It's possible that the introduction of CBDC may solve existing issues if China's e-CNY currency became widely accepted. (Allen F., 2022) Securing, improving, and meeting the needs of both clients and financial institutions have been the primary goals of digitalization and technological advancement in the industry. In light of the COVID-19 epidemic, this study examines the current challenge of digitization and the requirement for employees' digital abilities. (Mazurchenko A., 2022). There has been a growing need and urge for digital transformation in the banking sector due to the extensive usage of digital technology and the present pandemic (COVID). Customers in Northern India who use digital banking are really pleased with the level of service they receive. Customer satisfaction is most strongly impacted by the risk element "Reliability." (Kaur B., 2021).

Digital transformation in the banking sector in Greece is the focus of this essay. The outcomes of this study show how bank personnel see new technology. Executives want to know if their workers are ready to embrace and use technology in their workday. (Kitsios F., 2021). Almost every aspect of society is affected by digital change, which has ramifications for established businesses. Despite the same issues, the banking industry's effect is regarded to be greater than that of the insurance sector. The fear of Big Techs entering a larger market is one of the key drivers of digital transformation. (Werth O., 2020). Throughout the world, digitization has had a profound impact on society and economy. The study issue is whether Bangladesh's transition to a digital economy may have a positive impact on both the economy and society. The greatest impediment to the implementation of the Fourth Industrial Revolution (4IR) in the country was fear of job loss. (M.M., 2020). More than 700 million people from the developing world have joined the Internet in the last three years, making about half of the world's population. Economic growth might be on the verge of taking off in this country. The block chain technology that underpin crypto currencies will serve as the foundation for a new revolution that is only getting started. (S., 2019). FinTech businesses are a new and distinct type of par bank entity in the financial sector. Technology is used to build and deliver traditional financial services in a new way. It has been shown that FinTech businesses' ability to evade banking laws and regulations is growing. (Zveryakov M., 2019).

With the advent of new digital banking services, as well as changing client expectations, the banking industry is experiencing a period of rapid change. Fintechs, on the other hand, take use of the digital environment to create customer-centric solutions while banks struggle with innovation. However, there has been relatively little investigation into this phenomena, so that best practices may be developed. (Drasch B.J., 2018). When the economy is highly competitive, businesses create methods that aid in their long-term viability. Banks in Romania are working hard to retain existing customers while also luring in new ones. An evaluation of the Romanian banking system is presented, taking into account the number of workers, branches, goods and services, financial assets, and financial transactional activity. (Tamasila M., 2018).



**Bharath and Pradeep Kumar****Objectives**

1. To know the client retention strategies from the banks.
2. The challenges of client acquisition strategies.
3. New entrance of banking service strategies.

RESEARCH METHODOLOGY

Utilizing an exploratory research approach, the researcher reviewed material that had been obtained from a variety of secondary sources, including the internet, journals, magazines, and previous study reports. Feasibility studies help us understand the market and the marketing possibilities, and it helps us understand how essential fintech topics in future banking.

Findings

Existing banks have a leg up on their competitors because of the wealth of client data they possess. As a result of Open Banking, banks no longer have an informational edge over their customers. The incumbents are hindered in their transition to a digital environment by a large cost base and old IT systems. Future banks will employ financial technology to develop novel approaches of allocating credit. Adopting such solutions carries with it the dangers of moral hazard and knowledge asymmetry. Bank rivalry and the digitization of financial services are both intensifying, making customer retention all the more critical. Although they are middlemen, challenger banks have been specifically created to be digital from the inception. Anagnostopoulos (2018) argues that challenger banks focus more on solving consumers' concerns than established banks. Challenger banks benefit greatly from Open Banking since it makes it easier to switch accounts. New entrants in the banking industry are mostly responsible for brokering banking goods to individuals as services that can be paid for or subscribed to. As long as banks' balance sheets don't mature, customers don't give a damn. Brokers of banking as a service essentially aggregate services from other providers through open banking.

CONCLUSION

The Internet and new digital business models have resulted in a shift in the nature of banking intermediation. It showed how banking has evolved from a typical academic perspective. It demonstrated how this may be applied to explain the disintermediation caused by digital technology. The banking industry has been revealed to be dealing with a number of established issues. The balance sheet risk is being taken, securitized, and traded. Fintech has revolutionized how financial services are delivered. The nature of intermediation is also changing owing to the introduction of digital currency. That's not all: It's said that technology will make banking services more efficient and less expensive in the future, as well as making it more competitive. The Open Banking movement and how it promotes banking as a service were also discussed in the paper. Open Banking is driving banking as a service and increasing customer attrition. That, in turn, is altering the delivery of products. In order to stay on top of the ever-shifting competitive scene, we came up with four different techniques. As a result, incumbents may focus on retaining their customers, competitors can look for ways to offer a low-cost digital experience, and niche companies can start offering banking as a service. Digital strategies for both payments and service delivery are required in all of these circumstances. It was shown that both incumbents and competitors rely on the availability of financing and borrowers' credit worries for their success. That hasn't changed at all. The hazards of credit and default are unabated. Technology has become an integral part of every aspect of banking. Mediation is undergoing a paradigm shift as a result of the advent of the Internet. Peer-to-peer lending and saving is possible. New payment mechanisms and digital currencies are being made possible thanks to it. In order to meet these needs, banks will have to change and adapt. The vast majority of them are based on observation and experiment. But the point of this study was to show that knowledge of the banking model is a pre-requisite to being able to deal with these issues and to formulate hypotheses related to them. Fintech has the potential to transform the future of banks and the way they interact with



**Bharath and Pradeep Kumar**

customers. As a result, electronic money and financial assets may be transferred more easily. Customers are more engaged and banks are more competitive as a result of this. Banking research needs to evolve as a field of study. That said, trust will always be at the heart of banking, no matter what the future holds. Regulators will continue to keep an eye on deposits and lending in the same way.

REFERENCES

1. Allen F., G. X. (2022). Fintech, Cryptocurrencies, and CBDC: Financial Structural Transformation in China. *Journal of International Money and Finance*.
2. Drasch B.J., S. A. (2018). Integrating the 'Troublemakers': A taxonomy for cooperation between banks and fintechs. *Journal of Economics and Business*.
3. Kaur B., K. S.-A. (2021). Digital banking in northern india: The risks on customer satisfaction. *Risks*.
4. Kitsios F., G. I. (2021). Digital transformation and strategy in the banking sector: Evaluating the acceptance rate of e-services. *Journal of Open Innovation: Technology, Market, and Complexity*.
5. M.M., A. (2020). Digitization of the emerging economy: An exploratory and explanatory case study. *Journal of Governance and Regulation*.
6. Mazurchenko A., Z. M. (2022). DEMAND FOR EMPLOYEES' DIGITAL SKILLS IN THE CONTEXT OF BANKING 4.0. *E a M: Economie a Management*.
7. S., R. (2019). Several contemporary economy features, consequences of internet expansion and i.c.t. innovations in the world. *Studies in Business and Economics*.
8. Tamasila M., R. S. (2018). Evaluation of the Romanian banking system: Proposal of a strategic development framework. *Proceedings of the 31st International Business Information Management Association Conference, IBIMA 2018: Innovation Management and Education Excellence through Vision 2020*.
9. Werth O., S. C.-M. (2020). Influencing factors for the digital transformation in the financial services sector. *Zeitschrift für die gesamte Versicherungswissenschaft*.
10. Zveryakov M., K. V. (2019). FinTech sector and banking business: Competition or symbiosis? *Economic Annals-*





Mobile Banking in India: An Overview

Kavyashree, H^{1*} and Chandrashekar M Mathapati²

¹Research Scholar, Department of PG Studies and Research in Management, Karnataka State Akkamahadevi Women's University, Vijayapura, Karnataka, India.

²Assistant Professor, Department of PG Studies and Research in Management, Karnataka State Akkamahadevi Women's University, Vijayapura, Karnataka, India.

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Kavyashree, H

Research Scholar,

Department of PG Studies and Research in Management,

Karnataka State Akkamahadevi Women's University,

Vijayapura, Karnataka, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

With the tremendous growth of the digital world in the recent past, day-to-day banking transactions can be done through digital platforms like the internet and mobile banking. With the boundless spread of the internet, the banking industry progressively moved to technologically advanced and secured methods of transactions. We all are profoundly dependent on our mobile phones for virtually everything, including performing banking transactions through versatile banking platforms. By its nature, m-banking is a novel but routine phenomenon. To better understand the subject of portable banking this study provides a sharp outline of m-banking platforms and their services with merits.

Keywords: M-Banking, Portable banking, M-banking channels, Technology

INTRODUCTION

In recent years, technological revolutions have driven the banking industry into new markets by providing new products and services through efficient delivery channels. The Digitalization of banking transactions is the major technological uprising of the banking industry, which has made networked or internet banking possible for customers. Versatile banking is an evolution of internet banking. Mobile banking (M-Banking) or portable banking is one of the most preferred, trendy, and sophisticated methods of banking in the current era. Banking customers are highly inclined toward versatile banking because it allows customers to carry out banking transactions at their fingertips through mobile phones. According to the RBI (Reserve bank of India), Master Circular 2008 "Mobile Banking Transactions" means "Undertaking banking transactions using mobile phones by bank customers that involve accessing/credit /debit to their accounts". Lalitha Balakrishnan (2016) quoted Versatile banking as a fusion occurring between the telecommunication industry and the banking industry, to avail the services of banking with

45308



**Kavyashree and Chandrashekar M Mathapati**

the help of mobile devices. Therefore, using mobile phones to avail the banking services is invoked as Mobile banking. Parul Deshwal (2015) cited M-Banking as a provision being provided to banking customers. It empowers them to perform banking transactions through mobile phones by striking out the time limits and physical appearance in the branches. M-banking can be defined as a channel through which a user interacts with a bank via a mobile device, such as a mobile phone or personal digital assistant. (Stuart J. Barnes and Brian Corbitt)

REVIEW OF LITERATURE

Priyanka Kotecha (2019) Usage of portable banking took tremendous growth after demonetization in the year 2016 in India. To date, there is growth in M-banking in India. NishaSharam & Rupinderdeep Kaur (2016) Resolutions should be done to make the reach of versatile banking to the middle towns and rural areas of India. Awareness should be created among banking customers as well as among the non-banking population in India. Ektha Sidhu, Chinmay Khare and Chinmay Sidhu (2020) Individuals are yet to be made to accept portable banking by educating them about services safety and security of M-banking provided by banks in India. Lohith Kumar, Sreekanth, and Venugopal (2016) M-Banking in India and difficulties in practicing M-banking are spotlighted in this study and it has uncovered that clients should be provided with information, rules, and safety of mobile banking to accelerate the use of versatile banking in India. Deva Devan's (2013) Study on Difficulties in the utilization of M-banking in India uncovered that a greater part of the population of the research study was happy without mobile banking as they felt that their data was not safe in the portable banking system and feared the robbery of mobile phones. Asha Sahu & Deshmukh (2020) Banks can undertake awareness programs to make clients understand about uses and safety of portable banking. Cellular service operators can boost mobile banking usage by providing uninterrupted internet services.

RESEARCH OBJECTIVES

To understand the concept of Mobile banking and channels of mobile banking which provide platforms to banking customers to carry their M-banking transactions.

RESEARCH METHODOLOGY

This research is merely based on secondary data. Data have been gathered from research articles related to Mobile banking, Official websites of banks, information available on internet sources and RBI annual reports, and Circulars available on its official website.

LIMITATIONS OF THE STUDY

Versatile banking is itself a vast phenomenon to study. We can find plenty of aspects in this area for research. The study is confined to the channels or platforms through which people carry their mobile banking transactions in India.

MOBILE BANKING IN INDIA

Earlier portable banking had been performed through SMS (Short messaging service) named SMS banking by sending mobile alerts about banking transactions to registered banking customers. After the introduction of smart phones banking customers started performing the banking transaction on the mobile web with the support of WAP (Wireless application protocol) services. ICICI was the first bank to introduce the Mobile banking application "iMobile" in India (ICICI press release January 2008) which allowed its registered customers to carry their banking transactions through mobile phones. In India, mobile banking has become a vital part of performing day-to-day banking transactions. Demonetization in India in the year 2016 caused an enormous boost in the usage of M-banking. Since the launch of UPI (Unified payments interface) by RBI in the year 2016 there is drastic growth in performing banking transactions through mobile banking. RBI annual report 2018 declared that the volume of digital transactions through mobile banking channels authenticated the increase of 227.7% in the year 2018-2019 against



**Kavyashree and Chandrashekar M Mathapati**

91.7% in the year 2017-18 in India. The mobile banking segment accounts for the largest market share because of the increasing number of smart phones in India. Millennial customers, who prefer instant gratification, demand one-click solutions for everything, including payments and other banking services, which are driving the growth of mobile banking across the country. (Blue Weave Consulting and Research Pvt Ltd, January 2022). India is witnessing intimidating growth in mobile banking usage as more than eight in ten Indians who have bank accounts in metro cities use mobile banking services, especially after the occurrence of Covid-19. (Business Standard, 25th February 2022)

Channels of Mobile banking

Channels of mobile banking facilitate banking customers to perform mobile banking transactions in different platforms viz:

- Interactive Voice Response (IVR)
- SMS (Short messaging service) based channel
- USSD (Unstructured Supplementary Service Data) channel
- Application-based channel
- WAP (Wireless application protocol) based channel.

Interactive Voice Response (IVR)

International Business Machines (IBM) stated Interactive voice response, or IVR, is an “automated telephone system that combines pre-recorded messages or text-to-speech technology with a dual-tone multi-frequency (DTMF) interface to engage callers, allowing them to provide and access information without a live agent. If the IVR system cannot retrieve the information that the caller is looking for, the programmed menu options can assist in routing callers to the appropriate representative for help”. In the case of banking customers need to make a call to an established telephone number and they have to answer for pre-recorded voice according to menu options provided while ongoing call. IVR helps banks to improve responsiveness towards their customers by addressing their complaints and queries to the right point of the solution. Services about account information, investment updates, Credit card/ Debit card status, etc will be provided under this channel.

SMS (Short messaging service) based channel

This service is used to send text messages on mobile phones and is the most often used service of mobile phones. Registered banking customers can avail of this service even though they don't have an internet connection on their mobile phones. SMS facility is a simple and easy-to-use banking facility for the information-based banking service and financial services like balance inquiry, mini statement, view last three transactions, order cheque book, update email ID, funds transfer, mobile / DTH recharge, bill payments, and more. RBI technical committee report (January 2014) mentioned that “To avail mobile banking services over SMS, customer needs to send the request with a keyword and parameters to SMS short code or long code number, e.g. for Balance Enquiry, customer can send SMS BAL to 5667766 (short code) or 9212167766 (long code). The request is sent to the respective bank server, and the customer receives the response via SMS. Similarly in order to perform funds transfer using the IMPS platform, customer can send SMS “IMPS <Beneficiary account number><Beneficiary IFSC><Amount><M-PIN><Remarks>” to bank short code or long code. The request is forwarded to the bank server; the bank server processes the transaction, and sends the response to the customer via SMS.”

USSD (Unstructured supplementary service data) based channel

Banking customers can avail of USSD service with a basic mobile phone without any internet connection and Smartphone features. It enables clients to perform fund transfers, balance inquiries, check account statements, etc. Any application or software does not need to be downloaded to the handset. According to an RBI report “It is safer and much faster than traditional SMS-based transactions (recent TRAI guidelines on Quality of Service indicates two seconds as acceptable response time requirement for the USSD session).” National Payments Corporation of India (NPCI) launched USSD in November 2012 and implemented the common USSD gateway with the single short code



**Kavyashree and Chandrashekar M Mathapati**

*99# to offer the USSD channel of mobile banking for all banks. An interactive menu will be displayed on mobile screens by dialling *99#, clients should follow the instructions in the menu to avail of the deserved banking service. Registration of mobile numbers and getting MMID (Mobile money identifier) and MPIN (Mobile PIN) is compulsory to avail of USSD service.

Application Based Channel

A mobile banking application is a software application offered by various banks that can be easily downloaded on smart phones which empowers clients to carry out their mobile banking transactions. Mobile applications are available in the app stores such as Google, Apple, Blackberry, etc through which banks can reach their clients easily. It is an uncomplicated method of mobile banking for those who make use of smart phones proficiently. India's most used mobile banking applications are iMobile, CANDI, YONO LITE SBI, HDFC Mobile app, Bank of Baroda app, and many more. UPI (Unified payment interface) is a system that allows customers to link multiple bank accounts with the help of a single mobile application. According to the National Payments Corporation of India (NPCI) "Unified Payments Interface (UPI) is a system that powers multiple bank accounts into a single mobile application (of any participating bank), merging several banking features, seamless fund routing & merchant payments into one hood. It also caters to the "Peer to Peer" collect request which can be scheduled and paid as per requirement and convenience". To use UPI a user should have a virtual payment address (VPA) to carry out transactions. It is launched in August 2016 and has been developed by the National Payments Corporation of India (NPCI) and Regulated by RBI (Reserve bank of India). Google pay, Phonepe, BHIM app, Paytm, Amazon pay, etc are the UPI applications used in India.

WAP (Wireless application protocol) based channel

Banking through a mobile internet browser can be described as WAP based channel of mobile banking. According to RBI annual report (2006) "WAP technology enables a mobile phone holder registered with this service to access his/her bank website for banking services". WAP system allows internet connection on mobile phones. WAP is an open international standard for applications that use wireless communication. Banking customers can have access to their bank accounts through a mobile internet browser with this service.

CONCLUSION

Mobile banking channels are the most accepted platforms to carry out banking transactions over mobile phones, the transactions may be payments, fund transfers, balance inquiries, access to loan accounts, and many more. Customers' most preferred platforms to carry out banking transactions are M-banking platforms. As a result of the developing trend in usage of mobile banking, RBI has permitted 616 banks located all over India as of December 15th, 2021. Payments through cash debit cards and credit cards are relatively being replaced by portable banking in the past recent years. To educate the users, Digital awareness material regarding the safe and secure use of digital payments has been released by RBI. In the future banks will be undertaking many innovative programs to improve the quality of service, particularly in the mobile banking sector as there is continuous growth in the usage of mobile banking platforms.

REFERENCES

1. Dr. Lalitha Balakrishnan and Ms. V. Sudha. December- 2016 "Factors affecting Mobile Banking services–An Empirical Study" Volume1, Issue2
2. Dr. Parul Deshwal. December-2015. "A study of mobile banking in India". International Journal of Advanced Research in IT and Engineering, Vol.4, No.12
3. Stuart J Barnes and Brian Corbitt. "Mobile banking: concept and potential". International Journal. Mobile Communications, Vol. X, No. X, xxxx





Kavyashree and Chandrashekar M Mathapati

4. Dr. Priyanka Kotecha. April 2019. "Growth and Trends of Mobile Banking in India". RET Academy for International Journals of Multidisciplinary Research (RAIJMR). Vol. 8, Issue 4, April: 2019 (IJRMP) ISSN: 2320-0901.
5. Nisha Sharma and Rupinderdeep Kaur. June- 2016. "M-Services in India: A Study on Mobile banking and applications". Gian Jyoti e- journal, Volume 6, Issue 2.
6. Ekta Sidhu, Chinmay Khare and Simran Sidhu. June- 2020. "Analysis of mobile banking in India". Mukht Shabd Journal. Volume IX (IV), pp: 3121-3142.
7. Mr. K. Lohith Kumar, M. Sreekanth, K. Venugopal Naidu. February-2016. "A study on mobile banking in India". International journal of science technology and management. Vol no.05., pp: 392-397
8. V. Devadevan. June-2013. "Mobile banking in India - issues and challenges". International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 6.
9. Asha Sahu and Dr. G. K. Deshmukh.2020. "Mobile Banking Adoption: A Review". Journal of critical reviews. Volume7, issue 4.
10. <https://www.businesstoday.in/technology/story/india-to-have-1-bn-smartphone-users-by-2026-deloitte-study-323519-2022-02-22>
11. <https://economictimes.indiatimes.com/news/india/indias-growing-data-usage-smartphone-adoption-to-boost-digital-india-initiatives-top-bureaucrat/articleshow/87275402.cms>
12. https://www.business-standard.com/article/current-affairs/india-to-have-1-billion-smartphone-users-by-2026-deloitte-report-122022200996_1.html
13. <https://m.rbi.org.in/Scripts/AnnualReportPublications.aspx?Id=1322> (annual report 2021)
14. <https://m.rbi.org.in/Scripts/AnnualReportPublications.aspx?Id=1351> (annual report 2022)
15. <https://m.rbi.org.in/Scripts/AnnualReportPublications.aspx?Id=1293> (annual report 2020)
16. <https://rbi.org.in/scripts/AnnualReportPublications.aspx?Id=652> (annual report 2006)
17. <https://rbi.org.in/scripts/AnnualReportPublications.aspx?Id=903#b91> (annual report 2009)
18. <https://rbi.org.in/scripts/AnnualReportPublications.aspx?Id=1236> (annual report 2018)
19. <https://www.icicibank.com/managed-assets/docs/about-us/2008/iMobileBanking.pdf>
20. https://www.business-standard.com/article/economy-policy/8-in-10-indians-using-mobile-banking-apps-in-pandemic-report-says-122022500589_1.html
21. <https://www.ibm.com/cloud/learn/interactive-voice-response>
22. <https://www.airtel.in/blog/business/ivr-for-banks-benefits-and-use-cases/>
23. <https://www.icicibank.com/Personal-Banking/insta-banking/ivr-banking/index.page>
24. <https://www.creditmantri.com/mobile-banking/>
25. <https://www.bankofbaroda.in/personal-banking/digital-products/phone-banking/sms-banking>
26. <https://www.bankbazaar.com/savings-account/top-5-mobile-banking-apps.html>
27. <https://www.npci.org.in/what-we-do/upi/product-overview>
28. <https://www.mahaexcise.com/best-upi-apps/>
29. <https://economictimes.indiatimes.com/mobile-banking-is-the-future/articleshow/2142764.cms>
30. <https://www.dqindia.com/future-holds-indias-banking-sector/>





A Study on Customers' Perception and Experience of Recent Trends in Banking Sector- with Reference to Contactless Banking

Shalini S S^{1*} and Anitha A²

¹Global Institute of Management Sciences R R Nagara, Bengaluru, Karnataka, India

²NET, K-Set. Dayanandasagar College of Arts, Science and Commerce KS Layout, Bangalore, Karnataka, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Shalini S S

Global Institute of Management Sciences,

R R Nagara, Bengaluru, Karnataka, India

Email: shalinikeladi@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The concept of globalization, privatization and liberalization has made the banking sector bring changes in the mode of delivery of services. It is because of this the Indian banking sector has undergone tremendous transformation in its operation. In recent decades, banks are facing a lot of competition, despite this; Indian banks are coming out with innovative ideas to create value for their customers. All these innovations make customers comfortable and safe. Innovation and technology are playing a vital role in banking and financial institutions. The introduction of the core banking system, online payment mechanism, deposit and withdrawal system, online account opening, online customer service, etc, has taken the Indian banking sector to the most advanced level of banking. These technologies not only ease the work of bank employees but also take the banks to the doorstep of the customer. In recent years contactless services of banks have risen precipitously. The demand from the customers to save time and the recent pandemic and the advent of new technology like near-field communication, usage of smart phones, and smart devices has brought in a whole new mode of banking activities. This paper aims at understanding customer preferences and experience of Contactless services provided by banking institutions.

Keywords: Innovation and Technology, Globalization, Banking Services, Contactless Banking.



**Shalini and Anitha**

INTRODUCTION

The concept of globalization, privatization and liberalization has made the banking sector to bring changes in the mode of delivery of services. It is because of this the Indian banking sector has undergone tremendous transformation in its operation. In recent decades, banks are facing a lot of competition, despite this; Indian banks are coming out with innovative ideas to create value for their customers. All these innovations make customers comfortable and safe. Innovation and technology is playing a vital role in banking and financial institutions. The introduction of the core banking system, online payment mechanism, deposit and withdrawal system, online account opening, online customer service, etc., has taken the Indian banking sector to the most advanced level of banking. These technologies not only ease the work of bank employees but also take the banks to the doorstep of the customer. The banks which have a physical location to visit to perform the bank transaction are called a traditional or conventional banking system. Wherein customers need to go to the bank for deposits, withdrawals, payments, and other banking activities. On the other hand, the modern banking and digitalization of banking services which require customers to visit neither the bank nor the bank employees are called a contactless banking system. Contactless banking has come as a solution to the problem prevailing in the conventional banking system. Contactless banking services can be classified into two broad categories, one is online banking services and the other one is offline banking services. Online banking services are those services a bank offers online or through the bank's website, banking applications, etc. where a customer need not step out for banking, from his place of comfort or while traveling or from any remote place he can perform banking activities. On the other hand, offline banking is those banking services where customers need to come out or mobility of customers from their place to a particular place for banking activity. Such as ATM centers, Amount depositing centers, passbook entry counters, etc. in offline contactless banking customers will not come to contact with bank employees or service providers but they may have to visit banks sometimes.

REVIEW OF LITERATURE

Shilpa Chauhan, Asif Akhtar and Ashish Gupta (2022) "Customer Experience in Digital banking: A review and future research Direction.", International Journal of Quality and Service Sciences. This paper aims at understanding the influence of digital banking on customer evaluation of service experience. They identified customer experience as determined by functional clues (functional quality, trust and convenience), mechanical clues (website attributes, website design, perceived usability) and humanic clues (customer complaint handling). The study furthered to combine customer experience with the service profit chain model [2]. Y V Rao and Srinivasraobude (2015) "Banking technology innovations in India: Enhancing customer value and satisfaction", *Indian Journal of Science and Technology* 8 (33). This paper examines the development in information and technology enabling banks in value added services to be effective in satisfying customer needs by adopting new innovative solutions in banking services to meet perceived value and expectations. The findings of the research is that digital banking allows customization, providing the data and analytics capabilities needed to examine each customer's profitability and offer individualized or segment products and pricing[3]. Pushpendar Kumar, Anupreetkaur Mokha and Subhas Chandra pattanaik (2021). "Electronic customer relationship management (E-CRM), customer experience and customer satisfaction: evidence from the banking industry." Benchmarking: International Journal 29(2), 551-572. This paper was to examine electronic customer relationship management and customer satisfaction through the mediating role of customer experience in the banking industry. The result revealed that customer experience mediated the relationship between E-CRM and customer satisfaction confirming well with the hypothesized model[4].

OBJECTIVES

- To analyze customers' experience of contactless services from banking institutions.
- To study customers' preference toward contactless services.
- To suggest suitable recommendations based on the study.





STATEMENT OF THE PROBLEM

In recent years contactless services of banks have risen precipitously. The demand from the customers to save time and the recent pandemic and the advent of new technology like near-field communication, usage of smart phones, and smart devices has brought in a whole new mode of banking activities. This paper aims at understanding customer preferences and experience of Contactless services provided by banking institutions.

RESEARCH METHODOLOGY

The study is descriptive. The study is based on both Primary data and Secondary Data. The primary data was collected through a Structured Questionnaire. A sampling survey is used in administering questionnaires to respondents of various age groups. Secondary data is collected through books, previous research papers, and published journals.

SAMPLING METHOD AND TECHNIQUE

Convenient and snowball sampling method was used to collect information through questionnaires. Questionnaires were administered to various social groups. Responses were received from 55 respondents

LIMITATIONS

The study is restricted to the opinions given by the sample respondents only. The indifferent attitude and non-cooperation of the respondents affect the quality of the response which ultimately affects the findings and conclusions of this study. Difficulty in obtaining sample respondents on a probability basis is yet another constraint.

DATA ANALYSIS

Table-1 shows the age group of Respondents, Table-2 Shows the gender group of Respondents, Table-3 Shows the Educational qualification of the Respondents, Table-4 Shows the Occupation of the Respondents, Table 5- Shows the Educational qualification of the Respondents, Table-5 Shows the customer's responses regarding contactless banking, Graph: Customer ratings for contactless banking services

FINDINGS

- It is found that 50.9% of the respondents belong to the age group of 25 to 35 and 69.1% of them are females.
- It is seen that 92.7 % of the respondents are either graduates or post graduates which means that the source of the data collected can be relied upon.
- 58.2% of the respondents have a professional background.
- It is seen that majority of the respondents feel that contactless banking is friendly
- The majority of the Respondents feel that Contactless banking needs additional knowledge
- The majority of the respondents would prefer to avail of contactless services post-pandemic as well.
- It is found that respondents trust the reliability of the digital infrastructure
- The majority of the customers feel that contactless banking does not add to the burden of the customers.
- It was found that contactless services of the bank seemed to have gained popularity in recent years as the majority of them have started using these services for three years or less.
- The majority of the Respondents feel that it is considerably safer to store documents digitally
- The majority of the Respondents feel that at least 50 percent of the time can be saved by using contactless banking.
- It is seen that the majority of the respondents prefer to use online payment systems or mobile wallets to avoid contact with banking services.



**Shalini and Anitha**

- Most of the respondents have faced issues due to server problems and have experienced a delay in the transfer of funds electronically.
- The analysis of the collected data revealed that more customers use online payment systems and are rated high among other contactless banking services such as passbook entry systems, online customer care and grievance handling, loan processing, and cash depositing and withdrawing.

SUGGESTION

Based on the above findings the following recommendations can be made.

- When the majority of the customers feel contactless banking is friendly and the majority prefer this in the post-pandemic, it is advisable to provide the safest and most customized contactless services.
- Half of the respondents have said that they trust the present digital infrastructure but the other half are not confident with it. Therefore there is a scope for developing digital infrastructure. It is suggestible to the banks to adopt more research and development activities on contactless banking.
- The future of the bank is a contactless mode of rendering service. Therefore all the banks should get ready for the transformation. As already customers have accepted this transformation due to the pandemic and almost 90% of the respondents would like to continue contactless banking in the post-pandemic period.
- Many customers have faced server problems while working in online banking. Therefore it is suggestible to enhance server capacity so that both bank and customer experience hurdle less working online.
- Among a variety of contactless options of banking, online payment and mobile wallet are familiar and preferred modes of contactless banking. It is recommended to create awareness of different contactless banking services for the customer.

CONCLUSION

Customer satisfaction is the main aim of every business. But analyzing the level of satisfaction is a difficult job because many factors influence the satisfaction level of customers due to the individual differences among customers. When it comes to analyzing satisfaction with services; it is an even more complicated process. This paper has succeeded in getting the result on customer satisfaction and experience of contactless banking. The result of it is, that the majority of the customers are satisfied with contactless banking services. And with regards to experience, a few types of contactless banking services are opted for by the majority of customers and given good ratings. There are many more services that banks are offering but customers have not given good ratings for them; may be due to a bad experience or maybe they have not experienced it often. Thus this research has been undertaken to meet the said objectives and completed meeting those with the help of a survey and analysis of the surveyed data.

REFERENCES

1. <https://www.mdpi.com/2227-9091/9/11/209>
2. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=recent+trends+in+banking+in+india&q=digital+banking+customer+experience+in+india&btnG=#d=gs_qabs&t=1657389960624&u=%23p%3DnBoGmmur-aMJ
3. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=recent+trends+in+banking+in+india&q=digital+banking+customer+experience+in+india&btnG=#d=gs_qabs&t=1657389988120&u=%23p%3DTrM7VQw9plgJ
4. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&scioq=recent+trends+in+banking+in+india&q=digital+banking+customer+experience+in+india&btnG=#d=gs_qabs&t=1657390133375&u=%23p%3D_rkolBsSl8wJ

ANNEXURE

A study on Customers perception and experience of contactless services in Banking sector
Respected Sir/Madam,



**Shalini and Anitha**

We, Prof Shalini S S and Prof Anitha.A working as assistant professor in Commerce and Management is presenting a research paper on the above topic. In this regard we solicit your kind co-operation in filling up the following questionnaire. The information provided by you will be kept confidential and used purely for research purpose only. Thanks and regards.

Name _____

Age group

- Below 25
- 25-35
- 35-50
- 50 and above

Gender

- Male
- Female
- Prefer not to say

Educational Qualification

- SSLC/PUC
- Under-graduation
- Post-Graduation
- Others

Occupation

- Self employed
- Professional
- Home maker
- Business
- Others

Do you think contactless banking is more friendly than in person visits to bank *

- Yes
- No
- May be

Do you think contactless banking system requires customers to possess additional knowledge to perform operations

- Yes
- No
- Maybe

Do you prefer contactless mode rather than bank visits?

- Yes
- No
- Prefer due to pandemic only

Do you think the present digital infrastructure is reliable and trustworthy for your contactless banking transactions?

- Yes
- No
- Maybe

Do you wish to continue to use contactless mode of banking post pandemic?

- Yes
- No
- Maybe

Do you think contactless service put burden on customers?

- Yes
- No
- Maybe





Shalini and Anitha

How long have you been using contactless services of the bank

- Less than 1 year
- 1 -3 years
- 3-5 years
- More than 5 years

Do you feel its safer to store banking records digitally?

- Highly safe
- Considerably safe
- Not safe at all

How much of the total time is saved by using contactless banking services?

- 0-25%
- 25%-50%
- 50%-75%
- More than 75%

Which of the following would you prefer in order to avoid contact in banking services

- o Online payment system
- o ATMs for cash deposits and withdrawals
- o Online customer red ressal and service system
- o Digital loan processing and sanctioning
- o Mobile wallets
- o Digital account opening

Which of the following problems occurred while availing contactless banking services?

- o Rate the following services of a bank (1 being least and 5 being the best) *
- o Online payment system
- o Pass book entry system
- o Customer services and grievance handling
- o Loan processing and sanctioning
- o Cash depositing/ withdrawing

Table-1 shows the age group of Respondents

| Sl no | Age group | Percentage |
|-------|--------------|------------|
| 1. | Below 25 | 23.6% |
| 2. | 25-35 | 50.9% |
| 3. | 35-50 | 16.4% |
| 4. | 50 and above | 9.1% |

(In percentage)

Table-2 Shows the gender group of Respondents

| Sl no | Gender | Percentage |
|-------|--------|------------|
| 1. | Male | 30.9% |
| 2. | Female | 69.1% |
| 3. | Others | NIL |

(In percentage)

Table-3 Shows the Educational qualification of the Respondents

| Sl no | Gender | Percentage |
|-------|------------------|------------|
| 1. | SSLC/PUC | 5.5 |
| 2. | Under-graduation | 29.1 |
| 3. | Post-graduation | 63.6 |





Shalini and Anitha

| | | |
|----|--------|-----|
| 4. | Others | 1.8 |
|----|--------|-----|

(In percentage)

Table-4 Shows the Occupation of the Respondents

| Sl no | Occupation | Percentage |
|-------|---------------|------------|
| 1. | Self employed | 7.3 |
| 2. | Professional | 58.2 |
| 3. | Home maker | 20 |
| 4. | Business | 3.6 |
| 5. | Others | 10.9 |

(In percentage)

Table 5- Shows the Educational qualification of the Respondents

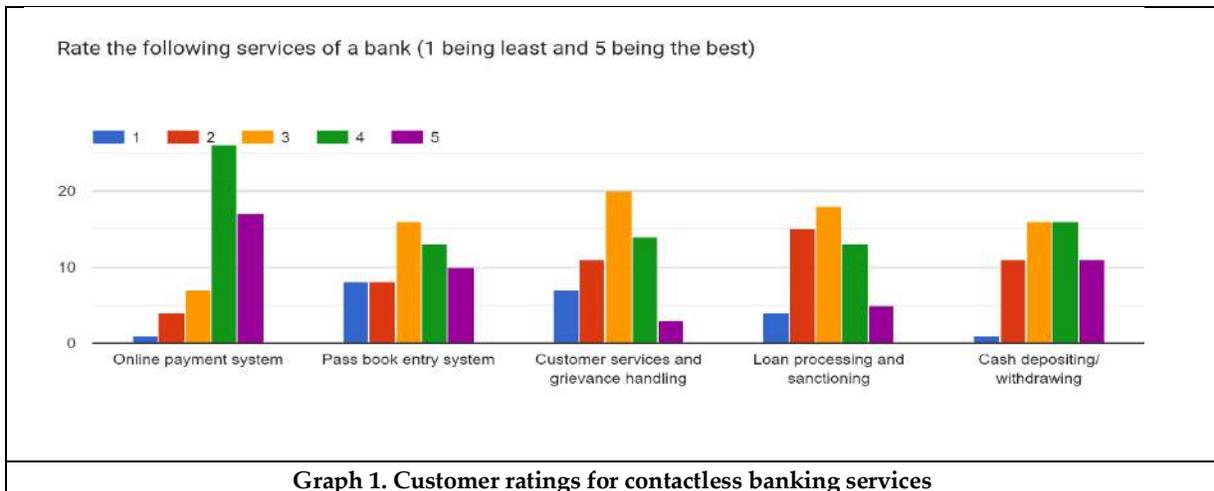
| Sl no | Gender | Percentage |
|-------|------------------|------------|
| 1. | SSLC/PUC | 5.5 |
| 2. | Under-graduation | 29.1 |
| 3. | Post-graduation | 63.6 |
| 4. | Others | 1.8 |

(In percentage)

Table-6 Shows the customer’s responses regarding contactless banking.

| Options | Contactless banking is friendly | Contactless banking needs additional knowledge | Prefer contactless mode | Digital infrastructure is reliable and trustworthy | Preference for Contactless services post pandemic | Burden on customers |
|---------|---------------------------------|--|-------------------------|--|---|---------------------|
| Yes | 81.8 | 69.1 | 83.6 | 52.7 | 89.1 | 21.8 |
| No | 7.3 | 21.8 | 5.5 | 20 | 3.6 | 61.8 |
| Maybe | 10.9 | 9.1 | 10.9 | 27.3 | 7.3 | 16.4 |

(In percentage)





The Influence of Online Mode of Learning during Covid Pandemic: Students and Teachers – an Overview

K.Rajeswari^{1*} and Smitha²

¹Associate Professor, Department Commerce and Management, Nagarjuna Degree College, Yelahanka, Bangalore, Karnataka, India

²Student, Department of BBA, Nagarjuna Degree College, Yelahanka, Bangalore, Karnataka, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

K.Rajeswari

Associate Professor,
Department Commerce and Management,
Nagarjuna Degree College,
Yelahanka, Bangalore, Karnataka, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The COVID-19 pandemic has disturbed teaching in all field of educational institutions. Electronic learning (e-learning) has become the essential method of teaching during the pandemic. Delivery of classes through online medium has been a current alternation brought out by the education system in India in the rouse in current pandemic situations. The purpose of study is to know the college teachers and students overview relating to online mode of learning, their experience and their problems related to online classes. To achieve these objectives online survey was conducted by distributing an online questionnaire to college faculties and students. Data gathered from the survey were analyzed with routine software. Thus, this survey describes college teachers and students overview and concerns with regard to taking online classes that have been made mandatory in wake of COVID-19. The sample consisted of 50 teachers and 500 students from colleges in Bengaluru City. The findings show that from teachers point of it is very difficult to keep classes for longer duration during online classes and technical issues effect the flow on online classes etc. And from students' point of view. They do not take online classes seriously and show lack of interest and involvement during online classes etc.

Keywords: E-Learning, Covid pandemic, technical support, Involvement, Online classes.



**Rajeswari and Smitha**

INTRODUCTION

Covid -19 has made a lot of people ill universally and has been declared as a global illness, plague, contagion by the World Health Organization on March 2020. This caused several nations everywhere in the world to choose to momentarily close totally educational institutions to stop COVID-19 string, series and restrains. Because of covid -19, usual in person classes had to be call off to make sure the well-being of students and lecturers. To reduce the impact of lockdown luckily, current expertise enabled electronic learning (e-learning) to be fundamental system of teaching the prospectus throughout the SARS-CoV-2 widespread, epidemic. Hence, academies have turn to continue to teach through the medium of online learning and no longer bodily classes were granted. Therefore, everyone started adopting e-learning and are becoming part of the online education system around the world. Consequently, this impact learner contentedness towards learning in over all as online learning varies from in person classes. Earlier, online learning has been held as short-term way out of a problem and never remained fully approved official type of education. Because of the expansion of this virus and its spreadable nature, in person classes has changed to electronic learning. Online learning allows for college students to make out at time and an area that's united with their studying wants. Online classes has made education very easy to understand and manageable by candidates. However online and remoteness, courses have been there for long time, overview to e-learning taking classes in differentiation to the old-style in person classroom method in universities and college have been measured only in the last few years. When it comes to education system, in person conversations or classroom tactic has always been the most remaining used. So, all colleges and universities have moved to the virtual classes appending bodily class rooms. Due to covid-19 both teachers and students have their own viewpoint regarding both positive and negative while they were adapting this virtual mode of learning. The innovations make things more manageable and calmer, it can also be restrictive especially in under developing countries. Where many students and teachers face an encounter in standings of admittance to the internet. Thus, in turn leads to problems with appearance and involvement in online classes, thereby making the adjustment of online classes of education is at ask. Many students and teachers have their own observation regarding online classes. Therefore e-learning is used as a statistics skill to advance the quality of education. The victory of online classes be subject to on many factors, correct usage of class, content etc. Online learning like other method of learning, has its own pros and cons for both students and teachers. Therefore, this research specifically lies on discovering the teachers and students' opinion towards the online classes in contrast to in person classes. This article defines the outcomes of survey which was done to know how well this technique of online mode is being used by both teachers and students what are the problems faced by them while taking online classes so as to help educational institutions and college and university administrations to understand the changes that bought by online classes. The response from this survey will help to expand online mode of classes in order to provide a better learning skill for students and a better teaching experience for the teachers.

OBJECTIVES

To have an in-depth knowledge about online mode of learning.

To understand the problems related to students and teachers, relating to online mode of learning.

REVIEW OF LITERATURE

The corona virus pandemic has impacted medical education globally. As universities seek to deliver medical education through new methods of modalities, this continuing of education ensures the learning of the future workforce of the NHS. Novel ways of online teaching should be considered in new medical curricula development, as well as methods of delivering practical skills for medical students online. (PREETI SANDU 2020). The survey findings reveal that almost all respondents' schools have switched to some form of distance teaching since the beginning of the COVID-19 crisis, and over 60% believe that school practices will not be the same when they reopen, with more online/distance teaching and learning than before. For two thirds of respondents, the closure of schools has led to their first experience with online teaching, which has been both positive and challenging. (EUROPES ONLINE PLATFORM FOR SCHOOL EDUCATION).



**Rajeswari and Smitha**

METHODOLOGY

From this study, which was directed to discover and expound students' opinion towards online learning. The survey questions estimated the complete observation and involvement of both students and teachers about online classes. The teacher survey had a cross-section of 3 demographic questions and 12 questions concerning teachers' opinion about taking online classes. In which they were asked both advantages and disadvantages characteristics of online learning. In students survey consisted of 3 demographic questions and 15 were asked about both advantages and disadvantages characteristics of online learning. Replies choices consisted of pre-defined options of agree, disagree, neutral, strongly agree, strongly disagree. The questions were distributed using Google form due to covid-19. The form was made available online on 31 January 2022 for 1 week. Teachers from Bengaluru colleges were conducting online classes were approached and asked to complete survey. A total of 50 teachers and 500 students were approached and asked questions. In which 39 teachers and 360 students had completed the survey due the pandemic rest couldn't complete it. Due to lack of time.

FINDINGS

This research explores Teacher's perception of the benefits and barriers to new technique, factors during online classes. The results of survey showed that the participants were from UG (54.6%) PG (52%), both UG/PG (24.2%). Teachers felt that even it is difficult to conduct online classes (19.4%) of them were strongly agreeing to it and (54.8%) of them were agreeing to it. Teachers felt that even online classes were convenient, lack of interaction, inability to engage the group, technical issues, (54.8%) of the sample felt that online classes were not very safe and secure medium. When asked about the problems faced by them while taking classes online or what were the negative aspects of online classes, majority of them (67.9%) reported having issues. (54.6%) of teachers reported lack of student involvement as problem. Majority (68.2%) felt that online classes were flexible and convenient. (65%) felt that online classes saved time. The students survey had the results that showed that (86.3%) of the students reported that they were like classroom rather than online classes. In which many of them felt lack of interaction (98%) and (65.3%) felt that they were having technical issues and some (69.9%) were having problems in clarifying doubts. And most of them felt that online classes are better than offline classes. The findings of this study indicated that majority of the students evinced a positive attitude towards online classes in the wake of corona. The online learning was found to be advantages as it provided flexibility and convenience for the learners. They also indicated the need for interactive sessions with quizzes and assignments at the end of each class to optimize the learning experience. Most students also reported that online classes could be more challenging than in person classroom because of technology constraints, delayed feedback and communication technologies. Therefore, all these factors should be considered while developing an online course to make it more effective and productive for the learner. It's possible that once the covid-19 pandemic settles down, we may see a continue increase in education systems using online platforms for study aids, albeit in hybrid mode in combination with regular classes. Hence this study will prove useful for reimagining and redesigning the higher education with components involving online mode.

CONCLUSION

Summing up with that has been stated so far teacher and students are more comfortable with online class the overall teaching and learning experience and determine the ultimate success or failure offline or online mode of education. As with most teaching methods, online learning also has its own sets of positive and negative, decoding and understanding these positives and negatives will help institutes in creating strategies' for more efficient delivery of the lessons, ensuring an uninterrupted learning of students. However, or hence form cautious needs to be increased concentration on the students and teacher. Online learning advantageous to the students, tutors and institutions offerings these courses. It has given opportunity to take up additional course along with their studies as convinces or





Rajeswari and Smitha

comfortable. In the era of digitalization, the scope of online education increases over more and will be beneficial for students and institutions.

REFERENCES

1. Touro College, (2020) /online education for higher ed.
2. Fortune m, Spielman m and Pangelinan d 2011 students' perception of online or face-to-face learning and social media in hospitality, recreation and tourism journal of online learning and teaching 7 (1) pp1-16.
3. Jones I and Blankenship D (2017). Students' perception of online courses. Journal of Research in higher education. Vol. 32
4. Dawadi, s, giri., r, simkhada, p (2020) impact of covid-19 on the education sector in Nepal: challenges and coping strategies.





Feature Selection and Review of Techniques for Predicting Dropouts in the University System

Nisha Rani^{1*}, Akshay Kumar² and P.Venkata Suresh³

¹Research Scholar, School of Computer and Information Sciences (SOCIS), IGNOU, New Delhi, India.

²Associate Professor, School of Computer and Information Sciences (SOCIS), IGNOU, New Delhi, India.

³Professor, School of Computer and Information Sciences (SOCIS), IGNOU, New Delhi, India.

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Nisha Rani

Research Scholar,

School of Computer and Information Sciences (SOCIS),

IGNOU, New Delhi, India

Email: nishaphdignou@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

As per the survey conducted by the National Statistical Office (NSO) of the Indian government, one out of every eight students enrolled in a school or college drops out before completing their education. Such a high dropout rate is unsuitable for any Educational Entity, whether school, college, or university, formal or distance learning. Thus, a high dropout rate is an area of concern for the educational sector. The problem can be remedied by accurately predicting the possible students who could drop out. An accurate prediction can result in timely remedial actions, which may reduce the dropout rate. The paper focuses on performing an exploratory analysis to extract relevant features and remove irrelevant features via Principal Component Analysis (PCA), Chi-Square, Anova Test, and other visualization tools. It uses the Student dropout dataset of a higher education institution having 35 features and 4424 rows provided by zenodo.org. The paper also compares the four classification techniques used for predictions: Logistic Regression, Support Vector Machine (SVM), Random Forest Classifier, and Neural Networks. The paper summarizes the recent research on dropout detection using classification techniques where most of the research uses Neural Networks and a Decision Tree for detecting dropouts.

Keywords: Educational Data Mining, Predicting Methods, Student Dropouts, Feature Selection, Data Mining.





Nisha Rani et al.,

INTRODUCTION

As per the NSO survey, 12.5% of students drop out of university and college [35]. Dropouts have been found in both open learning/distance learning universities and regular universities, whereas Student dropout occurs quite often in universities providing distance education [30]. Dropout prediction is one of the prominent concerns for people linked with the education sector: Teachers, students, or other concerned persons [23][29]. Researchers refer to dropout in two ways: first, a student who is unsuccessful in the course, and second who left the course without completing it [27]. In both cases, the reasons for dropout depend on various factors [22][23][26]. These factors include administrative, sociological, and behavioral factors: students' activeness during class, academic performance, previous qualification, domain knowledge, and activeness on various social sites. [18] suggests the dropout of a student is a continuous process that starts at the beginning of any course. Several classification models in educational data mining were used to identify the reasons behind the dropouts. In addition, [16] predicts students' performance using two categorization approaches: Neural Network and Decision Tree. CHAID[14] used decision trees as a prediction model, which helped examine the interrelationships between factors used to forecast success in post-secondary education. Factors including the medium of instruction, grades achieved in secondary school, and even where a student resided when they started high school were significant predictors. CHAID's seven class predictor factors [14] can predict student performance. Despite the CHAID model's limited and imbalanced data set, it was capable of predicting dropouts.

Various researchers have observed the dropout rates from different perspectives and focused on finding the correct method of forecasting dropouts to anticipate the current rate. Some researchers have used student personal and performance-based data, whereas some have worked on various social factors [29][30]. Some researchers have performed surveys to find reasons behind dropouts as they found that the data they have is not enough in terms of accuracy[29]. All predicting techniques use two basic approaches for data collection. First and foremost, conduct a survey having questionnaires with care for students who dropped out and evaluate the results of the survey timely. However, the survey requires that students participate and provide correct information. Second, use the information students supply when they enroll for the course and their results from the previous semester's exam[26]. In the former approach, maximum participation of students is needed. They need to fill out the survey with factual data which will lead to correct results. Therefore, the paper uses the second approach to predict student dropout as it only needs administrative information readily available at any university.

Accurately predicting the possible students who could drop out and taking timely remedial actions may decrease the dropout rate. Early dropouts' prediction using administrative data with higher accuracy is still a topic to explore. To develop an early dropout prediction, one has to focus on the following things: First, selecting relevant attributes/features; second, using the correct data mining algorithm to classify such students. Dataset, as given in the website zenodo. Org [32][33] belongs to a higher education institution and is used to perform feature selection to Predict students' dropouts. The dataset has 35 features and 4424 rows. Further, the paper performs exploratory feature analysis using PCA, Chi-Square, Anova Test, and other visualization tools such as scatter plots, heatmap, and bar graphs. The study would extract relevant features and remove irrelevant features. In addition, the paper explains the features and compares the performance of four classification techniques, viz. Logistic Regression, SVM, random forest classifier, and Neural Network for detecting dropouts. The comparison will help in the selection of a better dropout prediction technique. The rest of the paper is organized as follows: Section II identifies various Factors/features/attributes. Section III describes multiple feature selection techniques and analysis of results. Section IV presents the application of data mining techniques to sample datasets and results. Section V presents the conclusion and future directions.

Various factors/features/attributes affecting dropouts

In order to identify the dropouts early, the first requirement would be to identify the features that can be modeled for detecting student dropouts. The objective of this paper is to identify features that can be used for determining the





Nisha Rani et al.,

dropout. Many research [23][29][28] finds Academic Performance as one of the strong predictors of a student dropping out. Academic performance and success rates are lower for students who lack tenacity and do not have strong educational methods. [6] considers the following features as good predictors - start age, father's and mother's studies, academic achievement, success, average mark in degree and access form, and the maximum duration of the course. [18][1] identified important features as student dropout predictors (i) whether a student is engaged in other activities/profession, (ii) family status/background of students - family income, siblings in the family, the status of father /mother profession, etc. iii) medical fitness/history of the student. iv) academics: lack of available instructional material and the support system provided by the university for particular courses. Results show that dropouts in distant education are mostly caused by age groups and work situations, whereas gender does not appear to be an affecting factor. As per several studies, student dropout rates in undergraduate programs are substantially greater than in graduate schools. [16] grades, quizzes, lab work, tests, and students' attendance used to predict whether a student would continue education states that the most critical factor for such prediction is the student's Cumulative Grade Points Average (CGPA). CGPA is the average of grade points obtained in all the subjects. [3] shows that features - school scores ($p < 0.001$), gender ($p < 0.05$), and faculty ($p < 0.001$) have a major role in student performance, also advice including various academic year examination results for a better analysis of student dropout rates. It covers the numerous analytical methodologies used to forecast students' performance. Most studies have relied on CGPA and other forms of internal assessment as their primary data sources. [19] examined and compared some features of a dropout Student to those of students who have completed the course in the e-learning system: ALOC scores, satisfaction levels, gender distribution, college status, age, residence status, academic majors, graduation terms, GPA scores, weekly working hours, and found three relevant features: level of satisfaction, college status, and weekly working hours. The study has a low sample size with a wide range of students' majors.

This paper uses a dataset having administrative data of Students with records of two-semester performance, "Predict students' dropout and academic success" dataset contains 34 features and one Target variable. The target variable has three values: Dropout, Graduate and Enrolled. The research uses 15 categorical and 15 continuous features out of the 34 Features. Categorical features: Marital status, Course, Previous qualification, Nationality, Mother's qualification, Father's qualification, Mother's occupation, Father's occupation, Gender, Scholarship holder, Age at enrollment, Daytime/evening attendance, Tuition fees up to date, International, Educational special need, Displaced, Debtor and, Continuous features: Curricular units 1st sem (credited), Curricular units 1st sem (enrolled), Curricular units 1st sem (evaluations), Curricular units 1st sem (approved), Curricular units 1st sem (grade), Curricular units 1st sem (without evaluations), Curricular units 2nd sem (credited), Curricular units 2nd sem (enrolled), Curricular units 2nd sem (evaluations), Curricular units 2nd sem (approved), Curricular units 2nd sem (grade), Curricular units 2nd sem (without evaluations), Unemployment rate, GDP, Inflation rate. Out of 34 features dataset, 32 are found relevant in detecting dropout. Applying various feature Selection techniques can further reduce the number of features.

Feature Selection techniques to find relevant factors:

Predictor attributes differ for every university/course/level (UG/PG/senior secondary/secondary). Selection of the relevant features is an important task before building any predictor model. Feature selection algorithms have three categories: forward selection, backward elimination, and evolutionary. Various methods used for feature selection are Chi-square χ^2 test: chi-square test statistical independence between the categorical features.

Scatter plot: Scatter plots visualize the two dimensions combination of different attributes.

Correlation-based [21][28]: Karl Pearson's Coefficient of Correlation can be applied to two continuous features to determine the association's strength and direction.

$$r = \frac{\sum(x - \bar{x})\sum(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2}\sqrt{\sum(y - \bar{y})^2}} \quad (1)$$

Where \bar{x} = mean of x and \bar{y} is mean of y





Nisha Rani et al.,

Principal Component Analysis (PCA) is a feature reduction technique that highly places n-featured data into k orthogonal variables. [20][25][28] used PCA for feature selection. Random forest techniques, info gain, and Gini index were used as Feature selection techniques with the specified thresholds. Info [28][23]uses info gain, and [21] uses the random forest as a feature selection technique. The dataset contains 32 selected features and one Target feature with 4424 rows. The Dropout Class feature has three values Enrolled, Dropout, and Graduate. Research does not need an Enrolled Student as it does not classify a student as a dropout or graduate. Therefore, all rows consisting of 'enrolled' as the Target are removed. The predicting model needs only two class values: dropouts and graduates. This preprocessing reduces the dataset to 3630 rows. An exploratory analysis has been carried out, and observations are as follows: The Scatter plot (figure 1) visualized the Dropout Class feature with two continuous features. Grade of 1st and 2nd semesters are shown simultaneously on the x-axis and y-axis. The graph shows that if the grade in any of the two semesters is low, the student is likelier to drop out. The Scatter plot (figure 2) visualizes two features evaluation of two semesters with respect to the Dropout Class feature, showing high evaluation means the student has a high chance of graduating. PCA technique placed 34 features to k orthogonal dimensions where $k \leq 34$. A scatter plot (figure 3) visualizes the first two PCA components, PC1, and PC2, with Dropout Class. Dropouts are likely to fall where PC1 has a very low value, say negative value. The graph (figure 4) shows that scholarship holders are less likely to drop out of the courses than those who do not have a scholarship. Gender-wise bar graph (figure 5) shows that Females are less likely to be dropouts. A Heat map (figure 6) visualizes the association between all features to each other. As per the graph, Five features found to have more association with Dropout Feature are grades obtained in 1st-semester and 2nd-semester, evaluation of 1st-semester and 2nd-semester, and Tuition fees paid up to date. Chi-square (figure 7) tests to check statistical independence between the 15 categorical features to Dropout. The test shows predictor model must consider All 15 categorical features. A one-way ANOVA test (Figure 8) shows a p-value for every 15 continuous features against the Target.

The hypothesis for the ANOVA test for each continuous feature against two classes - Dropout and Graduate, is as follows:

- H0: $\mu_0 = \mu_1$, (indicates means of two classes have no difference),
 H1: $\mu_0 \neq \mu_1$, (indicates means of two classes are different).
 μ_0 : the mean of dropouts and μ_1 : the mean of graduates.

The null hypothesis (H0) can not be rejected for two features - The inflation rate and the Unemployment rate, as p-value > 0.05. Therefore, Only 13 continuous features other than the two features are selected to predict dropouts.

Application of Data mining techniques over different combination datasets and results. Classification [4][13] is a supervised data mining technique. Classification helps in learning a suitable prediction method for a predefined class. Detecting a dropout student, i.e., whether the student drops out or not, is also a classification problem. Various researches on EDM [7][8][9][10] use the classification technique to predict Students' Performance and detect Students' Dropout, etc. Classification techniques used for dropout prediction are decision trees, K-NN, Naive Bayes, SVM classification, Neural Network, etc [20][21][22][23][25][26][27][28][30]. The testing process needs to divide the dataset into two groups: training and test. Creating a predictor/classifier model requires a training set, while the accuracy verification process requires test data. This paper uses four classification techniques: Logistic Regression (LR): This is a simple classification model, but feature scaling is the primary concern before applying this model. Random forests or random decision forests: this is a method of classification, and regression technique, that works via constructing many decision trees at training time. SVM (Support Vector Machine) performs well for a small number of features. Whereas not suitable for non-linear problems having many features. Outliers do not influence the SVM. Neural Networks (NN) can process large volumes of data and can detect non-linear relationships between dependent and independent features. NN does not need any previous knowledge of these relationships but is complex and tends to overfit; therefore, it requires regularization.





Nisha Rani et al.,

Feature extraction/selection techniques such as PCA, Chi-Square, Anova Test, etc., reduced the dataset to 28 features and the Dropout Class Feature. The dataset is divided into training data (x_{train} y_{train}) and Test data (x_{test} y_{test}) in a ratio of 80:20. Four specified classification techniques are applied to predict the output. Different sets of Dataset have been created from different perspectives as follows:

Set1: Dataset containing all 34 features

Set2: Dataset containing 30 features retrieved after applying feature selection and extraction techniques.

Set3: Dataset containing 5 PCA components.

Set4: Dataset with 17 PCA components.

Set5: 5 features extracted as a result of heatmap- grades of two semesters, number of evaluations of two semesters, the fee paid up to date.

Set 6: 12 categories features- Marital status, Course, Previous qualification, Nationality, Mother's qualification, Father's qualification, Mother's occupation, Father's occupation, Gender, Scholarship holder, Age at enrollment.

Four classification methods: Logistic Regression, SVM, random forest classifier, and Neural Network, are applied over the different sets of sample Dataset. Parameters- the maximum iteration, the estimator's number, number of hidden layers are set via the hit and trial method to avoid the converge problem. The radial basis kernel function (RBF) is used as the kernel function. The accuracy of the model defines the performance of each classification technique. Accuracy of model = $(\text{True Positive} + \text{True Negative}) / (\text{True Positive} + \text{False Positive} + \text{False Negative} + \text{True Negative})$, Where, True Positive (TP): Observation is predicted positive and is truly positive. False Positive (FP): Observation is predicted positive and is truly negative. True Negative (TN): Observation is predicted negative and is truly negative. False Negative (FN): Observation is predicted negative and is truly positive. Finally, table 1 contains the calculated accuracy score for every four classification models after comparing predicted data values (y_{pred}) against test data values (y_{test}).

It is observed from Table 1 that the Neural Network performs better with 90% over set1, the dataset having 34 features. The Logistic regression performs better with 90% accuracy on set2, the Dataset with 30 elements. SVM performs better than the other three classification techniques, on set3 and set4 having 5 and 17 PC components, respectively. RFC performs better with an accuracy score of 85.1%. On the dataset, the set4 consisting five features- grade of 1st semester, grade of 2nd semester, evaluation of 1st semester, evaluation of 2nd semester, and Fees paid up to date. The result of four specified classification techniques over set6 shows scores approx 68 %, which indicates that this alone is not enough to classify the dropout.

CONCLUSION AND FUTURE

Various data mining algorithms have been applied and analyzed to predict dropouts. Different selection techniques of factors relevant to a student's dropout are applied in research instead of considering a particular technique. It concludes that different data mining algorithms have different accuracy with different consequences and scenarios. Logistic Regression and Neural Networks better classify dropouts with approximately 90 % accuracy using 30 features selected via Chi-square and ANOVA tests. Dataset considered in this paper lacks two continuous features- Family Income and Previous Qualification grades, which may increase the prediction model's accuracy. Administrative data is readily available during admission time. Therefore, Combining classification algorithms with good feature extraction techniques can lead to an improved dropout predictor algorithm in early semesters, say first and second semesters.





Nisha Rani et al.,

REFERENCES

1. Pierrakeas, Xenos, Panagiotakopoulos & Vergidis, A Comparative Study of Dropout Rates and Causes for Two Different Distance Education Courses, *International Review of Research in Open and Distance Learning* Volume 5, Number 2. ISSN: 1492-3831.
2. Lau, E.T., Sun, L. & Yang, Q. Modelling, prediction and classification of student academic performance using artificial neural networks. *SN Appl. Sci.* 1, 982 (2019). <https://doi.org/10.1007/s42452-019-0884-7>
3. Liga Paura, Irina Arhipova, Cause Analysis of Students' Dropout Rate in Higher Education Study Program, *Procedia - Social and Behavioral Sciences*, Volume 109,2014, Pages 1282-1286, ISSN 1877-0428,<https://doi.org/10.1016/j.sbspro.2013.12.625>.
4. Dutt, Ashish & Aghabozrgi, Saeed & Ismail, Maizatul Akmar & Mahroeian, Hamidreza. (2015). Clustering Algorithms Applied in Educational Data Mining. *International Journal of Information and Electronics Engineering (IJBayes and 10.7763/IJIEE.2015.V5.513*.
5. Cristóbal Romero, Sebastián Ventura, Enrique García, Data mining in course management systems: Moodle case study and tutorial, *Computers & Education*, Volume 51, ISSN 0360-1315, <https://doi.org/10.1016/j.compedu.2007.05.016>.
6. Araque, Francisco & Roldan, Concepcion & Salguero, Alberto. (2009). Factors influencing university dropout rates. *Computers & Education.* 53. 563-574. <https://doi.org/10.1016/j.compedu.2009.03.013>.
7. Ravinder Ahuja, Animesh Jha, Rahul Maurya, and Rishabh Srivastava, *Analysis of Educational Data Mining*, © Springer Nature Singapore Pte Ltd. 2019 https://doi.org/10.1007/978-981-13-0761-4_85
8. A. Dutt, M. A. Ismail, and T. Herawan, "A Systematic Review on Educational Data Mining," in *IEEE Access*, vol. 5, pp. 15991-16005, 2017, DOI: 10.1109/ACCESS.2017.2654247.
9. C. Romero and S. Ventura, "Educational Data Mining: A Review of the State of the Art," in *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, vol. 40, no. 6, pp. 601-618, Nov. 2010, DOI: 10.1109/TSMCC.2010.2053532.
10. S. Hari Ganesh and A. Joy Christy, "Applications of Educational Data Mining: A survey," 2015 *International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS)*, Coimbatore, India, 2015, pp. 1-6, DOI: 10.1109/ICIIECS.2015.7192945.
11. K.Kameshwaran, K.Malarvizhi, Survey on Clustering Techniques in Data Mining, (*IJCSIT*) *International Journal of Computer Science and Information Technologies*, Vol. 5 (2), 2014, doi=10.1.1.440.2001
12. Sander J. (2011) *Density-Based Clustering*. In: Sammut C., Webb G.I. (eds) *Encyclopedia of Machine Learning*. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-30164-8_211
13. A.D. Gordon A Review of Classification, *Journal of the Royal Statistical Society* <https://doi.org/10.2307/2344237>
14. M. Ramaswami and R. Bhaskaran, A CHAID Based Performance Prediction Model in Educational Data Mining, *IJCSI International Journal of Computer Science Issues*, <https://doi.org/10.48550/arXiv.1002.1144>
15. K. J Ashika, Jagruthi M. N, Nikhil N, Pooja S, Educational Data Analytics using Association Rule Mining for Student Job Prediction, *International Research Journal of Engineering and Technology (IRJET)*
16. Amirah Mohamed Shahiri, Wahidah Husain, Nur'aini Abdul Rashid, A Review on Predicting Student's Performance Using Data Mining Techniques, *Procedia Computer Science*,<https://doi.org/10.1016/j.procs.2015.12.157>.
17. T. M. Christian, M. Ayub, Exploration of classification using nbtrees for predicting students' performance, in *Data and Software Engineering (ICODSE)*, 2014 *International Conference on*, IEEE, 2014, pp. 1–6.
18. Shane Jimerson, L. Alan Sroufe, and Betty Carlso, A Prospective Longitudinal Study of High School Dropouts Examining Multiple Predictors Across Development, *Journal of School Psychology*, Volume 38, Issue 6,2000, Pages 525-549, ISSN 0022-4405, [https://doi.org/10.1016/S0022-4405\(00\)00051-0](https://doi.org/10.1016/S0022-4405(00)00051-0).
19. Yair Levy, Comparing dropouts and persistence in e-learning courses, *Computers & Education*, Volume 48, Issue 2, 2007, Pages 185-204, ISSN 0360-1315, <https://doi.org/10.1016/j.compedu.2004.12.004>.





Nisha Rani et al.,

20. B. Perez, C. Castellanos, and D. Correal, "Applying Data Mining Techniques to Predict Student Dropout: A Case Study," 2018 IEEE 1st Colombian Conference on Applications in Computational Intelligence (ColCACI), 2018, pp. 1-6, DOI: 10.1109/ColCACI.2018.8484847.
21. do Nascimento R.L.S., das Neves Junior R.B., de Almeida Neto M.A., de Araújo Fagundes R.A. (2018) Educational Data Mining: An Application of Regressors in Predicting School Dropout. In: Perner P. (eds) Machine Learning and Data Mining in Pattern Recognition. MLDM 2018. Lecture Notes in Computer Science, vol 10935. Springer, Cham. https://doi.org/10.1007/978-3-319-96133-0_19
22. A. Ortigosa, R. M. Carro, J. Bravo-Agapito, D. Lizcano, J. J. Alcolea and Ó. Blanco, "From Lab to Production: Lessons Learnt and Real-Life Challenges of an Early Student-Dropout Prevention System," in IEEE Transactions on Learning Technologies, vol. 12, no. 2, pp. 264-277, 1 April-June 2019, DOI: 10.1109/TLT.2019.2911608.
23. V. Hegde and P. P. Prageeth, "Higher education student dropout prediction and analysis through educational data mining," 2018 2nd International Conference on Inventive Systems and Control (ICISC), 2018, pp. 694-699, DOI: 10.1109/ICISC.2018.8398887.
24. Qiu, L., Liu, Y., Hu, Q. et al. Student dropout prediction in massive open online courses by convolutional neural networks. *Soft Comput* **23**, 10287–10301 (2019). <https://doi.org/10.1007/s00500-018-3581-3>
25. M. Nagy and R. Molontay, "Predicting Dropout in Higher Education Based on Secondary School Performance," 2018 IEEE 22nd International Conference on Intelligent Engineering Systems (INES), 2018, pp. 000389-000394, DOI: 10.1109/INES.2018.8523888.
26. Berens, J., Schneider, K., Gortz, S., Oster, S., & Burghoff, J. (2019). Early Detection of Students at Risk - Predicting Student Dropouts Using Administrative Student Data from German Universities and Machine Learning Methods. *Journal of Educational Data Mining*, 11(3), 1-41. <https://doi.org/10.5281/zenodo.3594771>
27. Iam-On, N., Boongoen, T. Improved student dropout prediction in Thai University using an ensemble of mixed-type data clusterings. *Int. J. Mach. Learn. & Cyber*, **8**, 497–510 (2017). <https://doi.org/10.1007/s13042-015-0341-x>
28. Carlos Marquez-Vera; Cristóbal Romero Morales; Sebastián Ventura Soto Predicting School Failure and Dropout by Using Data Mining Techniques IEEE Ibero-American Journal of Learning Technologies Volume: 8, Issue: 1 DOI: 10.1109/RITA.2013.2244695
29. Belloc, F., Maruotti, A. & Petrella, L. University drop-out: an Italian experience. *High Educ* **60**, 127–138 (2010). <https://doi.org/10.1007/s10734-009-9290-1>
30. Kotsiantis S.B., Pierrakeas C.J., Pintelas P.E. (2003) Preventing Student Dropout in Distance Learning Using Machine Learning Techniques. In: Palade V., Howlett R.J., Jain L. (eds) Knowledge-Based Intelligent Information and Engineering Systems. KES 2003. Lecture Notes in Computer Science, vol 2774. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-45226-3_37
31. A.K. Jain, M.N. MURTY AND P.J. FLYNN, Data Clustering: A Review *ACM Computing Surveys*, Vol. 31, No. 3, September 1999 DOI/10.1145/331499.331504
32. V. Realinho, J. Machado, L. Baptista, M. V. Martins. (2021). "Predict students' dropout and academic success" (1.0) [Data set]. Zenodo. DOI: 10.5281/zenodo.5777340
33. M. V. Martins, D. Tolledo, J. Machado, L. M. T. Baptista, V. Realinho. (2021) "Early prediction of student's performance in higher education: a case study" Trends and Applications in Information Systems and Technologies, vol.1, in *Advances in Intelligent Systems and Computing series*. Springer. DOI: 10.1007/978-3-030-72657-7_16
34. <https://theeducationdaily.com/2021/07/dropouts-higher-education-india>
35. Data Mining: Concepts and Techniques by Jiawei Han (Author)

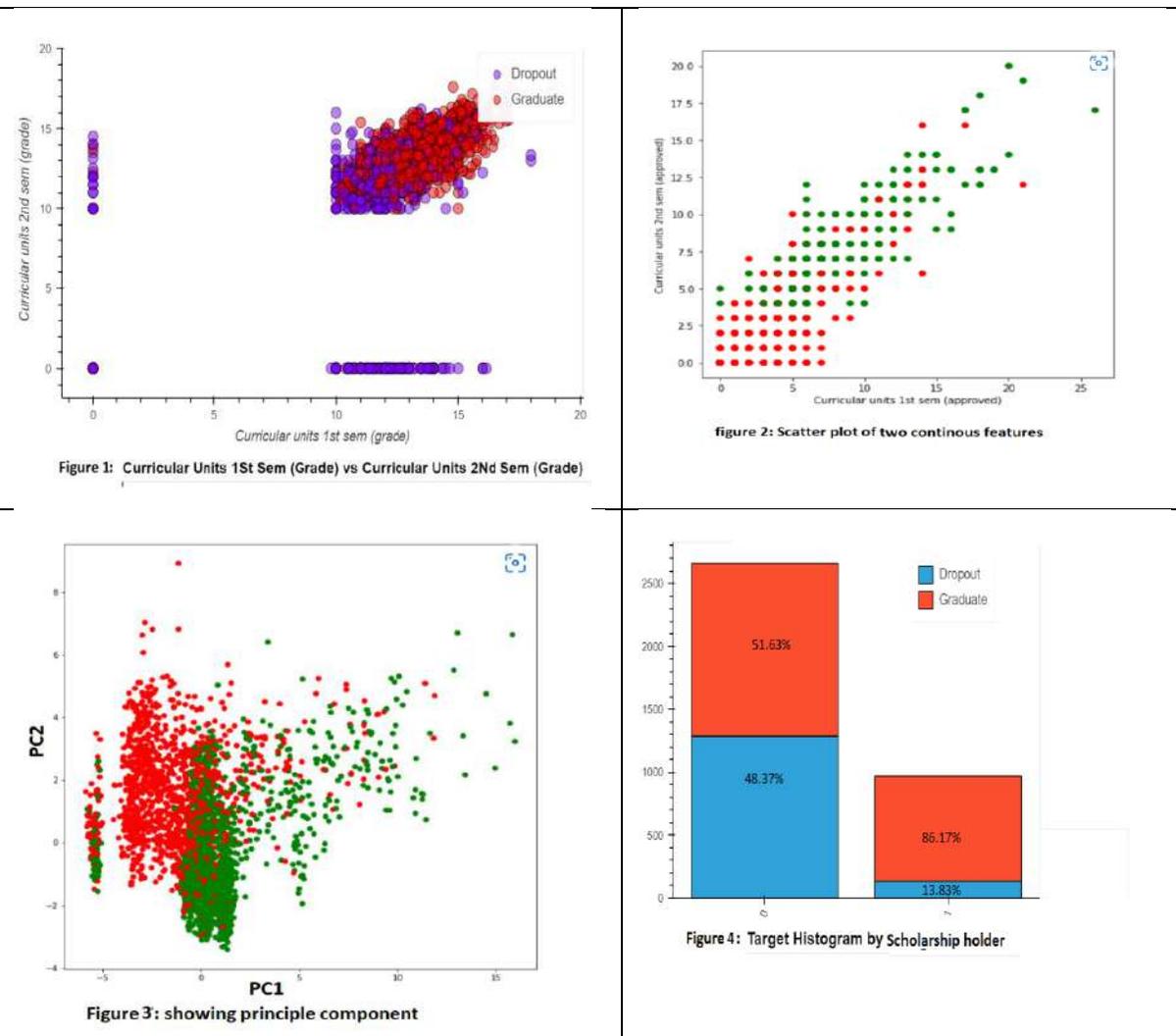




Nisha Rani et al.,

Table 1: Showing the accuracy of each classification with the different Dataset.

| Dataset ↓ / Classification Method → | Logistic Regression | SVM | Random Forest Classifier(RFC) | Neural Network |
|-------------------------------------|---------------------|--------|-------------------------------|----------------|
| Set1 | 0.9021 | 0.8234 | 0.869 | 0.9034 |
| Set2 | 0.9034 | 0.8207 | 0.8717 | 0.8938 |
| Set3 | 0.8441 | 0.8566 | 0.80 | 0.8248 |
| Set4 | 0.8786 | 0.8924 | 0.8303 | 0.8621 |
| Set5 | 0.8166 | 0.8303 | 0.851 | 0.8248 |
| Set6 | 0.6841 | 0.6717 | 0.6966 | 0.5848 |





Nisha Rani et al.,

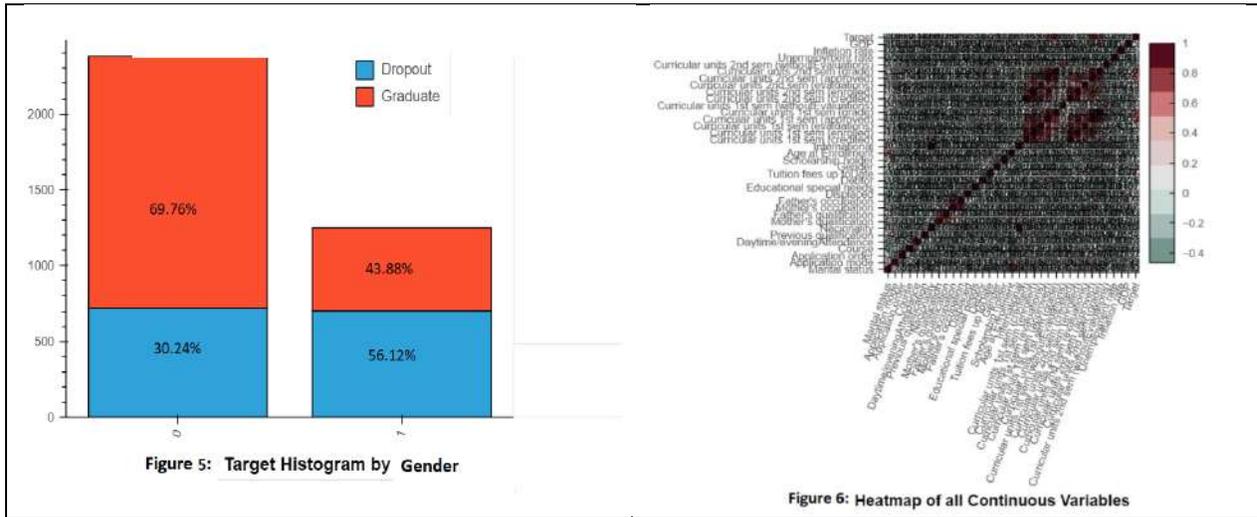


Figure 5: Target Histogram by Gender

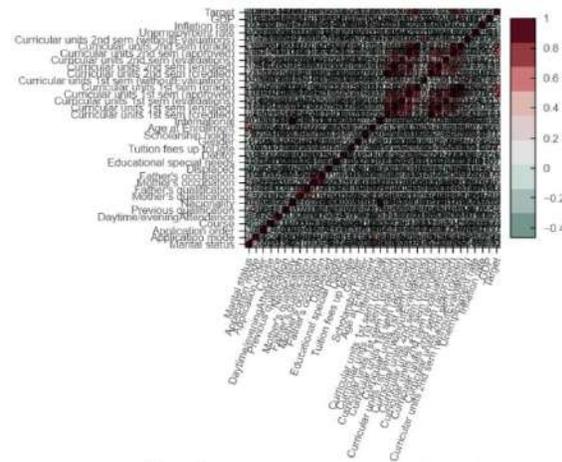


Figure 6: Heatmap of all Continuous Variables

Chi_Square Test of all categorize variable with related to Class variable Target (Dropout/Enrolled) are given as below

| Categories features | Dof | Probability | cal_chiSquare | Crit_chiSquare |
|----------------------------|-----|-------------|---------------|----------------|
| Marital status | 5 | 0.00 | 92.13 | 1.15 |
| Gender | 1 | 0.00 | 229.35 | 0.00 |
| Father's qualification | 33 | 0.00 | 147.86 | 20.87 |
| Mother's qualification | 28 | 0.00 | 143.01 | 16.93 |
| Father's occupation | 41 | 0.00 | 125.43 | 27.33 |
| Mother's occupation | 28 | 0.00 | 138.24 | 16.93 |
| Course | 16 | 0.00 | 442.95 | 7.96 |
| Daytime/evening attendance | 1 | 0.00 | 25.37 | 0.00 |
| Previous qualification | 16 | 0.00 | 150.60 | 7.96 |
| Nationality | 18 | 0.34 | 19.85 | 9.39 |
| Tuition fees up to date | 1 | 0.00 | 786.96 | 0.00 |
| Scholarship holder | 1 | 0.00 | 354.22 | 0.00 |
| Age at enrollment | 3 | 0.00 | 395.60 | 0.35 |
| International | 1 | 0.75 | 0.07 | 0.00 |
| Educational special needs | 1 | 0.78 | 0.08 | 0.00 |
| Displaced | 1 | 0.00 | 57.22 | 0.00 |

Figure7. Chi Squire

One -way ANOVA Test conducted of continuous variable with Target value(Dropout/Graduate)

| Features | f value | p value |
|--|---------|---------|
| Curricular units 1st sem (grade) | 1344.07 | 0.000 |
| Curricular units 1st sem (credited) | 8.00 | 0.005 |
| Curricular units 1st sem (enrolled) | 96.63 | 0.000 |
| Curricular units 1st sem (evaluations) | 13.01 | 0.000 |
| Curricular units 1st sem (approved) | 1613.96 | 0.000 |
| Curricular units 1st sem (without evaluations) | 20.33 | 0.000 |
| Curricular units 2nd sem (credited) | 9.99 | 0.002 |
| Curricular units 2nd sem (grade) | 2098.45 | 0.000 |
| Curricular units 2nd sem (enrolled) | 125.56 | 0.000 |
| Curricular units 2nd sem (evaluations) | 52.33 | 0.000 |
| Curricular units 2nd sem (approved) | 2711.44 | 0.000 |
| Curricular units 2nd sem (without evaluations) | 38.66 | 0.000 |
| GDP | 9.19 | 0.002 |
| Inflation rate | 3.34 | 0.065 |
| Unemployment rate | 0.06 | 0.800 |

If the p-value is less than some significance level (e.g. 0.05) then we can reject the null hypothesis and conclude that not all group means are equal.

Figure 8. ANOVA





A Study on Marketing Strategies and Challenges of Micro and Small Entrepreneurs in Shivamogga City

K. S. Sarala^{1*} and Seema H.M²

¹Professor, Department of Commerce and Management, Sahyadri Commerce and Management College, (Constituent College of Kuvempu University) Shivamogga, Karnataka, India.

²Research Scholar Department of Commerce Sahyadri Commerce and Management College (Constituent College of Kuvempu University) Shivamogga -577 203, Karnataka, India.

Received: 04 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

K. S. Sarala

Professor,

Department of Commerce and Management,
Sahyadri Commerce and Management College,
(Constituent College of Kuvempu University)

Shivamogga, Karnataka, India.

Email: kssmurthy94@yahoo.co.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Entrepreneur is an important input of economic development of any nation and it is very essential to take measures to develop entrepreneurial activities in India. Micro and small industries are back bone of large scale enterprises in India. Marketing plays a vital role in the success of any enterprise. Even though micro and small entrepreneurs have many opportunities and benefits they are facing different problems and challenges in producing and marketing their products and services. In this backdrop, the paper aims to examine the marketing strategies and challenges faced by the entrepreneurs in Shivamogga city, Karnataka. The study is carried out with the sample size of 60 and are selected by simple random sampling method. The study revealed that there are more number male entrepreneurs and majorly they have undertaken micro business activities rendering variety of services. It was observed that respondents have adopted variety of marketing strategies like social media marketing, posters and banners, user interface etc. and are facing marketing financial, competition, technological up gradation, poor advertisement challenges. It is suggested to create awareness among the entrepreneurs about proper implementation of marketing strategies to overcome marketing challenges.

Keywords: Challenges, Entrepreneurs, Marketing strategies





Sarala and Seema

INTRODUCTION

The growing need for money has given rise to new ideas, new insights in almost all the fields. The rise in the income levels lead to increase in the standard of living which in turn has greater impact on the development of economy as a whole. The economy develops because of business and well planned marketing is very essential for the improvement of business. The importance of marketing has led to increase in the new innovative marketing practices to improve the business. The government of India is providing assistance and undertaking several programmes encouraging micro and small enterprises to market their products and also purchasing the products at subsidized prices. In this competitive era, there is a need to grab marketing opportunities through effective entrepreneurial marketing strategies. Entrepreneurial marketing has rapidly progressed over the last few decades due to its effectiveness in high competitive markets and uncertain conditions. Enterprises focused on growth must be able to switch marketing gears quickly and attracts new and different customer requirements.

Concept of Entrepreneurial Marketing

The term Entrepreneurial marketing is described as the marketing activities of small and new ventures that have limited resources. Entrepreneurial marketing is different from marketing done by established companies as entrepreneurial companies have limited resources and limited or no market share as like larger companies. But, the entrepreneurs who use entrepreneurial marketing would have experience and marketing knowledge about the product or service that they plan to market. Subsequently, entrepreneurial marketing enables enterprises to focus more attention on new market areas rather than providing services to current ones. Morris, et.al.,(2002) defined entrepreneurial marketing as “ proactive identification and exploitation of opportunities for acquiring and retaining profitable customers through innovative approaches to risk management, resource leveraging and value creation.”

Review of Literature

Nasser Alqahtani et.al., (2022) examined the relationship between entrepreneurial marketing, market orientation, entrepreneurial orientation, firm's performance and the moderating effects of network structure, environmental variables and firm size. It is found that entrepreneurial marketing have significant influence on the firm's performance and suggested that new and B2B firms should engage in entrepreneurial behaviour. Gemechu Abdissa Shuremoet.al., (2021) studied the effect of entrepreneurial marketing on small and medium sized business and found that some non-traditional marketing strategies like innovation and customer intensity have positive impact on the performance of SMEs. Abdul Kanu, (2020) investigated the rewards and challenges of entrepreneurial marketing in SMEs and found that entrepreneurial marketing has positive impact on the performance of SMEs by helping in generating more sales and profit. It is further stated that SMEs are also facing many challenges like limited managerial knowledge, poor marketing skills, lack of expertise which has to overcome by making proper strategies. Robert Kwame Dzogbenuku, (2019) examined the relationship between marketing and entrepreneurship. It is found that entrepreneurial marketing has positive influence on the success of enterprise. It is suggested that enterprise must concentrate on customer satisfaction before making profit goals. Benazir and Swathy, (2014) It is identified that entrepreneurs are facing various problems relating to production, finance and government related. It is suggested that in order to tackle these challenges, government should conduct entrepreneurial development programmes and adequate data should be available to the entrepreneurs regarding marketing activities.

Statement of the Problem and Significance of the study

Every year, thousands of entrepreneurs with innovative strategies are striving to make their presence in the growing competition. Some of them have immediate prominence, but most of them are struggling to establish themselves. It is difficult for the new and inexperienced entrepreneurs to compete with the existing, profitable firms without adequate marketing strategies. It is observed that entrepreneurs are facing many problems in marketing their products and not able to reach the level as expected due to poor marketing skills, inadequate use of resources and lack of awareness about marketing practices. So, there is a need of proper marketing strategies in the micro and small enterprises and it is important to create awareness among the entrepreneurs about the significance of marketing



**Sarala and Seema**

practices and strategies through proper training facilities and by conducting various awareness and skill development programmes. Therefore, present study intends to study the marketing strategies and challenges of micro and small entrepreneurs in Shivamogga city, Karnataka.

Objectives of the Study

- To examine the different marketing strategies adopted by sample micro and small entrepreneurs in Shivamogga City
- To identify the marketing challenges faced by micro and small entrepreneurs
- To suggest for the successful implementation of the marketing strategies to overcome the challenges of micro and small entrepreneurs.

Scope of the Study

The scope of the study covers marketing strategies and challenges of micro and small entrepreneurs operating in Shivamogga city.

Limitations of the Study

- The study is confined only to micro and small entrepreneurs of Shivamogga city
- The study is undertaken to examine the marketing strategies and challenges of entrepreneurs.

Sources of Data

For the purpose of collection of data, both primary and secondary sources are used. Primary data has collected from the selected categories of micro and small entrepreneurs through survey in Shivamogga city. Secondary data have been collected from relevant books, articles, journals and online sources.

Sampling Design

Presently, 203 micro and small entrepreneurs are registered in Shivamogga city as per the records of District Industries Centre, Shivamogga District, Karnataka, June 2021-22. For the purpose of the study, 60 respondents (45 male and 15 female) are considered using simple random sampling method.

Research Instrument

A structured questionnaire is used for data collection with a set of questions containing basic information of entrepreneurs like age, gender and educational qualification, type of enterprise, nature of activity, marketing strategies adopted and the major challenges faced by them in marketing their products.

Statistical tool used

Percentage analysis was used to measure the responses towards each question and is presented by means of appropriate tables.

Data Analysis

The study conducted through 60 responses collected from micro and small entrepreneurs spread in Shivamogga city were recorded and was analyzed below by using tables. It is quite evident from the table that, out of 60 respondents, three fourth are male, around 44% respondents are from the age group of 30-40 years, maximum of 40% respondents are post graduates, micro enterprises accounting for 60%, services activities are conducted by 65% respondents, more than 38% respondents have monthly turnover of 50,000 only 10% enterprises are running with more than 15 employees and own funds account for 35% respondents to start their enterprises. As observed from the table, among 60 respondents, 38 strongly agreed with marketing through posters and banners followed by 37 respondents strongly agreed marketing through different social medias like Youtube, Facebook, etc. followed by 34 respondents agreed Google my business and user influence are the best marketing strategies, only 8 respondents disagreed that incentives and discounts as best marketing strategies. 80% respondents agreed marketing strategies are one of the important factors influencing on the growth of an enterprise. From the above table it is clear that, 35 respondents



**Sarala and Seema**

strongly agreed inconsistent marketing efforts will become challenge for marketing their products and services, 43 respondents strongly agreed technological up gradation is the major challenge for marketing the products, 41 respondents strongly agreed marketing budget constraint is also a biggest challenge and only 8 respondents disagreed that competition is major challenge for marketing products and services.

Major Findings of the Study

More than 40% of micro and small entrepreneurs in Shivamogga city belong to the age group of 30-40 years and 40% are graduates, 60% of the entrepreneurs are running micro enterprises and 65% of the respondent's business is service oriented, 38% respondent's monthly turnover is up to 50,000 rupees, 35% respondents have started business with their own funds. Out of 60, 38 respondents have adopted marketing through banners and posters as their marketing strategy. The respondents also adopted social media marketing as their marketing strategy, 80% respondents agreed that marketing strategies will influence on the growth and success of the business enterprise. Out of 60, more than 40% respondents strongly agreed that their biggest challenge is technological up gradation, 41 respondents strongly agreed facing budget constraint as biggest challenge in marketing their products.

Suggestions

As India is a country of youth there is a need to motivate graduate youth to take up entrepreneurial activities with proper education and skills needed to start their own enterprise. As majority of the entrepreneurs have undertaken service activities, there is a need to provide proper training and development to undertake manufacturing activities also Most of the entrepreneurs running micro enterprises which leads to generate limited income and the need to improve the status of micro entrepreneurs by providing government facilities and incentives is highlighted. It is suggested that the Government has to arrange various awareness programmers to the micro and small entrepreneurs to inculcate market knowledge and strategies. In this competitive world especially after Covid 19, micro and small entrepreneurs have to depend on online marketing platform to market their products and providing proper usage information of modern digital platforms is needed.

CONCLUSION

Marketing plays a vital role in any enterprise. The entrepreneurs have started recognizing the importance of marketing to market their products. Many of the entrepreneurs having awareness of marketing have adopted effective marketing strategies But, many are still following traditional marketing strategies and failed to compete with other entrepreneurs as well as are facing various marketing challenges like choosing inappropriate method of marketing, technological up gradation, budget constraint etc. Government is conducting awareness programmers to enhance marketing and financial literacy of entrepreneurs. So, adopting proper marketing strategies is very essential to overcome the challenges and improve the performance of the business enterprise as a whole.

REFERENCES**Books**

1. RajanSaxena (2017), Marketing Management: McGraw Hill Education (India) Private limited, Fifth Edition.
2. Vasant Desai (2010), Fundamentals of Entrepreneurship and Small Business Management, Himalaya Publishing House.

Journals

3. Dr. Abdul Kanu, "The Reward and Challenges of Entrepreneurial Marketing in SMEs," British Journal of Management and Marketing Studies, Volume 3, Issue 4, PP-19-36 ISSN-2689-5072, (2020).
4. Gemechu Abdissa Schuremo, Csaba BalintIlles and Anna Tosone Dunay "The Effect of Entrepreneurial Marketing on the Performance of Small and Medium Sized Enterprises," SHS web Conferences, (2021).





Sarala and Seema

5. Kurosh Rezaei- Moghaddam, Ommolbanikarami and Mahsa Fatemi, "The Comparative Analysis of Marketing activities among Rural Women Entrepreneurs in Far Province, Iran" Journal of Global Entrepreneurship Research, (2019).
6. Nasser Alqahtani, Can Uslay and SengunYeniyurt "Entrepreneurial marketing and firm performance: Scale Development, Validation and Empirical test" Journal of Strategic Marketing (April 2022).
7. Robert Kwame Dzagbenuku and Solomon Abekah Keelson, "Marketing and Entrepreneurial Success in emerging markets: the nexus", Asia Pacific Journal of Innovation and Entrepreneurship, volume 13, no.2 (2019).
8. S. Swathy and Y. Benazir, "A Study on the Challenges faced by Entrepreneurs", International Journal For Marketing Research Review, volume 2, Issue 4, (April 2014).
9. Sheetal, Sangeeta and Rajiv Kumar, "Marketing Strategies of Small and Medium Enterprises: A Sample Survey", International Journal of Management Sciences, Vol. 01, Issue 02, (June 2012) E-Sources
10. <https://www.legalraasta.com/marketing-challenges-entrepreneurs/>
11. <https://sites.google.com/site/dicshivamogga>
12. <https://www.investopedia.com/terms/m/marketing-strategy.asp>
13. [https://msmedibangalore.gov.in/files/DIC- Adress.pdf](https://msmedibangalore.gov.in/files/DIC-Adress.pdf)

Table -1 Demographic and Business Detail of Respondents

| Demographic and Business Details | | No. of Respondents | Percentage |
|------------------------------------|--|--------------------|------------|
| Gender | Male | 45 | 75 |
| | Female | 15 | 25 |
| | Total | 60 | 100 |
| Age Group | 20-30 | 12 | 20 |
| | 30-40 | 26 | 43.33 |
| | 40-50 | 15 | 25 |
| | Above 50 | 07 | 11.67 |
| | Total | 60 | 100 |
| Education Qualification | SSLC | 09 | 15 |
| | PUC | 15 | 25 |
| | Graduation | 24 | 40 |
| | Post-graduation | 06 | 10 |
| | Others | 06 | 10 |
| Type of Enterprise | Micro | 36 | 60 |
| | Small | 24 | 40 |
| Nature of Activity | Manufacturing | 21 | 35 |
| | Service | 39 | 65 |
| Monthly turnover of the enterprise | Up to 50,000 | 23 | 38.33 |
| | 50,000-1 lakh | 18 | 30 |
| | 1 lakh to 2 lakh | 12 | 20 |
| | More than 2 lakh | 07 | 11.67 |
| Number of employees working | Less than 5 | 16 | 26.67 |
| | Between 5-10 | 23 | 38.33 |
| | Between 10-15 | 15 | 25 |
| | Above 15 | 06 | 10 |
| Sources of Capital | Own Fund | 21 | 35 |
| | Loan from friends and relatives | 09 | 15 |
| | Loan from commercial banks | 10 | 16.67 |
| | Government Schemes | 12 | 20 |
| | Loan from private financial institutions | 08 | 13.33 |

Source: Field Survey





Sarala and Seema

Table-2 Marketing Strategies of Micro and Small Entrepreneurs

| Major Strategies | Opinion | | |
|--|----------------|--------------------|------------|
| | Strongly Agree | Agree | Disagree |
| Posters and Banners | 38 | 22 | 00 |
| Social media marketing | 37 | 21 | 02 |
| Google my business | 19 | 34 | 07 |
| User influence | 23 | 34 | 03 |
| Offering incentives and discounts | 34 | 24 | 02 |
| Innovative and creative advertisements | 29 | 23 | 08 |
| word of mouth promotion through delighting existing customers | 27 | 29 | 04 |
| Statement | Response | No. of respondents | Percentage |
| Marketing strategies influence on the growth and success of enterprise | Yes | 48 | 80 |
| | No | 12 | 20 |

Source: Field survey

Table-3 Marketing Challenges of entrepreneurs

| Major marketing challenges | Opinion | | |
|--------------------------------|----------------|-------|----------|
| | Strongly Agree | Agree | Disagree |
| Inconsistent marketing efforts | 35 | 19 | 06 |
| Technological up gradation | 43 | 17 | 00 |
| Retaining Customers | 39 | 14 | 07 |
| Budget Constraint | 41 | 19 | 00 |
| Generating brand awareness | 29 | 30 | 01 |
| Competition | 25 | 27 | 08 |
| Government regulations | 26 | 29 | 05 |

Source: Field Survey





A Study on the Impact of Pandemic towards Gold Investment Behaviour among the Working Women in Bangalore

Arshiya^{1*}, Suman A² and Gowrika R²

¹Assistant Professor & HOD of Commerce & Management St. George College, India

²MBA student St. George College, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Arshiya

Assistant Professor and HOD of Commerce and Management,

St. George College, India

Email: arshiya.syed99@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The main objective of this study is to analyse impact of pandemic on the behaviour of working women investing on gold. On the outburst of COVID 19 investor's behaviour has a huge change in their investment patterns. Gold is one of the precious metals in the world and also it is a tradition that women wear gold on special occasion, this is been continued from an ancient time. Gold is most preferred investment as investors think gold as a safest investment with less risk. As each investment avenues have their own pros & cons but gold have an extraordinary benefit as an investment option for investors. Gold is also a tool as a financial security for the investors because paper money might lose its value but not gold. The objective of this study is to understand the behaviour of investors towards gold. And also, to know if allocation of savings towards gold is only for consumption purpose or it is for investment. Both primary and secondary data is used for this research paper. It is found that many of the investors prefer gold as an investment avenue.

Keywords: Pandemic, Gold, Investment Avenue & Gold price

INTRODUCTION

Around 3 in 5 ladies began to invest interestingly, in the midst of the pandemic, says a study directed by Scrip box, a computerized abundance the board organization. The review features a developing pattern of ladies assuming more prominent command over their cash, advanced by the financial effect of the pandemic. The study likewise focuses to the instruments these new ladies' financial backers. As indicated by the review, gold is the most favored venture instrument and is the decision of 22% of ladies overviewed. Around 34% of ladies like to place their cash in a blend of fixed deposit, recurring deposit, PPF and investment accounts. Around 30% of them depend on advanced venture





Arshiya et al.,

stages for data on monetary preparation and financial planning, 20% rely upon loved ones and 15% allude to articles on individual budget. Families allot their profit in to individual resources and investment assets. Individual resources are those which are utilized for utilization and investment assets are those from which returns are normal and abundance made. According to RBI report of family finance panel 2017, Indian families hold 84% of their wealth in land, 11% in gold and remaining 5% in monetary resources. Land and gold are both utilization and investment assets. There are number of investment avenues accessible for financial backers to browse in view of their targets. The different investment avenues incorporate Bank Deposits, Bonds, and Equity shares, Bonds, Commodities, Mutual Funds and Life Insurance. Despite the fact that there are number of resources accessible, Gold has been one of the #1 among Indians. This could be because of its fancy worth as it is definitely utilized for standard use and furthermore utilization on unique events. Indian families own gold for both utilization as well as investment. As per World Gold Council, the interest for gold in India has expanded by 5.12% from 1,053.3tonnes to 1,107.9tonnes in 2019. Aside from actual gold, instruments connecting with gold like Gold ETFs, Gold Funds and Gold Bonds are additionally accessible. The presentation of these gold hidden instruments relies upon the cost of actual gold.

THEORETICAL BACKGROUND OF THE STUDY

ArshiyaGold is a huge metal that has been respected by individuals since former periods. Individuals utilize gold for coins, upgrades, advancements, moreover, different current purposes. At this point, gold stores shaped the explanation of world money related frameworks. Gold plays a basic work in giving the best affirmation against the distinctions of both political and money related situation, essentially in Asia, the Middle east nations what's more in India. The discharge of the pandemic, Covid-19, has impacted the whole globe and impacts the ground level of pay influencing the speculation plan. The determinants of gold speculation coordinate Prices of gold, Inflation rates, Interest rates, Demand-Supply factors, Indian Jewelry Market, Import Duty and Government Reserves. The threatening consequence of this pandemic has harmed various affiliations and accomplished the shift of different speculation choices. The necessities of experience are clearly drafting its penchant and the new normal circumstances rouses another frenzy in speculation plan. Individuals pick their roads relying upon unambiguous pay, risk and bring inclination back. In India, today, the different roads combine Bank Deposits, Government Securities, Insurance, Public Provident Funds, Real Estates, Commodities, Mutual Funds, Debt and Equity. With this wide variety of hypothesis choices accessible, totally it will overall be organized into monetary and authentic resources. Indian financial ally is viewed as leaned towards one uncommon sort of road among the various kinds of speculation roads that makes the holder of the money related promoter portfolio solid and peril free. The most regarded speculation road among them is the yellow metal - gold. Gold is related with different financial promoters as a precious/shrewd resource and generally as a mental resource as well. This resource is taken out from the mines as a brand name asset and generally has been in India. Gold has a momentous spot in Indian culture and was persistently made sure to be great for introducing gold as a present or buying for oneself, basically all events like wedding, kid showers, naming ceremonies, birthday events, house warming ceremonies, and so on. The legendarily extraordinary and puzzle nature of Gold makes it essentially more incredible for agents and clients to contemplate this exceptional engaging resource. Indian Culture has asserted this resource class from different times concerning Vedas, Epics, Puranas, Upanishads and substantially more old things. India stays as one of the best clients of Gold on the planet.

MAJOR FACTORS INFLUENCING DEMAND FOR GOLD IN INDIA

TRADITIONAL DEMAND

It is the standard practice and part of Indian culture that on each promising event gold is bought. Gold gems is gifted the second the kid is conceived. In country India, ranchers ordinarily purchase gold adornments after each fruitful reaping season.

CELEBRATIONS AND WEDDING

Gold is bought during celebrations like Diwali (Dhan-Teras), Akshaya Tritiya, Dussehra. No wedding in India is finished without the acquisition of gold adornments. Rich or needy individuals purchase according to their capacity to spend. With 10 million relationships a year occurring in India, wedding-related request is large business.





Arshiya et al.,

EXPANDING WELL-TO-DO AND WORKING-CLASS POPULACE

Rising pay and opulence of youthful and metropolitan populace has affected utilization of products going from very good quality vehicles to extravagance things. Adornments is likewise remembered for their buy list as a component of speculation or reserve funds plot. The study likewise focuses to the instruments these new ladies financial backers. As indicated by the review, gold is the most favored venture instrument and is the decision of 22% of ladies overviewed. Around 34% of ladies like to place their cash in a blend of fixed deposit, recurring deposit, PPF and investment accounts. Around 30% of them depend on advanced venture stages for data on monetary preparation and financial planning, 20% rely upon loved ones and 15% allude to articles on individual budget.

OBJECTIVE OF THE STUDY

- To analyze impact of pandemic on the behaviour of working women investing on gold.
- To know if allocation of savings towards gold is only for consumption or as an investment avenue.
- To determine perception & preferences of working women towards gold.
- To understand the factors affecting working women towards gold market.

REVIEW OF LITERATURE

Raj (2019) Stated volatility and relationship between physical Gold and Gold ETFs by using various statistical tools. Data for this study is based on 3 years historical data on NSE and based on top 5 gold ETFs. The aim of this study is to analyze effect of volatility in gold and gold ETFs, which is estimated with the help of returns, Mean, Median, Mode, Karl Pearson's Correlation Test and Regression. As a result of this study, it was found that there is a strong positive short-run relationship and long-run equilibrium relationship between physical Gold and Gold ETFs. It reveals that it is unidirectional and few are multiple directional cause and relationship which occurs in this study. And proved there is a positive impact on Gold and Gold ETFs. Nishad Nawaz and Sudindra V R, (2013): A concentrate on different types of gold venture features the different structures in which an financial backer can select to pick gold. The gold structures is not saved to just gems however spreads over gold coins, gold is, bullions, ETF, gold common assets, e- congold, and so on. Aslishan Gizem Korkmaz et. al, (2020): The monetary choice made in the midst of the pandemic period will without a doubt change the family portfolio pattern and there will be a change in risk conduct of the financial backer the linear likelihood models are utilized to break down the family level effects of covid19. Arpita Gurbaxani and Rajani Gupte (2021): Led an examination entitled " A Study on the effect of COVID - 19 on financial backer way of behaving of Individuals in a modest community in the province of Madhya Pradesh, India" to survey the impact of COVID - 19 pandemic on the speculation choices of people in SIPs. The review was completed on individual financial backers, dwelling in humble communities of India. The information required was gathered through overview. Discoveries of the exploration portrayed that, there was a decrease in the SIP speculations, especially during the pandemic. It was observed that there was a relationship between the reserve funds and venture conduct of people and the preventive estimates taken by the public authority to prevent the pandemic. Suryavamshi et. al, (2021) The reallocations of portfolios during the pandemic circumstance are drafted in this paper The way to deal with acting of financial support during the pandemic, on moving hazardous assets for a bet-free asset shifts starting with one monetary sponsor then onto the next. The variables impacting the hypothesis streets to be picked by the solitary monetary benefactor for widening the portfolio is contemplated among gold and stocks as safer and perilous theories independently.

RESEARCH GAPS

This paper concentrates on the varieties got by the pandemic in the financial backers' choices. To examine in the event that there is a tremendous change in gold speculations and to concentrate on the change in these designs because of the cost fluctuations.

PURPOSE OF THE STUDY

To examine in the event that there is a sublime change in gold speculations because of pandemic and to study the change in these patterns because of the cost. variances during this period





Arshiya et al.,

STATEMENT OF THE PROBLEM

As per RBI reports Indian household hold 11% of their wealth in the form of gold.. Gold is involved by householders for both utilization and speculation. As gold is a non-productive asset for economy, Government of India introduced Gold Bonds so that householders can purchase these bonds and earn the same returns provided by physical gold. Also, other gold underlying investments like Gold Funds and Gold ETFs also serve the same purpose. The success of gold underlying investments depends upon the investor's perception and preference for gold as an investment asset rather than as a consumption asset.

RESEARCH METHODOLOGY AND DESIGN

The paper estimates the element of gold venture going through the pandemic at different cost levels and at various phases of life. The study incorporates both the data primary as well as secondary data.

- **Primary Data**

- Essential information is gathered from financial backers (the respondents) with the assistance of a well-structured questionnaire and individual meeting.

- **Secondary Data**

- The review extracted the secondary data information from the different sources which incorporates research journals, books, thesis reports, certain distributed sources.

- **Sample Size**

- Since the population under consideration is very large. A total number of 80 sample respondents has been selected for the purpose of the present study.

ANALYSIS AND OUTCOME OF THE STUDY

The above information is based on the demographical variables of respondents. It is found that out 80 respondents 38 respondents i.e., 47% of them are between age group of 40-50 year; hence majority of respondent's income level is more than 5 lakhs. It is also estimated that 64% of respondents were married whereas only 16% of them were unmarried. This research also helped to know that 28% of respondents are graduates and only 11% of respondents are illiterates. In the further study we also understood that 89% of respondents belong to a nuclear family. Few of the demographical variables have been analyzed using chi square test. From the above estimated value, it is observed that the calculated value (24.1) is greater than the table value (0.11), hence the H_0 is rejected and alternative H_1 is accepted.

Significant relationship between age and reason for purchasing of gold.

H_0 : There is no significance relationship between the age and cause behind purchasing gold.

H_1 : There is a significance relationship between the age and cause behind purchasing gold.

From the above analysis it shows that the calculated value (7.58) is greater than the table value (0.12), hence the H_0 is accepted and alternative H_1 is rejected.

Significant relationship between education and gold purchase.

H_0 : There is significance relationship between the education and cause behind purchasing gold. H_1 : There is no significance relationship between the education and cause behind purchasing gold. In reference with the above table indicates that the calculated value (28.8) is greater than the table value (0.078), hence the H_0 is rejected and alternative H_1 is accepted.

Significant relationship between marital status and gold purchase.

H_0 : There is no significance relationship between the marital status and cause behind purchasing gold.

H_1 : There is significance relationship between the marital status and cause behind purchasing gold.

The table says that the calculated value (35.32) is greater than the table value (0.11), hence the H_0 is rejected and alternative H_1 is accepted.





Arshiya et al.,

Significant relationship between income level and gold purchase.

Ho: There is no significance relationship between the education and cause behind purchasing gold.

H1: There is significance relationship between the education and cause behind purchasing gold.

From the above table it shows that respondents purchase gold ideally in light of high liquidity and at the second spot it expresses that they purchase gold due to its portfolio enhancement, it additionally found numerous female respondents purchase gold because of their pride and magnificence, it is likewise tracked down that main few purchase gold in view of expansion Most of the investors agree to the statement that the major disadvantage of buying gold is it does not give regular returns like other investments. The other set of respondent's states that gold is having less realizable value; Respondents also specified that making charges of gold is very high. Some of the respondents for buying gold they have a fear of theft, they also feel the volatility in gold is quite risky, only few respondents revealed that storing gold is costly. 59% of respondent's states that they prefer to buy gold in pandemics because many marriages had taken place during pandemic as this study is specifically for working woman's they say that have bought more gold during pandemic. 41% of respondents says that they don't prefer buying gold during pandemic because it does not give regular returns.

FINDINGS

A careful survey of writing uncovered that there is parcel of changes in present patterns. Gold Jewelry today has practical, representative and close to home estimation unequivocally. Gold adornments stays the need when contrasted with some other valuable metals like platinum, silver. In any case, ladies today are prepared to settle on gold with lesser cartage and are likewise prepared to explore shaded gold which is getting up to speed in market gradually. Working ladies favor specialty stores while ladies in business lean toward general goldsmiths. The significant justification behind this was specialty stores offered lightweight, present day and popular extravagant adornments which they could use as everyday wear. Conversely, ladies with business occupation got advantage of resale or swearing gold during monetary emergency, so they favored significant burden gold gems from general gem specialists.

CONCLUSION

The endeavor example of shift in gold expenses impacting a speculation road during the pandemic time frame is examined and stalled as end. Monetary supporter's mindset for gold has customs and sentiments associated which make it very basic for the monetary sponsor to put gold in their case of portfolio as one of the required assets which should be accessible for most of the promising occasions like wedding, house warming help, festivities, etc. In the ongoing business sector situation of high unstable, quickly changing commercial center, different roads for interest in gold are making the disarray among Investors. According to different concentrates on 16,000 tons of gold is there in Indian families overwhelmingly as adornments. There are different choices accessible for interest in gold through choices like adornments, coins, bullions, ETF, shared reserves, E-gold and so on. The current review "A concentrate on different types of gold speculation" attempts to concentrate on types of gold venture accessible to financial backers. The targets of the review is to comprehend the different speculation choices for financial backers, factors should know about and skill of putting resources into gold, upsides and downsides of different types of ventures and to help financial backers in making mindfulness about different gold speculation choices. With the end goal of study, the essential information and Secondary information has been gathered. Essential information comprises of survey and auxiliary information through site, research papers and magazines. In light of the examination, it is found that numerous financial even backer favor adornments, gold coins and gold bullion bars types of venture and really like to put resources in to ETF and Futures and choices which gives more benefit and simple type of speculation.





Arshiya et al.,

REFERENCES

1. https://www.researchgate.net/publication/303898266_A_Study_on_Various_Forms_of_Gold_Investment.
2. <https://bit.ly/3PnBaXU>
3. shorturl.at/PQU24
4. <https://cutt.ly/9LYvXVr>
5. <http://journalppw.com>
6. <https://rb.gy/afxffc>
7. <http://www.publishingindia.com>

Table 1: Data Regarding Demographical Variables of Respondents

| Variables | Categories | Number of respondents | Percentage |
|----------------|------------------|-----------------------|------------|
| Age | Below 20 years | 9 | 11.25 |
| | 20-40 years | 14 | 18 |
| | 40-50 years | 38 | 47 |
| | 50 Years & above | 19 | 24 |
| | Total | 80 | 100 |
| Marital Status | Married | 64 | 64 |
| | Un married | 16 | 16 |
| | Total | 80 | 100 |
| Income Level | Below 50,000 | 9 | 11 |
| | 50,000- 1lakh | 8 | 10 |
| | 1lakh-5 lakh | 22 | 27 |
| | Above 5 lakh | 41 | 52 |
| | Total | 80 | 100 |
| Education | Illiterates | 10 | 22 |
| | SSLC | 22 | 28 |
| | PUC | 19 | 24 |
| | UG | 22 | 12 |
| | PG | 11 | 14 |
| | Total | 80 | 100 |
| Family Type | Nuclear Family | 71 | 89 |
| | Joint Family | 9 | 11 |
| | Total | 80 | 100 |

| Table 2. Chi Square test | | | |
|--------------------------|-------|-----|------------|
| Age | Value | d.f | Sig. value |
| Chi Square test | 24.1 | 5 | 0.1107 |

| Table 3. Chi Square test | | | |
|--------------------------|-------|-----|------------|
| Education | Value | d.f | Sig. value |
| Chi Square test | 7.58 | 6 | 0.12 |

| Table 4. Chi Square test | | | |
|--------------------------|-------|-----|------------|
| Marital Status | Value | d.f | Sig. value |
| Chi Square test | 28.8 | 3 | 0.078 |





Arshiya et al.,

| Income level | Value | d.f | Sig. value |
|-----------------|-------|-----|------------|
| Chi Square test | 35.32 | 5 | 0.11 |

Table 6. Data Regarding Factors Effecting Working Women to Invest In Gold

| Sl. no | Description | Strongly Agree | Agree | Agree nor disagree | Disagree | Strongly disagree | Rank |
|--------|---------------------------|----------------|-------|--------------------|----------|-------------------|------|
| 1 | High Liquidity | 36 | 30 | 10 | 4 | 0 | 1 |
| 2 | Portfolio diversification | 31 | 32 | 9 | 2 | 6 | 2 |
| 3 | Safety | 17 | 27 | 14 | 16 | 6 | 4 |
| 4 | Beauty & Pride | 17 | 30 | 24 | 6 | 3 | 3 |
| 5 | Inflation | 13 | 29 | 16 | 9 | 13 | 5 |

Table 7. Data regarding respondents perception and preferences on risk of buying gold

| Sl. no | Description | Strongly Agree | Agree | Agree nor disagree | Disagree | Strongly disagree | Position weight | Rank |
|--------|-----------------------|----------------|-------|--------------------|----------|-------------------|-----------------|------|
| 1 | High Making charges | 15 | 28 | 13 | 13 | 11 | 253 | 3 |
| 2 | Storage Cost | 10 | 25 | 15 | 7 | 23 | 222 | 7 |
| 3 | Fear of Theft | 13 | 29 | 16 | 9 | 13 | 250 | 4 |
| 4 | Volatility in price | 11 | 27 | 16 | 8 | 18 | 235 | 6 |
| 5 | Impurity | 12 | 28 | 17 | 7 | 16 | 243 | 5 |
| 6 | No Regular Income | 31 | 32 | 9 | 2 | 6 | 310 | 1 |
| 7 | Less Realizable value | 18 | 26 | 13 | 14 | 7 | 262 | 2 |

Table 8. Data Regarding Respondents Opinion On Investing In Gold During Pandemic

| Opinion regarding investing in gold | FREQUENCY | PERCENTAGE (%) |
|-------------------------------------|-----------|----------------|
| Yes | 47 | 59 |
| No | 33 | 41 |
| Total | 80 | 100 |





A Review on the Well being of House-Keeping Workers during COVID-19 Pandemic

B.Vidya Sri¹ and S.Vasantha^{2*}

¹Ph.D. Research Scholar, School of Management Studies, VISTAS, Pallavaram, Chennai, Tamil Nadu, India

²HoD and Professor, School of Management Studies, VISTAS, Pallavaram, Chennai, Tamil Nadu, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

S.Vasantha

HoD and Professor,

School of Management Studies,

VISTAS, Pallavaram,

Chennai, Tamil Nadu, India

Email: vasantha.sms@velsuniv.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Wellbeing plays a major role in human being lives. When people are in a good state of wellbeing then they tend to develop high-quality of potential, positivity, and happiness around them. From children to elderly people, it is an important factor in building up their physical, mental, and emotional constraints. The covid-19 pandemic has created fear among many people throughout the world. Their financial constraints and fear of losing employment have crashed people emotionally. Housekeeping workers have faced many obstacles during this crisis, in the challenge of controlling it. This paper makes a review to establish the wellbeing of housekeeping workers. The main objective of the study is to examine the drive of wellbeing among workers and to know its positive and negative impact on them. Well-being is seen as a central feature even in the case of plan suggestion. It is a bigger task for working people to contribute for their wellbeing in this fast-moving environment but it is also important for them to manage their daily tasks and face the challenges.

Keywords: Covid-19, Family, Mental Wellbeing, Pandemic, Staff, Workers

INTRODUCTION

To begin with, the well-being concept is the fact of feeling good about oneself. The positive emotion of people such as happiness, the feeling of satisfaction makes them, overcome their fear and difficulties in life. Well-being is not just connected with their characteristics; it also deals with physical, emotional, mental, and financial traumas. In a few cases, it is based on their life experience. The recent covid 19 pandemics has made people think of the various



**Vidya Sri and Vasantha**

purposes in life. Even though it is a positive outcome approach, this pandemic made people approach some negative aspects too. Many indicators started to measure the people's emotions, their quality of a relationship, their resilience, and overall fulfillment of happiness before and after the pandemic as it changed their huge perspective towards their life. Well-being during covid, gives us a holistic approach to their physical as well as mental health. If people's mental well-being is healthy then, they can prevent any type of disease by fighting with the help of mental health. That is why famous personalities tend to follow if mental well-being is good and it will make a person face any sort of failures and fears. Individuals who are contributing more positive energy in their work or communities were said to have a high level of happiness. Self-care and self-strengthening traits help people to build their life purposefully. It also helps them to have a deeper thought on both the negative and positive shades of life. (Maunder RG, Leszcz M, Savage D, 2008). During this covid-19 individuals were facing problems like fear, anxiety and they were losing positive emotions within themselves. Doing exercise and involving themselves in more physical activities make better wellbeing and its outcome will result in people's quality of life. Therefore, when a person follows a good lifestyle by dedicating themselves to certain activity it will benefit them in achieving healthy wellbeing. (Penedo, Frank J, Dahn, and Jason R, 2005). Various researchers have exclaimed about different features of wellbeing which affected mostly the frontline workers in our society. The framework of the study is discussed in detail below with the help of a proposed conceptual model.

Objectives

- To review the positive & negative shades of wellbeing during covid.
- To review the existing literature on wellbeing of housekeeping workers.

METHODOLOGY

This article discusses the wellbeing of workers during the covid-19 pandemic and the suggestions were given based on the research papers of various authors. This paper reviews literature on how from pre- to post-pandemic wellbeing of individuals has differed.

LITERATURE REVIEW**Well-being of housekeeping workers**

During the research study of Ramadhani et al (2016), the researchers have found that individuals who have a positive approach towards themselves and who see positive things from others will possess a good well-being and they also have characteristics to explore and improve their ability in all possible ways. In the earlier period, many research studies have been conducted on the wellbeing of frontline workers. Here, we have reviewed the literature based on the major types of wellbeing such as social wellbeing, psychological wellbeing, and Emotional wellbeing.

Social wellbeing: Promoting work life balance

Work life balance is created only when the person has the same level of satisfaction and priorities in their career as well as in personal life. When work life balance is increased among workers it will give a positive output on their social wellbeing. But when their home responsibility, working hours, work commitments, and responsibilities with children increase they tend to have an imbalance between their work and personal life. This positivity in work life will affect the employers and workers as well. (Sanflippo, 2020). During the covid persons who worked by staying away from home also stayed with families. There was fear among individuals that they might transmit the infection to family members. The balance between work and life was reduced among the frontline workers and mental distress was increased. World Health Organization has also given various measures for the frontline workers to face this pandemic situation World Health Organization (2020). The best way of preventing is by following the rules given by the government like lockdown strategy, maintaining social distance, and reducing mass movements. (Ambikapathy and Krishnamurthy, 2020). Bhopal, (2020) developed a model to examine the worker's wellbeing. The study was investigated to find out the barriers faced by workers during the pandemic. They have found that



**Vidya Sri and Vasantha**

housekeeping workers had language barriers in understanding the covid health information. The health department of the UK addressed the housekeeping and healthcare worker's wellbeing in their review study. They highlighted the needs and measures to be followed to maintain health and to promote social wellbeing. They also remitted about five steps of changes to be made at the workplace to make a progress in the health of workers wellbeing. They are, engaging the staffs in all the activities, understanding their safety needs, creating good leadership, promoting work life balance, focusing on their capability towards their job. (Boorman S,2009). In the research study of Rothstein & Coughlin, 2019, they explored the factor which affects the satisfaction of social wellbeing among housekeeping workers. Their findings are lack of trust in the strategies implied by the government and also by their employer, fear of losing their job due to transmission of disease, and fear of being taken away from home and family in name of isolation. In addition to this, they also addressed the physical wellbeing factor of having limited access to health and safety facilities in their workplace.

Psychological wellbeing: Ensuring a healthy and safe environment

To decrease the infection spread and mental distress among individuals, medical nurses and staff are helping in controlling it by providing necessary measures. These medical people can easily identify the people's issues and distress by being a part of covid care groups. (Grover s , Dua D, Sahoo S, Mehra A, Nehra R and Chakrabarti S,2020). Covid-19 severity was found to be a factor that pessimistically reduced people's happiness. Life satisfaction becomes significantly low due to this negative predictor. When frustration is reduced and restrictions are minimal, people would be having more positive impacts on their life. (Stephen X Zhang Yifei Wang Andreas Rauch Feng Wei,2020). In this surfacing covid, one thing that has been constantly remaining unchanged is the measures and requests from the government side all over the world. Both the governments (central & state) have implemented measures like social distancing, self-isolation, and wearing the mask, and so on. Housekeeping workers are the people who carry out their work, without any breaks and they are the ones who ensure to give us a healthy environment in pre and post covid state. By following all these measures, millions of workers lives have changed dramatically. (Brooks et al., Lima et al., 2020). The consequences of covid had its impact on people's well-being, societal status and also the country's economy. (Baker, Bloom, Davis, Terry, 2020). In their research study, they outlined the challenges faced by frontline workers and also the difficulties faced by them. In the research study conducted in the UK on the covid-19 pandemic, the findings were that the workers of the UK are very much concerned about their psychological and financial wellbeing rather than knowing the impact of the virus. The governments have implicated more measures for these community workers who are unaware of the future consequences. (Holmes E A, 2020)

Emotional wellbeing: Exploring their hidden talents

In recent years, much literature has proposed the effect of emotional wellbeing and how it has changed the lives of people. When they spend their time with nature, they have found positive changes in their daily lives. Their interactions with nature make them have healthy well-being. (Mackerron & Mourato, 2013)(Hanson & Jones, 2015) (Gonza & burger, 2017). Ryff and Singer B, (2016) in their interview with the general public, they have said about the six dimensions of good well- being. The six dimensions are Personal growth, self developing, and self growth, finding new opportunities, timely learning practices, and emotional handling. Aguninis & Burgi-Tian, (2021) before this pandemic situation every organization adopted various programs to bring out the talents of their workers but after this crisis, the evaluation for such programs is not questioned. Every individual worker has started to realize, time is one of the most valuable resources for them during this lockdown. Under normal working hours, people focused only on their payroll jobs but after the pandemic, they started to self realize their talents and focused on improving them for self-satisfaction.

Pre- and post-covid-19 wellbeing

Before this covid situation, everyone in the family was running behind something to satisfy the needs of life. More than caring for their own family, people have served other companies and sectors. This pandemic has made a drastic rollover in each individual's life. As we all know, there are many factors of covid are connected with wellbeing. Generally, this pandemic not only affected physical wellbeing but also mental wellbeing. While making various analyses researchers have exclaimed that people have used up to 74% of their daily time at home and the time spent





Vidya Sri and Vasantha

with relatives, outdoors, and meeting friends was 8%. This level of percentage change made people have a positive impact on their wellbeing. Even the people who have been following a very unsystematic life started to do yoga, exercise, gardening; walking and they tend to invest in creating new hobbies. In a recent research study, a housekeeping worker has said “wellbeing for him is, after a heavy work in a day, to take good food and to have a good sleep, gives him the strength of life satisfaction. Few researchers examined Parent relationships with children. They found the time spent with children has increased, due to this the responsibilities they share a way for new beginnings and happiness in their lives. In this changing forum of post covid scenario, everyone needs to take care of their wellbeing more than the pre covid. In the newspaper article published in August 2020, they have interviewed a few housekeeping workers and the information they shared has been discussed here. The world may be under lockdown but they have no option of working from home or family time. Few people have said that they know their role of job and how it is important during this toughest time. They are the people who are in the front-line battle and they cannot afford to miss their work and in addition to that, the people are ready to risk their life for any battle, whether it is a lockdown, rain, or floods.(Source: Times-group and Nation’s health publication of APHA. August 2020)

CONCLUSION

Workers who do 24*7 jobs in maintaining the environment and caring for other people inwards, cleaning, and standing along with emergency workers tend to get affected by covid. They are the people who often miss caring for their well-being. The heart of this article is to make housekeeping and other workers provide awareness and make them understand how important they are too. By caring for themselves, they are investing in caring for a nation. This study also recommends, in these pandemic situations people have to monitor their wellbeing and follow the measures stated by the government along with their way in fighting covid.

REFERENCES

1. Altaf engineer ria J, Gualano Robert L, Crocker Jacquelyn L, Smith Victoria maizes, Andrew weil Esther M, Stenberg (2020), An integrative health framework for wellbeing in the built environment
2. Ambikapathy B & Krishnamurthy K (2020) Mathematical modeling to assess the impact of lockdown on COVID-19 transmission in India. Model development and validation.
3. Bhopal R (2020), covid-19, migrants workers are at risk, BMJ, 369,1673, <https://doi.org/10.1136/bmj.m.1673>
4. Boorman S (2009), Department of Health NHS and wellbeing review improvement framework. London, Department of health.
5. Brooks S K, Webster R K, Smith L E, Woodland L, Wessely S, Greenburg N, and Rubin G J (2020). The Psychological Impact of Quarantine and How to Reduce It: Rapid-Review-of-the-Evidence. *The-Lancet*,-395:912-920. [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30460-8/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30460-8/fulltext)
6. Conger R. D & Elder G. H Jr. (Eds.) (1994).Families in troubles times. Adapting to change in rural America. Hawthorne, NY: Aldine de Gruyter
7. Dodi wirawan Irawanto , Khusunal rofida novianti and Kenny roz (2020),Work from Home: Measuring Satisfaction between Work–Life Balance and Work Stress during the COVID-19 Pandemic in Indonesia
8. Donahue M J, (1985), Intrinsic & extrinsic religiousness. Review analysis. *Journal of Personality & Psychology*, 48(2), 400
9. Gonza G & Burger A (2017). Subjective well-being during the 2008 economic crisis identify of mediating and moderating factors. *Journal of Happiness Studies*, 18, 1763–1797. <https://doi.org/10.1007/s10902-016-9797-yHa>
10. Grover S, Dua D, Sahoo S, Mehra A, Nehra R, and Chakrabarti S (2020). Why all COVID-19 hospitals should have mental health professionals. The importance of mental health in a worldwide crisis. *Asian psychiar*,51,102-147.





Vidya Sri and Vasantha

11. Hanson S & Jones A (2015). Is there evidence that walking groups have health benefits –A systematic review and Meta analysis? *British Journal of Sports Medicine*, 49, 710–715. <https://doi.org/10.1136/bjsports-2014-094157>
12. Herman Aguinis and Jing Burgi-Tian (2021), Talent management challenges during COVID-19 and beyond, Performance management to the rescue. *BRQ Business Research Quarterly* 2021.24:233-240
13. Holmes E A (2020), multi-disciplinary research priorities for the covid-19 pandemic for mental health Science. *Lancet Psychiatry*, 7:547-60, 10.1016/S2215-0366(20)30168-1
14. James Gillen, Aida Santaolalla, Lorena Valdearenas, Clara Salice, and Monsteserrat futse(2020), Impact of the COVID-19 pandemic on the mental health and well-being of UK healthcare
15. Jitender jakhari and Pradip Kharya (2020), Social distancing and Promoting psychological well-being during covid-19 pandemic
16. JuliusOhrnberger, EleonoraFichera, and Mattsutton(2019), The relationship between physical and mental health, A mediation analysis. *Science direct*.
17. Kramer, Amit and Karen Z Kramer (2020), the potential impact of the covid-19 pandemic on occupational stress, work from home, occupational mobility. *Journal of Vocational behavior*-103442.
18. Mac Kerron G & Mourato S (2013). Happiness is greater in natural environments. *Global Environmental Change*, 23, 992–1000 <https://doi.org/10.1016/j.gloenvcha.2013>
19. MD mahbub Hossain , Mariya Rahman, Nusrat Fahmida, Samia Tasnim et al, (2020), Prevalence of anxiety and depression in South Asia during COVID-19, A systematic review and meta analysis
20. Mani A, Mullainathan S., Shafir E, Zhao J (2013), Poverty impedes cognitive function. *Science*, 341 (6149), 976–980.
21. Maunder RG, Leszcz M , and Savage D (2008), Applying the lessons of SARS to pandemic influenza: an evidence-based approach to mitigating the stress experienced by healthcare workers. *Canadian Journal of Public Health* 2008; 99: 486–8
22. Penedo, Frank J, Dahn, and Jason R (2005), Exercise and well-being a review of mental and physical health benefits associated with physical activity. *Journals.lww.com* Volume- 18, issue: 2, page: 189-193.
23. Qian Liu, Dan Luo, Joan E Haase, Qiaohong Guo, Xiao Qin Wang, Shuo Liu, Lin Xia, Zhongchun Liu, Jiong Yang, Bing Xiang Yang, (2020), The experiences of health-care providers during the COVID-19 crisis in China: a qualitative study, *Lancet Global Health* 2020
24. Ramadhani T & Djunaedi S, (2016), Insight: *Journal Bimbingan dan Konseling*, 108 – 115
25. Razieh A et al (2013), the analysis of relationship between self-leadership strategies and components of quantum organization at universities. *International Journal of Academic Research-in Economics and Management Sciences* 2013; 2(5): 192–203
26. Reed J & Ones D. S (2006). The effect of acute aerobic exercise on positive activated affect Ameta-analysis, *Psychology of Sport and Exercise*, 7, 477–514. <https://doi.org/10.1016/j.psychsport.2005.11.003V>
27. Rothstein M A and Coughlin C N (2019) Ensuring compliance with quarantine by immigrants and other groups. *Public health politics. American journal of public health*.109,1179,1183. <https://doi.org/10/2105/AJPH.2019.305201>
28. Ryff and Singer B, (2016), Psychological well-being, measurement and implication of psychotherapy research and psychometrics. Page 14-23
29. Samantha K Brooks, Rebecca K Webster, Louise E Smith, Lisa Woodland, Simon Wessely, Neil Greenberg, Gideon James Rubin-The psychological impact of quarantine and how to reduce it: rapid review of the evidence
30. Sanflippo, (2020), article on how to improve your work life balance-professional-personal life, *Business newsdaily.com*-5244-improve-work life-balance-today
31. Stephen X Zhang Yifei Wang Andreas Rauch Feng Wei,(2020), Health, distress and life satisfaction of people in China one month into the COVID-19 outbreak, FT to NT Article, *THELANCET-D-20-03542- SSRN-id3555216*
32. Tayyiba Wasim, Gule Raana, Natasha Bushra, Anam Riaz, (2020), Effect of covid-19 pandemic on mental wellbeing of healthcare workers in territory care hospital.
33. World Health Organization (2020). Mental Health and Psychosocial Considerations during COVID-19 Outbreak. <https://www.who.int/docs/defaultsource/coronaviruse/mental-health-considerations.pdf>





Vidya Sri and Vasantha

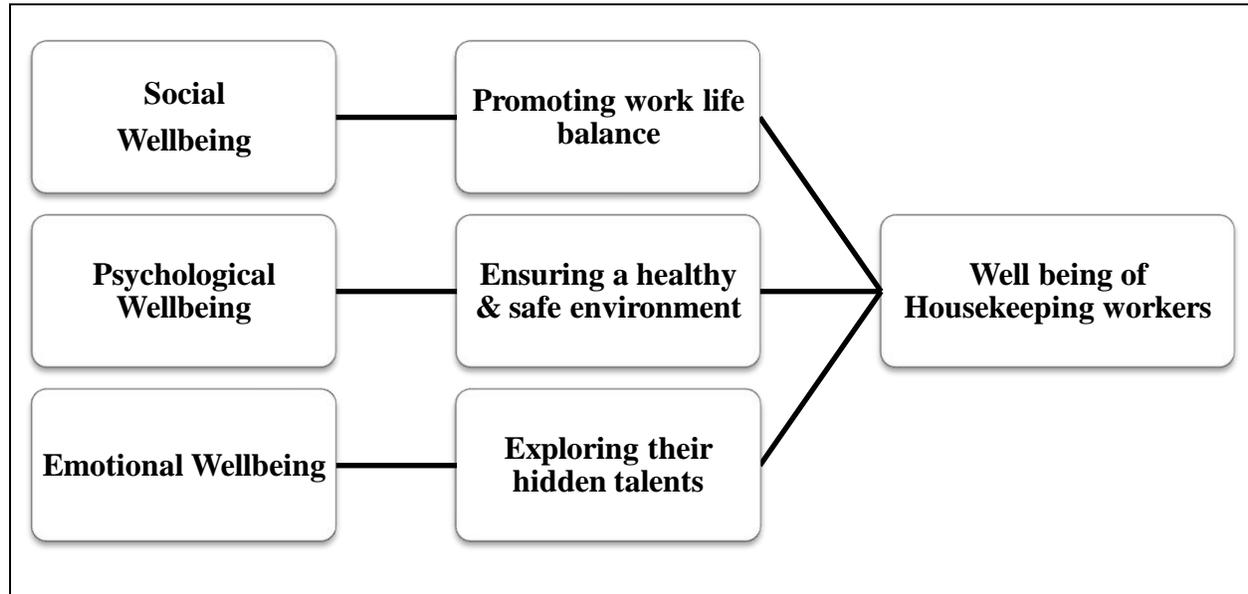


Fig. 1. Conceptual model of housekeeping workers wellbeing during covid-19

They have no work from home option

Railway's sanitary workers defy odds to fight Covid-19

The main services may have been suspended due to the country-wide lockdown, but there is no break for thousands of sanitary workers who are on duty round the clock to keep stations premises, railway colonies and train coaches free of infections in the city.

Besides, more than 900 Central Railway's and over 6000 Western Railway's house-keeping assistants along with hundreds of contract workers are continuously performing their job.

Forty-five-year-old Lakshmi Bhatnagar is part of the CR's team of housekeeping assistants. Posted at GFB Nagar Railway Colony, Bhatnagar has been working with utmost devotion despite the hazards of contracting the coronavirus, say her seniors.

Ever since the lockdown started on March 21, Bhatnagar, who lives in Bangla, has every night her duty. She waits at the bus stop for up to an hour daily and travels 14 km to work at GFB Nagar Railway Colony every day by a State Transport bus.

Bhatnagar ensures the colony is neat and clean and garbage bins are regularly cleaned up, thus helping the residents breathe a clean air.

"For their commitment and sincerity in work in creating a clean environment that helps in fighting the possible infection of the coronavirus," said an officer of CR.

Bhatnagar understands that she has to be punctual and regular in her job in these trying times.

"I know these are difficult times for all of us, but at the same time, I

also know that our job is very important for winning the battle against Covid-19. That is why I decided to continue working come what may," Bhatnagar said.

"Sanitary workers are the ones who see the first line of defence in the battle against the coronavirus pandemic. This is our department, where there is no work from home option. Whether it is inclement weather, transport breakdown or lockdowns, the sanitary workers each afford to miss their work," she said.

Bhatnagar Kumar, senior house-keeping assistant of CR who lives in Badliwala, walks eight km to the bus station every day to reach Kalyan to take another bus for the Bhyrappa station. He leaves his house at 5 am and returns by 7.30 pm.

"Cleaning is a day-to-day job. It can't be stopped under any circumstances. That is why I make sure that I don't miss my duty. I keep the Bhyrappa railway station premises safe by cleaning and disinfecting the premises," said Kumar.

"These workers, motivated by the fact that they can easily fall victim to the coronavirus, are doing a great service to the people. They keep the railway premises, staff quarters and colonies clean and free of germs," said a senior railway official.

"With the invasion of Covid-19, these housekeeping assistants were asked to take all preventive measures while doing their duty. They have been provided with hand gloves, masks and soaps and other things needed to keep them protected. There are the real heroes of battle against Covid-19," said Naveen Kumar, chief public relations officer of Central Railway.

Meat packers, retail workers sickened

Essential workers facing higher risks during COVID-19 outbreak

COORDINATED WORK against COVID-19 between health officials in northern Utah and a local meatpacking plant began in early March — before any confirmed cases in the area. By the end of May, at least 287 of the plant's employees had been infected.

"But we believe the actual number of cases linked to the facility is likely higher," Josh Greer, public information officer at Deer River Health Department in Logan, Utah, told *The Nation's Health* in June. "Trying to trace each case is becoming less and less realistic."

Typical working conditions inside meatpacking plants make the perfect setting for coronavirus spread. Employees work close together; they breathe heavily while doing physically intense, high-speed

See WORKER SAFETY, Page 16

Employees work on pork at a meat processing facility in St. Joseph, Missouri, in 2017. As of June, nearly 28,000 COVID-19 cases and 100 deaths were tied to U.S. meatpacking plants.

Care threatened

Oral health working to protect staff, patients from pandemic

DENTISTRY IS a messy job. From scraping plaque to removing cavities, procedures send saliva, contaminated water and bacteria from patient mouths into the air.

And during the COVID-19 pandemic, those routine practices make dentistry an increasingly high-risk occupation.

"Almost everything done in the chair produces aerosols," said Joseph Craig Wolfe, PhD, RDH, CRRS, chair of APHA's Oral Health Section and director of oral health at the Texas Health Institute. "There is a tremendous amount of risk there, and providers have had to adjust practice based off a

See DENTAL CARE, Page 18

Fig2: Recent reports on Well-being





Enhanced Supply Chain Management of Agriculture Industries using Blockchain Technology

R. Anitha^{1*} and Dinesh Rai²

¹Research Scholar Sushant University, Gurugram, Haryana, India.

²Associate Professor, Sushant University, Gurugram, Haryana, India.

Received: 04 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

R.Anitha

Research Scholar,

Sushant University,

Gurugram, Haryana, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The value chain digitisation has entirely changed the way of transactions in every business industry, and it is no different in the case of the agricultural industry. However, ICT is also not free from bias regarding use of collected data along with the process of data collection. . It is worth noting that it is the largest producer of rice, pulses, wheat, spice products and spices. Middle men play a crucial role in breaking the communication between farmers and the consumers related to price, supply, and stock of any agricultural product. In all spheres of the economy and businesses, supply chain management always plays the most important role by using specific processes to connect the requirements of the consumers with the producer through a specific chain. Food supply chain has become more complex in this age of intense competition due to globalisation with food traceability, food quality and safety. Agricultural industry is ready to get the opportunity to utilise blockchain in every aspect, including maintaining transparency in the food supply chain. It also helps in the procedure of handling weather fluctuations and optimizations of fertilisers, labours, and water.

Keywords: Working, blockchain, food, safety, agricultural

INTRODUCTION

The value chain digitization has entirely changed the way of transactions in every business industry, and it is no different in the case of the agricultural industry. Agricultural business transactions have also gone through a visible change with the hands of Quick Response (QR) and Radio-Frequency Identification across the value chain. In this specific place, block chain plays a critical part as an emerging technology to address the gap regarding deceptive data in transactions while keeping records and conducting verification. This technology increases traceability, improves logistics and food safety practices. Hence, the conference paper focuses on presenting the usage of block

45352



**Anitha and Dinesh Rai**

chain technology in improving supply chain management in the agriculture industry. Food supply chain, e-commerce of agricultural products, and smart agriculture are the areas that will be analyzed and presented through the lens of block chain.

From ICT to Block chain

Information and Communication Technology (ICT) helps in using data and information for the agriculture sector to improve sustainability along with productivity. However, ICT is also not free from bias regarding use of collected data along with the process of data collection. ICT operations always work on the way of using data as per the interests of individuals as per their own. However, block chain has saved the scenario by meeting the gap in decision-making that only results in creating supply chain expertise. A peer-to-peer network of block chain helps to manage the entire process of generating a product or service along with transacting it and consuming it by its end-users (Li *et al.* 2020). The entire process is done through the ledger system of the block chain verified by the network itself. Alteration to the recorded data is all about following the consensus decision-making protocol without violating the interests of any party. Hence, it is a transformative system of ICT that has the potentiality to revolutionize the process of using data in the agriculture industry to provide a better experience to the consumers and the farmers simultaneously.

Potential Block chain Technology and Benefits for Agriculture

There is no need for a middleman in the agriculture sector at the time of using block chain to complete tasks of peer-to-peer transactions transparently. Trust is everything in any business, and block chain ensures the trust among the parties at the time of transaction in the agriculture sector that is the backbone of a country such as India with 18% of its Gross Domestic Product along with the employment of the 50% of the workforce in the country (Borah *et al.* 2020). From the producer that is the farmer down to the end-users, the supply chain in India is full of inefficient intermediaries. It is worth noting that it is the largest producer of rice, pulses, wheat, spice products and spices. Middle men play a crucial role in breaking the communication between farmers and the consumers related to price, supply, and stock of any agricultural product. It is also an undeniable fact that the Government initiated many planning and management techniques, including Advanced Supply Chain Planning and Optimization, and Enterprise Resource Planning along with Material Requirement Planning (Niknejadet *et al.* 2021). However, these efforts did not work well to meet the gap regarding centralized authority, trust, and transparency in this industry. Block chain technology is the new place of hope to bridge the gap between the farmers and consumers by eliminating the middle men with extreme profit. Block chain is a decentralized Distributed Ledger Technology that stores data without tampering it. It is a completely new approach to store and transmit data with great potentiality for the agriculture business by helping consumers and the farmers efficiently (Jothikumar, 2021). Combining cryptography of block chain is undoubtedly helpful for guaranteeing permanence and integrity of data. The features of block chain technology are very much attractive that include decentralization, query, and immutability, along with customized approach.

Decentralization

The peer-to-peer network does not leave any point of control and failure, it is all about decentralized control regarding federation of voting nodes.

Query

Block chain provides the opportunity to write any query that can be run to search any stored data related to assets, transactions, blocks, and metadata (Niknejadet *et al.* 2021).

Immutability

It is not only about tamper-resistance when it comes to storing any data through block chain it is also about undeletable and unchangeable data (Jothikumar, 2021).

Customizable

**Anitha and Dinesh Rai**

True decentralization is happening in this block chain system in the agriculture industry due to the design of a public network with transparency, permissions, and transactions along with custom assets.

Application of Block chain in Supply Chain

In all spheres of the economy and businesses, supply chain management always plays the most important role by using specific processes to connect the requirements of the consumers with the producer through a specific chain. The chain is important from every perspective whether it is any other business or agriculture industry. However, the agriculture supply chain system is also full of problems such as lack of transparency in the whole chain as the chain is the important factor in transiting goods and rampant corruption among the middlemen. Lack of accountability is required to be addressed efficiently through the envision of using block chain enabled systems to manage the whole supply chain in agriculture business (Mukherjee *et al.* 2021). Decentralized distributed ledger Technology is the key factor in the process of decentralizing the data and management of the data through tracking and tracing the origin of food products without facing any problem. Internet-of-Things (IoT) devices will also be used to improve the usability of the products in the supply chain along with the improved traceability.

Smart Agriculture

Underlying systems regarding agriculture and the block chain lie in the case of managing the natural resources when it comes to supporting all forms of farming. Products, data, and information flow simultaneously adding values from inputs to output while financial flow follows inputs and output. Machine learning sensors play a crucial role in managing the various modern data collection and IoT to establish smart agriculture to develop a comprehensive security system (Khan *et al.* 2022). Most importantly, crop and food production is a crucial area of getting improved profits even under unfavorable environmental conditions. Increasing population requires more food with minimal resources along with the need for reducing environmental footprint. Along with that, ensuring fair income to farmers is a great issue in the field of agriculture, and the block chain technology is promising to resolve the problem by enabling transparency all across the supply chain. Handling weather fluctuations has become a crucial factor in conducting agricultural business efficiently. Farming resources such as fertilizers, labour, and water are optimized through the sustainable practice in this industry, and this aspect has become possible only because of block chain technology.

Food Supply Chain

Food supply chain has become more complex in this age of intense competition due to globalization with food traceability, food quality and safety. At the same time, the supply chain inefficiency is a greater problem to maintain the trust regarding food (Khan *et al.* 2022). These factors affect the health of people along with the economy and social life. In this specific place, block chain plays a crucial role in establishing trust between the consumers and the producers. This technology provides an opportunity to the enterprises in the agriculture industry to add value to the consumers with the products along with increasing the relevance and competitiveness in the industry. The perspectives of the consumers will remain reliable and true to the available transaction along with providing environment friendly food that is safe for the people. The interaction between the consumers and the producers becomes easy with the convenient approach of the block chain. At the same time, the support from the consumers also helps in completing the task of strengthening the confidence and trust among the consumers regarding food safety (Niknejadet *et al.* 2021). From the perspective of regulatory agencies, it also becomes easy for the government to imply regulations efficiently due to availability of information more efficiently. It is worth noting that, even in the early stage of using block chain in the food supply chain for the characteristics of decentralization, security, and transparency. Hence, all the parties, including government regulatory bodies, consumers, and producers have the opportunity to get benefits from the usage of block chain.

E-Commerce of Agriculture Products

Trade of agricultural products online is not easy due to having less information regarding the production and the supply chain of the product on e-commerce websites. The basic information regarding the product from the agricultural industry is not trusted by the consumers all the time, and the logistics service along with the cash on



**Anitha and Dinesh Rai**

delivery system are not reliable for the consumers in this business. In such a condition, e-commerce retailers face problems related to operating costs for time-consuming orders for small amounts of deliveries. This aspect becomes easy with the resiliency, automation, validation, and aggregation of block chain technology, and it becomes easy for the household producers to become a part of the e-commerce and selling products directly to the consumers by getting the confidence back from the end-users along with developing customer loyalty through the decentralization of the data (Xiong *et al.* 2020). It is with noting that, the need for wide research is increasing with the relevance of the development of the services in the analysis process of the multitude of different solutions and benefits. Initiation of smart contracts, digital mode authentication, management of records, and electronic voting along with tracking items are the key aspects of e-commerce business, and all these areas are well covered with the fault tolerance and transparency of organizations through block chain in the agriculture industry. Therefore, the transparency, trust, and efficiency in working processes are the key aspects of block chain in the agriculture industry that help producers to reach the consumers through the path of farms to groceries (Mukherjee *et al.* 2021). Most importantly, food safety and improved quality control are the two crucial parts in using block chain in the agriculture industry with the ability to weed out counterfeits in supply chains of this industry along with the agri-food production.

CONCLUSION

Agricultural industry is ready to get the opportunity to utilize block chain in every aspect, including maintaining transparency in the food supply chain. It also helps in the procedure of handling weather fluctuations and optimizations of fertilizers, labors, and water. Maintaining the trust in food and supplies only help in the improvement of social and economic structure. Adding value to the consumers and the relevance of competitiveness of the industry when it comes to utilizing transparency, security, and decentralization of the block chain technology. E-commerce of agriculture products is another important place that gains advantages from this technology to deliver a better service to the consumers. Most importantly, the producers, that is the farmers in this industry, have the opportunity to reach the consumers directly with the safety of the block chain without the fear of violation of data due to the middle men.

REFERENCES

1. Borah, M.D., Naik, V.B., Patgiri, R., Bhargav, A., Phukan, B. and Basani, S.G., 2020. Supply chain management in agriculture using blockchain and IoT. *Advanced applications of blockchain technology*, 25(2)pp. 227-242.
2. Jothikumar, R., 2021. Applying blockchain in agriculture: a study on blockchain technology, benefits, and challenges. *Deep Learning and Edge Computing Solutions for High Performance Computing*, 25, pp. 167-181.
3. Khan, H.H., Malik, M.N., Konečná, Z., Chofreh, A.G., Goni, F.A. and Klemeš, J.J., 2022. Blockchain technology for agricultural supply chains during the COVID-19 pandemic: Benefits and cleaner solutions. *Journal of Cleaner Production*, 347, p.131268.
4. Li, X., Wang, D. and Li, M., 2020. Convenience analysis of sustainable E-agriculture based on blockchain technology. *Journal of Cleaner Production*, 271, p.122503.
5. Mukherjee, A.A., Singh, R.K., Mishra, R. and Bag, S., 2021. Application of blockchain technology for sustainability development in agricultural supply chain: justification framework. *Operations Management Research*, pp.1-16.
6. Niknejad, N., Ismail, W., Bahari, M., Hendradi, R. and Salleh, A.Z., 2021. Mapping the research trends on blockchain technology in food and agriculture industry: A bibliometric analysis. *Environmental Technology & Innovation*, 21, p.101272.
7. Xiong, H., Dalhaus, T., Wang, P. and Huang, J., 2020. Blockchain technology for agriculture: applications and rationale. *frontiers in Blockchain*, 3, p.7.





A Systematic Literature Review on TQM Practices in SMEs- The Road Travelled

Asic Ali Saiboudin I^{1*} and B.Rajeswari²

¹Research Scholar, Department of Management Studies, Pondicherry University, India

²Associate Professor, Department of Management Studies, Pondicherry University, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Asic Ali Saiboudin I

Research Scholar,

Department of Management Studies,

Pondicherry University, India

Email: asicalisaiboudin@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of this paper is to provide a systematic review about the impact of TQM on Organizational Performance. Continuous improvement (CI), Training and Development (T&D) for the workforce, Total employee empowerment and Quality driven culture are considered for the study. TQM as an integrated cum holistic approach is aimed at integrating all the functional systems of the organization with a view to achieve established organizational objectives. The systematic literature review methodology proposed by (Tranfield, 2003) is followed in this paper. TQM as an approach aims at nurturing employees to become self-driven, motivated and empowering them to be more productive by developing their skill sets for sustainability. This paper will aid researchers irrespective of their discipline of study to understand and implement Systematic Literature Review methodology. This article is an attempt to utilize Systematic Literature Review Methodology along with network visualization with VOS viewer.

Keywords: Total Quality Management (TQM), TQM practices, Quality Management Tools, Network Visualization, VOS viewer, Systematic Literature Review.

Paper Type: Review Paper.

INTRODUCTION

Quality planning consists of developing the products and processes required to meet customer's needs." – Joseph Juran. Total Quality Management (TQM) has transformed as a key tool for corporate managements to sustain in the global market (Toke & Kalpande, 2021) and it has a significant association with organizational performance specifically in the industrial sector (Iqbal et al., 2018). The TQM philosophy is considered as a holistic approach for integrating all organizational functions to achieve the organizational objectives (V. Kumar et al., 2009). TQM

45356



**Asic Ali Saiboudin and Rajeswari**

concentrates on constructing a quality culture in the organization where each and every contributor(s) ultimate goal is customers' delight(Alghamdi, 2016). Several studies have revealed that TQM is a strong predictor for boosting organizational performance and proves that there is a strong association between TQM practices and Organizational Performance(Prajogo & Brown, 2004).As a matter of fact, Quality Management Initiatives(QI) has extended its hand for Small Medium Enterprise's(SME's) to remain supreme by providing competitive advantage over other market players after globalization(Fening, 2012). It is done for the benefit of SME's since they are the backbone of strong and Successful economy(Alkhoraif et al., 2019). Organizational performance (OP) indicates an organization's effectiveness in achieving its goal (Amhalhal et al., 2022). TQM focuses on nurturing an environment where every concerned party will toil together for performance improvement. It supports the fact that "Committing employees alone for performance improvement is unfair and insufficient"(Yazdani, 2022).For a successful long run, focus on customers and concern on long-term supplier relationships are inevitable for Quality Improvement which has an adverse effect on OP(Bagodi et al., 2020),(Lepistö et al., 2022).

The prominent players such as IBM, Toyota, British Airways and Rank Xerox etc., who are the frontier large business houses have been keenly evolving through adoption of key management philosophies which includes TQM implementation(Yusof & Aspinwall, 2000), (Rao et al., 1997). On contrary, their suppliers (Small businesses) lack pace in keeping momentum and are not capable of achieving/receiving the attention they deserve(Kureshi et al., 2009). Whereas, the pertinent efforts made by their customers (large companies) will be succumbed if those smaller companies are not following them in the race(Cetindere et al., 2015). Implementation and progression of TQM practices in both Large businesses and Small business should be in a synchronized state and has to go hand in hand for sustaining their collective efforts(Yusof & Aspinwall, 2001).The prominent Japanese companies achieved excellence in the pursuit of Quality by implementing a handful of Quality Management (QM) systems, tools and techniques in the manufacturing SME's sector through their QI(Georgiev & Ohtaki, 2019). TQM as a new approach or a familiar/popularized approach for a company can reap benefits if they ensure that each and every stakeholder possess knowledge and awareness of its concepts, objectives, values, principles, tools and techniques for its successful implementation(Talib et al., 2011).Even though there are more studies on TQM that deals with emergence and application of key TQM practices, Leadership and Management role in TQM implementation, Relationship, Model and Framework development, very meagre studies have been done with relevance about its impact on OP.

SYSTEMATIC LITERATURE REVIEW

The Systematic Literature Review (SLR) methodology proposed by (Tranfield, 2003)where the authors originally evaluate the process of this SLR in the field of medical sciences is employed in this paper. In this paper, an attempt was made to extend the use of systematic literature review that can be applied in the management field for enhancing knowledge for context sensitive research. It comprises of three stages viz., Planning, Conducting and Reporting(&Dissemination) of the review. It is shown in the Figure 1 below. The planning stage has three phases. The first two phases in planning stage focuses on identifying the need and preparing a proposal for the review (It was done in the "Introduction" stage) and the final phase aims at developing a review protocol.

The conducting stage proceeds with identifying the right sources for extracting the required/relevant papers. The prominent data sources such as Journal Storage (JSTOR), Emerald, Science direct, Inderscience, IEEE, Web of Science World Public Library, EBSCO (Academic Source and Business Source Premier), Taylor & Francis, Springer, Pro Quest Wiley were sought. Key words used to search in these journals: Total Quality Management and Organizational performance, TQM and Organizational performance, TQM and OP, TQM and OP in India, TQM and OP Indian MSME Sector, MSME and TQM implementation, TQM and Lean Six Sigma, Lean Six- Sigma and OP, Indian Manufacturing and Service firms. TQM and Quality Improvement, Quality initiatives and TQM, Quality initiatives and Organizational Performance. A total of 219 relevant papers were found and they are screened using their Title, Abstract and Key words. It helped to identify and remove the papers that are repeated/duplicated. Succeeding this, we had 107 articles of which all the abstracts were scrutinized on the inclusion/exclusion criteria basis. Then, all of the remaining 70 articles were read following the preceding criteria. The articles that are listed in the reference list were read for improving search criteria. The breakdown of this process is explained in the Fig.1.



**Asic Ali Saiboudin and Rajeswari****ANALYSIS AND FINDINGS****Descriptive analysis.**

The selected papers (70) were considered eligible for carrying out a descriptive analysis. The year wise distribution of Articles is explained in the following Fig.2. Year wise distribution of Publication. Fig.2 exhibits year wise distribution of articles and it pinpoints that there is a clear surge can be seen in no of articles published after the year 2016. Among the 70 articles that have been selected for the study, 45 of them (>64%) were published between the years 2016-2021 which indicates a spike in publications during this period. A total of 16 articles (>23%) were published in 2018, which is the most followed by the year 2019 with 12 articles (>17%) and a total of 5 articles each (>14%) were published in the years 2016 and 2020. The article with most citation (776) was published in the year 1996.

Ten highly cited Articles

Ten highly cited articles among the 70 selected articles were studied and it is explained in the Table.1 below. As stated earlier, the article published in the year 1996 with title "Total Quality Management in SMEs" authored by (Ghobadian & Gallea, 1996) leads the chart with a massive 776 citations closely followed by the paper titled "Critical success factors for TQM implementation and their impact on performance of SMEs" by (Ismail Salaheldin, 2009) having a total of 641 citations and succeeded with a large margin by its next close competitor titled and authored by (Lakhal et al., 2006) "Quality management practices and their impact on performance" with 526 citations. The article "Impact of TQM on company's performance" authored by (V. Kumar et al., 2009) stands in fourth place with 398 citations under its belt and the article by (Gadenne & Sharma, 2009) titled "An investigation of the hard and soft quality management factors of Australian SMEs and their association with firm performance" stands fifth with 285 citations under its name. The citations details are extracted from Google Scholar as on 21-07-2022.

Count of Papers by Publisher

Fig.3 depicts that Emerald publishing limited is leading the chart by 28 papers, followed by Science direct with 20. Taylor and Francis have 9 papers while Inder Science and Springer has 6 papers equally split between them. Chalmers (CPL), DOAJ, IJARM, Research Gate, Qurtuba University Press, In tech Open, and TJPRC have 1 paper each. It shows 57 out of 70 papers (~ 82%) were published in Emerald, Science Direct and Taylor & Francis.

Geographical distribution of Articles

Fig.4 depicts about the geographical distribution of the articles where the study has been conducted. There are instances where the authors have done a trans-national study by comparing the practices that are followed in their country with another country {e.g.(Rao et al., 1997)} or entirely in another/away from their country{e.g.(Hilman et al., 2019)}. From the fig.5, it is observed that majority of the study (15 Papers) were conducted in context with Indian Industry, followed by UK (with 7) and Pakistan (6 Papers).

Articles distribution by no of authors

It shows that most no of articles (26) were authored by exactly 2 of them. It is closely followed by 3 authors having a count of 24 articles. A maximum no of 7 authors have published in 2 different papers, followed by a paper having 6 authors. A total of 10 papers were published by single author, while publications with 4 authors and 5 authors were having 4 papers and 3 papers respectively.

Distribution of Articles by Organization type

Fig.6 portrays distribution about the type of organization for all the papers selected for the study. It is evident that majority of the organization falls under Production/Manufacturing sector where 34 papers (>48%) were published. 7 papers (10%) were published under Service sector category and the remaining 29 papers (>41%) included both Manufacturing and Service sectors.



**Asic Ali Saiboudin I* and B.Rajeswari²****Time period of Publication**

The selected 64 papers were grouped into five different groups based on its time period of publication which are mentioned in the Table.2 below.

Network Visualization

For visualizing the bibliometric connection between the articles, VOS viewer has been used. It is a software interface for constructing networks based on citation, co-citation, co-authorship and bibliographic coupling. Then it establishes a network that connects and visualizes bibliometric networks. The networks may be sources from researchers' data about publications, journals, articles and extends a mighty hand for text mining functionality which is aimed at constructing co-occurrence networks of terminologies extracted from scientific body of literature. In this paper, we used bibliographic data that includes keyword co-occurrence, citation, bibliographic coupling and co-citation for analyzing and developing clusters. The details are extracted from all the 219 papers that are considered for the study through Scopus and EBSCO. Then it resulted the following figure 7. Fig.7 indicates that the no of interactions with the word Total Quality Management is predominantly higher than the other words that are present in the cluster. It is denoted by the largest node with largest circumference in the network. The spatial cluster diagram explains that the size of each node is weighted based on their interconnection, and it is directly proportional to the number of occurrences. Thicker the line, interconnectivity is more and vice-versa. It can be observed from the fig.7, that the word TQM has a strong connection with other words such as SMEs, Quality Control, Organizational Performance and Strategic Planning. Fig.8 portrays about the cluster association between TQM and Organizational Performance. This cluster provides a better view to relate both of the constructs as they are mainly focusing on the interactions such as SMEs, Quality Assurance, Performance, Quality Control, Entrepreneurial orientation with several others that are evident.

DISCUSSION

This article has studied TQM and its impact on Organizational performance. And it has identified that the management practice/concepts/factors are vital for implementing the TQM factors and to achieve optimal results(Lakhal et al., 2006), (Ismail Salaheldin, 2009). Continuous improvement and training, total employee involvement and empowerment and quality driven culture are considered as the key underpinnings for the concept of TQM approach and it was considered as a revolution in the field of Management(Vouzas& Psychogios, 2007). TQM professes and empowers employees to become more productive, efficient, motivated and satisfied to do their job. It also ensures that they are able to nurture their skills in order to sustain in the future(Sony et al., 2020). Quality performance and Quality improvement is the ultimate goal of every TQM process which in turns aids in achieving expected Organizational outcomes. Whenever a new system is introduced in the organization, all the employees are expected to adapt accordingly. There will be a change in their roles, which requires training for meeting new performance standards which in turn will pave way for an overall cultural change in the organization (Nasim, 2018). But, There is a clear void between awareness about the TQM techniques and its implementation in their business(Psomas & Jaca, 2016),(Kureshi et al., 2009) which cramps the expected results(M. Kumar & Antony, 2008),. It is essential for enterprises to monitor the proper implementation and progress of TQM practices and its impact on business/organizational performance(Youssef et al., 2014).

CONCLUSION

A renowned stalwart in the field of Quality Management Philip B. Crosby states "Quality is the result of a carefully constructed cultural environment. It has to be the fabric of the organization, not part of the fabric". Implementing TQM practices in an organization is fruitful when all the stakeholders involved in the process are in a synchronized state i.e aware and well informed. Several studies have revealed that the penultimate reason for failure/ setback is caused by improper methodology adopted, lack of knowledge and understanding, inadequate resources,



**Asic Ali Saiboudin and Rajeswari**

miscommunication and more importantly lack of consistent teamwork with good leadership. In a nutshell, Leadership and Education has a strong association with the results that defines a successful TQM implementation. Organizations should navigate their concern for providing proper education, training and support for employees about Quality and should monitor their progress for effective TQM implementation under the guidance of Top Management. Organizations should desire to improve their performance through emphasis on effective TQM implementation, so that they can attain their desired results/ outcomes and can propel forward for epitome of perfection.

REFERENCES

1. Alghamdi, H. (2016). Toward Better Understanding of Total Quality Management (TQM). *Journal of Business & Economic Policy*, 3(4), 29–37. www.jbepnet.com
2. Alkhorairif, A., Rashid, H., & McLaughlin, P. (2019). Lean implementation in small and medium enterprises: Literature review. *Operations Research Perspectives*, 6(December 2018), 100089. <https://doi.org/10.1016/j.orp.2018.100089>
3. Amhalhal, A., Anchor, J., Papalexi, M., & Dastgir, S. (2022). Organisational performance and the use of multiple performance measures in an emerging market. *International Journal of Quality and Reliability Management*, 39(1), 236–257. <https://doi.org/10.1108/IJQRM-04-2019-0107>
4. Bagodi, V., Thimmappa Venkatesh, S., & Sinha, D. (2020). A study of performance measures and quality management system in small and medium enterprises in India. *Benchmarking*, 28(4), 1356–1389. <https://doi.org/10.1108/BIJ-08-2020-0444>
5. Cetindere, A., Duran, C., & Yetisen, M. S. (2015). The effects of total quality management on the business performance: An application in the province of Kütahya. *Procedia Economics and Finance*, 23(October 2014), 1376–1382. [https://doi.org/10.1016/s2212-5671\(15\)00366-4](https://doi.org/10.1016/s2212-5671(15)00366-4)
6. Fening, F. A. (2012). Impact of Quality Management Practices on the Performance and Growth of Small and Medium Sized Enterprises (Smes) in Ghana. *International Journal of Business and Social Science*, 3(13), 1–13.
7. Gadenne, D., & Sharma, B. (2009). An investigation of the hard and soft quality management factors of Australian SMEs and their association with firm performance. *International Journal of Quality and Reliability Management*, 26(9), 865–880. <https://doi.org/10.1108/02656710910995064>
8. Georgiev, S., & Ohtaki, S. (2019). Critical success factors for TQM implementation among manufacturing SMEs: Evidence from Japan. *Benchmarking*, 27(2), 473–498. <https://doi.org/10.1108/BIJ-01-2019-0037>
9. Ghobadian, A., & Gallea, D. N. (1996). Total quality management in SMEs. *Omega*, 24(1), 83–106. [https://doi.org/10.1016/0305-0483\(95\)00055-0](https://doi.org/10.1016/0305-0483(95)00055-0)
10. Hilman, H., Ali, G. A., & Gorondutse, A. H. (2019). The relationship between TQM and SMEs' performance: The mediating role of organizational culture. *International Journal of Productivity and Performance Management*, 69(1), 61–84. <https://doi.org/10.1108/IJPPM-02-2019-0059>
11. Iqbal, T., Huq, F., & Bhutta, M. K. S. (2018). Agile manufacturing relationship building with TQM, JIT, and firm performance: An exploratory study in apparel export industry of Pakistan. *International Journal of Production Economics*, 203(August 2017), 24–37. <https://doi.org/10.1016/j.ijpe.2018.05.033>
12. Ismail Salaheldin, S. (2009). Critical success factors for TQM implementation and their impact on performance of SMEs. *International Journal of Productivity and Performance Management*, 58(3), 215–237. <https://doi.org/10.1108/17410400910938832>
13. Kumar, M., & Antony, J. (2008). Comparing the quality management practices in UK SMEs. *Industrial Management & Data Systems*, 108(9), 1153–1166. <https://doi.org/10.1108/02635570810914865>
14. Kumar, V., Choisine, F., De Grosbois, D., & Kumar, U. (2009). Impact of TQM on company's performance. *International Journal of Quality and Reliability Management*, 26(1), 23–37. <https://doi.org/10.1108/02656710910924152>
15. Kureshi, N. I., Mann, R., Khan, M. R., & Qureshi, M. F. (2009). Quality management practices of SME in



**Asic Ali Saiboudin and Rajeswari**

- developing countries: a survey of manufacturing SME in Pakistan. *Journal of Quality and Technology Management*, V(11), 63–89. https://www.researchgate.net/profile/Nadeem_Kureshi/publication/255823005_Quality_Management_Practices_of_SME_in_Developing_Countries_A_Survey_of_Manufacturing_SME_in_Pakistan/links/0deec520c4edd4220d000000/Quality-Management-Practices-of-SME-in-Developin
16. Lakhali, L., Pasin, F., & Limam, M. (2006). Quality management practices and their impact on performance. *International Journal of Quality and Reliability Management*, 23(6), 625–646. <https://doi.org/10.1108/02656710610672461>
 17. Lepistö, K., Saunila, M., & Ukko, J. (2022). The impact of certification on the elements of TQM exploring the influence of company size and industry. *International Journal of Quality and Reliability Management*, 39(1), 30–52. <https://doi.org/10.1108/IJQRM-11-2020-0362>
 18. Nasim, K. (2018). Role of internal and external organizational factors in TQM implementation: A systematic literature review and theoretical framework. *International Journal of Quality and Reliability Management*, 35(5), 1014–1033. <https://doi.org/10.1108/IJQRM-10-2016-0180>
 19. Prajogo, D. I., & Brown, A. (2004). The Relationship between TQM Practices and Quality Performance and the Role of Formal TQM Programs: An Australian Empirical Study. *Quality Management Journal*, 11(4), 31–42. <https://doi.org/10.1080/10686967.2004.11919131>
 20. Psomas, E. L., & Jaca, C. (2016). The impact of total quality management on service company performance: evidence from Spain. *International Journal of Quality and Reliability Management*, 33(3), 380–398. <https://doi.org/10.1108/IJQRM-07-2014-0090>
 21. Rao, S. S., Raghunathan, T. S., & Solis, L. E. (1997). A comparative study of quality practices and results in India, China and Mexico. *Journal of Quality Management*, 2(2), 235–250. [https://doi.org/10.1016/s1084-8568\(97\)90005-5](https://doi.org/10.1016/s1084-8568(97)90005-5)
 22. Sony, M., Naik, S., & Antony, J. (2020). Lean Six Sigma and social performance: A review and synthesis of current evidence. *Quality Management Journal*, 27(1), 21–36. <https://doi.org/10.1080/10686967.2019.1689799>
 23. Talib, F., Rahman, Z., & Qureshi, M. N. (2011). Assessing the awareness of total quality management in Indian service industries. *Asian Journal on Quality*, 12(3), 228–243. <https://doi.org/10.1108/15982681111187074>
 24. Toke, L. K., & Kalpande, S. D. (2021). Strategic planning to investigate the decision index of organization for effective total quality management implementation – in context of Indian small and medium enterprises. *Journal of Engineering, Design and Technology*. <https://doi.org/10.1108/JEDT-11-2020-0447>
 25. Tranfield, D. et al. (2003). *British J of Management - 2003 - Tranfield - Towards a Methodology for Developing Evidence-Informed Management Knowledge by.pdf*. *British Journal of Management*. <https://doi.org/https://doi.org/10.1111/1467-8551.00375>
 26. Vouzas, F., & Psychogios, A. G. (2007). Assessing managers' awareness of TQM. *TQM Magazine*, 19(1), 62–75. <https://doi.org/10.1108/09544780710720844>
 27. Yazdani, B. (2022). TQM, employee outcomes and performance: the contingency effect of environmental uncertainty. *International Journal of Quality and Reliability Management*, 39(2), 647–672. <https://doi.org/10.1108/IJQRM-04-2018-0090>
 28. Youssef, M. A., Youssef, E. M., & Saleh, F. (2014). Quality management practices: An international perspective. *International Journal of Services and Operations Management*, 19(1), 1–28. <https://doi.org/10.1504/IJSOM.2014.064032>
 29. Yusof, S. M., & Aspinwall, E. (2000). Conceptual framework for TQM implementation for SMEs. *TQM Magazine*, 12(1), 31–36. <https://doi.org/10.1108/09544780010287131>
 30. Yusof, S. M., & Aspinwall, E. (2001). Case studies on the implementation of TQM in the UK automotive SMEs. *International Journal of Quality and Reliability Management*, 18(7), 722–743. <https://doi.org/10.1108/02656710110396058>





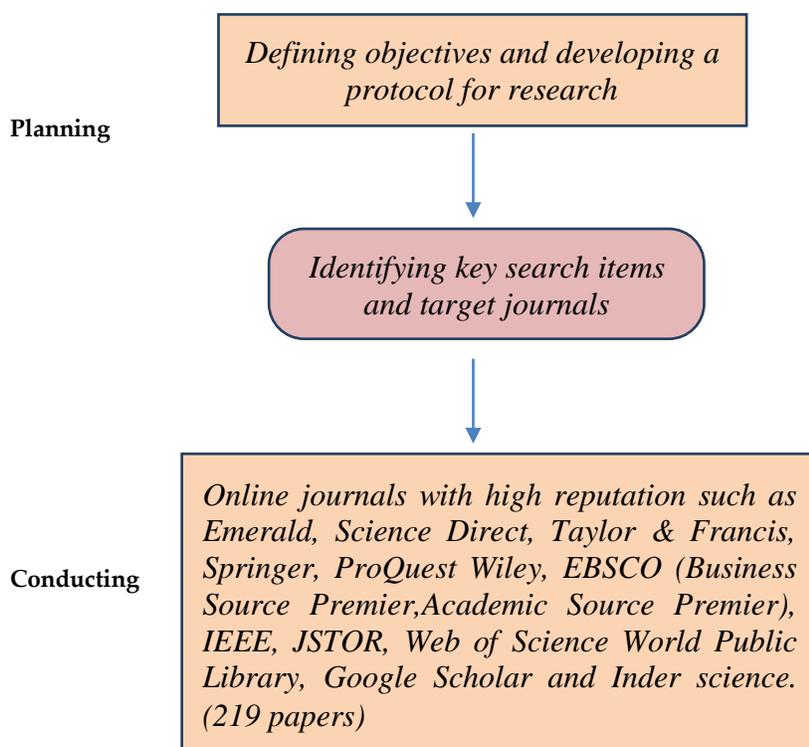
Asic Ali Saiboudin and Rajeswari

Tab.1 Ten Highly cited articles. (Google Scholar citation as on 21-07-2022)

| S. No | Title | No of Citations |
|-------|---|-----------------|
| 1 | Total Quality Management in SMEs | 776 |
| 2 | Critical success factors for TQM implementation and their impact on performance of SMEs | 641 |
| 3 | Quality management practices and their impact on performance | 526 |
| 4 | Impact of TQM on company's performance | 398 |
| 5 | An investigation of the hard and soft quality management factors of Australian SMEs and their association with firm performance | 285 |
| 6 | Comparing the quality management practices in UK SMEs | 252 |
| 7 | Assessing managers' awareness of TQM | 248 |
| 8 | The Relationship between TQM Practices and Quality Performance and the Role of Formal TQM Programs: An Australian Empirical Study | 195 |
| 9 | The effect of TQM on organizational performance: empirical evidence from the textile sector of a developing country using SEM | 181 |
| 10 | A conceptual framework for TQM implementation for SMEs | 175 |

Table 2. Time period wise distribution of Publications

| S. No | Period of Publication (Year) | No of papers published in the period |
|-------|------------------------------|--------------------------------------|
| 1 | 1996-2000 | 3 |
| 2 | 2001-2005 | 2 |
| 3 | 2006-2010 | 8 |
| 4 | 2011-2015 | 13 |
| 5 | 2016- Present | 44 |
| Total | | 70 |





Asic Ali Saiboudin and Rajeswari

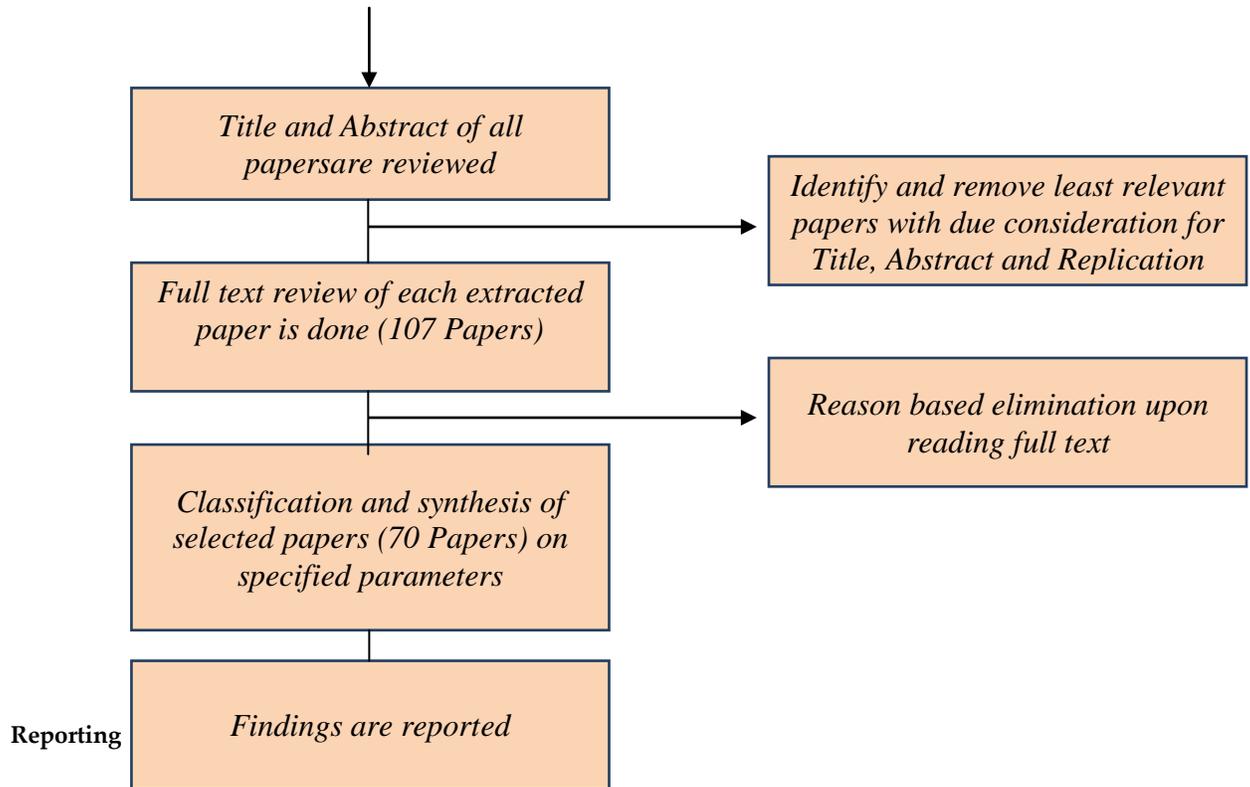


Fig.1 SLR Methodology

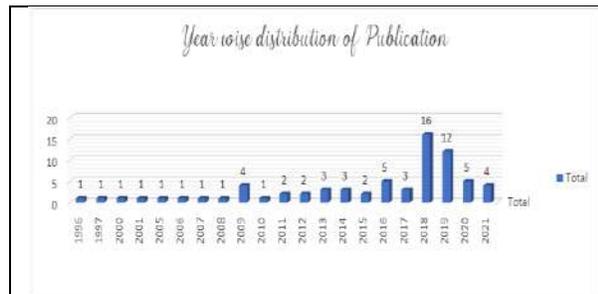


Fig. 2 Year wise distribution of Articles

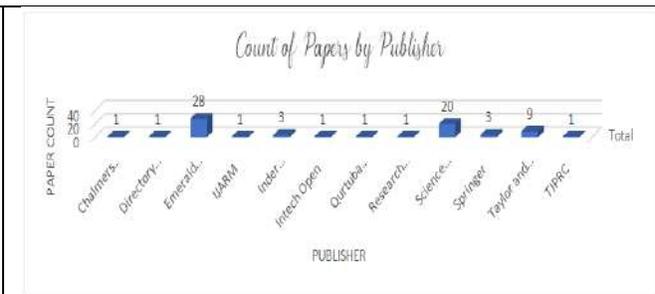


Fig.3 Publisher wise distribution of Articles





Role of Indian Organic Agriculture Products Production in the Development of Country (India)

Sapna Sugandha^{1*} and Naveen Singh²

¹Associate Professor, Dept. of Management Sciences, Mahatma Gandhi Central University, Bihar, India

²Research Scholar Dept. of Management Sciences Mahatma Gandhi Central University, Bihar, India

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Sapna Sugandha

Associate Professor,

Dept. of Management Sciences,

Mahatma Gandhi Central University,

Balua tal, Motihari-845401, Bihar, India

Email:sapnakarn27@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

From the entire analysis of the research paper, it has been identified that the different aspects of organic farming are able to enhance the development of the country as it enhances the lifestyles of the farmers. Along with that, the increased use of organic vegetables are able to develop the health of the consumers and improves the health conditions of the country. Therefore, the government is required to invest less in the healthcare sector of their country. Furthermore, from the data analysis section, this has been identified that the Age of the individuals is statistically associated with their knowledge regarding the impact of organic farming on the wild and agro biodiversity of India. Regression analysis, ANOVA and descriptive statistics and Reliability analysis has been performed with SPSS.

Keywords: Organic agriculture, development, economy, farmer, climate

INTRODUCTION

Background

Organic farming and the production of different requirements in organic farming are able to increase sustainability in the agriculture industry. As narrated by Dhiman (2020), social transformations are based on the organic farming range of the countries. This helps people to think about sustainability and become more conscious of the environment. From the agriculture industry, the Indian government earned 6.4 trillion INR in the year 2020 (statista.com, 2022). Therefore, this is a huge amount, and this makes the country self-dependent in terms of producing sufficient food for their citizen. According to the statistical analysis, over 2% of the net area in India was under organic farming, a major increase from last year (statista.com, 2022). Therefore, this is to comment that the interest's level regarding organic farming is getting enhanced in the country for well-being in different aspects of the country such as economy, health and environment.



**Sapna Sugandha and Naveen Singh****Research Objectives**

This research paper aims to prove that the production of organic farming is able to create more positive impacts on the development of India.

RO1: To analyse the impact of organic farming on the environment and biodiversity of India

RO2: To critically evaluate the different impacts of organic farming on the food production capabilities of the country

RO3: To describe the impacts of the organic farming on Indian economy.

Research Questions

The research questions of this paper are:

RQ1: What is the impact of organic farming on the environment and biodiversity of India?

RQ2: What are the different impacts of organic farming on the food production capabilities of the country?

RQ3: How do the organic farming tendencies affect Indian economic conditions?

LITERATURE REVIEW**Importance of organic farming to the environment**

Organic farming is able to discourage the impacts of harsh chemicals along with that it is also able to contribute to the preservation of the natural environment. According to different research works, unsustainable agriculture is the largest contributor to the loss of biodiversity in different countries. As highlighted by Łuczka & Kalinowski (2020), fertility of the soils is able to get enhanced when organic farming is being followed. Organic farming is able to increase the different aspects of products in order to make the crops more sustainable and healthier along with maintaining a higher level of nutritional values in the foods. On the other hand, Mangain (2019) have described that cumulative increments in the knowledge of the farmers are essential in terms of developing their food production while they are following the organic farming. This process is able to take more time, and the farmers are required to stay well aware of the different components that are able to be considered organic and inorganic before using those in their farming.

Importance of organic farming to the economic environment

After switching to organic farming, the farmers are able to make a cost reduction in the farming often as they are not required to be concerned about the different uses of pesticides. Furthermore, organic products are able to command higher prices among health-conscious customers. Therefore, this is able to improve the economic conditions of the farmers. In this context, Tal (2018) has suggested that the nutritious values of the food produced by the organic farming methods are able to get more socio-economic values as this gives exposure to improving the conditions of the soil. Therefore, as a result, the soil becomes more productive, and the farmers are able to implement a wide variety of nutritious crops. In contrast to this, Diacono et al. (2019) have highlighted that organic farming is able to get developed based on a “zero waste” strategy which is able to enhance the income of the farmers. Therefore, this affects the farmers positively, which indirectly affects the GDP rate of the countries. Hence, organic farming is able to create positive impacts on the economy of the countries.

Impact of organic farming on the Indian farmers

Organic farming keeps soil healthy and maintains environment integrity, thereby promoting the health of consumers. Moreover, the organic produce market is now the fastest-growing market all over the world, including in India. As a result of this, the farmers are able to get influenced by the organic market as this is able to reduce the different skin and other health-related issues of the farmers along with increasing their economic conditions. As highlighted by Assefa & Tadesse (2019), organically farmed products are able to be sold at higher prices among the population of health-conscious people. Although the population is growing, the rate of customers for organic vegetables and crops is getting enhanced, which is able to decrease the issues of the economic condition of the farmers. On the other hand, Singh (2021) has suggested that less use of pesticides and herbicides is able to affect the air quality of the locality of the farmers. Hence, this helps the farmers to stay healthy.





Sapna Sugandha and Naveen Singh

METHODOLOGY

The context

The mixed research methodology has been implemented in this research work in order to gain the proper knowledge regarding the impact of organic farming on the development of India. As highlighted by Snyder (2018), mixed research methods help the researcher to analyse the different complex relations. Therefore, the primary quantitative datasets are able to analyse the different and in-depth knowledge of the people related to organic farming in India. Additionally, the implementation of secondary qualitative data sets is able to justify the identified answers with reliable and valid explanations.

Data collection process

In order to accomplish the primary quantitative data sets, the researcher has utilised a survey method. The researcher has used Google form in order to spread the questionnaire among the selected population. Hence, the population size in this survey was 100 people, and the sample size was 40. A simple random sampling method has been followed by the researcher in order to gather the sample population in this research. As narrated by Mohajan (2018), simple random sampling is the easiest and less time-consuming process. Moreover, in order to collect the secondary qualitative data sets, Google scholar and ProQuest has been used to collect authentic articles. Topic relevance, language and information availability have been maintained at the time of collecting the articles.

Data Interpretation process

The primary quantitative data sets have been interpreted with the help of statistical analysis. Therefore, SPSS analysis has been performed in terms of developing the statistical analysis of the collected data sets. As described by Pandey & Pandey (2021), SPSS helps to create authentic data analysis. Furthermore, in order to analyse the secondary qualitative data, thematic analysis has been followed. This helps to develop a bridge among the different research variables (Pandey & Pandey 2021). Hence, this increases the reliability quotients of the paper.

FINDINGS AND DISCUSSION

Reliability analysis

From the analysis of the Cronbach alpha table, the reliability score has been identified to be 0.71. Therefore, the range of reliability scores is 0.7 to 0.8 (Bourque, 2019). Therefore, this is able to state that the identified primary data sets are highly reliable to the research topic.

Descriptive analysis

According to the descriptive statistical analysis maximum numbers of the survey participants who belong to an agricultural family background belong to the age group of 25-30. The mean value of the age group has been found to be 2.9. Furthermore, the mean value of gender is one that indicates that the maximum numbers of participants are female and are employed.

Regression analysis

H₁: The Age of the individuals is statistically associated with their knowledge regarding the impact of organic farming on the wild and agro biodiversity of India

H₀: The Age of the individuals is statistically associated with their knowledge regarding the impact of organic farming on the wild and agro biodiversity of India

From the regression table, the R-value has been identified to be 0.17 with the R square value of 0.30. Therefore, this is able to comment that there is 17 times the chance that the knowledge of organic farming among the farmers is associated with the wild and agro biodiversity of India. Furthermore, the significance level of the data sets is 0.028, which is lower than the value of 0.05; hence, this alternative hypothesis is acceptable.



**Sapna Sugandha and Naveen Singh****ANOVA**

The significance level of the data sets has been identified to be 0.055. Therefore, this is the significance level that is standardised. Hence, the alternative hypothesis is being accepted in this analysis.”

Thematic analysis**Theme 1: Organic farming reduces the rate of food production; however, this enhances the nutritious value of the food**

Compared to conventional agriculture, organic farming is able to provide more value s and benefits to the different aspects of the environment; however, this flowers down the rate of production. As narrated by Smith et al. (2019), the organic farm system requires more land in terms of developing their production rate. The growth rate of the crops is natural in this process. As a result, the farmers agave to wait until the crops are growing by themselves as they are unable to give any kind of artificial products to grow the crops faster. However, this is able to create a positive impact on the health of the consumers along with the farmers. Therefore, it helps the governments to reduce the expenses on healthcare. Contradictorily, the maintaining the biodiversity the, organic agriculture is able to get negatively affected due to the climate (Röös et al. 2018). The farmers are required to be strongly dependent on the climate.

Theme 2: Economic conditions of the farmers are able to improve due to organic farming, and this enhances the development of the country

Health-conscious behaviour and food habits of the individuals are able enhance the chances of selling organic vegetables. As highlighted by Łuczka & Kalinowski (2020), due to the use of organic farming methods, the farmers are able to increase the value of their products by 10-20%. Therefore, this enhances the economic conditions of the farmers. Furthermore, the increased interest level of the customers is able to allow the farmers to enhance the process of their organic products (Tsvetkov et al., 2018). These prices hikes are able to increase the economic conditions of the farmers as this is able to affect them to make fewer investments in farming, and they are able to utilise their incomes more effectively. As a result of significant improvements in the economic conditions of the farmers, the developments in the countries are able to have occurred.

CONCLUSION**Contributions to research and managerial implications**

From the entire discussion, this can be concluded that the different aspects of organic farming are able to enhance the development of the country as it enhances the lifestyles of the farmers. Along with that, the increased use of organic vegetables arable to develop the health of the consumers and improves the health conditions of the country. Therefore, the government is required to invest less in the healthcare sector of their country. Furthermore, from the data analysis section, this has been identified that the Age of the individuals is statistically associated with their knowledge regarding the impact of organic farming on the wild and agro biodiversity of India. Therefore, the research paper has shown this from the statistical analysis of the perspectives of the different populations of the country. Therefore, the data analysis has been conducted with highly reliable data sets according to the reliability analysis. Furthermore, this is able to comment that the thematic analysis has revealed that organic farming reduces the rate of food production; however, this enhances the nutritious value of the food. Along with that economic conditions of the farmers are able to improve due to organic farming, and this enhances the development of the country.

Research limitations and directions for future research

This research work has been conducted with the population where the maximum of the people belongs to the age group of 30-35 years. Therefore, this is able to create a level of bias in the result as due to the same age group, the perception of the people is able to be more or less similar, which can affect the research repo. Furthermore, this research paper is expanding the path of future researchers to make primary qualitative data analysis regarding this





Sapna Sugandha and Naveen Singh

topic along with the experiences of the farmers. This is able to allow the individuals to make an in-depth analysis of the research variables.

REFERENCES

1. Assefa, S., &Tadesse, S. (2019).The principal role of organic fertilizer on soil properties and agricultural productivity-a review. *Agri Res and Tech: Open Access J*, 22(2), 1-5. DOI: 10.19080/ARTOAJ.2019.22.556192
2. Bourque, J., Doucet, D., LeBlanc, J., Dupuis, J., & Nadeau, J. (2019).L'alpha de Cronbachestl'un des piresestimateurs de la consistance interne: uneétude de simulation. *Revue des sciences de l'éducation*, 45(2), 78-99. DOI: <https://doi.org/10.7202/1067534ar>
3. Dhiman, V. (2020). Organic farming for sustainable environment: Review of existed policies and suggestions for improvement. *International Journal of Research and Review*, 7(2), 22-31. Retrieved from: <https://www.academia.edu/download/63116247/IJRR00520200427-111425-1hchkqc.pdf>
4. Diacono, M., Persiani, A., Testani, E., Montemurro, F., &Ciaccia, C. (2019).Recycling agricultural wastes and by-products in organic farming: Biofertilizer production, yield performance and carbon footprint analysis. *Sustainability*, 11(14), 3824. Retrieved from:<https://www.mdpi.com/2071-1050/11/14/3824/pdf>
5. Łuczka, W., &Kalinowski, S. (2020). Barriers to the development of organic farming: A polish case study. *Agriculture*, 10(11), 536. Retrieved from: <https://www.mdpi.com/2077-0472/10/11/536/pdf>
6. Łuczka, W., &Kalinowski, S. (2020). Barriers to the development of organic farming: A polish case study. *Agriculture*, 10(11), 536.Retrieved from: <https://www.mdpi.com/2077-0472/10/11/536/pdf>
7. Mamgain, A. (2019). Status, importance, prospects, and vision of organic farming in India. *International Journal of Advance Research, Ideas and Innovations in Technology*, 5(1), 436-443. Retrieved from:https://www.researchgate.net/profile/Dr-Anuj-Mamgain/publication/331089712_Status_importance_prospects_and_vision_of_organic_farming_in_India/links/5c65595da6fdccb608c18fc9/Status-importance-prospects-and-vision-of-organic-farming-in-India.pdf
8. Mohajan, H. K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, 7(1), 23-48. Retrieved from: https://mpira.uni-muenchen.de/85654/1/mpira_paper_85654.pdf
9. Pandey, P., & Pandey, M. M. (2021). Research methodology tools and techniques.Bridge Center.Retrieved from: <http://dSPACE.vnbrims.org:13000/jspui/bitstream/123456789/4666/1/RESEARCH%20METHODOLOGY%20TOOLS%20AND%20TECHNIQUES.pdf>
10. Rööös, E., Mie, A., Wivstad, M., Salomon, E., Johansson, B., Gunnarsson, S., ...& Watson, C. A. (2018). Risks and opportunities of increasing yields in organic farming.A review. *Agronomy for sustainable development*, 38(2), 1-21. DOI: <https://doi.org/10.1007/s13593-018-0489-3>
11. Singh, M. (2021).Organic farming for sustainable agriculture. *Indian Journal of Organic Farming*, 1(1), 1-8.Retrieved from:<https://www.cpublishingmedia.com/wp-content/uploads/2020/11/Organic-Farming-for-Sustainable-Agriculture.pdf>
12. Smith, L. G., Kirk, G. J., Jones, P. J., & Williams, A. G. (2019). The greenhouse gas impacts of converting food production in England and Wales to organic methods. *Nature Communications*, 10(1), 1-10. DOI:<https://doi.org/10.1038/s41467-019-12622-7>
13. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of business research*, 104(1), 333-339. Retrieved from: <https://reader.elsevier.com/reader/sd/pii/S0148296319304564?token=AE3398C4BF6BA0C1E33E5CF9D1CD2BF442E6A99E2B66B57AC7E76EABDAD23EEBB8A198C4D4E7AC715EADA28034E8503F&originRegion=eu-west-1&originCreation=20220421105138>
14. statista.com, (2022), Contribution of agriculture to India's GDP from 2nd quarter 2018 to 4th quarter 2020, retrieved from: <https://www.statista.com/statistics/1233800/india-gdp-contribution-from-agriculture/>





Sapna Sugandha and Naveen Singh

15. statista.com, (2022), Share of net area under organic farming in India from financial year 2016 to 2020, retrieved from: [https://www.statista.com/statistics/1132405/india-net-area-under-organic-farming/#:~:text=In %20 financial%20year%202020%2C%20over,more%20demand%20for%20organic%20food](https://www.statista.com/statistics/1132405/india-net-area-under-organic-farming/#:~:text=In%20financial%20year%202020%2C%20over,more%20demand%20for%20organic%20food).
16. Tal, A. (2018). Making conventional agriculture environmentally friendly: moving beyond the glorification of organic agriculture and the demonization of conventional agriculture. *Sustainability*, 10(4), 1078. Retrieved from: <https://www.mdpi.com/2071-1050/10/4/1078/pdf>
17. Tsvetkov, I., Atanassov, A., Vlahova, M., Carlier, L., Christov, N., Lefort, F., ...&Atanassov, I. (2018). Plant organic farming research–current status and opportunities for future development. *Biotechnology & Biotechnological Equipment*, 32(2), 241-260. DOI: 10.1080/13102818.2018.1427509

Appendix: Survey questionnaire

Questionnaire

Are you Indian?
 Yes
 NO

What is your age?
 18-20
 20-25
 25-30
 30-35
 35-40

What is your Gender?
 Male
 Female
 Others

Are you employed in agricultural industry?
 Yes
 No

Your family belongs to agriculture?
 Yes
 No

Do you agree with the fact that the production of organic agricultural products are required to be enhanced?
 Strongly disagree
 Disagree
 Neutral
 Agree
 Strongly agree

Do you agree with the fact that organic farming increase wild and agrobiodiversity in India?
 Strongly disagree
 Disagree
 Neutral

Agree
 Strongly agree

Organic firming is Time-consuming. Do you agree with this fact or not?
 Strongly disagree
 Disagree
 Neutral
 Agree





Sapna Sugandha and Naveen Singh

Strongly agree
Loss of competitiveness of small farmers creates shortage of food production in India. Agree or not?
 Strongly disagree
 Disagree
 Neutral
 Agree
 Strongly agree
Developing organic farming culture in India can enhance Water savings. Agree or not?
 Strongly disagree
 Disagree
 Neutral
 Agree
 Strongly agree
 Do you think that agricultural entrepreneurship can mitigate unemployment issue in India?
 Strongly disagree
 Disagree
 Neutral
 Agree
 Strongly agree

Table 1: Cronbach’s Alpha

| Reliability Statistics | |
|------------------------|------------|
| Cronbach's Alpha | N of Items |
| .711 | 10 |

Table 2: Descriptive statistics

| Statistics | | | | | | |
|----------------|---------|-------------|-------|--------|------------|-------------------|
| | | Nationality | Age | Gender | Employment | Family background |
| N | Valid | 40 | 40 | 40 | 40 | 40 |
| | Missing | 0 | 0 | 0 | 0 | 0 |
| Mean | | 1.00 | 2.95 | 1.45 | 1.15 | 1.13 |
| Median | | 1.00 | 3.00 | 1.00 | 1.00 | 1.00 |
| Std. Deviation | | .000 | 1.431 | .597 | .362 | .335 |

Table 3:Regression table

| Model Summary | | | | | | | | | |
|--|-------------------|----------|-------------------|--------------------------------|-------------------|----------|-----|-----|---------------|
| Model | R | R Square | Adjusted R Square | Std. The error of the Estimate | Change Statistics | | | | |
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .173 ^a | .030 | .004 | 1.200 | .030 | 1.170 | 1 | 38 | .286 |
| a. Predictors: (Constant), Age | | | | | | | | | |
| b. Dependent Variable: Increase_wild_agro biodiversity | | | | | | | | | |





Sapna Sugandha and Naveen Singh

| ANOVA | | | | | | |
|---|------------|----------------|----|-------------|-------|-------------------|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 1.684 | 1 | 1.684 | 1.170 | .286 ^b |
| | Residual | 54.716 | 38 | 1.440 | | |
| | Total | 56.400 | 39 | | | |
| a. Dependent Variable: Increase_wild_agrobiodiversity | | | | | | |
| b. Predictors: (Constant), Age | | | | | | |

Coefficients

| Model | | Unstandardised Coefficients | | Standardised Coefficients | t | Sig. |
|---|------------|-----------------------------|------------|---------------------------|-------|------|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 2.872 | .439 | | 6.540 | .000 |
| | Age | .145 | .134 | .173 | 1.081 | .286 |
| a. Dependent Variable: Increase_wild_agrobiodiversity | | | | | | |

Table 4: ANOVA

| ANOVA | | | | | | |
|---------------------------------|----------------|----|-------------|------|------|--|
| Increase_wild_agro biodiversity | | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. | |
| Between Groups | 4.541 | 4 | 1.135 | .766 | .554 | |
| Within Groups | 51.859 | 35 | 1.482 | | | |
| Total | 56.400 | 39 | | | | |

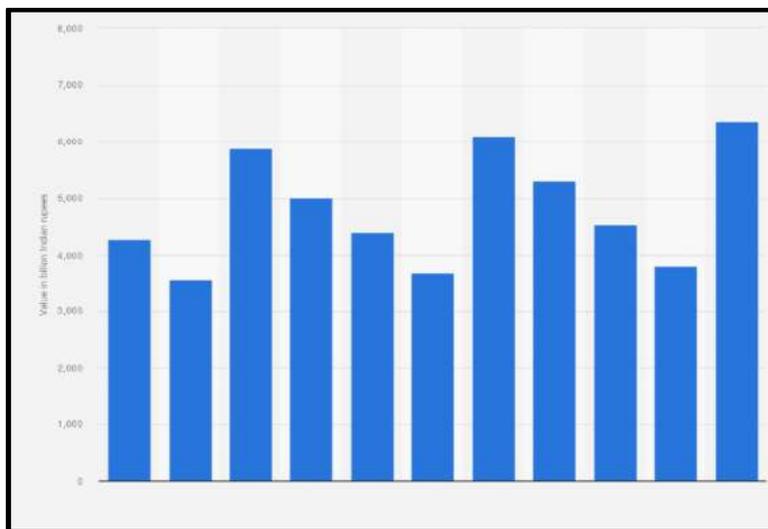


Figure 1: rate of GDP from the Indian agriculture industry





Impact of Black Friday Sales on the Stock Market and its Effectiveness on Consumer Response

Ganesh R^{1*}, Safeeda K A² and Kessia Issac³

¹Assistant Professor, PG and Research Department of Commerce and Management Studies, St. Mary's College, Sulthan Bathery, Wayanad, Kerala, India.

²Research Scholar, PG and Research Department of Commerce and Management Studies, St. Mary's College, Sulthan Bathery, Wayanad, Kerala, India

³Post Graduate Student, PG and Research Department of Commerce and Management Studies, St. Mary's College, Sulthan Bathery, Wayanad, Kerala, India

Received: 05 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Ganesh R

Assistant Professor,

PG and Research Department of Commerce and Management Studies,

St. Mary's College, Sulthan Bathery,

Wayanad, Kerala, India.

Email: ganeshrppg@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Black Friday is a shopping weekend when retailers, both online and offline, offer tempting discounts to induce customers to shop for Christmas, which has become a tradition in many nations. Despite having its roots in the US, Black Friday sales is being popular in India too, owing to the growing acceptance of e-commerce and online buying. Since there haven't been many attempts to look at the biases that consumers confront while buying on Black Friday, this study looks into how online customers perceive Black Friday offers. Investors have typically been influenced by their expectations for corporate turnover when making investment decisions. Therefore, this study explores how stock market investors feel about black Friday deals and looks at how that attitude is mirrored in stock prices during that time. The study employed both primary data gathered from investors and online customers in India via structured questionnaires and secondary data gathered from Yahoo finance. This study will help businesses understand the consumer behaviour towards offers given during Black Friday Sales and investors' perception of this. The influence of behavioural biases such as ratio bias and ad bias in trading during the Black Friday sales is also investigated. The study eventually also looks into the actual impact of these offers on their share price.

Keywords: Black Friday, Ratio Bias, Ad bias, Investment Behaviour, Consumer Behaviour

JEL Code: G11, G40, G41, M30, D91.





Ganesh et al.,

INTRODUCTION

In the United States, the day after Thanksgiving is referred to as "Black Friday" and is traditionally regarded as the beginning of the key Christmas shopping season. It is commenced on the fourth Thursday of November. It's typical for businesses to offer exceptional offers on Black Friday, both offline and online, to entice customers. Black Friday sales were first solely observed in the US market, but with the passage of time and globalization, they have expanded to many other nations, including India. While customers view discount and offer sales as an opportunity to buy for their necessities while adding more value by purchasing at fantastic offers and discounts (Santini et al. 2015), retailers view Black Friday sales as a helpful strategy from which they may grow their sales volume and attract new customers. Due to the widespread use of the internet, many e-commerce websites offer exclusive discounts and deals during the Black Friday sales. In 2020, there were over 150 million annual online shoppers, up from around 135 million in 2019, making India the second-largest online market globally. This surge can be ascribed to the expansion of the Indian e-commerce market as well as the Covid-19 epidemic, which changed consumers' shopping habits. After the outbreak of the virus, e-commerce's popularity increased by 17%, and this trend is predicted to continue (Sharma, 2020).

In this study, we look at how Indian online customers view the Black Friday deals being given by various e-commerce sites and examine if ratio bias has an impact. The ratio bias is the tendency for people to view probability stated as ratios of large numbers as more probable than probabilities of the same magnitude or even greater expressed as ratios of tiny numbers. The marketing tactics used during Black Friday sales may have an impact on investors' perceptions, just as every decision a firm makes can affect its market value and stock prices. Investors in the stock market keep an eye on the marketing tactics used by various businesses in order to predict the profitability of the enterprise. Researchers have discovered how investors' perceptions are impacted by marketing methods (Aspara & Chakravarti, 2015). Fehle et al. (2005) have discovered a significant rise in volume and return of the stock in response to sales promotion strategies and Ganesh et al. (2021) have demonstrated the existence of ad bias among investors in the Indian stock market. As a result, this study looks at how Indian retail investors perceive Black Friday sales and whether they are influenced by advertising bias. It also examines how Amazon.com stock prices respond to the Black Friday sales. This study is more important because of the rising trend in Indian market for online shoppers and retail investors, as well as the growing global appeal of Black Friday discounts.

BACKGROUND OF THE STUDY

The first Black Friday was celebrated in the US in the early 19th century. It is the busiest shopping day of the year in the US. It was intended to serve as a reminder that the holiday shopping season had begun. The phrase "Black Friday" was first used in the context of accounting, where the colour black stands for profit and the colour red denotes a loss. Thus, Black Friday is the day when retailers attempt to turn a profit. This day has been considered a celebration of the start of the Christmas shopping season (Pruitt, 2015). In the United States, Black Friday is widely recognized as the largest shopping day of the year (Tsiotsou, 2017). According to Simpson et al. (2011), Black Friday promotes customers to make impulsive purchases, stimulates overspending and leads to a shopping spree, and confuses people into making impulsive purchases. Because of the social, adventurous, and competitive aspects of the event, Black Friday rituals have value for customers. The findings show that although customers appreciate Black Friday shopping, they prefer Cyber Monday due to its increased convenience (Swilley & Goldsmith, 2013).

Since Indian customers are becoming more aware of Black Friday Sales, vendors are using online marketplaces like Amazon, Flipkart, and Paytm as a connecting link to market their goods to shoppers. They organized Black Friday Sales first, taking advantage of the first mover advantage. Even if sales haven't exploded as they have in the US, they have nonetheless increased somewhat. Over the weekend, Amazon India will be giving customers a 40 percent discount. Each of Honor's and Sony's sales events is separate (Bose, 2018). Regarding comparing customer behaviour and their perspectives in relation to Black Friday between India and Australia. The investigation's findings indicate that Indian consumers had less access to information and data about the Black Friday tradition than did Australian





Ganesh et al.,

consumers (Chatrath et al. 2020). Customers in the Delhi region routinely buy things because they are devoted to them, but during Black Friday Sales, customers buy products because of the rebates and discounts offered on them, according to Srivas & Bhattil (2020). Consumers start their purchases for goods on Friday on Wednesday of the week and continue through Sunday.

When examining how TV commercials affect investor behaviour, it was found that abnormal returns increase with the number of commercials used and are greater for companies that can be easily identified from the contents of the commercials, which is consistent with the presence of mood and attention effects (Fehle et al. 2005). According to Capon et al. (1996), about 25% of individual investors are "advertising-driven." By analyzing S&P 500 index fluctuations and using data from the 2009–2018 period, Dailydyte & Buziene (2020) came to the conclusion that the black Friday impact is no longer viable. While examining whether brand messages and advertising expenditures increase firm value equally when delivered through different media, results showed that the impact of advertising expenditures depends on which media companies use. It was also discovered that brand messages only increase firm value when broadcast through certain specific media (Tenorio, Romero, 2020). According to the research, Indian consumers' attitudes about Black Friday sales are unusual. A lack of effort has been made to investigate how investors view Black Friday sales. The responsiveness of stocks over the Black Friday period has not been previously examined. Investor expectations and actual market reaction have never been compared before in the Black Friday context. So, in the context of Black Friday, this study focuses on these topics.

RESEARCH GAP

This study seeks to understand how stock market investors and online customers view Black Friday sales. It also examines whether investors are subject to ad bias and whether online shoppers exhibit ratio bias. This study analyses the return on the stock of Amazon.com for the month of November to determine the true response of stock prices of E-commerce companies to Black Friday sales. This study has been conducted among the stock market investors in India who take part in seasonal offer sales such as Black Friday sales of E-commerce websites such as Amazon.com, Flipkart.com etc. This study is the first in the literature to examine how investors and customers perceive black Friday sales while also using secondary data to examine how investor behaviour is reflected in stock prices.

OBJECTIVES

The study meets the following objectives:

- To understand how online customers feel about Black Friday sales
- To gain insights into how investors view marketing tactics like black Friday sales
- To Examine the existence of ratio bias among online shoppers and the presence of ad bias among stock market investors
- To determine how responsive stock returns are to Black Friday sales.

DATA AND METHODOLOGY

This study uses both primary and secondary data. Primary data for the study were collected from 100 stock market investors in India who takes part in online shopping through a structured questionnaire. Self-selection sampling was chosen as the sampling technique for the investigation. Respondents are those who voluntarily participate in the survey as the questionnaire was sent as a google form. The perception of respondents as investors and online shoppers was examined using primary data. Daily trade data of Amazon.com were obtained from Yahoo Finance for the 3 weeks prior to, during, and following Black Friday week for five years in order to determine how stock prices responded to that time period (i.e 2017 to 2021). Mean, Percentage, independent sample t-tests, and One-Way ANOVA are used as statistical tools for the analysis.





Ganesh et al.,

RESULTS AND DISCUSSION

According to the demographic profile, 52 percent of responders are female and 48 percent are male. It demonstrates the growing involvement of women in internet shopping and stock market investing. The greater interest of women has been observed by Simpson et al. (2011) in Black Friday sales that are taking part. The respondents' average age of 30.59 demonstrates that they are not very young and are mature. 56.8% of responders have postgraduate degrees, 36.5 percent have degrees, 4.1 percent have diplomas, and 2.7 percent have only a 12th-grade education. Therefore, the respondents have solid academic backgrounds. 44.5 percent of responders are students, 40.5 percent are salaried workers, and 8.1 percent of participants work in business or professions. 55.4 percent of responders reported having yearly incomes under Rs. 250000, 23 percent between Rs. 250000 and 500000, 14.9 percent between Rs. 500000 and 1000000, and the remaining 6.8 percent of participants reported having annual incomes exceeding Rs. 1000000. Respondents were asked about when they do shop more, 80 percent of the respondents were shopping when a need arises and the remaining 20% were shopping more when there is a discount/offer before them. So shopping behaviour is not very influenced by seasonal discounts and offers (Refer Table 2.)

To know the perception of customers towards various factors of online shopping questions were asked. Customers observe Reviews and ratings provided by other customers for the product is considered by them in the first place while shopping online (Mean- 4.176), Price is the next factor that seems to be important when making online shopping(mean- 4.122), respondents give the third rank to familiar brands, that shows they are more confident with familiar brands while shopping online, Discounts and offers come in the fourth position with a mean of 3.554 so discounts and offers are also considered important by the respondents. Free shipping and payment modes available for the product come in the fifth and sixth ranks.

Factors attracting online customers to shop during offer sales were examined. 42 percent of respondents agreed that they shop during discount and offers to save their money, 34 percent were attracted to discount/offer sales as they can buy more products with their money and 12 percent opined that the availability of more choices is the factor attracting to shop during offer/discount sales. 7 percent were not attracted to discount/offer sales and 5 percent purchased as they loved being part of offer sales. So the study found economic benefit is the factor attracting most people to take part in discount/offer sales.

The study analyzed customers' perceptions of Black Friday sales. Their perception was analyzed using a five-point Likert scale, ranging from strongly disagree(1) to strongly agree(5). Table.5 shows respondents' level of agreement with various statements. Customers show their positive agreement towards the three statements in the questionnaire, they do purchase only those products which are already in their mind, E-commerce websites provide sufficient choices of products with offers during discount sales, and they enjoy shopping for products that offer high discounts. They were somewhat neutral to the other statements.

Two questions were asked to the respondents to test the presence of ratio bias. People affected by ratio bias will overestimate large numbers, without going for any complex calculations they believe larger the number, better the offer. Table.6 shows the first question measuring ratio bias. Respondents were asked to choose the better offer among two choices. A wide majority of 73 percent said that an offer of 25% off for a product with Rs.80 is better than the offer of Rs.20 off on a product with Rs.80. Only 10 percent could recognize that both offers are the same. So the presence of Ratio bias is evident among respondents. The response to the second question measuring ratio bias is presented in Table.7. Here also respondents exhibit the influence of ratio bias. 62 percent of respondents chose an offer of a discount of 9/100 over a discount of 1/10.

Following Table.8 presents the agreements of respondents towards various statements measuring Investor perception towards Black Friday sales. 5 point Likert scale was used to know the investor perception. Respondents agree with the statements "Marketing strategies have a great influence on stock prices" and "I do consider the



**Ganesh et al.,**

expected financial returns of the company before making an investment". They did not show any disagreements towards the statements on average. The study investigated the presence of ad bias among respondents affected by ratio bias. An Independent sample t-test was carried out to know the presence of Ad bias among the respondents who are affected by ratio bias. The null hypothesis is there is no significant difference in the impact of ad bias between respondents affected by ratio bias and who did not. Table.9 shows the results of the independent sample t-test. The mean of the statement "I do make investments in familiar stocks only" is higher (3.370) for respondents affected by ratio bias, but as the P value (0.845) is not significant we accept the null hypothesis in the first case. While testing the second statement "I do consider the expected financial returns of the company before making an investment" respondents who are not affected by ratio bias have a higher mean score of 3.615, which shows the absence of ad bias too, but the P value of t-test(0.71) is insignificant, hence we accept the null hypothesis.

The statement "My attachment to a particular brand had led me to make an investment in it" has a higher mean score (3.555) for respondents affected by ratio bias. This shows biased customers are affected by ad bias also. As the P value (0.555) of the t-statistic is not significant, we accept the null hypothesis in this case too. Respondents affected by ratio bias has a mean score of 3.537 for the statement "My positive experience towards a product has affected my interest in investing". Which is more than the mean score (3.231) of respondents not affected by ratio bias. The mean of the two groups are not significantly different as the P value is 0.432. The mean of the statement "I believe seasonal sales offers and discounts can boost the return of the company" is higher for respondents affected by ratio bias (3.685), and the P value is .004, therefore the null hypothesis is rejected, i.e the presence of Ad bias is different among respondents affected by ratio bias and those who are not. So, ad bias is evident among ratio biased respondents. The presence of Ad bias among respondents affected by ratio bias was observed in the statement "Marketing strategies have great influence on stock prices". Because the mean is higher (4.037) for affected category and P value (.012) is significant. So it is evident from the Table.9 that respondents affected by ratio bias is also affected by Ad bias. The response of Stock prices to Black Friday sales were analyzed using the daily trading data of Amazon.com for the past 5 years from 2017 to 2021. One-way ANOVA was run to know the significant difference in the average return on a stock with regard to three different weeks. Three weeks are the week before black Friday, the week of Black Friday and the week after Black Friday. The results are shown in Table.10. The P value is not significant for all the periods, therefore we accept the null hypothesis. H_0 : There is no significant difference in the average return on stock with regard to three different weeks.

IMPLICATIONS OF THE SURVEY

The study used the primary data collected from 100 respondents through a structured questionnaire. The results of the analysis show that approximately half of the respondents are female and half are male participants. This finding can be attributed to the increasing participation of women in stock market investment as well as online shopping. Respondents belong to an average age of 30 which is considered an age not so young and old and they possess good educational background also. The study analyzed the perception of respondents towards online shopping. A good majority of respondents shop more when a need arises and a few percent purchase in larger quantities during seasonal discounts/offers. This shows respondents shops more during normal seasons without waiting for seasonal discounts/offers. Reviews and ratings are given to the product, price, brand familiarity, and discounts/offers are the most important factors influencing an online customer. This means customers are concerned about the quality and value of the product. Respondents shops during massive discount/ offer sales with a view to save their money or to buy more products with the available money in their hands. So results say the economic benefit is the core reason for shopping during Discounts/ offer sales. They purchase only those products which are already in their mind, they are satisfied with the choices of products with offers during discount sales given by E-commerce businesses, and they enjoy shopping for products that offer higher discounts. The results showed that online customers are affected by ratio bias. When they are given two offers with two choices each, in both cases most of the respondents chose the option with large numbers without looking for the real benefit they get from those offers. Even if the majority of customers said they are shopping when a need arises, they are affected by ratio bias when they purchase products with discounts/offers. Looking at the perception of respondents as investors towards black Friday sales they believe that marketing strategies such as Black Friday sales influence the stock prices and they make the investment after





Ganesh et al.,

considering the expected financial return of the company. As their average reaction to the statements measuring Ad bias was positive, we can say that respondents are not free from Ad bias. This study examined whether respondents affected by ratio bias are also affected by ad bias or not. The findings were positive, that respondents who are affected by ratio bias shows the influence of ad bias also in their behaviour. So, we can say that respondents are not rational customers as well as rational investor. The reaction of stock prices to Black Friday sales was tested to know how the investor perception and stock market return are related. By analyzing the return on stock over three weeks (before Black Friday, during Black Friday and after Black Friday) it is found that black Friday has no significant influence on stock prices. The reason for the disparity between investor perception and actual market response may be, that the respondents in this study are from India and the stock we analyzed is Amazon.com which is listed on US stock market. The perception of US stock market investors can be different from investors in Indian stock market.

CONCLUSION

The present study looked into the perception of online customers as well as stock market investors in India towards Black Friday sales. It also examined the presence of ratio bias and ad bias among the respondents. It is concluded that online customers in India have a positive perception of online shopping, they enjoy purchasing during black Friday sales as it gives them economic benefits. The customers do not fall for discounts/ offers by 100 percent, even though they believe that they can gain from such massive discount/offer sales. They believe that events like Black Friday can influence the stock market. This study could reveal the fact that online customers in India are affected by ratio bias and Ad bias is present among the investors in Indian stock market. The presence of ad bias is more among those who are affected by ratio bias. Even if the investors expect stock prices to have a positive response to Black Friday sales the stock prices under consideration for the study didn't show any such response. This is because the majority of the investors are rational in their decisions and are supported either by fundamental or technical analysis. This study will help both online firms to understand how customers view their marketing methods as well as online consumers because it addresses the ratio bias that consumers may have when making purchases during promotions with steep discounts. This study enables stock market participants to recognize the influence of advertising on their decision-making. The present study considered only the daily stock price of Amazon.com while analyzing the stock market's response to Black Friday sales since no Indian e-commerce companies' trading data is accessible. A similar study might be expanded to include regular consumers to determine how their perceptions differ from those of stock market investors. India celebrates a broad variety of festivals, like Holy, Dussehra, Pongal, Onam, etc., and stores provide price cuts and offer during those times, so research in that context is also possible.

REFERENCES

1. Al-Zyoud, M.F. (2019). How Black Friday can Mess with Jordanian Customers' Minds, *Academy of Strategic Management Journal*. 18(4).
2. Aspara, J., & Chakravarti, A. (2015). Investors' reactions to company advertisements: the persuasive effect of product-featuring ads. *European Journal of Marketing*. 49(5).
3. Bell, G.C., Weathers, M.R., Hastings, S.O. & Peterson, E.B. (2014) Investigating the Celebration of Black Friday as a Communication Ritual, *Journal of Creative Communications*. 9(3), 235–251.
4. Bose, R. (2018). Black Friday Sale is a Growing Rage in India but Do You Know What It Means. Retrieved from <https://www.news18.com/news/buzz/black-friday-sale-is-a-growing-ragein-India-but-do-you-know-what-it-means>.
5. Capon, N., Fitzsimons, G.J., & Prince, R.A. (1996). An individual level analysis of the mutual fund investment decision. *Journal of Financial Services Research*, 10 (1), 59-82.
6. Dailydyte, I., & Buziene, I. (2020). Black friday and other effects-are they still sustainable in financial markets?. *Journal of security and sustainability issues*, 9(4), 1245-1257.





Ganesh et al.,

7. Swilley, E., & Goldsmith, R. E. (2013). Black Friday and Cyber Monday: Understanding consumer intentions on two major shopping days. *Journal of retailing and consumer services*, 20(1), 43-50.
8. Fehle, F., Tsyplakov, S., & Zdorovtsov, V. (2005). Can companies influence investor behaviour through advertising? Super bowl commercials and stock returns. *European Financial Management*, 11(5), 625-647.
9. Ganesh, R., Thiagarajan, S., & Naresh, G. (2021). Appealing for investors through IPO advertisements. *Global Business and Economics Review*, 25(2), 133-153.
10. Garg, A., Bodla, B. S., & Chhabra, S. (2010). Seasonal anomalies in stock returns: A study of developed and emerging markets. *IIMS Journal of Management Science*, 1(2), 165-179.
11. S. K., Kaur, A., & Singh, H. (2020). A Comparative Analysis Regarding Testing the Awareness about Black Friday among Indian and Australian Customers. *Systematic Reviews in Pharmacy*, 11(12), 2118-2127.
12. Lopez-Tenorio, P. J., & Romero, J. (2020). Investors' response to advertising: the role of media. *Journal of Marketing Management*, 36(15-16), 1505-1526.
13. Nawaz, S., Mirza, N. (2012) Calendar Anomalies and Stock Returns: A Literature Survey. *Journal of Basic and Applied Scientific Research*, 2(12), 12321-12329.
14. Pruitt, S. (2015). What's The Real History Of Black Friday?. *History*. (2), 116 <https://www.history.com/news/whats-the-real-history-of-black-friday>
15. Santini, F. D. O., Sampaio, C. H., Perin, M. G., & Vieira, V. A. (2015). An analysis of the influence of discount sales promotion in consumer buying intent and the moderating effects of attractiveness. *Revista de Administração (São Paulo)*, 50(4), 416-431.
16. Sharma, K. (2020). A surge in e-commerce market in India after COVID-19 pandemic. *Gap gyan-a global journal of social sciences*, 3(4), 54-57.
17. Simpson, L., Taylor, L., O'Rourke, K. & Shaw, K. (2011), An Analysis of Consumer Behavior on Black Friday. *Faculty Research & Creative Activity*. 13 (1), 1-6.
18. Srivas, P., & Bhatti, K. K. Impact of Black Friday Sales on Consumers in Delhi Region. *Periyar Journal of Research in Business and Development Studies*, 5(2), 1-6
19. Thomas, J. B., & Peters, C. (2011). An exploratory investigation of Black Friday consumption rituals. *International Journal of Retail & Distribution Management*. 39(7), 522-537
20. Tsiotsou, R. H. (2017). "Black Friday": Attitudes, Behavior and Intentions of Greek Consumers. In *Advances in national brand and private label marketing* 11-17.

Table.1 Gender

| Gender | Frequency | Percentage |
|--------|-----------|------------|
| Male | 49 | 49 |
| Female | 51 | 51 |
| Total | 100 | 100 |

Source: Primary data

Table.2 Reason for shopping more

| Variables | Frequency | Percentage |
|----------------------|-----------|------------|
| Need | 80 | 80 |
| Discounts and offers | 20 | 20 |
| Total | 100 | 100 |

Source: Primary data





Ganesh et al.,

Table-3: Factors Considered While Shopping

| Factors | Mean | Rank |
|-------------------------|-------|------|
| Price | 4.122 | 2 |
| Discounts and offers | 3.554 | 4 |
| Payment modes available | 3.364 | 6 |
| Free shipping | 3.513 | 5 |
| Review and ratings | 4.176 | 1 |
| Familiar brands | 3.649 | 3 |

Source: Primary data

Table 4 Factors Attracting to Discount/Offer Sales

| Attracting factor | Frequency | Percentage |
|-------------------------------------|-----------|------------|
| Saves Money | 42 | 42 |
| Availability of more choices | 12 | 12 |
| Able to buy more with limited money | 34 | 34 |
| Love being part of offer sales | 5 | 5 |
| Not attracted to offers /discounts | 7 | 7 |
| Total | 100 | 100 |

Source: Primary data

Table. 5 Statement measuring perception towards Black Friday sales

| Statements | Mean | S.D |
|--|-------|-------|
| Advertisements on E-commerce websites tempt me to shop | 3.257 | 1.007 |
| I keep on surf E-commerce websites to check discounts or offers | 3.108 | 1.041 |
| I have postponed my purchases awaiting discounts and offers | 2.959 | 1.152 |
| I do compare prices before and during discount/ offers | 3.256 | 1.086 |
| I do purchase only those products which are already in my mind | 3.594 | .9351 |
| I have made purchases of items simply because of the attractive offer | 2.838 | 1.159 |
| Discount sales such as black friday sales attracts me | 3.027 | 1.110 |
| I am ready to switch my brand to another if there is huge discounts/ offers | 3.338 | 1.197 |
| I enjoy shopping products that offer high discounts | 3.514 | .969 |
| I feel products with big offers value very much | 3.081 | 1.095 |
| offer sales gives me more satisfaction than shopping in normal days | 3.473 | 1.063 |
| E-commerce sites provides sufficient choices of products with offers during discount sales | 3.595 | 1.059 |
| I make additional purchase to catch special discount \ offer for shopping a certain amount | 3.338 | 1.197 |

Source: Primary data

Table.6 Testing of Ratio bias

| Variables | Frequency | Percentage |
|-----------------------------------|-----------|------------|
| 25% off for a product with Rs.80 | 73 | 73 |
| Rs.20 off on a product with Rs.80 | 17 | 17 |
| Both are same | 10 | 10 |
| Total | 100 | 100 |

Source: Primary data





Ganesh et al.,

Table.7 Testing of Ratio bias

| Variables | Frequency | Percentage |
|----------------------------------|-----------|------------|
| Discount of 1/10 of the price | 37 | 37 |
| A discount of 9/100 of the price | 62 | 62 |
| Total | 100 | 100 |

Source: Primary data

Table. 8 Statements showing Investor perception

| Statements | Mean | S.D |
|---|-------|-------|
| I do make investments in familiar stocks only | 3.405 | 1.072 |
| I do consider the expected financial returns of the company before making an investment | 3.729 | .983 |
| My attachment to a particular brand had led me to make an investment in it | 3.459 | .9819 |
| My positive experience with a product has affected my interest in investing. | 3.405 | .992 |
| I believe seasonal sales offers and discounts can boost the return of the company | 3.446 | 1.087 |
| Marketing strategies have great influence on stock prices | 3.851 | .989 |

Source: Primary data

Table.9 Presence of Ad bias among ratio-biased respondents

| | Ratio bias Affected | Not affected | Total |
|---|------------------------|--------------|-------|
| I do make investments in familiar stocks only | | | |
| N | 73 | 27 | 100 |
| Mean | 3.370 | 3.308 | |
| SD | 1.01491 | 1.109 | |
| T-stats | .196 | | |
| P value | .845 | | |
| Remarks | Equal variance assumed | | |
| I do consider the expected financial returns of the company before making an investment | | | |
| N | 73 | 27 | 100 |
| Mean | 3.372 | 3.615 | |
| SD | .899 | 1.391 | |
| T-stats | .373 | | |
| P value | .710 | | |
| Remarks | Equal variance assumed | | |
| My attachment to a particular brand had led me to make an investment in it | | | |
| N | 73 | 27 | 100 |
| Mean | 3.555 | 3.385 | |
| SD | .883 | 1.121 | |
| T-stats | .594 | | |
| P value | .555 | | |
| Remarks | Equal variance assumed | | |
| My positive experience with a product has affected my interest in investing. | | | |
| N | 73 | 27 | 100 |
| Mean | 3.537 | 3.231 | |

Source: Primary data





Ganesh et al.,

| | | | |
|---|----------------------------|-------|-----|
| SD | .863 | 1.301 | |
| T value | .807 | | |
| P value | .432 | | |
| Remarks | Equal variance not assumed | | |
| I believe seasonal sales offers and discounts can boost the return of the company | | | |
| N | 73 | 27 | 100 |
| Mean | 3.685 | 2.769 | |
| SD | .928 | 1.235 | |
| T value | 2.989 | | |
| P value | .004 | | |
| Remarks | Equal variance assumed | | |
| Marketing strategies have great influence on stock prices | | | |
| N | 73 | 27 | 100 |
| Mean | 4.037 | 3.308 | |
| SD | .823 | 1.251 | |
| T value | 2.574 | | |
| P value | .012 | | |
| Remarks | Equal variance not assumed | | |

Table.10 ANOVA of return on the stock

| Week | Mean | SD | F Value | DF | P value |
|---------------------|-------|-------|---------|------|---------|
| 2017 | | | | | |
| Before black Friday | .0008 | .008 | 2.171 | 2,9 | .170 |
| Black Friday week | .012 | .0118 | | | |
| After black Friday | -.007 | .018 | | | |
| Total | .0058 | .0378 | | | |
| 2018 | | | | | |
| Before black Friday | -.014 | .021 | 3.266 | 2,10 | .081 |
| Black Friday week | -.015 | .027 | | | |
| After black Friday | .027 | .033 | | | |
| Total | -.002 | .113 | | | |
| 2019 | | | | | |
| Before black Friday | -.005 | .007 | 2.656 | 2,11 | .114 |
| Black Friday week | .001 | .006 | | | |
| After black Friday | .008 | .012 | | | |
| Total | .004 | .025 | | | |
| 2020 | | | | | |
| Before black Friday | -.002 | .006 | 1.997 | 2,9 | .192 |
| Black Friday week | .008 | .0095 | | | |
| After black Friday | -.001 | .007 | | | |
| Total | .005 | .0225 | | | |
| 2021 | | | | | |
| Before black Friday | .008 | .018 | 1.942 | 2,10 | .194 |
| Black Friday week | -.006 | .018 | | | |
| After black Friday | -.016 | .016 | | | |
| Total | -.014 | .052 | | | |

Source: Secondary data





India's Inflation: Theory, Measurement, Policy and Trend

Dhakshayini K N^{1*} and Vinaykumar A²

¹Associate Professor, Department of Commerce, Nagarjuna Degree College, Karnataka, India.

²Assistant Professor, Department of Commerce, Nagarjuna Degree College, Karnataka, India.

Received: 05 June 2022

Revised: 20 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Dhakshayini K N

Associate Professor,

Department of Commerce,

Nagarjuna Degree College,

Karnataka, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

One of the main variables for monetary policy proposals is inflation. The steady rise in prices of goods and services over time is referred to as inflation. States frequently struggle to control the rate of monetary expansion and keep inflation under control during periods of economic growth. In order to determine the magnitudes of the monetary policy executed, this paper scrutinises the strategy used by Indian monetarists for inflation and studies recent changes in inflation rate. This research also seeks to describe the prognosis of the inflationary phenomenon. In addition, it discusses whether recent inflation developments have an impact on the outcomes of inflation target policy. The combined Consumer Price Index and Wholesale Price Index are used to measure inflation in India. By charting a chart of WPI inflation and the combined CPI inflation, which also covers the trends of inflation in previous years, the average yearly data of the CPI and WPI are used to investigate the inflation rate from the years 2017 through 2020 and 2021.

Keywords: Inflation, CPI, WPI, Targeting policy.

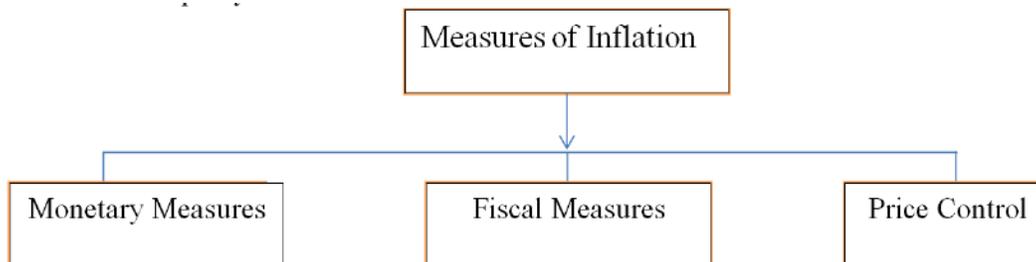
INTRODUCTION

A single value can be used to indicate the rise in the price level of goods and services in an economy over time. Inflation tries to measure the total impact of price changes for a diverse range of commodities and services. The central bank of a nation is the proper monetary authority and is responsible for managing the supply of credit and money in order to keep inflation within acceptable bounds and maintain a healthy economy. Every economy has inflation, which is thought to be a complex condition. An economy may face dire consequences if inflation rises above a reasonable level. Since it should be kept under control, it is difficult to do so by utilising a specific tool or





measure. Each measure's primary goal is to lessen the amount of money entering the economy or the amount of market liquidity.



Monetary Measures

The central bank raises the interest rate on commercial banks' borrowings. Commercial banks raise their rates of interest on consumer credit as a result. People choose to save money in such circumstances rather than invest it in new businesses. As a result, the market's money supply would decline, which would curb inflation. In addition, the central bank limits the ability of commercial banks to provide credit in order to manage inflation. Among the monetary controls on inflation are:

(i) Bank rate policy (BRP) (ii) Cash reserve ratio(CRR) and (iii) Open market operations (OMO).

Fiscal Measures

Additionally, the government utilises budgetary policies to restrain inflation. Government revenue and government spending make up the two primary pillars of fiscal policy. In terms of fiscal policy, the government can lower government spending, private spending, both, or none to manage inflation.

Price Control

Preventing further price increases for products and services is another strategy for reducing inflation. This approach uses price control to stifle inflation, but it is not long-term sustainable. Such a situation prevents the economy's fundamental inflationary pressure from showing itself for a little period of time in the form of an increase in prices. Suppressed inflation is what is meant by this word. In this chart, the inflation rate gradually increases from 3.6% in 2017-18 to 6.2% in 2020-21. The Wholesale Price Index (WPI) of a basket of products and services is used in India to calculate inflation as the percentage change in value from one year to the next. A year-over-year change in the Wholesale Price Index's (WPI) value is referred to as inflation. It displays the shift in prices for a selection of goods and services over the course of a year. The WPI is used as the benchmark for calculating inflation in India. Contrarily, the majority of other nations use the retail or consumer price index to measure it.

Implications of Inflation

Inflation influences lives are the purchasers or the public much antagonistically. Excessive costs of everyday merchandise make it hard for common customers to manage even the essential necessities of life. This prompts helpless way of life and constrains them to request higher salaries. Swelling additionally makes the fares non-competitive. Hence, in a condition of value rise the fares of the nation decrease. This makes shortage in the unfamiliar exchange, prompting current record deficiency and decrease in the worth of the cash for example of Rupee in the event of India. On a decrease in the conversion scale of the money, the imports become all the more expensive and this prompts further value rise, etc. On the off chance that it goes on persistently, the economy may confront texture me emergency. Henceforth, the public authority and the national bank for example RBI consistently attempts to monitor expansion. The national bank additionally does likewise. Not with standing how a moderate degree of expansion might be called useful for an economy, as it urges individuals to contribute more, works with ascend in cash supply, for venture and request creation by improving upgrade pay level. Hence, some ascent in cash





supply prompting improved interest, trailed by expanded interest and creation to off-set the increment in cash supply by the more significant level or supply of labour and products prompts supported financial development.

Concepts Regarding Inflation (Theories of Inflation)

Money supply variations are taken into account as a potential source of changes in price level in monetary theories of inflation. These include Milton Friedman, Alfred Marshall, and Irving Fisher's quantity theories. An extensive version of the quantity theory of money was developed by Irving Fisher. He asserts that the equation of exchange is $M V = P T$, where M is the amount of money in circulation, V is the rate of money circulation, P is the level of prices, and T is the actual volume of transactions. Fisher contends that V is stable over a long time. Therefore, changes in the price level will be exactly equal to changes in the amount of money if T stays constant. The quantity theory is updated by Alfred Marshall, who also adds the concept of "desire to hold money. $M=kPO$ " M is the quantity of funds, P is the price level, O is the output, and k is the percentage of actual income that people want to hold in the form of money. Together, these variables make up the cash balance equation of exchange. As a result, the Marshallian approach considers liquidity preference to be crucial. Along with money supply, psychological factors must be taken into account. The quantity theory is restated by Milton Friedman and other economists from the Chicago School of Economics. Instead of discussing money supply and production, they present a theory of money demand. Friedman viewed money as an asset as well as a means of trade. Because money demand is a function of income level and interest rates, calculating prices also takes into account these two elements. People demand money, in accordance with Keynesian theory, for three reasons: transactions, precautions, and speculative motive. The amount of money spent, not the amount of money spent, dictates how the price level will change. The ultimate amount spent, however, is significantly influenced by the amount of money available. The demand pull that drives inflation is the foundation of the Keynesian and monetary theories of inflation. Cost-based inflation theory holds that, in some cases, rising production costs are also to blame for inflation, in addition to rising demand and money supply. Cost-push inflation may be brought on by rising wages, raw material prices, administrative price increases, etc. There are instances when labour unions become so strong that they may raise wages annually, pushing up prices. On this aspect of inflation, James L. Laughlin, J.R. Hicks, and S.H. Slichter concentrated. The structural theory of inflation is largely concerned with emerging markets. The fundamental tenet of structural theory is that social tensions and structural rigidities are what lead to inflation. With the reference of Raul Prebisch, "Economic development calls for constant changes in the form of production, in the economic and social structure and in patterns of income distribution. Failure to make these changes in time or to undertake them partially and completely leads to maladjustments and stresses which release the ever-latent and extremely powerful inflationary forces in the country".

India's Inflation Measures

Through the use of index numbers, changes in the level of prices over time are measured. A wide range of necessities for life are included in this index of pricing for products and services. Up until recently, India used five different indexes for tracking price increases or inflation. The fifth is the Wholesale Price Index (WPI), which covers the entire economy. Of these, four are Consumer Price Indices (CPIs), which are tailored to a class or group of consumers. These indices include a wide range of currently consumed goods and services. Additionally, since 2012, three new indices have been introduced to address the shortcomings of these five existing indexes. In order to measure inflation or the level of prices in the economy, India employed five significant national indices till 2012. The official headline inflation measure for India was (A) The Wholesale Price Index (base 1993–1994). (B) The four different consumer price indices, each of which is used to calculate inflation rates for various segments of the labour force. (C) The current series of WPI, with a base year of 2004–2005, has 676 commodities. It is accessible on a quarterly basis and serves as an indication of inflation for the economy as a whole as well as its various sectors. Three consumer price indices (CPIs) are formally released on a regular basis at the national level to reflect changes in the retail prices of goods and services relevant to the various population segments in the nation. These are: (i) Consumer Price Index for Industrial Workers (CPI-IW) (ii) CPI for Agricultural Labourers (CPI-AL) (iii) CPI for Rural labourers (CPI-RL). The basket of CPI for Industrial Workers (CPI-IW) is based on 2001 as the base year and includes 120-360 items.



**Dhakshayini and Vinaykumar****Wholesale Price Index (WPI)**

India is one of a relatively small number of nations that determines the economy's inflation rate using the Wholesale Price Index (WPI). The Consumer Price Index (CPI), often known as the Retail Price Index, is used by the majority of developed nations to determine inflation. The WPI is believed to have been originally published in 1902 and was one of the most widely used economic indicators available to policy makers until the 1970s, when the Consumer Price Index supplanted it in the majority of developed nations. The wholesale pricing index, or WPI, is used to track changes in the average price level of items traded there. The WPI, a measure of changes in commodity prices across all trade transactions, is used in India to track data on price levels for a total of 676 products. It is also the price index, which is made available for reference at the minimum possible time lag, or just two weeks, on a weekly basis. The WPI is a measure of the rate of inflation in the economy used by the Indian government. Since it is the only index provided weekly with a two-week lag, WPI is widely used in India for short-term policy initiatives. In general, inflation must be controlled in light of changes in the pricing of final goods or consumer items. So, replacing WPI with CPI is currently being discussed in India as well. The Office of Economic Adviser, Ministry of Commerce and Industry, periodically publishes this index (WPI), which is the most generally and officially used as the inflation indicator for the majority of policy decisions in India. The government bases all significant monetary and fiscal policy choices on changes in the WPI. It has been in use and being published in India since 1939. The content and the base year of the WPI have undergone numerous revisions due to the changing circumstances and changes in consumption patterns. The base year for the current series of the Wholesale Price Index is 2004–2005, and the index is calculated using 676 items. According to the Working Group's recommendations, which was formed with Prof. Abhijit Sen, a member of the Planning Commission, as its chairman, the most recent revision of the WPI series was implemented on September 14, 2010, and its base year was changed from 1993–1994 to 2004–2005.

Consumer Price Index (CPI)

Numerous consumer price indices, including the Consumer Price Index for Industrial Workers (CPI-IW), the Consumer Price Index for Agricultural Laborers (CPI-AL), and the Consumer Price Index for Urban Non-Manual Employees (CPI-UNME), are only collected on a monthly basis. The CPI-IW is compiled by the Labour Bureau of the Government of India. It gathers adjustments to preset baskets of products and services that the target group purchases at retail pricing (namely the average working class family). This index is created on a monthly basis based on the Income and Expenditure survey being undertaken by the National Sample Survey Organization of the Central Government (NSSO) in 78 chosen centres. It is built using average monthly family spending on the following consumption categories' products: food, fuel and light, housing, clothing, bedding, and other miscellaneous items (including medical care, education, recreation, transport, communication etc.). Along with fixing and updating minimum salaries, the government uses this index to determine the dearness allowance that will be provided to industrial workers, Central and State Government employees, and other employees. The implicit price deflator of GDP is another more thorough indicator of inflation. This is an annual series that becomes available after a two-year delay. The GDP quarterly series, which is more recent, is also accessible. The CPI tracks changes in a basket of prices for goods and services from the viewpoint of retail customers. It is therefore the accurate index of pricing for the general public. It reflects the actual inflation that people have to deal with. The CPI is intended to track changes in the proportion of a defined group of consumers' incomes spent on specific products and services at retail across time.

The New Series of CPI started Since 2012: The first three indices listed above, which were created by the Ministry of Labour and Employment's Labour Bureau, and the fourth, which was created by the Ministry of Statistics and Programme Implementation's Central Statistical Organization (CSO), both reflect the impact of changes in the prices of various goods and services that particular populations in the nation buy and consume. These indices don't accurately depict how prices have been behaving across the nation as a whole. As a result, the Ministry of Statistics and Programme Implementation's Central Statistics Office (CSO) has started to compile a new series of CPIs. These are (a) the CPI (Urban) for the entire urban population and (b) the CPI (Rural) for the entire rural population (Rural) (c) Based on the above two CPIs, a combined CPI for urban and rural areas will also be created. These indexes show changes in the cost of different commodities and services that urban and rural populations use. With 2010 as its base year, the new series also covers services that are absent from the WPI series. However, the data for 2012 will only be





available for comparison between producer price indices (PPI) and wholesale price indices (WPI) in 2013, which is when this new series will become pertinent. Instead of the WPI, many countries utilise the Producer Price Index. The average change in selling prices made by producers of goods and services over time is measured by the Producer Price Index (PPI). The majority of OECD nations use the Producer Price Index (PPI) to assess inflation, but a small number also uses the World Price Index (WPI). WPI is used by OECD nations like Japan, Greece, Norway, and Turkey. The PPI offers broader coverage in terms of products and industries, and it is more consistent with the national account. In comparison to one at the wholesale level, PPI can be thought of as more pertinent and technically superior. However, we are still using WPI in India. As the primary indicator of inflation, the consumer price index (CPI) took the place of the wholesale price index (WPI) in 2013. Food and beverages make up the majority of the consumer price index in India (45.86% of the total weight), with prepared foods like meals, snacks, and sweets coming in at 5.55%, vegetables at 6.04%, milk and products at 6.61%, meat and fish at 3.61%, and oils and fats at 9.67% (3.56%). Transportation and communication (8.59%), health (5.89%), and education (28.13%) make up the remaining categories (4.46%). 10.07% of the economy is devoted to housing, 6.84 % to energy, 6.53% to clothing and footwear, and 2.38% to alcohol, tobacco, and other drugs.

Background of Monetary Policy of India

In order to formally embrace the flexible inflation targeting (FIT) framework, the Government of India and the RBI signed the Monetary Policy Framework Agreement (MPFA) in February 2015. Following this, the RBI Act, 1934 was amended in May 2016 to provide a legal foundation for the implementation of the FIT framework. With this step toward modernising the monetary policy process, India joined those nations that began using New Zealand's inflation targeting as their monetary policy framework in 1990. The Consumer Price Index (CPI) inflation target will be 4% with a tolerance zone of 2% for the period from August 5, 2016 to March 31, 2021, the Central Government announced in the Official Gazette dated August 5, 2016. A Liquidity Adjustment Facility (LAF) was established in 2000; under this facility, the RBI may use the repo rate and the reverse repo rate as its primary policy signalling rates. The Market Stabilization Scheme (MSS), which was launched in early 2004 and allows the RBI to issue treasury bills and dated securities, was another significant move in monetary policy. Under this programme, the government holds the proceeds of these bonds in a distinct cash account that is maintained and run by the RBI. The 2008 global financial crisis resulted in significant capital flight and pressure on the foreign exchange market. As a result, the Indian economy had a sharp decrease in growth rate in 2008–09 after experiencing five years of uninterrupted high growth. The RBI cut the repo rate from 9% to 4.75%, the reverse repo rate from 6% to 3.25%, and the CRR significantly from 9% to 4.75% in order to counteract the effects of the global financial crisis. A six-member Monetary Policy Committee (MPC) was established to set the policy rate in 2016, and the monetary policy framework shifted to flexible inflation targeting. India joined the group of nations that have embraced inflation targeting as their monetary policy framework with this step toward modernizing the monetary policy process. The Government of India set a target for inflation based on the Consumer Price Index (CPI combined).

Key Components of a Monetary Policy Framework

Instruments → Operating Targets → Intermediate Targets → Goals of Monetary Policy

The end objectives of monetary policy are closely tied to the intermediate targets, which are factors that can be impacted by monetary policy. Monetary indices and both short- and long-term interest rates could be considered intermediate aims. Goals are the ultimate aims of a policy. Price stability, economic expansion, financial stability, and exchange rate stability are a few examples. This broad concept is used to both the inflation targeting framework that has been in effect since 2016 and the monetary targeting framework with feedback that was in use from 1985 to 1998. Although broad money was treated as an intermediate target and the goals of monetary policy are the same across the various frameworks, the multiple indicator approach that was in operation from 1998 to 2016 was based on a number of financial and economic variables and was not exactly specified on the basis of this framework. According to a World Bank analysis from 2018, the Indian economy witnessed significantly reduced and declining levels of



**Dhakshayini and Vinaykumar**

macroeconomic stability between 2008 and 2012 as a result of high budget and current account deficits as well as rising inflation. Up until 2013, the RBI's multiple indicator strategy worked well since it kept inflation under control or manageable levels. However, following 2013, inflation continued to rise and reached double digit levels. As a result, the Indian monetary policy framework adopted the policy of inflation targeting after Raghuram Rajan was appointed governor of the RBI in September 2013 to combat the then-high rates of inflation. A Monetary Policy Framework Agreement (MPFA) was signed between the GOI and RBI on February 20, 2015, with the goal of bringing down inflation below 6% by January 2016.

Recent Trends of Inflation in India

The time period chosen here is from the years 2017–18 to 2000–21 in order to demonstrate the most current trend in inflation rate in the Indian economy. To examine the trend of inflation in India over the past few years, annual average statistics from the WPI for all commodities and the CPI are used. The time frame chosen is the one during which the central bank implemented its inflation targeting economic strategy. Only during this time span has the RBI changed its inflation measurement methodology from using WPI to CPI. Thus, it's fascinating to observe the trends of both inflation series, one of which is obtained from the WPI and the other from the CPI-C. These inflation trends were calculated using data from the RBI's yearly publication, "Handbook of Statistics on Indian Economy." The Combined Consumer Value Index rate and Wholesale Price list are shown in this outline. Strangely, the behaviour of the two expansion series derived from the two separate records exhibits a large deal of diversity. Over the entire time period included by this analysis, CPI-C-based expansion continuously outperforms WPI-based expansion in terms of value. With WPI at 101.73 % and CPI-C at over 104.52 % in 2016–17, there is a very serious discrepancy between the two inflation estimates. Then, as the Indian financial system began to focus on inflation, both series show a consistent trend in which the WPI expansion displays a very sharp decrease and the CPI expansion increases gradually. When compared to WPI, which is at 102.92 % in 2017–18, CPI-C shows a value of roughly 108.27 %; this is the largest gap between the two series to date. WPI expansion appears as a harp grade after 2017–18 and was 5.35 % in 2016–17 and 2.79 % in 2017–18. While this is happening, the CPI-C swelling series has been rapidly growing step by step and is now at 112.04 %. After that, it will rise to 112.04 % in 2018–19. There are several explanations for this distinction between the two series. The primary causes of divergences that can be cited are as follows: 1. Administrations, such as education, health care, and accounting, are weighted in the CPI but not the WPI. 2. When compared to CPI, the value of goods like metal has a large weight in the WPI. 3. The price of food items, which have a higher rate of inflation in the CPI than other classifications and the cost of fuel and force classes, may be the main cause of the disparity.

CONCLUSION

To sum up the information presented in this paper, it can be said that India's inflation peaked in 2019–20, following which the country was given the Inflation Focusing arrangement as the main strategy. After some time, inflation successfully focused on arrangement control expansion, and in 2018–19, the inflation rate dropped to approximately 3.41 percent. This essay looks at the basic financial structure of the Indian government or national bank and the inflation theory. However, there may be some negative effects of this arrangement on other macroeconomic aspects like business, monetary insufficiency or financing costs, and so forth. It is conceivable that the expansion focused strategy works well to control swelling in India. Adverse effects of increased focus are not covered in the scope of this research. Therefore, it should be possible to do additional research to analyse the impact of expansion by concentrating on various factors.

REFERENCES

1. Bhagavatiprakashsharma(July2014),InflationinIndia,GautamBuddhaUniversity.
2. 2 A mandeepSinghMARCH2019,Inflation in India: Theory ,Measure ,Policy and Trend,





Dhakshayini and Vinaykumar

3. [volume 6 Issue 1]Jan.–March 2019].
4. Mohanty, D.,Rath, D.P.,& Ramaiah,M.(2000). Measures of core inflation for India. Economic and Political Weekly, 273-282.
5. Patra,M.D., &Ray,P.(2010).Inflation expectations and monetary policy in India: An empirical exploration (No. 10-84). International Monetary Fund.

Table1: Consumer Price Index (CPI)

| Months /Years | Overall Growth rate | Growth of Coal (%) | Growth of Crude Oil (%) | Growth of Natural Gas (%) | Growth of Petroleum Refinery Product (%) | Growth of Fertilizers (%) | Growth of Steel (%) | Growth of Cement (%) | Growth of Electricity (%) |
|------------------|---------------------|--------------------|-------------------------|---------------------------|--|---------------------------|---------------------|----------------------|---------------------------|
| 2017-18(Apr-Mar) | 4.3 | 2.6 | -0.9 | 2.9 | 4.6 | 0.03 | 5.6 | 6.3 | 5.3 |
| 2018-19(Apr-Mar) | 4.4 | 7.4 | -4.1 | 0.8 | 3.1 | 0.3 | 5.1 | 13.3 | 5.2 |
| 2019-20(Apr-Mar) | 0.4 | -0.4 | -5.9 | -5.6 | 0.2 | 2.7 | 3.4 | -0.9 | 0.9 |
| 2020-21(Apr-Mar) | -6.5 | -1.9 | -5.2 | -8.2 | -11.2 | 1.5 | -9.0 | -11.4 | -0.5 |
| 2019-20(Apr-May) | 4.5 | 2.4 | -6.8 | -0.4 | 1.3 | -2.58 | 13.3 | 2.5 | 6.7 |
| 2020-21(Apr-May) | -29.4 | -14.7 | -6.7 | -18.3 | -22.7 | 2.0 | -61.3 | -53.7 | -18.7 |
| 2021-22(Apr-May) | 35.8 | 8.2 | -4.2 | 22.5 | 22.8 | -3.9 | 149.5 | 100.4 | 21.5 |

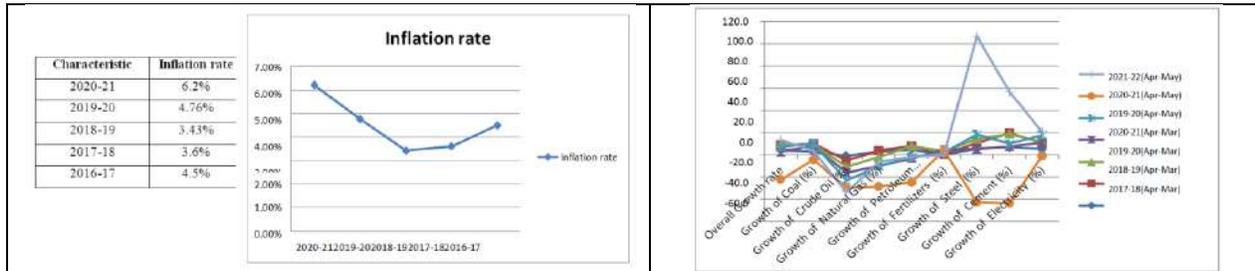


Fig. 1. Inflation rate from 2017-18 to 2020-21

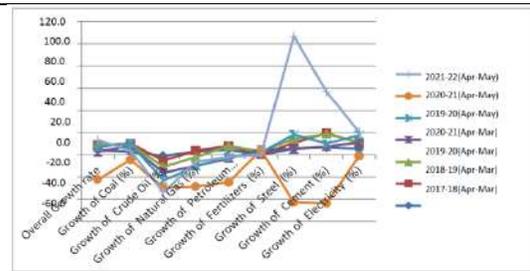


Fig. 2. Consumer Price Index (CPI)

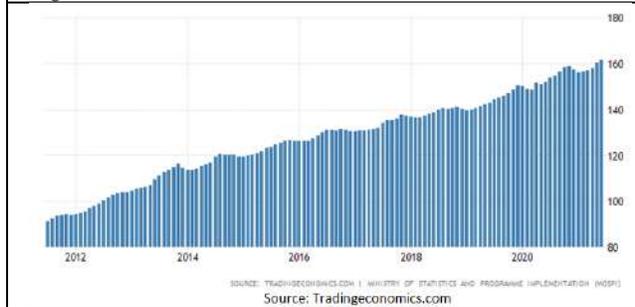


Fig.3. Primary Indicator

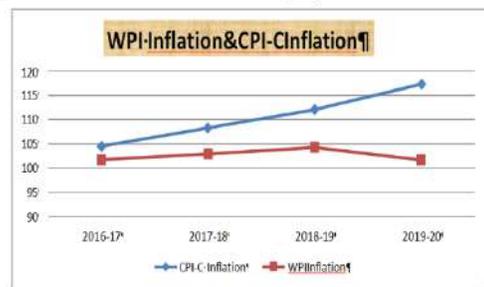


Fig. 4. WPI- Inflation & CPI Inflation





Buying Intention of Z gen on Green Electronic Home Appliances: An Empirical Investigation

Najma P^{1*} and Munavver Azeem Mullappally kayamkulath²

¹Junior Research Fellow, Department of Commerce and Management Studies, PSMO College, Tirurangadi, Kerala, India

²Assistant Professor, Research Supervisor, Department of commerce & management studies, PSMO College, Tirurangadi, Kerala, India.

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Najma p

Junior Research Fellow,

Department of Commerce and Management Studies,

PSMO College, Tirurangadi, Kerala, India

Email: najmakdpm@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Environmental sustainability has risen to the top of the international political agenda in recent decades, and it is now recognized as a key driver of innovation. The concept of green marketing arose as a result of organizations' concern for the environment. Green purchasing concept can encourage companies and community to undertake sustainability also try to balance the demand and supply sides of the trade cycle while addressing environmental and social benefits. Consumers are more sensitive to green products when making purchasing decisions as their awareness of environmental impact grows. The youth of today, who portray our society's future, appears to have a unique perception and attitude, allowing them to reflect on their choice of green products. This research empirically examines various personal factors which prompt young generation towards the buying of green electronic products. A survey was administered to collect responses from youth and questionnaire construction process held with the help of previous studies which were distributed among young consumers to know their valuable responses. For the analysis of data Simple correlation and regression were used and the study found out that there is significant relation between the personal factors and purchase intention among the z gen towards green electronic products.

Keywords: Green product, Purchase intention, Attitude, Emotion, Knowledge, Willingness to pay, Trust





Najma et al.,

INTRODUCTION

Over the last decade, global consumer consumption of goods and services has increased dramatically, resulting in depletion of natural resources and severe environmental damage. (Chen and Chai, 2010). Various countries around the world are becoming aware of this threat and have begun to work toward reducing the negative impact of their business activities on the environment. Intro to going green has become much more popular as the educated crowds become more willing to accept responsibility to preserve the natural environment. People are reducing their ecological footprint by engaging in environmentally friendly behaviours such as purchasing eco-friendly products. This realization and concern for the environment and society has given rise to the concept of 'sustainable development,' which emphasizes the need to promote sustainability and advocates for development that has the least negative impact on the environment and society. Green consumption provides the dual benefit of improved health and the opportunity to contribute to environmental sustainability (Leonidou et al., 2013). Green products are those that are environmentally friendly or sustainable, do not harm the environment, do not deplete natural resources, and can be recycled or conserved (Kim et al., 2013; Shamdasani et al., 1993). Environmental protection and waste reduction are the main two agenda of Green (Wu et al., 2018b). Yet literature says that the acceptability of green electronics products is slow (Jones, 2019; Kam-Sing et al., 2012; Zammit-Lucia, 2013). Environmental scientist have studied various components of green behaviour from both internal and external perspectives and have unanimously reported that environmental awareness, attitudes, beliefs, social influence, product price, product quality, and brand personality all have a considerable effect on green purchasing behaviour.(Chan, 2001; Chan and Lau, 2000; Goh and Balaji, 2016; Hahnel et al., 2014; Hassan, 2014; Lee et al., Lee, 2014; Panda et al., 2020). We believe that consumers' ability to think about and feel about the green environment can compel them to purchase green electronics products even at a higher price if they believe these products are performing well (Kumar and Ghodeswar, 2015; Wu et al., 2016a). Many studies on green purchasing behaviour have found a "gap" between consumers' expressed favourable attitudes and actual purchasing practises. (Tanner and Kast, 2003; Vermeir and Verbeke, 2006; Vermeir and Verbeke, 2008). Today, industrial products have caused significant environmental contamination throughout the world, attracting increased societal attention (Chang & Chen, 2013) As a result, we identified electronic and electric production as a category with a significant impact on environmental contamination; additionally, these products are under enormous pressure from legal regulations and public demand for environmentally friendly production(Ng, Butt, Khong, & Ong, 2013). Furthermore, some industries have implemented measures and taken the necessary steps to reduce environmental pollution. These measures include green marketing or environmentally friendly marketing, which means improving marketing actions in an environmentally and naturally friendly manner, as well as utilizing the company's social/environmental role to achieve continuous progress (Ranai Kordshuli & Yari Buzejani, 2011). With the growing importance of green marketing and corporate trends, particularly their critical role in company success, several studies have been conducted to explain the relationship between the green variables; however, additional research on this subject is required. The overall aim of this study was to examine various personal factors which leads the young generation to purchase green electronic product and to examine the trend of their purchasing intention.

REVIEW OF LITERATURE AND HYPOTHESIS

In this section, we argue the green purchase behaviour of the younger generation by drawing on findings from the literature on consumer adoption of green products as well as the literature on young consumers' involvement in environmental issues. (Liere and Dunlap) (1980) investigated people's perspectives for environmental issues and discovered that age, education, and political ideology were all highly connected, leading them to the conclusion that younger, well-educated, and liberal people are more concerned about environmental quality. And in the meantime, (Schultz 2001) revealed that the biosphere is yet another excuse for people to be concerned about their surroundings. Green marketing is a relatively new phenomenon in the field of marketing and business that has grown rapidly in the last few years (Chang & Chen, 2013) Green purchasing intention and behaviour are the most commonly





Najma et al.,

measured aspects of green purchasing. Green purchase intention refers to consumers' willingness to buy environmentally friendly products. Aspirations grasp the motivating factors that influence consumers' green purchasing behaviour. (Ramayah, Lee, and Mohamad, 2010). Through this study we aim to consider some Individual factors which related to an individual decision maker.

ATTITUDE

The measure of consumer perception to sustainable products is characterized as the views or attitudes that consumers have toward green products and their potential positive or negative effects on the environment. The aforementioned cognitive measure is often regarded as a special subjective norms in the literature on green consumer psychology. (Chen & Chai, 2010; Hines, Hungerford, & Tomera, 1987; Kaiser & Gutscher, 2003.) However, due to the mindset gap of green buying decisions made in the interest of environmental preservation, it differs from the measure of overall environmental attitude (Bamberg, 2003; Joshi & Rahman, 2015; Kaiser, Wöfling, & Fuhrer, 1999; Tan, 2011). Regarding the causal relationship between the general purchase attitude and the green purchasing attitude, several researchers confirmed that the purchase attitude is a stronger predictor of intention in the environmental behavioural study. They also discovered that consumers' favorable purchasing attitudes would result in their high level of green purchase attitudes. (Chan, 2001; Chan & Lau, 2000; Lai & Cheng, 2016; Lee, 2008; Yadav & Pathak, 2016). Therefore, the study tries to validate such causal relation of sustainable purchasing behaviour in the rising economies.H1: Consumers attitude towards green electronic products have a significant relationship with their green purchase intention.

EMOTION

(Makatouni, 2002) says that consumer are concerned about the environmental values. They are aware about the human, animal, and environment centred values. (Chan and Lau, 2000; Kanchanapibul et al., 2014) analysis shows that the ecological effect and knowledge are major factors which determine the buying behaviour of consumer. (Makatouni, 2002; Padel and Foster, 2005; Wang, Liu, and Qi, 2014; Zhao et al., 2014)Both the environmental concerns and responsibility have a direct relationship on purchase intention and actual purchase behaviour. Therefore, from the above reviews, it is clear that consumer emotions, specially environment concern has optimistic and straight impact on consumer green purchase intention and behaviour.H2: Consumers emotion about green electronic products have a significant relationship with their green purchase intention

KNOWLEDGE

There is a disconnection between ecological information and environmental performance, and there is ample evidence that these two aspects are not connected (Kollmuss and Agyeman (2002). According to (Kaiser et al. (1999) the relationship between these two variables and the findings appear to show that a favourable response affects each dimension. This is an important human commitment aspect that can promote ecological understanding and a behavioral viewpoint. When someone has a broad awareness of ecologically relevant topics including pollution, recycling, energy use and efficiency, renewable energy, and other green technologies, they are said to have a high level of environmental knowledge. (Chan, 2001; Kang et al., 2013; Murphy, 2005; Yadav & Pathak, 2016).According to the literature, environmental knowledge can be broadly divided into two categories: First, broad environmental knowledge, or a person's overall understanding of the natural world, its various ecosystems, and the issues it is associated with(Fryxell & Lo, 2003) Another is behavioral knowledge or practical advice based on consumers' capacity to perceive sustainability-related symbols, concepts, and their responsiveness to the issues. (Laroche et al., 2001; Mostafa, 2007b; Lee, 2011) The younger generation gets deeply interested in consumer activities. Despite these facts, little study has been undertaken on the importance of the knowledge and intentions of the younger generation with regard to environmental issues.H3: Consumers knowledge about green electronic products have a significant relationship with their green purchase intention.

WILLINGNESS TO PAY

Due to the high cost of production, green items are considerably more expensive than traditional products (Ling, 2013). Price has thus been identified as a vital constraint to green consumption (Gleim et al., 2013; Nasir and



**Najma et al.,**

Karakaya, 2014). Price plays a prominent role in picking which products to choose, especially among younger consumers with low purchasing power. Based on particular research from the West, people who care for the environment are not particularly price sensitive, and price has little bearing on whether they would want to buy green products (Grankvist and Biel, 2001; Cronin et al., 2011) In a survey conducted by state restaurant groups in the USA, had shown that consumers are unwilling to pay a premium for ecologically friendly goods and services (Choi and Parsa (2006)) The purchasing behaviour of Indian customers has indeed been shown by a few of previous studies. Manaktola and Jauhari (2007) reported that although customers with high EC supported hotels using green techniques, they were unable to pay a price premium for it. , Yadav and Pathak (2017) and Prakash and Pathak (2017) discovered that people would pay more for environmentally products. It is essential to investigate the impact of willingness to pay on green PIs in light of these contradicting findings. H4: Consumers willingness to pay for green electronic products have a a significant relationship with their green purchase intention.

TRUST

Trust is described as a conviction or expectation on a mitigating the environmental performance from the perspective of green products (Chen, 2012). In many research, the authors analyzed and examined the impact of customer trust on both behaviour and goal is to make green products. These research discovered that a significant obstacle to purchasing green products was the lack of consumer trust and respect in green promises and product attributes. (Bang et al., 2000; Fotopoulos and Krystallis, 2002; Gupta and Ogden, 2009; Krystallis et al., 2008; Tung et al., 2012; Vermeir and Verbeke, 2008) Vermeir, I., & Verbeke, W. (2008). Sustainable food consumption among young adults in Belgium: Theory of planned behaviour and the role of confidence and values. *Ecological Economics*, 64(3), 542-553. H5: Consumers trust about green electronic products have a significant relationship with their green purchase intention.

PURCHASE INTENTION

Purchase intent denotes an emotional reaction caused by a consumer's overall evaluation of a product, as well as the possibility that the consumer would like to purchase the product. (Grewal, Monroe, & Krishnan, 1998) Purchase intent is the best predictor of purchase behaviour. (Morwitz & Schmittlein, 1992). Zeithaml (1988) proposed three indexes as variables for measuring purchase intention: the likelihood that consumers will purchase the product, whether they consider purchasing the product, and whether they will recommend the product to their relatives and friends.. Dodds, Monroe, and Grewal (1991) Purchase possibility, purchase price, purchase probability, and purchase intention are all items raised for measuring purchase intent.. Bei and Yu (2001) Consumer purchase intent was measured using two major items: repurchase and recommending the item to other consumers.

METHODOLOGY

We focused on green electronics products that have a high impact on the environment and collected 329 valid samples in total from young generation who are the back bone of the present and future society by circulating Online questionnaires among college students in kerala using 'Likert scale'. Sample contains 329 respondents of graduate and post graduate students from various colleges in kerala. The measurements of variables (Attitude, Emotion, Knowledge, Willingness to pay, Trust, and Purchase intention) are adapted from past instruments. Analysis methods used to measure the variables are Statistical Package for Social Science (SPSS version 25.0). Table 1 shows the demographic details of the respondents.

DATA COLLECTION

The data was gathered from two (2) sources: primary data and secondary data. Primary data was collected using structured online questionnaires, with 329 sets of questionnaires distributed to graduate and postgraduate students from various colleges in Malappuram District via an online platform. The online survey was carried out using the Whatsapp application. Secondary data sources for this research include internet journals, articles, websites, and online publishing.





Najma et al.,

MEASUREMENT

All variable measurement scales are derived from previously developed scales. These variables are rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

FINDINGS AND CONCLUSION

Pearson Correlation Analysis Results between Dependent and Independent Variables are shown in table 2

- To determine the relationship between average attitude and average purchase intention, a Pearson correlation was used. There was a statistically significant positive correlation between attitude and average purchase intention. ($r=.355, n=329, p<0.000$)
- A positive and significant correlation was also found between average emotion and average purchase intention. ($r=.613, n=329, p<0.000$)
- Between knowledge of the young people and their purchase intention there was a positive and significant correlation found out. ($r=.522, n=329, p<0.000$)
- There was a statistically significant positive correlation between average willingness to pay and average purchase intention. ($r=.646, n=329, p<0.000$)
- A positive and significant correlation was also found between average trust and average purchase intention. ($r=.696, n=329, p<0.000$)

In this respect all the H1, H2, H3, H4, and H5 Hypothesis were accepted.

The findings of regression analysis are as follows;

- A simple linear regression was used to see how well purchase intention predicted a customer's Attitude toward purchasing a green electronic product. The regression equation for predicting attitude based on purchase intention was $\hat{y}=2.550+.360*$ average attitude. The R Square for this equation was .126; that is 12.6% of the variance in dependent variable purchase intention was explained by independent variable attitude. For each unit of increase in attitude, purchase intention increased by about .360 unit. Thus the simple linear regression shows a significant relation between average attitude and purchase intention. ($p<0.000$)
- The regression equation for predicting emotion based on purchase intention was $\hat{y}=1.413+.623*$ average emotion. The R Square for this equation was .376; that is 37.6% of the variance in dependent variable purchase intention was explained by independent variable emotion. For each unit of increase in emotion, purchase intention increased by about .623 unit. Thus the simple linear regression shows a significant relation between average attitude and purchase intention. ($p<0.000$)
- To determine how well purchase intention predicted a customer's knowledge about purchasing a green electronic product, a simple linear regression was used. The regression equation for predicting knowledge based on purchase intention had an average knowledge of $=2.540+.422*$. The R Square for this equation was .272, which means that independent variable emotion explained 27.2 percent of the variance in dependent variable purchase intention. Purchase intention increased by about .422 unit for every unit increase in emotion. As a result, the simple linear regression demonstrates a significant relationship between average attitude and purchase intention. ($p < 0.000$)
- A simple linear regression was used to see how well purchase intention predicted a customer's willingness to purchasing a green electronic product. The regression equation for predicting willingness to pay for green electronic products based on purchase intention was $\hat{y}=1.883+.548*$ average willingness. The R Square for this equation was .417; that is 41.7% of the variance in dependent variable purchase intention was explained by independent variable emotion. For each unit of increase in emotion, purchase intention increased by about .548 unit. Thus the simple linear regression shows a significant relation between average attitude and purchase intention. ($p<0.000$)
- To determine how well purchase intention predicted a customer's trust in purchasing a green electronic product, a simple linear regression was used. The average trust in the regression equation for predicting trust based on purchase intention was $=1.569+.627*$. The R Square for this equation was .484, indicating that the independent





Najma et al.,

variable trust explained 48.4 percent of the variance in the dependent variable purchase intention. Purchase intention increased by about .627 unit for every unit increase in trust. As a result, the simple linear regression reveals a significant relationship between average attitude and purchase intention. ($p < 0.000$)

So from the above findings all the hypothesis are accepted. The table (3) shows the result of hypothesis testing based on the correlation and regression analysis.

CONCLUSION

Greener worlds are difficult to create unless both businesses and consumers begin by thinking green and feeling affectionate towards a clean environment collectively. Because of the growing number of green productions and businesses, marketers must advance their understanding of consumer psychology toward green products in order to increase green consumption. The youngsters seem to be more engaged in environmental issues than other groups. One important reason for this is their ability to communicate and exchange information using borderless technology. Young people's social networks have a tendency to dominate their perception, which reinforces their personal affective response and refines their ecological knowledge. According to the findings, personal affective response is a major motivator for getting involved in environmental issues.

The study says that the various personal factors like attitude, emotion, knowledge, willingness to pay, and trust has a positive significant relation with the purchase intention of green electronic products. Attitude of young generation towards the environment has increased tremendously as their environmental concern has developed. Their consciousness and realization about the environmental issues are greater as compared to past as they are exposed to the nature than before. Likewise the emotion of the younger people also plays a vital role in their purchase intention. Their feeling and sensation towards the environment has brought changes in their consumption pattern also. They are more knowledgeable about the green electronic product how they differ from other product, how the packaging can reduce the amount of landfill waste. Most of the youth were aware about the labels in the product package and symbols. The study also found that the today's youth are not much concerned about the premium price of the green products as they are aware about the environmental hazardous. And because of this reason they are ready to pay the premium price for the product. The findings confirm that the personal factors play a significant role in determining young consumers' green involvement as well as their actual purchase. Future research could be conducted by broadening the study into other individual factors and situational factors which could be revealed by comparing different groups of consumers.

REFERENCES

1. Bamberg, S. (2003). How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. *Journal of Environmental Psychology*, 23(1), 21–32
2. Bang, H. K., Ellinger, A. E., Hadjimarcou, J., & Traichal, P. A. (2000). Consumer concern, knowledge, belief, and attitude toward renewable energy: An application of the reasoned action theory. *Psychology & Marketing*, 17(6), 449-468
3. Bei, L. T., & Yu, C. C. (2001). An integrated model for the effects of perceived product, perceived service quality, and perceived price fairness on consumer satisfaction and loyalty. *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior*, 14, 125-140.
4. Chan, R. Y. (2001). Determinants of Chinese consumers' green purchase behavior. *Psychology & Marketing*, 18(4), 389–413. Chan, R. Y., & Lau, L. B. (2000). Antecedents of green purchases: A survey in China. *Journal of Consumer Marketing*, 17(4), 338–357.
5. Chan, R. Y., & Lau, L. B. (2000). Antecedents of green purchases: a survey in China. *Journal of consumer marketing*, 17(4), 338-357.
6. Chan, R.Y., 2001. Determinants of Chinese consumers' green purchase behavior. *Psychol. Market.* 18 (4), 389–413.





Najma et al.,

7. Chan, R.Y., Lau, L.B., 2000. Antecedents of green purchases: a survey in China. *J. Consum. Market.* 17 (4), 338–357. doi:10.1108/07363760010335358.
8. Chang, C.-H., & Chen, Y.-S. (2013). Managing green brand equity: The perspective of perceived risk theory. *Quality & Quantity*, 48, 1753–1768.
9. Chang, C.-H., & Chen, Y.-S. (2013). Managing green brand equity: The perspective of perceived risk theory. *Quality & Quantity*, 48, 1753–1768.
10. Chen, J., & Lobo, A. (2012). Organic food products in China: determinants of consumers' purchase intentions. *The International Review of Retail, Distribution and Consumer Research*, 22(3), 293-314.
11. Chen, T. B., & Chai, L. T. (2010). Attitude towards the environment and green products: Consumers' perspective. *Management science and engineering*, 4(2), 27- 39.
12. Chen, T. B., & Chai, L. T. (2010). Attitude towards the environment and green products: consumers' perspective. *Management Science and Engineering*, 4(2), 27
13. Choi, G. and Parsa, H.G. (2006), "Green practices II: Measuring restaurant managers' psychological attributes and their willingness to charge for the 'Green Practices' ", *Journal of Food Service Business Research*, Vol. 9 No. 4, pp. 41-63.
14. Cronin, J.J. Jr, Smith, J.S., Gleim, M.R., Ramirez, E. and Martinez, J.D. (2011), "Green marketing strategies: an examination of stakeholders and the opportunities they present", *Journal of Academy of Marketing Science*, Vol. 39 No. 1, pp. 158-174
15. Dodds, W. B., Monroe, K., & Grewal, D. (1991). Effects of price, brand, and store information on buyers' product evaluations. *Journal of Marketing Research*, 28, 307-319. <http://dx.doi.org/10.2307/3172866>
16. Fotopoulos, C., & Krystallis, A. (2002). Organic product avoidance: reasons for rejection and potential buyers' identification in a countrywide survey. *British Food Journal*, 104(3/4/5), 233-260.
17. Fryxell, G. E., & Lo, C. W. (2003). The influence of environmental knowledge and values on managerial behaviours on behalf of the environment: An empirical examination of managers in China. *Journal of Business Ethics*, 46(1), 45–69
18. Gleim, M.R., Smith, J.S., Andrews, D. and Cronin, J.J. (2013), "Against the green: a multi method examination of the barriers to green consumption", *Journal of Retail*, Vol. 89 No. 1, pp. 44-61.
19. Goh, S.K., Balaji, M., 2016. Linking green skepticism to green purchase behavior. *J. Clean. Prod.*, 131 629–638. <https://doi.org/10.1016/j.jclepro.2016.04.122>
20. Grankvist, G. and Biel, A. (2001), "The importance of beliefs and purchase criteria in the choice of eco-labeled food products", *Journal of Environmental Psychology*, Vol. 21 No. 4, pp. 405-410.
21. Grewal, D., Monroe, K. B., & Krishnan R. (1998). The effects of price-comparison advertising on buyers' perceptions of acquisition value, transaction value, and behavioral intentions. *Journal of Marketing*, 62(2), 46-59. <http://dx.doi.org/10.2307/1252160>
22. Gupta, S., & Ogden, D. T. (2009). To buy or not to buy? A social dilemma perspective on green buying. *Journal of Consumer Marketing*, 26(6), 376-391.
23. Hahnel, U.J., Gözl, S., Spada, H., 2014. How does green suit me? Consumers mentally match perceived product attributes with their domain-specific motives when making green purchase decisions. *J. Consum. Behav.* 13 (5), 317–327
24. Hassan, SH, 2014. The role of Islamic values on green purchase intention. *J. Islam. Market.* 5 (3), 379–395. doi:10.1108/jima-11-2013-0080.
25. Jones, E., 2019. Rethinking greenwashing: corporate discourse, unethical practice, and the unmet potential of ethical consumerism. *Sociol. Perspect.* 62 (5), 728– 754. doi:10.1177/0731121419849095
26. Joshi, Y., & Rahman, Z. (2015). Factors affecting green purchase behaviour and future research directions. *International Strategic Management Review*, 3(1), 128–143
27. Kaiser, F. G., & Gutscher, H. (2003). The proposition of a general version of the theory of planned behavior: Predicting ecological behavior. *Journal of Applied Social Psychology*, 33(3), 586–603
28. Kam-Sing Wong, S., Bigliardi, B., 2012. The influence of green product competitiveness on the success of green product innovation. *Eur. J. Innov. Manag.* 15 (4), 468–490. doi:10.1108/14601061211272385





Najma et al.,

29. Kanchanapibul, M., Lacka, E., Wang, X., & Chan, H. K. (2014). An empirical investigation of green purchase behaviour among the young generation. *Journal of Cleaner Production*, 66, 528-536. Kang, J., Liu, C., & Kim, S. H. (2013).
30. Kim, Y.J., Njite, D. and Hancer, M. (2013), "Anticipated emotion in consumers' intentions to select eco-friendly restaurants: augmenting the theory of planned behavior", *International Journal of Hospitality Management*, Vol. 34 No. 1, pp. 255-262.
31. Krystallis, A., Vassallo, M., Chrysosoidis, G., & Perrea, T. (2008). Societal and individualistic drivers as predictors of organic purchasing revealed through a portrait value questionnaire (PVQ)based inventory. *Journal of Consumer Behaviour*, 7(2), 164-187
32. Kumar, P., Ghodeswar, B.M., 2015. Factors affecting consumers' green product purchase decisions. *Market. Intel. Plann.* 33 (3), 330–347. doi:10.1108/ mip-03-2014-0068
33. Laroche, M., Bergeron, J., & Barbaro-Forleo, G. (2001). Targeting consumers who are willing to pay more for environmentally friendly products. *Journal of Consumer Marketing*, 18(6), 503–520.
34. Lee, K. (2011). The role of media exposure, social exposure and biospheric value orientation in the environmental attitude-intention-behavior model in adolescents. *Journal of Environmental Psychology*, 31(4), 301–308.
35. Lee, K., 2008. Opportunities for green marketing: young consumers. *Market. Intel. Plan.* 26 (6), 573–586. <https://doi.org/10.1108/02634500810902839>
36. Leonidou, C.N., Katsikeas, C.S. and Morgan, N.A. (2013), " 'Greening' the marketing mix: do firms do it and does it pay off?", *Journal of Academy of Marketing Science*, Vol. 41 No. 2, pp. 151-170.
37. Liere, K., Dunlap, R., 1980. The social bases of environmental concern: a review of hypotheses, explanations and empirical Evidence. *Public Opin. Q.* 44 (2),181e197.
38. Ling, C.Y. (2013), "Consumers' purchase intention of green products: an investigation of the drivers and moderating variable", *Elixir Marketing Management*, Vol. 57A No. 1, pp. 14503-14509.
39. Makatouni, A. (2002). What motivates consumers to buy organic food in the UK?: Results from a qualitative study. *British Food Journal*, 104(3/4/5), 345-352.
40. Manaktola, K. and Jauhari, V. (2007), "Exploring consumer attitude and behaviour towards green practices in the lodging industry in India", *International Journal of Contemporary Hospitality Management*, Vol. 19 No. 5, pp. 364-377
41. Morwitz, V. G., & Schmittlein, D. (1992). Using segmentation to improve sales forecasts based on purchase intent: which interders actually buy? *Journal of Marketing Research*, 29(4), 391-405. <http://dx.doi.org/10.2307/3172706>
42. Mostafa, M. M. (2007b). Gender differences in Egyptian consumers' green purchase behaviour: The effects of environmental knowledge, concern and attitude. *International Journal of Consumer Studies*, 31(3), 220–229.
43. Murphy, P. E. (2005). Sustainable marketing. *Business & Professional Ethics Journal*, 24(1/2), 171–198.
44. Nasir, V.A. and Karakaya, F. (2014), "Consumer segments in organic foods market", *Journal of Consumer Marketing*, Vol. 31 No. 4, pp. 263-277.
45. Ng, P. F., Butt, M. M., Khong, K. W., & Ong, F. S. (2013). Antecedents of green brand equity: An integrated approach. *Journal of Business Ethics*, 121, 203–215
46. Padel, S., & Foster, C. (2005). Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food. *British food journal*, 107(8), 606-625.
47. Panda, T.K., Kumar, A., Jakhar, S., Luthra, S., Garza-Reyes, J.A., Kazancoglu, I., Nayak, S.S., 2020. Social and environmental sustainability model on consumers' altruism, green purchase intention, green brand loyalty and evangelism. *J. Clean. Prod.*, 243, 118575 doi:10.1016/j.jclepro.2019.118575.
48. Ramayah, T., Lee, J. W. C., & Mohamad, O. (2010). Green product purchase intention: Some insights from a developing country. *Resources, Conservation and Recycling*, 54(12), 1419-1427.
49. Ranai Kordshuli, H., & Yari Buzejani, A. (2011). Effects of green marketing mix on green purchasing decisions of consumers (Case Study: Consumers of Pegah Dairy Company in the city of Shiraz). *The Quarterly Journal of Modern Marketing Research*, 4, 180–165.
50. Schultz, P., 2001. The structure of environmental concern: concern for self, other people, and the biosphere. *J. Environ. Psychol.* 21 (4), 327e339.





Najma et al.,

51. Tanner, C., & Wölfling Kast, S. (2003). Promoting sustainable consumption: Determinants of green purchases by Swiss consumers. *Psychology & Marketing*, 20(10), 883-902.

52. Tung, S. J., Shih, C. C., Wei, S., & Chen, Y. H. (2012). Attitudinal inconsistency toward organic food in relation to purchasing intention and behavior: An illustration of Taiwan consumers. *British Food Journal*, 114(7), 997-1015.

53. Vermeir, I., & Verbeke, W. (2006). Sustainable food consumption: Exploring the consumer “attitude-behavioral intention” gap. *Journal of Agricultural and Environmental Ethics*, 19(2), 169-194.

54. Vermeir, I., & Verbeke, W. (2008). Sustainable food consumption among young adults in Belgium: Theory of planned behaviour and the role of confidence and values. *Ecological Economics*, 64(3), 542-553.

55. Wang, P., Liu, Q., & Qi, Y. (2014). Factors influencing sustainable consumption behaviors: a survey of the rural residents in China. *Journal of Cleaner Production*, 63, 152-165

56. Wu, J., Guo, S., Huang, H., Liu, W., Xiang, Y., 2018b. Information and communications technologies for sustainable development goals: state-of-the-art, needs and perspectives. *IEEE Commun. Surv. Tutor.* 20 (3), 2389–2406

57. Wu, J., Guo, S., Li, J., Zeng, D., 2016b. Big data meet green challenges: greening big data. *IEEE Syst. J.* 10 (3), 873–887.

58. Yadav, R. and Pathak, G.S. (2017), “Determinants of consumers green purchase behavior in a developing nation: applying and extending the theory of planned behavior”, *Ecological Economics*, Vol. 134 No. 1, pp. 114-122.

59. Yadav, R., & Pathak, G. S. (2016). Young consumers' intention towards buying green products in a developing nation: Extending the theory of planned behavior. *Journal of Cleaner Production*, 135, 732–739

60. Zammit-Lucia, J., 2013. Why green brands are failing to capture public attention. *Guard*. 5 July.

61. Zeithaml, V. A. (1988). Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *Journal of Marketing*, 52, 2-22. <http://dx.doi.org/10.2307/1251446>

62. Zhao, H. H., Gao, Q., Wu, Y. P., Wang, Y., & Zhu, X. D. (2014). What affects green consumer behavior in China? A case study from Qingdao. *Journal of Cleaner Production*, 63, 143-151.

Table 1. Demographic profile of respondents

| Demographic variables | Category | Frequency | Percent |
|-----------------------|---------------|-----------|---------|
| Gender | Male | 189 | 57 |
| | Female | 140 | 43 |
| Education | Graduate | 151 | 46 |
| | Post graduate | 178 | 54 |
| | Others | - | - |
| Income/month | Below 5000 | 183 | 55 |
| | 5000-10000 | 52 | 16 |
| | Above 10000 | 94 | 29 |

Table 2. Correlation between Dependent and Independent Variables

| Factors | | Purchase intention |
|-----------|---|--------------------|
| ATTITUDE | R | .355** |
| | P | .000 |
| | N | 329 |
| EMOTION | R | .613** |
| | P | .000 |
| | N | 329 |
| KNOWLEDGE | R | .522** |
| | P | .000 |
| | N | 329 |





Najma et al.,

| | | |
|--|---|--------|
| WILLINGNESS | R | .646** |
| | P | .000 |
| | N | 329 |
| TRUST | R | .696** |
| | P | .000 |
| | N | 329 |
| Correlation is significant at the 0.01 level (2-tailed). | | |

Table 3. influence of attitude on purchase intention of green electronic products

| Model Summary | | | | |
|--|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .355 ^a | .126 | .123 | .44808 |
| a. Predictors: (Constant), AVRG_ATTITUDE | | | | |

Table 4. Influence of emotion on purchase intention of green electronic products

| Model Summary | | | | |
|---|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .613 ^a | .376 | .374 | .37854 |
| a. Predictors: (Constant), AVRG_EMOTION | | | | |

Table5. Influence of knowledge on purchase intention of green electronic products

| Model Summary | | | | |
|---|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .522 ^a | .272 | .270 | .40888 |
| a. Predictors: (Constant), AVRG_KNOWLEDGE | | | | |

Table6. influence of willingness on purchase intention of green electronic products

| Model Summary | | | | |
|---|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .646 ^a | .417 | .415 | .36595 |
| a. Predictors: (Constant), AVRG_WILLINGNESS | | | | |

Table 7. influence of trust on purchase intention of green electronic products

| Model Summary | | | | |
|---------------------------------------|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .696 ^a | .484 | .482 | .34437 |
| a. Predictors: (Constant), AVRG_TRUST | | | | |



**Najma et al.,****Table 8. Result of hypothesis testing**

| Hypothesis | Result |
|--|----------|
| H1; : Consumers attitude towards green electronic products have a positive association with their green purchase intention | Accepted |
| H2; Consumers emotion about green electronic products have a positive association with their green purchase intention | Accepted |
| H3; : Consumers knowledge about green electronic products have a positive association with their green purchase intention | Accepted |
| H4; : Consumers willingness to pay for green electronic products have a positive association with their green purchase intention | Accepted |
| H5; : Consumers trust about green electronic products have a positive association with their green purchase intention | Accepted |





Promotion and Sustainability of Eco-friendly Behaviour among Employees through Green HRM Practices with reference to Higher Educational Institute

Deepika .V^{1*} and Kavya K D²

¹Associate Professor,

Global Institute of Management Sciences, RR Nagar, Bangalore, Karnataka, India.

²Assistant Professor, Global Institute of Management Sciences, RR Nagar, Bangalore, Karnataka, India

Received: 04 June 2022

Revised: 22 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Deepika .V

Associate Professor, Global Institute
of Management Sciences, RR Nagar, Bangalore,
Karnataka, India.

Email: deepikavenkatesh2609@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In the present context, green HRM is a hot topic for research. Due to the human resource department's potential to be instrumental in going green, Green Human Resource Management (GHRM) has emerged as a critical component of administration strategies in Higher Education. A Green HRM practice, which combines environmental management with HRM, is becoming more and more necessary in institution. Green HRM initiatives in HR are comprehensive type of corporate social responsibility. It is wide approach for creating an eco-friendly culture of sustainability which might benefit the green human resource management function of the institution. The Green HRM Practices involves making adjustments to HR tasks like hiring, on boarding, training and development, as well as conducting performance reviews and paying employees. The Green Human Resource Management will play a significant part in firm's efforts to address environmental issues by incorporating it into management philosophies, HR policies and practices, employee training, and the application of environmental safety laws. In this study, efforts are made to highlight the significance of Green HRM on employee eco-friendly behavior through its practices in Higher Education. The current study is on "Promotion and Sustainability of Eco-friendly Behavior among employees through Green HRM Practices with reference to Higher Education Institute"

Keywords: Green HRM, Green HR practices, Sustainability, Promotion, Eco-friendly Employee Behaviour, Higher Education.



**Deepika and Kavya**

INTRODUCTION

The term "human resources" is used to refer to both the employees of a business or organization as well as the division in charge of overseeing all employee-related issues. Employees are one of the most valuable resources in any company or organization. When the importance of labour relations started to gain attention and ideas like motivation, organizational behavior, and selection assessments started to take shape in all different kinds of work environments, the word "human resources" was first used in the year 1960s. An organization's human resources department should have the tools necessary to play a significant part in the creation of their sustainable culture.

WHAT IS GREEN HRM?

The word 'Green' does not only notify the colour but it conveys the idea of environmental friendly. It became originated in 1996 which is given by Wehrmeyer (1996) who have edited the e-book titled Greening people: Human Resources and Environmental Management. Green HRM is the application of HRM policies to promote resource sustainability inside organizations and, more frequently, to assist environmental sustainability. Through the influence of organizations/ business/ institution green strategies, green HRM practices currently affect employees' perception and cognition. By fostering a sustainable environment, these qualities will motivate workers to provide green recovery services from the perspective of transformational leadership. Corporate attention was primarily directed at financial gain and environmental harm. The catastrophes that are happening all around the world are serious, not to mention that humanity frequently fails to protect itself. Since industries and business are our suppliers of needs, we as individuals cannot stop the causes from these entities. Therefore, in order to rescue the earth and the future generations, we must all do additional alternative acts by practicing green behaviour.

GREEN HRM MANAGEMENT

A green organization is characterized as a workplace that values social responsibility, resource efficiency, and environmental sensitivity. Different definitions of "green management" for sustainable development can be found in environmental writing, all of which aim to make clear and necessity striking of a balance between organizational growth for wealth creation and environmental protection in order for future decision-making to be successful (Daily and Huang, 2001). In the past, organizations and their shareholders have equated the organization's financial performance with its corporate success, but this is no longer appropriate. In order to achieve profitable and financial outcomes carbon footprints must be minimized, social and environmental awareness must be raised.

LITERATURE REVIEW

Sushma Rani & Dr. K. Mishra (2014) "Green HRM: Practices and Strategic Implementation in the organizations", International Journal on Recent and Innovation trends in computing and communication, Volume: 2. this paper examines the relationship between green HRM practices and its strategies and implementation in the organization. The objectives of this research were to study green HRM in more comprehensive manner and to study the outcome after adopting the green HRM in the organization. The literature on green HRM and a few green practises was examined in this paper, which also provided a paradigm for green HRM. Employers can receive support from unions and workers by approving Green HRM practises and policies that safeguard and enhance employee health and wellbeing. The model described in this study clearly distinguishes between a system that implements Green HRM and a system that uses commonly accepted HRM system practises in an organization, emphasising the advantages of Green HRM and some associated practises.

Subhadeep Mukherjee 1, Dr. Soumendrabhattacharjee 2, Nabanita Paul 3, Urvashi Banerjee 4 (2020) "Assessing Green Human Resource Management Practices in Higher Education Institute", The Mattingley Publishing Co., Inc., Volume 82, Page No. 221-240, Issue: Jan-Feb 2020. This paper assesses the green HRM practices in Higher Educational Institute. This paper intended to identify the best green practices at NIT Silchar and to identify the extent of use of green HRM practices at NIT Silchar. Through this study it was found out that majority of the respondents, around 80% are aware of green practices. They plant trees at home and office regularly and most of



**Deepika and Kavya**

them uses own vehicle for commuting within the campus. Very less number of respondents uses TOTO or bicycle for daily use. One of the issues observed is the awareness of employees about the green policies. It seems that even policies exist but employees are not aware of it. This indicates that there is lack of information sharing among employees from the top management.

Mehtab-un-Nisa 1, AtifMahmood 2, Moeed Ahmad Sandhu 3, Sara Kanwal 4, Mr. JavedIqbal (corresponding author) 5,(2016) "The Effect of Green HRM practices on sustainability: Evidence from Manufacturing companies in Pakistan" Pakistan Journal of Social Sciences (PJSS), Volume 36, No.1, PP 177-188. This paper examines the relationship between Green HRM practices and its effects on sustainability in the manufacturing companies. The objectives of this study was to understand the effect of green human resource management practices on sustainability of manufacturing companies employees, to Conduct studies on several green practices and processes that can be integrated in organizations for structure a green workplace and to identify the effect of GHRM practices on sustainability in the presence of control variables like age, gender, designation, education and length of employment. Though this study it was found out that significance of green HRM practices is dynamic to endorse employee confidence and this may help in arriving at a great deal of advantage for both the business and employees.

RESEARCH GAP:

Various research is been taken up and done based on Green HRM practices adopted in various industries or organization but Academic Institute based research paper are very limited, even though awareness of green activities is been practiced by many Institutions all over the world. And there are research done on various Green HR practices. Hence there is a need for additional research to be carried on the Green HRM practice adopted in Higher Education its promotion and sustainability. This current study is done to fill that gap.

OBJECTIVE OF STUDY

The main purpose of this study is:

- To Review the various Green HRM practices followed at institutions of higher education.
- To Study the steps adopted by institutions in promoting eco-friendly behavior through Green HRM practice.
- To understand the Sustainability of Green HRM practices at institutions of higher education.

RESEARCH METHODOLOGY**Research Method**

Descriptive method was followed to conduct this specific research, as the data for the study was collected through a survey with the objective of understanding the opinion of the respondents on the topic of study. This study also follows analytical method of research where we understand the relationship between Green HRM practice followed at institutions and its effect on eco-friendly behavior of the employees.

Research Area

The research is carried out in the institutions of Higher Education affiliated to Bangalore University, Bangalore, Karnataka.

Sampling Method

The Samples for this study are drawn using Non-Probability method of Sampling, using Snowball method.

Sample Unit

The Sample unit for this study are both Teaching and Non-Teaching Staffs of Higher Education.



**Deepika and Kavya****Sample Size**

The sample size selected for this specific study is 54 respondents out of which 80% of respondents are teaching staffs and 20% of respondents are non-teaching staffs.

Data Collection Method**Primary Data**

Primary data is collected through a Structured Questionnaire consisting of 27 question of different category such as multiple choices, dichotomous, descriptive and viewpoint questions which are divided in three categories distributed to both teaching and non-teaching staffs of higher education.

Secondary Data

Secondary data are collected through various secondary sources such as Project reports, journal thesis and web browser.

DATA ANALYSIS AND INTERPRETATION

The Study was targeted to a sample size of 60 respondents. To collect response a well-structured questionnaire was designed and distributed to staffs of Higher Education Institute through G-form out of which only 54 respondents participated and completed the survey and remaining 6 respondents did not participate in the survey.

Demographic Characteristics of the respondents (N=54):

The demographic characteristics of the participant's area, age, gender, type of staff, educational qualification, and type of employment, designation and work experience of the respondents. This will basically help to understand the overall demographic profile of the employees Higher Educational Institute.

Type of Staff

The above Table 1 represents the categories of staff participated in the survey. Out of 100% of respondents majority of the respondents are teaching staff i.e., 89% and the remaining are non-teaching staffs.

Type of Employment

From the data displayed above from Table No.2, it is found out that there is equal no of permanent and temporary staffs participated in the survey. Only 3.7% of respondents are part-time staffs.

Survey Questions on Topic**Awareness about Green HRM practices at institute**

From the above Table No.3, it is absorbed that out of % of respondent's majority of the respondents that is 81.5% of respondents are aware of the Green HRM practices and its sustainability in their institute. But around 3.7% of respondents say that there is such practice in our institute.

Green HRM practices followed at institutes

From the data displayed in the above Table No.4 and chart No.1, it is interpreted that out of the various most common Green HRM practices followed at institute the most popular and intensely followed is creating awareness about switching off lights, fan, computer and other devices when not in use and other popular GHM practices are using both the side of sheets, providing sapling during special occasion and planting and maintaining plants and trees in around the campus.

Green Recruitment and Selection practices followed in institutes

From the above data from table no.5 and chart 2 it can be interpreted that the most popular method of green recruitment and selection practices followed at institutes are online job posting and submission of application as it is one of the most cost effective method of recruitment and its more effective as its reach is vast with reference to geography and saves lot of money and time of both candidate and the management.



**Deepika and Kavya****Green Training and Development followed at institutes**

As the response collected from the survey it is projected in the above table no.10&Chart 3, that majority of the respondents stated that institution provides induction on environmental practices and sustainability as awareness about the GHRM practices from day one contributes to effective practice also, providing training on saving and conserving energy in the campus is the Green T&D followed in the organization.

Green Exit Practices followed at institute

From the data displayed in the above table no.6 , and chart 4 it is found that the most popular method of green exit practice followed at institute is accepting resignation of employees through email or online portal, it's definitely a eco-friendly practiced as well awarding certificates to employees initiating green practice during the tenure.

Top Management support towards Green HRM practices at the institute

From the data projected in table No.7, it is interpreted that majority of the respondents agree that the top management of the institute support Green HRM practice or initiatives in the campus. As implementing Green HRM has huge initial cost it has to be bared by institute by the support of management only then is promotion and sustenance in the campus is possible.

Research Findings**Summary of the findings from the data collected for 1st objective**

Through this survey we have review various Green HRM practices followed at various Higher Educational Institute among which most popular and intensely followed GHRM practice is creating awareness about switching off lights, fan, computer and other devices when not is use and other popular GHRM practices are using both the side of sheets, providing sapling during special occasion and planting and maintaining plants and trees in around the campus.

Summary of the findings from the data collected for 2nd objective

Through this study it was found out that Green HRM practices are followed in various HRM functions of Higher Educational Institutes such as Recruitment and selection where the most popular method is online job posting and submission of application through online. In case of training and development, induction on environmental practices and sustainability are introduced from day one of employee joining the institute. And in case of employee participation employees are given opportunity in sharing their innovative ideas in green practice in the institute. But Green performance evaluation system and green exit is not that effectively followed and given importance.

Summary of the findings from the data collected for 3rd objective

Top management of the institute are giving importance for promotion and sustainability of Green HRM practices in the institute by giving the financial support, by organizing programmers and providing training to both staffs and students.

CONCLUSION

As we see green HRM implementation in higher education institutes are increasing as it is very important in current scenario to upgrade its HR practices aligned with environment friendly practices. Higher educational institutes play a very vital role in the society. Therefore the employees of Higher education should be responsible enough to protect the environment and spread awareness among students regarding environmental practices. Top management of the institute should realize the importance of green HRM and implement it to a large extent. They should take initiatives to motivate students and teachers to follow green practices at work places as well as home. One of the issues observed was not including green performance evaluation system in the policy by including; it will motivate the staffs to follow green practices in the institutes. It seems that even Green Exit policies should be initiated in the institute in the coming days.





Deepika and Kavya

REFERENCES

1. Daily, B. F. and Huang, S. (2001). Achieving sustainability through attention to human resource factors in environmental management. *International Journal of Operations & Production Management*, 21(12), 1539- 1552.
2. Lee, K. H. and Ball, R. (2003). Achieving Sustainable Corporate Competitiveness: Strategic Link between Top Management's (Green) Commitment and Corporate Environmental Strategy. *Greener Management International*, (44), 89-104.
3. Sushma Rani & Dr. K. Mishra (2014) "Green HRM: Practices and Strategic Implementation in the organizations", *International Journal on Recent and Innovation trends in computing and communication*, Volume: 2.
4. Siegel, D. (2009). Green Management Matters Only If It Yields More Green: An Economic/Strategic Perspective. *The Academy of Management Perspectives*, 23(3), 5
5. Brio, J.A.D., Fernandez, E., and Junquera, B.,13Management and employee involvement in achieving an environmental action-based competitive advantage: an empirical study, *The Inter. J. of H R M*, 18(4),(April), (2007)
6. Brockett, J., Change agents,16 *People Management*, 23rdNovember, 18-19 (2006)
7. Brockett, J.,17 Prepare now for big rise in "green"jobs, *People Management*, 17th May (2007).
8. Subhadeep Mukherjee 1, Dr. Soumendrabhattacharjee 2, Nabanita Paul 3, Urvashi Banerjee 4 (2020) "Assessing Green Human Resource Management Practices in Higher Education Institute", *The Mattingley Publishing Co., Inc.*, Volume 82, Page No. 221-240, Issue: Jan-Feb 2020.
9. Denton, D.K., 10 Employee involvement, pollution control
10. Opatha, HHDNP. (2013). Green Human Resource Management: A Simplified Introduction. *Proceedings of the HR Dialogue –2013*, 12-20.
11. Sriram, V. P., and Suba, M. (July, 2017). Impact of Green Human Resource Management (G-HRM) Practices over Organization Effectiveness. *Journal of Advance Research in Dynamical & Control Systems*.
12. Mandip, G. (Jan, 2012). Green HRM: People Management Commitment to Environmental Sustainability. *Research Journal of Recent Sciences*, 1, 244-252.
13. Agarwal, D., and Tiwari, P. (December, 2015).Green HRM- A way to greening the environment. *IOSR Journal of Business and Management*, 17, 45-53.
14. James, P. (1996) 'Total Quality Environmental Management and Human Resource Management', in Wehrmeyer, W. (ed) (1996), op cit., pp.35-48.
15. Beard, C., and Rees, S. (2000) 'Green teams and the management of environmental change in a UK county council', *Environmental Management and Health*, vol.11, no.1, pp.27-38.
16. Mehtab-un-Nisa 1, AtifMahmood 2, Moeed Ahmad Sandhu 3, Sara Kanwal 4, Mr. JavedIqbal (corresponding author) 5,(2016) "The Effect of Green HRM practices on sustainability: Evidence from Manufacturing companies in Pakistan" *Pakistan Journal of Social Sciences (PJSS)*, Volume 36, No.1, PP 177-188.
17. Brockett, J. (2007) 'Prepare now for big rise in 'green' jobs', *People Management*, 17th May, p.9.
18. Pollack, S. (1996) 'Learning to Change: Implementing Corporate Environmental Policy in the Rover Group', in Wehrmeyer, W. (ed) (1996), op cit., pp.317-337

Table 1: Type of Staff

| Staff | No. of Respondents | Percentage (%) |
|--------------|--------------------|----------------|
| Teaching | 48 | 88.9 |
| Non-Teaching | 06 | 11.1 |
| TOTAL | 54 | 100 |

Source: Survey





Deepika and Kavya

Table 2: Type of Employment

| Type of Employment | No. of Respondents | Percentage (%) |
|--------------------|--------------------|----------------|
| Permanent | 26 | 48.1 |
| Temporary | 26 | 48.1 |
| Part-Time | 2 | 3.7 |
| TOTAL | 54 | 100% |

Sources: Survey

Table 3: Details of Awareness about Green HRM practices and its Sustainability in institute

| Awareness of HRM practices | No. of Respondents | Percentage (%) |
|----------------------------|--------------------|----------------|
| YES | 44 | 81.5 |
| NO | 8 | 14.8 |
| We don't follow | 2 | 3.7 |
| TOTAL | 54 | 100 |

Source: Survey

Table 4: Green HRM practices followed at institute

| Green HRM Practice | No. of Respondents |
|---|--------------------|
| Providing saplings to Dignitaries during special occasion | 22 |
| When writing, printing, or making a photocopy institution use both sides of the paper. | 22 |
| Lighting, fans, computers, and other devices are switched off in campus when not in use. | 23 |
| Idea of paperless office is encouraged for storing records, issuing receipts etc. | 9 |
| Encouraging Bicycle and electricity vehicles in campus. | 7 |
| Encouraging students and staffs to follow waste serration. | 9 |
| Campus uses natural lighting and Ventilation. | 13 |
| Institution uses IT resources/ Tools for sharing Study material, circulars, notification etc. | 12 |
| Planting, growing and maintaining plants and trees in and around campus. | 22 |
| When you identify environmental hazards, such as damage, potential harm, etc., is institution reporting it to the appropriate team. | 8 |
| Rain Water harvesting | 14 |
| Waste water recycling plant | 8 |
| Plastic Free Campus | 13 |

Sources: Survey

Table 5. Details of Green Recruitment and Selection practices followed in institute

| Details | No. of Respondents | Percentage (%) |
|--|--------------------|----------------|
| Online posting of jobs and submission of applications. | 17 | 31.5 |
| Job advertisement reflecting environmental values and criteria | 12 | 22.2 |
| Interview through Telephone and Tele-conference | 11 | 20.3 |





Deepika and Kavya

| | | |
|---|-----------|------------|
| Job description reflects sustainability agenda | 4 | 7.4 |
| Candidates with environmental awareness are given priority. | 8 | 14.8 |
| Others | 2 | 3.7 |
| Total | 54 | 100 |

Sources: Survey

Table 6. Details of Green Training and Development followed at institutes:

| Details | No. of Respondents | Percentage (%) |
|---|--------------------|----------------|
| Providing induction on environmental practices and sustainability | 15 | 27.7 |
| Fresher's are made aware of institution green objectives. | 10 | 18.5 |
| Green training programs are conducted on regular intervals | 6 | 11.1 |
| Providing training on saving and conserving energy in the campus | 12 | 22.2 |
| Providing training material online | 10 | 18.5 |
| Others | 1 | 1.8 |
| Total | 54 | 100 |

Sources: Survey

Table 7. Details of Green Exit practices followed at institute

| Details | No. of Respondents | Percentage (%) |
|--|--------------------|----------------|
| Accepting Resignation of employees through email or online portal | 19 | 35.1 |
| Awarding certificates to employees who took a lead role in the institutional green initiatives during your tenure. | 16 | 29.6 |
| Discuss and appreciate green initiatives take during your tenure | 16 | 29.6 |
| Criticizing for not achieving individual green targets. | 1 | 1.9 |
| others | 2 | 3.7 |
| Total | 54 | 100 |

Sources: Survey

Table 8. Details of Top Management support towards Green HRM practices at the institute:

| Particulars | No. of Respondents | Percentage (%) |
|-------------------|--------------------|----------------|
| Strongly disagree | 6 | 11.1 |
| Disagree | 0 | 0 |
| Neutral | 10 | 18.5 |
| Agree | 28 | 51.9 |
| Strongly Agree | 10 | 18.5 |
| TOTAL | 54 | 100 |

Sources: Survey





Deepika and Kavya

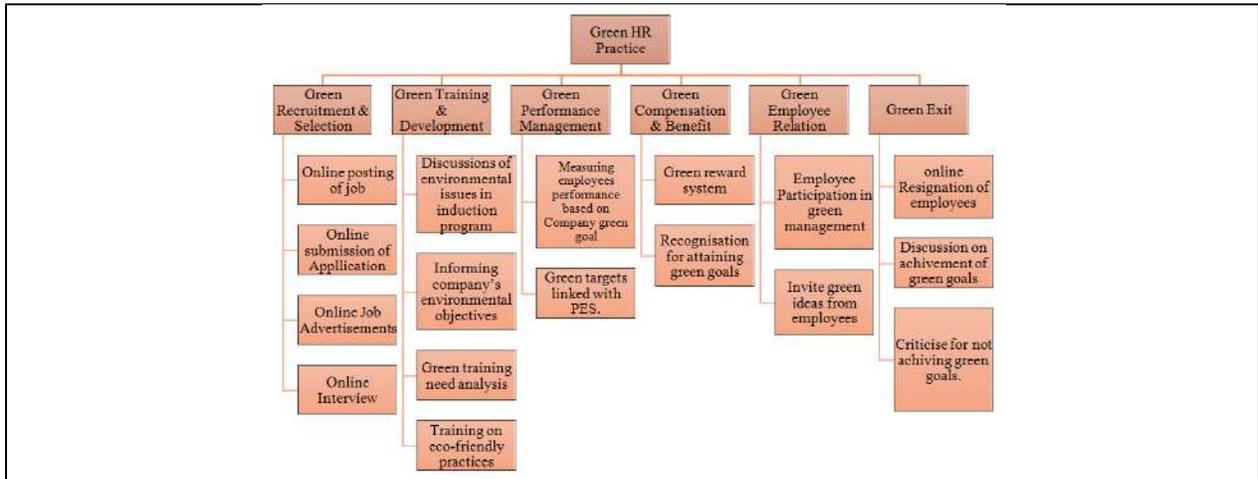


Fig. 1. Green HR Practices



Chart No.1: Green HRM practices followed at institute

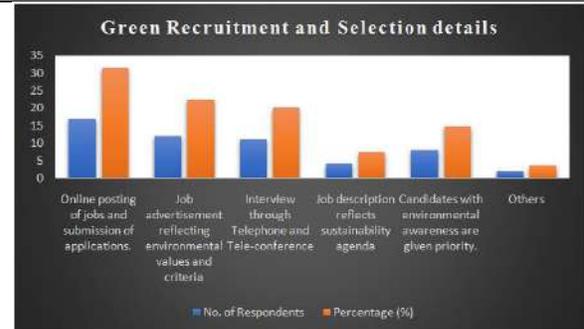


Chart No.2: Green Recruitment and Selection practices followed in institutes



Chart No. 3: Details of Green Training and Development followed at institutes



Chart No. 4: Details of Green Exit practices followed at institute





Talent Development Strategies Adopted by Higher Educational Institutions - Bangalore

Aravinda H. G^{1*} and Balu. L²

¹Assistant Professor at Nagarjuna Degree College, Department: Commerce and Management, Yelahanka Bangalore and Research Scholar at Presidency University, Rajanakunte, Bangalore, Karnataka, India.

²HOD and Assistant Dean, Presidency University, Department: Commerce Presidency University, Bangalore, Karnataka, India.

Received: 03 June 2022

Revised: 23 June 2022

Accepted: 23 July 2022

*Address for Correspondence

Aravinda H. G

Assistant Professor at Nagarjuna Degree College,
Department: Commerce and Management,
Yelahanka Bangalore and
Research Scholar at Presidency University,
Rajanakunte, Bangalore, Karnataka, India.
Email: aravindahg@yahoo.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

This paper explores the existence and implementation of talent development strategies and practices prevailing in private Higher Educational Institutions with particular focus on the talent management strategies and organizational strategy along with the metrics and scales used to measure the academic performance. Majority of business leaders, practitioners and academicians attach numerous values to talent and talent development but there is a little gap about how and how well Talent Development really works in practice, especially in a higher educational system. In addition, current assumptions, viewpoints and actions appear to be based on a narrow and biased Talent Development Shift. The primary focus of the present study is to explore the importance for talent management system in Indian higher educational system. The paper considers major key issues and challenges related to quality of Teaching Fraternity and Non-Teaching Staff which explores the ways in which a talent development system can be used as a strategy to attract and retain highly talented faculty fraternity for the benefit of both Academic and Institutional growth from the view point of overall educational development.

Keywords: Talent Development, Talent Management, Knowledge Management, Educational Sector, Organizational Strategy, Talent Management Practices, Technology Factors, Academic Performance Metrics



**Aravinda and Balu****INTRODUCTION**

As an Educational Institution, it is highly important to think about the way you invest in your employees. From recruitment to development, creating the right processes to develop your employees is crucial for your company's growth and success. One of the most effective ways to achieve this is to design a talent management strategy tailored to your organization's goals. Talent management involves a continuous process of attracting top-notch employees, increasing their knowledge and skills through training, inspiring them to improve their performance, and overall, promoting a positive work environment. When handled strategically, these processes can make your employees feel empowered, helping the company achieve its visions and goals. In this research paper, we will explore some of the best talent management strategies that can help you recruit the best talents, retain your employees, and facilitate their continuous training and development. A talent management strategy is an adaptable system of nurturing the human assets of the company through innovative recruitment and performance management initiatives. It allows you to implement methods that improve your standard talent management process to take advantage of your human capital in driving growth and success for the higher educational institutions. With employee talent as your academician's performance, having a talent management strategy helps you attract and retain employees, especially the top-performing ones. At the same time, it enables you to meet the needs and expectations of employees so they feel satisfied and have a sense of growth. Your talent management strategy can start right from the talent hunt. Through effective recruitment strategies, you'll be able to reach applicants and recognize the most qualified candidates in an efficient process. From there, you can continue to apply relevant strategies to the skills development of your employees to ensure that they are always on top of their game. This way, your employees don't feel stagnant with their careers and are constantly honing their capabilities and strengths. Without a proper talent management strategy, your institution won't be able to make the most of the talents of your employees. Worse, it can result in unsatisfactory work experience among employees and a high turnover rate that can disrupt business operations.

OBJECTIVES OF THE STUDY**The main objectives of the study are**

1. To create knowledge base of captured tacit and explicit knowledge of staff and students/ Institute
2. To study the application of ICT and web technology for creating knowledge base
3. To share resources or knowledge of an Institute
4. To preserve knowledge of an Institute
5. To study the current situation and/or problems of knowledge management practices and strategies used in the selected NAAC "A" Grade academic institutes in Bangalore

Introducing a Talent Development Strategy at Higher Educational Institutions

The reasons for introducing talent development strategies at higher educational institutions covers the major aspects including things like employees demanding higher total compensation for their work, due to mounting pressure caused by the tightening of the talent market. When you throw high turnover and lack of leadership into the mix, you have a very volatile beast on your hands. Facing these obstacles, complexities and possible outcomes, talent development planning is still ignored frequently – In an academic world that's moving too fast to stay in the present moment there is a constant struggle between looking at the here and now and planning for the future. Time is always under the microscope: most of the time there just isn't enough time to invest in developing the talent of your team members or employees.

How can you adopt and Improve Talent Development Strategies at Higher Educational Institutions-Bangalore?

In order to improve talent development strategies and program for your higher educational institutions requires planning and cooperation between your human resource and learning teams. However, wherever things sit currently, it is possible to make some major improvements over time by following some simple talent development strategies and best practices. Learn and practice how and where you can start with:



**Aravinda and Balu****Understand your Educational Institutions objectives**

Based on the Higher Educational Institution objectives, you need to build your improved talent development plan to align with these goals and your business strategy for the near future. Start from where you are now and build from there. This will help you make sure that you're investing in the right initiatives. Let's say your Institution is planning to work more with machine learning. That means that developing your employees' skills in that area will be crucial for the future success of your Institution.

Identify opportunities for up skilling and reskilling

Take an inventory What's being utilized, and what's just waiting to be applied? Understanding where underutilized expertise and knowledge are can be an excellent way to develop the necessary skills and capabilities for the organization. Take into consideration that new job types will require new or adaptable skills. Which employees already have the basic skills that you can focus on developing? These are great candidates for participating in up skilling in iterative. Also, if there are jobs that are at risk of becoming obsolete while other roles are emerging, consider how you can re-skill your existing employees to take on the new positions.

Provide many learning options and methods

By using a tailored approach to learning and development, you can build a program that meets the needs of all employees. Talent development isn't just about formal training. It can also include on-the-job learning, mentorship programs, coaching, e-learning, self-learning, and more. Involve managers in the process and create directories of learning resources. These should be readily available to your employees.

Create a culture that embraces continuous learning

Encourage active learning and focus on developing adaptability. Inspire employees keep out time to learn every day. Make continuous learning a cultural core value and find ways to instill this mindset into your workforce. **Example** of this is Visa by establishing a learning team, corporate university, and an ongoing effort to provide education industry leading customized curriculum for its employees.

Promote performance coaching

As a form of on-the-job learning, performance coaching stimulates employees to improve their skills through everyday interactions. It plays a crucial role in talent development.

For example: Top level Management of educational institutions can use a Matrix to determine the right coaching strategies for individual employees. Learning should always be linked to performance, which, in turn, should be defined in measurable parameters.

Include leadership development

Start identifying these people now and prepare leadership for them. This will help your institution to build a solid leadership talent pipeline that will be ready for whatever happens in the future. In addition, focus on helping managers develop better behaviors to improve their relationships with subordinates

Include all stakeholders in the effort

Now this is the time to focus on communication between all the people who can build this employee development and training program. This includes human resources, talent managers, team managers, and the employees themselves. Create a committee to regularly discuss gaps, monitor progress, and cheerlead the talent development strategy.

Evaluate and improve, often

For talent development programs to succeed, there needs to be a way to track data and measure it against performance goals and objectives. Majority of learning management systems offer reporting that can help achieve



**Aravinda and Balu**

this. However, also look at the feedback received from employees on the quality of the learning and make improvements in response.

Talent Development in the Workplace Strategies

- Identify organizational goals
- Build company-wide partnerships
- Nurture a growth mindset
- Invest in up skilling and reskilling efforts
- Evaluate and adjust accordingly Examples
- Individualized growth plans
- Formal internal programs
- Partnerships with external providers
- Mentorship opportunities

Talent Management Strategies Adopted by Higher Educational Institutions of Bangalore**Use Employee Training and Development Tools and Activities**

No matter what field of work you're in, one of the first steps to consider when managing your employees is to provide them with professional development opportunities through good training programs. But instead of implementing monotonous seminars, initiatives, and activities or providing them with hard-to-read modules, you can make use of employee training tools like micro learning platforms, video training software, learning management systems (LMS), and the like to create and deploy interactive learning content.

Standardize Strategy for Talent Review and On boarding Processes

Employees are the backbone of your business. This is why hiring good talent is one of the most important things you can do to help your company succeed. But without standardized talent review and on boarding processes in place, it can be extremely difficult to keep track of all your recruitment activities.

Track and Measure Performance

As a manager, it's important to set goals and key performance indicators (KPIs) for your team. These metrics enable you to track past and current performances, rectify problems, and adjust standards to hit goals. Tracking KPIs also helps you get insights into possible knowledge gaps, pinpoint current weaknesses, and address these challenges.

Give Feedback Examples and Reviews

For a lot of educational institutions, performance reviews are generally utilized as a basis for employee promotions, salary compensations, and even job termination. These review processes usually happen once to four times a year, allowing you to determine KPIs for each employee, set expectations, and provide them with constructive feedback examples based on their past performance.

Recognize and Reward Top Performers with Initiatives

Although often over looked ,employee recognition can greatly impact an organization. According to a study by Gallup ,lack of recognition and appreciations one of the most common reasons why an employee leaves a company. The best way to mitigate this risk is to keep your employees happy and motivated at work. You can achieve this by recognizing their achievements, providing regular feedback, and giving them the appropriate rewards for their work.

Increase Employee Motivation

It's completely normal for employees to experience low levels of motivation from time to time, but if they start losing interest in their work, that's when it becomes a big problem. In any organization, keeping employee motivation high requires continuous effort.



**Aravinda and Balu****Provide Career Development Paths**

Employees feel more engaged with their work when they believe that their employer is interested in their growth and development. Without skill development and growth opportunities, they are more likely to leave the organization. But by providing them with a clear career path, you give them a chance to enhance their skills and knowledge and eventually master their jobs. It then opens the opportunity for promotions to higher roles within your company as an example. The implementation of career growth strategies also provides positive results for your company, resulting in improved employee satisfaction, increased productivity, higher employee retention rates, and better performance.

Establish your Organization's Goals and Objectives

HR managers must focus not only on hiring and retaining skilled workers but also on aligning their career growth with the organization's overall goals and objectives. Establishing key objectives through proper communication skills and teamwork helps your team members focus on the company's main goals.

Promote Mentoring and Interventions

Mentoring and interventions are powerful strategies used by many organizations to improve their employees' performance. Unlike online courses or seminars, mentoring and interventions involve direct interaction between two individuals wherein the mentor helps the mentee improve their skills through communication, hands-on teaching, and collaboration. Among its many benefits include reinforcing accomplishments, improving decision-making and time-management skills, enhancing communication and people skills, and building confidence. And the best thing about mentoring and interventions is that it can be achieved even across distances, between different cultures, throughout generations, and with all skill levels.

Focus on Culture Compatibility

Educational Institutions culture involves the behaviors, rituals, symbols, and values of the institution and its employees. It is often manifested through company decisions and employees' interactions with one another.

CONCLUSION

Most of the higher educational institutions recognize the importance of implementing talent management strategies and practices, in order to improve their performance and to create a sustainable competitive advantage that will permit them to stand out in the market. Talent management practices mainly focus on talent attraction, talent retention, learning and development, and career management. As a result, talent management strive to develop and retain high potential employees, and thus provide organizations with managerial talent source and competitive human resource advantage which impact organization performance. corporate assets to create products an organization has, the better it will perform.

REFERENCES

1. Anderson, M.C. (2008) 'Taking coaching to the next level: critical insights from ROI evaluations', in Drake, D.B., Brennan, D. and Gørtz, K. (Eds): The Philosophy and Practice of Coaching: Insights and Issues for a New Era, Jossey-Bass, San Francisco, CA, pp.317–332.
2. Ashton, C. and Morton, L. (2005) 'Managing talent for competitive advantage', Strategic HR Review, Vol. 4, No. 5, pp.28–31.
3. ASTD (American Society for Training and Development) and SHRM (Society for Human Resource Management). (1999) Recruiting and Retaining Employees: Using Training and Education in the War for Talent, ASTD, Alexandria, VA





Aravinda and Balu

4. Alhammad, F, Faori, S. & Abu Husan, L. (2009). Knowledge sharing in the Jordanian Universities, Journal of Knowledge Management Practice, Vol.10, No. 3.
5. Alhawary, F. A. & et al, (2011). Building a Knowledge Repository: Linking Jordanian Universities Elibrary in an integrated database system, International Journal of Business and Management, 6(4), 129-135.
6. Aswath, L. & Gupta, S. (2009). Knowledge management tools and academic library services, ICAL 2009-Vision and roles of the future academic libraries.
7. Paauwe, J. HRM and Performance. In Search of Balance; Tilburg University: Tilburg, The Netherlands, 2007.



Fig1: What is a talent management strategy?





Study of Physico-Chemical Panorama of Three Lakes at Coimbatore City, Tamilnadu, India

P. R. Soumya^{1*}, S. Brindha¹ and K.S. Tamil Selvi²

¹Research Scholar, Department of Botany, PSGR Krishnammal College for Women, Peelamedu, Coimbatore, Tamil Nadu - 641004, India.

²Assistant Professor, Department of Botany, PSGR Krishnammal College for Women, Peelamedu, Coimbatore, Tamil Nadu - 641004, India.

Received: 22 Apr 2022

Revised: 28 May 2022

Accepted: 07 July 2022

*Address for Correspondence

P. R. Soumya

Research Scholar,
Department of Botany,
PSGR Krishnammal College for Women,
Peelamedu, Coimbatore,
Tamil Nadu - 641004, India.
Email: soumyakrishnan72@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Water is one of the most essential compounds for all the living organisms. Due to industrialization, urbanization and all kinds of human activities, water is contaminating qualitatively and quantitatively in all over the world. Regular Monitoring of water quality allows protecting water ecosystem. Therefore; present research work was aimed to analysis of water quality in Singanallur, Sular and Ukkadam lake, Coimbatore. Water samples were collected at quarterly intervals from January 2018 to December 2018 and analyzed for various Physico-chemical parameters like; pH, temperature, Electric Conductivity, Biological Oxygen Demand, Chemical Oxygen Demand, Total Dissolved Solids, Total Suspended Solids, alkalinity, chlorides and hardness. The results revealed that all the parameters were exceeded the permissible limit of WHO for drinking water.

Keywords: Water quality, Physico-chemical parameters, pH, Temperature, Electric conductivity, Hardness, Chlorides

INTRODUCTION

Water is one of the fundamental compound for all the living organisms. Nowadays, management and monitoring of natural bodies are crucial for sustainable development. Lakes are one of the vital natural resource for fresh water, recharging of ground water, habitat for wide variety of fauna and flora and provides various services to the society. Therefore; "conservation of "Lake Ecosystem" is most essential for growth and development of human population.

45416





Soumya *et al.*,

As a results of various kinds of pollution, it is a universal receivers of waste water and urban runoff. Discharge of agriculture and hospital effluents, industrialization and liberation of various kinds of nutrients cause degradation of water quality.

Due to urbanization, dumping of wastes and deforestation causing rapid deterioration of Lake ecosystem, specifically situated in the vicinity of cities. Coimbatore is one of the largest and fastest growing city in Tamilnadu, consists of 28 wetlands and most of the wetlands are fed by Noyyal river. "Ukkadamlake" was considered as largest water spread area and covered 337.00 acres lake bed area. Average depth and water volume of the lake were 5.82m (19.1 ft) and 1,982,179.262m³ 0.000475550095cu mi respectively. Ukkadm lake receives water from Selvachinthamani lake and outflow connecting with valankulam lake. "Singanallur lake" was considered as 9th largest lake and it is fed by Sanganur and Udayampalayam canal. Current lake bed area of the lake was reported 269.27 acres. Average depth and water volume of lake were 4.25 m (13.9 ft) and 52,270,000 m³ (0.01254 cu mi) respectively. Average depth and surface area of "Sulur lake" were 8.50 ft and 0.332km² respectively (Babu and Balasundaram, 2016, Priyatharasini and Dhanalakshmi, 2016; Crispin and Sivakumar, 2020).

MATERIALS AND METHODS

Collection of water samples

Surface water samples were collected from Singanallur, Sulur and Ukkadam lake during four different seasons such as, winter, pre monsoon, monsoon and post monsoon during the period from January to December, 2018 at three different sampling sites (Figure 1). Samples were collected in pre-cleaned and sterile bottles and stored in a cold room at 4°C.

Physico-chemical Analysis of water samples

Various physico-chemical characteristics such as pH, temperature, Electric Conductivity (EC), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), alkalinity, chlorides and hardness were analysed.

Temperature was measured using glass thermometer. pH was analyzed using digital pH meter (IS: 3025 (Part 11) (RA-2002). Electric conductivity was determined by using conductivity meter (IS: 3025 (Part 14) (RA-2002). BOD was measured "Winkler's titrimetric method". Water samples were incubated at 20°C for 5days (IS: 3025 (Part 44) (RA-2003). COD was analyzed using spectroquant Multy (IS: 3025 (Part 58) (RA-2006). TDS and TSS were analyzed by the method of "filtration and evaporation" (IS: 3025 (Part16 & part17). Alkalinity was measured by titrimetric method using standard sulphuric acid solution (IS: 3025(Part 23) (RA-2003)". Chlorides was determined by using "titrimetric Method" using silver nitrate solution (IS: 3025 (Part 32) [RA-2003] and hardness was determined by using EDTA "titrimetric method (IS: 3025 (part 21) [RA- 2002].

RESULTS AND DISCUSSION

The physico chemical parameters of Singanallur, Sulur and Ukkadam lakes during four different seasons varied based on their surrounding environment and pollution status. Temperature in water samples ranged from 26.33±0.33 °C to 30.57±1.32 °C. Maximum temperature (30.57±1.32 °C) recorded in Singanallur lake during post monsoon and Minimum temperature (26.33±0.33 °C) recorded in Singanallur lake during monsoon (Table 1). Similar result reported by Manikandan *et al* (2016). Temperature in water samples in Singanallur lake, Sulur lake and Ukkadam lake varied from 26.33±0.33 °C - 30.57±1.32 °C, 27.20±0.15 °C to 28.83±0.17 °C and 26.67±0.33 °C - 28.67±0.33 °C respectively. The pH values were observed to be in the range of 6.69±0.16 to 8.19±0.05, 6.86±0.31 to 8.15±0.03 and 6.62±0.01 to 8.67±0.04 in Singanallur lake, Sulur lake and Ukkadam lake respectively Table 1). Variation of pH is due to the leaching of mineral elements as well as different kinds of human activities (Skoulidikidis *et al.*, 1998). Among the three lakes,



**Soumya et al.,**

maximum value (8.67 ± 0.04) of pH recorded in Ukkadam lake during pre monsoon, which exceeded the permissible limit of WHO for drinking water. Same result reported by Mohanraj *et al* (2000), Chandra *et al* (2010) and Manikandan *et al* (2016). Higher ranges of pH in aquatic ecosystem enhances the photosynthetic activity during premonsoon and summer seasons (Sunkand and Patil, 2004). Electric Conductivity of water samples ranged from 0.937 ± 0.02 mS/cm to 2.237 ± 0.02 mS/cm. The highest value (2.237 ± 0.02 mS/cm) of EC recorded in Ukkadam lake during pre monsoon, whereas, lowest value (0.937 ± 0.02 mS/cm) recorded in Sular lake during post monsoon Table 1). Previously EC in Singanallur lake and Ukkadam lakes were reported to be $973 \mu\text{mhos}$ and $1793 \mu\text{mhos}$ respectively (Mohanraj *et al.*, 2000). Karthika and Krishnaveni, (2014) reported the values of electric conductivity in Singanallur lake and Sular lake were $1557.290 \pm 362.0 \mu\text{s/cm}$ and $1132.680 \pm 121.97 \mu\text{s/cm}$ respectively.

BOD and COD values ranged from 15.3 ± 0.06 mg/L to 157 ± 0.55 mg/L and 29.33 ± 7.80 mg/L to 367.67 ± 45.56 mg/L respectively. Maximum value (157 ± 0.55 mg/L) of BOD noted in Sular lake during winter season and minimum value (15.3 ± 0.06 mg/L) observed in Singanallure lake during premonsoon. BOD values varied from 15.3 ± 0.06 mg/L to 153 ± 0.58 mg/L, 36.4 ± 0.09 mg/L to 157 ± 0.55 mg/L and 18.0 ± 0.58 to 49.7 ± 0.37 mg/L in Singanallur lake, Sular lake and Ukkadam lake respectively (Table 1). Recorded BOD values exceeded the permissible limit of WHO for drinking water. Highest value of BOD has been reported by Babu and Balasundaram *et al* (2016) and Manikandan *et al* (2016). The maximum values (367.67 ± 45.56 mg/L) of COD observed in Singanallur lake during winter season and minimum value (29.33 ± 7.80 mg/L) observed in Singanallur lake during premonsoon. COD values in Singanallur lake, Sular lake and Ukkadam lake varied from 29.33 ± 7.80 mg/L to 367.67 ± 45.56 mg/L, 121.67 ± 37.91 mg/L to 201.33 ± 137.09 mg/L and 83.00 ± 36.01 mg/L to 259.33 ± 164.91 mg/L respectively (Table 1). Highest value of COD has been reported by Mohanraj *et al* (2000) and Chandra *et al* (2016). Releasing of higher concentration of organic and inorganic wastes in to the lakes are associated with higher values of COD and BOD (Manikandan *et al.*, 2016).

TDS and TSS values ranged from 666.67 ± 133.34 mg/L to 9133.33 ± 240.38 mg/L and 400.00 ± 0.00 mg/L to 1600.00 ± 400.01 mg/L respectively. Highest value (9133.33 ± 240.38 mg/L) of TDS noticed in Singanallur lake during pre monsoon and lowest value (666.67 ± 133.34 mg/L) of TDS noticed during post monsoon Sular (Table 2). The TDS values in Singanallur lake, Sular lake and Ukkadam lake varied from 1200.00 ± 230.95 mg/L to 9133.33 ± 240.38 mg/L, 666.67 ± 133.34 mg/L to 7866.67 ± 133.34 mg/L and 1200.00 ± 611.03 mg/L to 5866.67 ± 266.67 mg/L respectively, which exceeded the permissible limit of WHO for drinking water. TDS value exceeded the previous results reported by Mohanraj *et al* (2000).

The Total alkalinity and total hardness ranged from 386.00 ± 16.50 mg/L to 587.00 ± 55.65 mg/L and 221.67 ± 10.14 mg/L to 461.67 ± 20.88 mg/L respectively. However, highest value (587.00 ± 55.65 mg/L) of total alkalinity noticed in Singanallur lake during premonsoon season, whereas lowest value (386.00 ± 16.50 mg/L) noticed in Ukkadam lake during post monsoon. The values Total alkalinity in Singanallur, Sular and Ukkadam lake varied from 437.00 ± 6.03 mg/L to 587.00 ± 55.65 mg/L, 394.67 ± 11.20 mg/L to 518.33 ± 71.10 mg/L and 386.00 ± 16.50 mg/L to 540.67 ± 11.89 mg/L respectively (Table 2). The result of Total alkalinity of water samples exceeded the permissible limit of WHO for drinking water. Higher level of Total alkalinity in water is due to augmentation of domestic wastes in wetland system. Previous result reported by Chandra *et al* (2010) and Mohanraj *et al* (2000) who have recorded higher level of total alkalinity in wetlands. The maximum value (461.67 ± 20.88 mg/L) of total hardness was found in Singanallur lake during post monsoon. Sewage and hospital wastes are common factors for increasing of total hardness in lake water (Virha *et al.*, 2011). Similar results were documented by Manikandan *et al* (2016) and Mohanraj *et al* (2000).

Chlorides of lake water samples varies from 226.60 ± 3.33 mg/L to 434.87 ± 7.64 mg/L. Maximum value (434.87 ± 7.64 mg/L) of chloride showed in Ukkadam lake during Premonsoon season and minimum value (226.60 ± 3.33 mg/L) showed in Sular lake during monsoon. The chloride values in Singanallur, Sular and Ukkadam lake varied from 283.25 ± 11.66 mg/L to 363.22 ± 15.90 mg/L, 226.60 ± 3.33 mg/L to 356.56 ± 4.41 mg/L and 321.57 ± 19.64 mg/L to 434.87 ± 7.64 mg/L respectively (Table 2). Chloride content of water samples exceeded the permissible limit of WHO for drinking





Soumya *et al.*,

water. The previous results reported by Chandra *et al* (2010) and Karthika and krishnaveni, (2014) supports our work.

CONCLUSION

The present research work affirmed that, all the physicochemical parameters exceeded the permissible limit of WHO for drinking water. This may due to the discharging of organic and inorganic waste, textile effluents are directly in to the lakes. Therefore, implementation of great waste management system is necessary for protection of ecosystem. As well as, analysis and monitoring of water quality at particular intervals are mandatory for conservation of wetlands in Coimbatore.

ACKNOWLEDGMENT

We would like to thank DBT for financial support.

REFERENCES

1. Babu A and Balasundaram N. Environmental impact of Singanallur lake Coimbatore. International journal of engineering science and research technology 2016; 5: 272-283.
2. Priyatharasini P and Dhanalakshmi B. Piscine diversity of Coimbatore wetlands, Tamilnadu ,India International Journal of Fisheries and Aquatic Studies 2016; 4: 280-285.
3. Crispin AC and Sivakumar R. Urbanization and Industrialization Impact on Surface Water in Coimbatore-Sulur Sub watershed. International Journal of Recent Technology and Engineer in. 2020; 8: 2277-3878.
4. IS:3025(Part 11)-[RA 2002].
5. IS:3025(Part 14)-[RA 2002].
6. IS:3025(Part 44)-[RA 2003].
7. IS:3025(Part 58)-[RA 2002].
8. IS:3025(Part 16 & Part 17)
9. IS:3025(Part 23)-[RA 2003].
10. IS:3025(Part 32)-[RA 2003].
11. IS:3025(Part 21)-[RA 2002].
12. Skoulikidis NT, Bertahas I, Koussouris I. The environmental state of freshwater resources in Greece (rivers and lakes). Environmental Geology 1998; 36: 1-2.
13. Mohanraj R, Sathiskumar M, Azeez P, Sivakumar R. Pollution status of wetlands in Urban Coimbatore, Tamilnadu, India. Bull Environ. Contam. Toxicol 2000; 64: 638- 643.
14. Chandra A, Nishadha KA, Azeez PA. Monitoring water quality of Coimbatore wetlands, Tamilnadu, India. Environ Monit Assess. 2010; 169: 671-676.
15. Manikandan R, Ezhili N, Muthulakshmiandal N, Favas PJC, Venkatachalam P. Assessment of physic chemical characteristics and level of nutrient contents as well as heavy metal ions in waters of three lakes at Coimbatore, Tamilnadu, India. J. Mater. Environ. Sci 2016; 7: 2259-2266.
16. Sunkad BN and Patil HS. Water quality assessment of Fort lake of Belgaum (Karnataka) with special reference to zooplankton. Journal of environmental Biology. 2004; 25: 99-102.
17. Karthika P and Krishnaveni N. Impact Assessment of Dragonfly diversity in Different wetland ecosystems in Coimbatore with special reference to abiotic factors. International Journal of Advanced Research 2014; 2: 639-648.
18. Virha R, Biwa AK, Kakaria VK, Qureshi, TA Borana K, Malik N. Bull. Environ. Contam. Toxicol. 2011; 86: 168-174.





Soumya et al.,

Table1: physico-chemical analysis of water samples

| S. No | Study areas | Season | Temp (°C) | pH | EC mS/cm | BOD (mg/L) | COD (mg/L) |
|-------|-------------|--------|------------|-----------|------------|------------|---------------|
| 1. | SN | SI | 27.60±0.21 | 7.13±0.05 | 1.433±0.02 | 153±0.58 | 367.67±45.56 |
| 2. | SR | | 27.20±0.15 | 7.03±0.11 | 1.177±0.03 | 157±0.55 | 187.67±132.60 |
| 3. | UK | | 26.67±0.33 | 7.08±0.09 | 1.163±0.01 | 49±0.09 | 120.67±48.27 |
| 4. | SN | S2 | 27.33±0.33 | 8.19±0.05 | 2.070±0.02 | 15.3±0.06 | 29.33±7.80 |
| 5. | SR | | 27.33±0.33 | 8.02±0.03 | 1.707±0.02 | 36.4±0.09 | 121.67±37.91 |
| 6. | UK | | 27.67±0.67 | 8.67±0.04 | 2.237±0.02 | 23.6±0.06 | 186.97±151.47 |
| 7. | SN | S3 | 26.33±0.33 | 7.76±0.24 | 2.100±0.01 | 62.3±0.21 | 229.33±69.60 |
| 8. | SR | | 28.57±0.26 | 8.15±0.03 | 1.597±0.04 | 65.4±0.10 | 201.33±137.09 |
| 9. | UK | | 28.67±0.33 | 8.29±0.01 | 2.077±0.00 | 49.7±0.37 | 83.00±36.01 |
| 10. | SN | S4 | 30.57±1.32 | 6.69±0.16 | 1.213±0.03 | 25.0±0.58 | 201.33±137.09 |
| 11. | SR | | 28.83±0.17 | 6.86±0.31 | 0.937±0.02 | 48.5±0.09 | 201.33±137.09 |
| 12. | UK | | 28.50±0.29 | 6.62±0.01 | 1.060±0.01 | 18.0±0.58 | 259.33±164.91 |

Datas are mean n=3

SN - Singanallur Lake , SU Sular lake , UK – Ukkadam lake, SI-Winter , S2- Premonsoon, S3- Monsoon, S4-Post monsoon

Table 2: physico-chemical analysis of water samples

| S. No | Study areas | Season | TDS (mg/L) | TSS (mg/L) | Alkalinity (mg/L) | Chlorides (mg/L) | Hardness (mg/L) |
|-------|-------------|--------|--------------------|--------------------|-------------------|------------------|------------------|
| 1. | SN | S1 | 1200.00± 230.95 | 1600.00± 400.01 | 437.00± 6.03 | 363.22± 15.90 | 420.00± 0.00 |
| 2. | SR | | 1200.00± 230.95 | 533.33± 133.34 | 418.67± 20.51 | 356.56± 4.41 | 408.33± 4.41 |
| 3. | UK | | 1866.67± 352.78 | 800.00± 230.95 | 399.00± 9.54 | 381.55± 12.01 | 331.67± 12.02 |
| 4. | SN | S2 | 9133.33± 240.38 | 1600.00± 0.00 | 587.00± 55.65 | 304.90± 9.99 | 425.00± 10.41 |
| 5. | SR | | 7866.67± 133.34 | 1600.00± 0.00 | 422.67± 4.33 | 294.91± 17.55 | 318.33± 16.92 |
| 6. | UK | | 5866.67± 266.67 | 1600.00± 0.00 | 531.67± 10.93 | 434.87± 7.64 | 221.67± 10.14 |
| 7. | SN | S3 | 1866.67± 352.78 | 1600.00± 400.01 | 576.67± 13.02 | 283.25± 11.66 | 381.67± 12.02 |
| 8. | SR | | 3866.67± 581.20 | 533.33± 133.34 | 518.33± 71.10 | 226.60± 3.33 | 300.00± 13.23 |
| 9. | UK | | 1733.33± 266.67 | 666.67± 133.34 | 540.67± 11.89 | 336.56± 3.33 | 246.67± 17.40 |
| 10. | SN | S4 | 1866.67± 480.75 | 533.33± 133.34 | 449.00± 25.70 | 286.58± 17.40 | 461.67± 20.88 |
| 11. | SR | | 666.67± 133.34 | 533.33± 133.34 | 394.67± 11.20 | 286.57± 23.15 | 351.67± 20.88 |
| 12. | UK | | 1200.00± 611.03 | 400.00± 0.00 | 386.00± 16.50 | 321.57± 19.64 | 273.33± 15.90 |

Datas are mean n=3

SN-Singanallur Lake, SU-Sular lake, UK-Ukkadam lake, SI-Winter, S2- Premonsoon, S3- Monsoon, S4-Post monsoon





Soumya et al.,

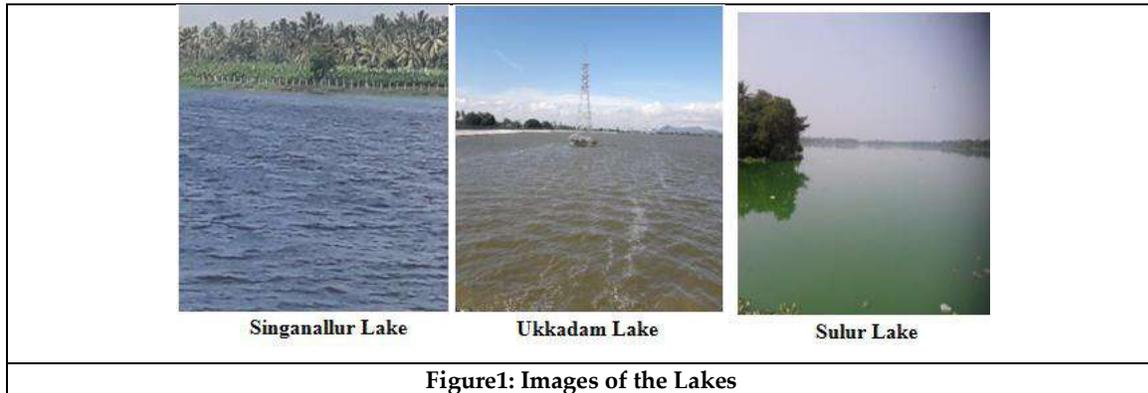


Figure1: Images of the Lakes

